CHEMOSYSTEMATICS OF THE POLYGONACEAE

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INTRODUCTION

The Polygonaceae (the buck wheat family) consists of about 30 genera and 1000 species (Cronquist, 1981), mainly distributed on north temperate region.

Buckwheat (Fagopyrum esculentum), rhubarb (Rheum officinale) and Indian rhubarb (R.emodi) are some of the economically important plants in this family. Buckwheat, the seeds of Fagopyrum esculentum (a pseudocereal), is widely used in USSR, as one of the chief foods of the peasants. This plant received a lot of attention recently as a source of rutin, a flavonoid glycoside, which is used in the treatment of capillary fragility associated with hypertension or high blood pressure. Rhubarb, the rhizome and roots of Rheum officinale and R.palmatum, is used as a tonic, laxative and for indigestion. Indian rhubarb, a substitute, comes from Rheum emodi and allied species. Antigonon leptopous and Muhlenbeckia platiclada are some of the ornamentals from this family.

A majority of the Polygonaceae members are annual or perennial herbs or shrubs, lianous (Antigonon) and trees (Coccoloba) are rare. Leaves are mostly alternate, simple

and entire. Stipules are commonly well developed and connate into a usually scarious or hyaline Sheath (Ocrea) around the stem (absent in Eriogonum). Inflorescence various; commonly in small involucrate fascicles, individually often subtended by a persistent ocreola. Flowers are relatively small, perfect or sometimes unisexual (Triplaris) regular, primitively trimerous. Tepals 2-6, basally connate into a minute to evident floral tube, green herbaceous to often coloured or more or less petaloid. Stamens 2-9, commonly 6 in 2 cycles of 3, originating in front of and in association with carpels. Filaments distinct or basally connate, often of two lengths, those of the inner series often dilated. Anthers tetrasporangiate and dithecal, opening by longitudinal slits. An annular nectary-disk often present around the base of the ovary. Gynoecium (2) 3(4) carpels united to form a compound unilocular ovary with distinct or proximally united styles. Ovules are solitary on a basal or very shortly columnar (free-central) placenta, orthotropous or rarely anatropous, crassinucellar, bitegmic or sometimes more or less unitegmic. Endosperm development nuclear. Fruit is an achene or a small nut, very often trigonous, sometimes closely subtended by the persistent accrescent tepals or enclosed in a fleshy hypanthium. Seeds with a dicotyledonous, straight or often curved excentric or peripheral embryo and a well-developed

starchy, oily, hard (rarely soft) endosperm with solitary starch grains.

TAXONOMY

The Polygonaceae are placed in the series Monochlamydeae by Bentham and Hooker (1865) along with families such as the Amaranthaceae, Chenopodiaceae, Nyctaginaceae and Phytolaccaceae. But in some of the recent systems of classification, this family is placed in a monotypic order Polygonales, along with the Caryophyllales (which contains the Amaranthaceae, Chenopodiaceae, Nyctaginaceae, Phytolaccaceae etc.) and Plumbaginales (Cronquist, 1981; Takhtajan, 1980).

Based on the number of tepals and stamens, the nature of stigma and the presence of ocrea, Bentham and Hooker (1880) classified the family into 6 tribes, the Erigoneae, Koengieae, Eupolygoneae, Rumiceae, Coccoloboeae and Triplarideae. But Dammer (1895) devided the Polygonaceae into three subfamilies viz. the Rumoideae, Polygonoideae and Coccoloboideae on the basis of the nature of the flowers and endosperm. The Rumoideae possess cyclic flowers and non-ruminate endosperm whereas the Polygonoideae have acyclic flowers (except a few Coccoloboideae) and ruminate endosperm. The subfamily Coccoloboideae is characterised by cyclic flowers (except a few) and ruminate

endosperm. The Rumoideae contain two tribes Rumiceae and Erigoneae, the former with ocrea and the latter without ocrea. Based on the habit, the subfamily Polygonoideae is further classified into two tribes the Atraphaxideae and Polygoneae. Members of the Atraphoxideae are shrubs and of the Polygoneae are herbs. The Coccolobeae and Tripleridene are the two tribes distinguished in Coccoloboideae, the former tribe contains bisexual flowers and the latter with unisexual flowers. Thorne (1968) also supported this classification, but he renamed the subfamily Rumoideae as Erigonoideae, while accepting the other two subfamilies as such.

