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THE SEED ATLAS OF PAKISTAN-XIV.POLYGONACEAE

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Abstract

Macro and micro morphological characters of seeds of 40 taxa belonging to the family Polygonaceae were examined by using light and scanning electron microscopy including seed descriptions, keys and micrographs. Considerable variation was observed in seed size, shape, colour and surface at generic and specific levels. The present study provides an additional tool to strengthen the delimitation of taxa on the basis of seed morphology within the family Polygonaceae from Pakistan. This data is further analysed numerically by clustering to trace out the phylogenetic relationship of taxa at various levels.

Key words: Seed morphology, Phylogeny, Polygonaceae, Pakistan.

Introduction

The family Polygonaceae comprises 46 genera with 1200 cosmopolitan species (Mabberley, 2008). It is represented in Pakistan by 19 genera and 103 species (Qaiser, 2001). According to APG III (2009) the family Polygonaceae is splitted into two subfamilies viz., Eriogonoideae and Polygonoideae. All the studied taxa are placed to the subfamily Polygonoideae. While the taxa of the subfamily Eriogonoideae are found in new world (Anjen *et al*., 2003). Ayodele & Zhou (2010) examined the seed morphological characters of 18 taxa of the family Polygonaceae through scanning electron microscope and concluded that seed morphological characters may form a good correlation with gross morphology for taxonomic delimitation at various levels. Khalid & Shad (1990) studied the seed shape, size and surface pattern of the genera *Polygonum* and *Rheum* to distinguish the seeds of weeds from economically important plants. The purpose of the present study is to carry out detailed seed morphology and the data is numerically analysed to assess the phylogenetic relationship among the taxa of the family Polygonaceae.

Material and Methods

Mature seeds of 40 taxa of the family Polygonaceae were collected from herbarium specimens and fresh material was also collected from field. The list of voucher specimen is deposited in KUH. Mostly 10 plants/species and 15-20 seeds/plant were studied. The seeds were examined for their morphological characters under stereomicroscope (SMZ800) and scanning electron microscope (JSM-6380A). For scanning electron microscopy dry seeds were directly mounted on metallic stub using double adhesive tape and coated with gold for a period of 6 minutes in sputtering chamber and observed under SEM. The terminology used is in accordance to Berggren (1981) and Stearn (1983) with slight modifications. Presently different seed characters viz., seed number, size, shape, colour, surface and position of hilum have been observed.

Numerical analysis: Hierarchical clustering was performed by using Euclidean distance index and group strategy with the computer package (SPSS 18, 2012).Each of the species was treated as operational taxonomic unit (OTU). Characters were recorded in binary state and coded as presence or absence (1 or 0 respectively). The average values of the quantitative characters viz., seed number, length and breadth were directly used.

Observations and Results

General seed characters of the family Polygonaceae: Single seed per fruit. Seed 1-11.5 x 0.4-6.5 mm, bigonous, trigonous or bigonous-trigonous, angles sharp or blunt, ovate, ovate-elliptic, obovate, elliptic, deltoid, deltoid-ovate or lanceolate, seed apex acute, acuminate, emarginate or retuse, base cuneate, obtuse or obtuse-cuneate, light brown, brown, golden brown, greenish brown, copper brown, dusty brown, dark brown, brown-black, light-dark brown, golden brown-dark brown, greenish brown-brown or black, shiny or unshiny, surface entirely or centrally smooth, marked with various ornamentations either towards the margins or entirely, tuberculate, tuberculate and punctate, granulate,lineate, rugose, punctate, puncticulate, foveolate, favulariate, ruminate, ruminate and puncticulate, ruminate and punctate, rugose and sparsely tuberculate, undulately lineate and foveate, rugose-lineate, rugose-lineate and appressedly tuberculate, puncticulate with rugose and foveolate or alveolate and tuberculate. Hilum basal (Tables 1.1-1.3; Figs. 1-8; Plates 1-10).

Aconogonon (Meisn.) Reichenb.

Seeds 2.5-4.5 x 1.5-3 mm, trigonous, elliptic, apex acute, base cuneate, brown, dull brown or dusty brown and shiny, surface punctate or ruminate. Hilum basal (Plate 1 A-D).

Presently represented by 2 species viz., *Aconogonon rumicifolium* (Royle ex Bab.) Hara and *A. tortuosum* (D.Don) Hara with 2 varieties *A. tortuosum* (D.Don) Hara var. *tortuosum* and *A. tortuosum* (D. Don) Hara var. *tibetanum* (Meisn.) S.P. Hong.