EARLIER CHEMICAL WORK

The known chemical data of various Polygonaceae members include flavonoids, quinones and steroidol saponins (Table 16).

The known flavonols from this family includes catacehin, herbacetin, gossypetin, quercetin, kaempferol, rutin, and quercetagetin. Phenolic acids like protocatechuic, vanillic, caffeic, n-oxybenzoic, ferulic and salicylic also are detected. Juglone (Napthaquinone), hydroxy methyl anthraquinone, physcion, emodin, chrysophanol are the quinones reported in this family.

TABLE - 16 LIST OF THE EARLY CHEMICAL WORK IN THE POLYGONACEAE

	Name of the plants	Organ	Name of the compounds	Reference
1.	[illegible]	[illegible]	TANNINS AND RELATED COMPOUNDS	
1.	Knot weed	Root	Catchins	Varmaite et.al.(1972)
2.	Rhubarb	-	3 tannin related compounds	Nonaka et.al. (1981)
			FLAVONOIDS	
1.	Rheum palmatum		Catacehin 5-O-β-D glucopyranoside	
2.	Rhapiolepis umbellata		Catechin 7-O-β-D glucopyranoside	Nonaka et.al.(1983)
3.	Paeonia tencifolia			
4.	P. delavary			
5.	P. lutea var. ludlowii	Pollen	Herbacetn	Wiermann et.al.(1981)
6.	P. daurica		Gossypetin (pollen pigment)	
7.	P. daurica			
8.	Polygonum persicaria	Seeds	Kaempferol, quercetin	Komuasi et.al.(1974)
9.	Polygonum coriarium	Leaves	Hyperoside (Quercetin 3-O-β-L-galactopyranoside)	Chumbalov et.al.(1970)
10.	Polygonum persicaria	-	Quercetin, isoquercetin and Hyperoside	Mukhamed Yarova,(1968)
11.	Polygonum nodosum	-	Quercetin-3- -D glucopyranoside, 2" galate	Furoyanagi et.al.(1982)

12.	Polygonum multifolium	-	2"-and 3'-O-monogalloyl ester of 2,3,5,4-tetrahydroxy stilbene -O-β-D-glucopyranoside	Nonaka et.al.(1982)
13.	Fagopyrum emarginatum	-	Rutin	Grinevich et.al. (1970)
14.	Rumex acflosa		Quercetagetin	Wiermann et.al. (1981)
15.	R. actosella	Pollen grains		
16.	Rheum rhaponiticum	Rhizome	3,5,Dihydroxy-4'-methoxy stilbene	Gsuper (1970)
17.	Rhubarb			
18.	Rhaphiolepis umbellata		(+)-Catechin 5-O-β-D glycopyranoside and (-)Catecchin 7-O-β-D-glucopyranosice	Nonaka et al.(1983)

PHENOLIC ACIDS

1.	Polygonum weyrichii			
2.	P. schmidt, P.panjutinii P. Sachalinecon, P.Cuspidatum		Protocatechoic, Vanillic, Caffeic,n-Oxybenzoic, Ferulic, Salicylic	Vyochar, et.al. (1980)

QUINONES

1.	Polygonum cuspidatum	Roots	2-Methoxy-6-acetyl-7-Methyl juglone (Naphtha quinone)	Kimura et.al.(1983)
2.	Polygonum convolvulus	Whole plant	Hydroxy methyl anthraquinone	Petrescu, (1974)
3.	Rheum compactum		Anthraquinone glycoside	De Pasquale,et.al. (1980)

4.	.heum palmatum	Root	Physcion-8-O- -D-gentiobioside	/ Holzschuh et.al.(1982)
5.	.umex acetocella			
6.	R. tritanicus			
7.	R. hydrolapathium			
8.	R. maritimus	-		
9.	R. mexicanus		.nthraquinone and its derivatives	/ Nadd et al.(1974)
10.	R. thyrifolium			
11.	R. patientia			
12.	R. aquatica			
13.	Rumex vesicarius	Root	Emodin and Chrysophanol	/ Nai et. al. (1970)
14.	Rumex rechingerianus	Root	Frangula emodin Chrysophanol Physcion	/ Contar, et.al.(1980)
			TERPENOID	
	Polygonum hydropiper	Lvs	Polygonic acid 4-Drimerine type sesquterpenoid	/ Fukuyama et.al.(1983)

In the present work, 17 plants belonging to the 3 subfamilies of Dammer (1895) have been systematically screened for various chemical markers. The data thus made available as also the data gathered from other disciplines were critically examined for a proper appraisal of the present classification of the family and to discern the evolutionary trends within the family.

MATERIALS AND METHODS

Screening was done with plant materials collected from different states of India. Species of Rumex, and Polygonum were collected from Kashmir (Gulmarg and Pahalgham). Coccoloba, Rivina, Antigonon and Muhlenbeckia were procured from Gujarat (Baroda). Oxygonum was obtained from Kerala (Quilon). All the plant materials were properly dried, preserved and deposited in the Herbarium of Botany Department, M.S. University of Baroda, Baroda, India. (Appendix-1)

Standard procedures were followed in the extraction, isolation and identification of various chemical markers (refer Chapter 2).

RESULTS

The distribution of flavones, flavonols, glycoflavones, proanthocyanidins, phenolic acids, saponins, steroids,

TANNINS AND QUINONES

TABLE - 17. DISTRIBUTION OF FLAVONOIDS IN THE FAMILY POLYGONACEAE*

Sl.No.	Name of the Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	TRIBE - EUPOLYGONEAE															
1.	Oxygonum sinuvatum Burch.			+									+			
2.	Polygonum hydropiper Linn.						+		+							+
3.	P.lapathifolium Linn.															+
4.	P.amphibium Linn.						+				+					*
5.	P.plebeijum Br.prodr.	+						+								
6.	Persicaria glabra (Willd.)				+		+		+							
7.	Polygonum alpinum All.Fl.pedem						+		+		+					+
8.	P.kashmiricum Linn.					+	+		+		+					
9.	P.amplexicaule Don prodr.		+									+				
10.	P.hetrophyllum Linn.				+		+		+	+						
	TRIBE-RUMICEAE															
11.	Rumex hastatus Don prodr.								+		+					
12.	R.acetosella Linn.	+					+								+	

(Contd....)

TABLE -17 (Contd.)

Sl.No.	Name of the Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13.	Rumex nepalensis Spreng.															
14.	R.patientia Linn.															
15.	TRIBE - COCCOLOBAE															
15.	Antigonen leptopus HK & Arn.				+											
16.	Coccoloba grandiflora P.Br.				+											+
17.	Muhlenbeckia platiclada Meissr.				+									+		

1. Luteolin, 2. 7-OMe Luteolin, 3. 7-3',4'-triOMe Luteolin, 4. Kaempferol, 5. 4'OMe Kaempferol, 6. Quercetin, 7. 3-OMe quercetin, 8. 3'-OMe quercetin, 9. 4'OMe quercetin, 10. 3',4'-diOMe quercetin, 11. 7'-OMe Quercetin, 12. 7,3',4' triOMe quercetin, 13. 6-Glycosylated Apigenin, 14. 3'-OMe Orientin, 15. Quinones.

* After Bentham and Hooker (1880).

TABLE - 18. DISTRIBUTION OF PHENOLIC ACIDS, TANNINS, SAPONINS, AND PROANTHOCYANIDINS IN THE FAMILY POLYGONACEAE*

Sl.No.	Name of the Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	TRIBE - EUPOLYGONEAE																
1.	Oxygonum sinuvatum Burch	+			+			+			+				+	+	
2.	Polygonum hydropiper Linn.	+	+												+	+	
3.	P.lapathifolium Linn.	+	+	+		+								+	+	+	+
4.	P.amphibium Linn.	+		+				+						+	+	+	+
5.	P.plebeium Br.prodr.	+		+		+								+	+	+	+
6.	Persicaria glabra (Willd.)	+	+		+									+	+	+	+
7.	Polygonum alpinum All.Fl.pedem	+	+	+	+			+				+			+	+	
8.	P.kashmiricum Linn.	+	+	+								+	+		+	+	
9.	P.amplexicaule Don Prodr.	+	+	+	+		+		+						+	+	
10.	P.hetrophyllum Linn.	+	+	+	+										+	+	

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(Contd...)

TABLE - 18 (Contd.)

Sl.No.	Name of the Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	TRIBE - RUMICEAE																
11.	Rumex hastatus Don Prodr.	+	+	+	+				+						+	+	
12.	R.acetosella Linn.	+	+		+			+	+						+	+	
13.	R.nepalensis Spreng.	+		+		+				+					+	+	
14.	R.patientia Linn.	+		+			+							+	+	+	+
	TRIBE - COCCOLOBAE																
15.	Antigonen leptopus HK & Arn.	+		+			+				+			+	+	+	+
16.	Coccoloba grandiflora P.Br.	+	+	+										+	+	+	+
17.	Muhlenbeckia platiclada Meissr.	+	+	+		+								+	+	+	+

1. Vanillic, 2. Syringic, 3.p-OH Benzoic, 4. Melilotic, 5. Gentisic, 6. p-Coumaric,
7. Ferulic, 8. Synapic , 9. Phloritic, 10. Protocatechuic, 11. Gallic,
12. O-Catachuic, 13.Tannins 14. Saponins, 15. Steroids, 16. Proanthocyanidins.

* After Bentham and Hooker (1880).

tannins and quinones from leaves of 17 Polygonaceae members is presented in the table. 17-16

Of the 17 members screened, 14 contained one or the other type of flavonoids. Flavonoid system was absent in Rumex nepalensis, R. patientia and Polygonum lapathifolium.

Flavonols formed the predominant phenolic pigments of this family. Quercetin and its mono-, di- and trimethoxylated derivatives were found as the major constituents. In the subfamily Polygonoideae, quercetin and its mono-, di- and trimethoxylated derivatives were present, whereas in the Rumoideae, quercetin, 3-OMe quercetin and 3',4'-diOMe quercetin were located. Quercetin was the only flavonol in the Coccoloboideae. Kaempferol and its monomethoxylated derivatives were confined to the subfamily Polygonoideae.

Luteolin, 7-OMe luteolin and 7,3',4'-triOMe luteolin were the flavones located in this family and which were confined to the Polygonoideae and Rumoideae. In the Polygonoideae luteolin was present in Polygonum plebejum, 7-OMe luteolin in Polygonum amplexicaule and 7,3',4'-triOMe luteolin in Oxygonum sinuvatum. Rumex acetosella was the only member with a flavone (luteolin) in the subfamily Rumoideae.

Glycoflavones located in this family were restricted to the two subfamilies Rumoideae and Coccoloboideae, of which isovitexin (6-glycosylated apigenin) was present in Muhlenbeckia platiclade (Coccoloboideae) and 3'-OMe orientin in Rumex acetosella (Rumoideae).

Of the 12 phenolic acids detected, vanillic, syringic, p-OH benzoic, gentisic and p-coumaric acids were common to all the 3 subfamilies. Vanillic acid showed 100% incidence in all the tribes. Syringic acid was confined to Polygonoideae and Rumoideae whereas protocatechuic acid was present in all the subfamilies except Rumoideae. Gallic acid was restricted to the subfamily Polygonoideae.

All the members screened showed the presence of saponins and steroids. Eight out of seventeen plants showed positive tests for tannins and proanthocyanidins, of which 4 belonged to the Polygonoideae, one to the Rumoideae and 3 to the Coccoloboideae. Quinones were located in 5 plants. None contained iridoids or alkaloids.

DISCUSSION

The distribution pattern of the flavonoids, phenolic acids and other natural products indicates, the homogeneity

of the family Polygonaceae. All the plants possess the same type of flavonols and phenolic acids. The absence of iridoids and alkaloids are the other unifying characters of the family.

In the subfamily Coccoloboideae, all the members contained flavonols. The 100% incidence of flavonols, proanthocyanidins and tannins strongly points the primitive nature of this subfamily. Pollen morphology also appear to be unique for this subfamily. The ektexine surface consists of proximal irregular protruberences, supported by a moderately thick tectum underlain by notably reduced columella, greatly thickened foot layer and an extremely thin endexine (Nowicke and Skvarla, 1977).

The subfamily Rumoideae appears to be relatively advanced over the other two taxa. The overall low percentage of incidence of flavonols (50%), tannins (25%) and proanthocyanidins (25%) is in support of its advanced position in the evolutionary sequence. It may be noted that, of the three plants devoid of flavonoids, two belonged here. Palynological data (pantoporate and very finely and evenly spinulose ekterine (Nowicke and Skvarla, l.c.)) also show the identity of this subfamily.

The subfamily Polygonoideae seems to have an intermediate position in the evolutionary sequence.

Eventhough this subfamily has a high incidence of flavonols, which is considered to be a primitive character, three plants out of nine showed the presence of flavones - an advanced character. The lesser percentage of incidence of tannins (40 %) and proanthrocyanidins (40 %) also shows its relatively advanced nature. Palynologically this subfamily has a wider range of pollen type especially within the genera Polygonum (Nowicke and Skvarla, l.c.).