Key to the genera

1 + Seeds with sharp angles ……………………………………..…………………………………..….…..…... 2
- Seeds with blunt angles …………………………………....……………………………….……….……….….... 3

2 + Seeds shiny, surface other than favulariate ……………………………………….…………………….….. *Rumex*
- Seeds not shining, surface favulariate …………..……….………….. *Emex*

3 + Seeds 1-5mm long ………………………………..……..……………………………………………………. 4
- Seeds 11-11.5 mm long ……………………..……………... *Fagopyrum*

4 + Seed surface entirely smooth ……………………..….………………………………………………. *Atraphaxis*
- Seed surface smooth from the middle …..……………………….………………………………………….. 5

5 + Seed surface smooth centrally and rugose towards the margin ……………………………………….... *Bistorta*
- Seed surface not as above ……………..……………....…..…………..… 6

6 + Seed apex acuminate …………..……..…………...……………………………………………..… *Persicaria*
- Seed apex acute ……………………………………..……..…….. *Koenigia, Polygonum, Fallopia, Aconogonon*

Key to the species

1 + Seeds 4-5 mm long, surface punctuate ………………..… *A. rumicifolium*
- Seeds 2.5-3 mm long, surface ruminate …………………………………….……….……….… *A. tortuosum*

Atraphaxis L.

Seeds 3-4x2.5-3mm, bigonous, ovate, apex emarginate, base obtuse, brown and shiny, surface smooth. Hilum basal (Plate 1 E-F).

It is represented by a single species viz., *Atraphaxis spinosa* L.

Bistorta Adanson

Seeds 4.5-5 x 3-3.5 mm, trigonous, elliptic, apex acute, base cuneate, golden brown and shiny, surface centrally smooth and rugose at apex and base. Hilum basal (Plate 1 G-H).

Presently represented by a single species viz., *Bistorta amplexicaulis* (D. Don) Green

Emex Campd.

Seeds 2.5-3x1-1.5 mm, trigonous with sharp angles, ovate, apex acute, base obtuse, copper brown and unshiny, surface favulariate. Hilum basal (Plate 2 A-B).

It is represented by a single species viz., *Emex australis* Steinh.

Fagopyrum Mill.

Seeds 11-11.5x6-6.5mm, bigonous, lanceolate, margin slightly wavy, apex retuse, base cuneate, brown and shiny, surface longitudinally grooved and rugose. Hilum basal (Plate 2 C-D).

Presently represented by a single species viz., *Fagopyrum tataricum* (L.) Gaertn.

Fallopia Adans.

Seeds 2-4.5x1.5-2.5mm, trigonous, elliptic, apex acute, base cuneate, brown or brown-black, shiny or unshiny, surface tuberculate. Hilum basal (Plate 2 E-H).

Presently represented by 2 species viz., *Fallopia convolvulus* (L.) Holub and *F. dumetorum* (L.) Holub

Key to the species

1 + Seeds shiny ……………………………………..………………..…….………..……...…..…….. *F. dumetorum*
- Seeds unshiny ………………….…………….……...…………………………………………. *F. convolvulus*

Koenigia L.

Seeds 1-1.5x0.4-0.5 mm, bigonous, ovate-elliptic, apex acute, base cuneate-obtuse, brown and unshiny, surface appressedly tuberculate and punctate. Hilum basal (Plate 3 A-B).

It is represented by a single species viz., *Koenigia islandica* L.

Persicaria Mill.

Seeds 1.5-3x1-2.5 mm, bigonous, trigonous or bigonous-trigonous, ovate,obovate, deltoid or elliptic, seed apex acute-acuminate, base cuneate-obtuse, light brown, copper brown, dark brown or black and shiny, surface rugose, ruminate, foveolate, puncticulate, alveolate or tuberculate. Hilum basal (Plates 3C-H, 4A-F).

Presently represented by 6 taxa viz., *Persicaria glabra* (Willd.) Gomes de la Maza, *P. lapathifolia* (L.) S.F. Gray var. *lapathifolia*, *P. lapathifolia* (L.) S.F. Gray var.*nodosa* (Pers.) Qaiser, *P. longiseta* (De Bruyn) Kitagawa, *P. maculosa* S.F. Gray. and *P. nepalensis* (Meisn.) H. Gross

Table. 1.1. Seed morphological characters of the Family Polygonaceae.

Name of taxa	Seed size (mm)	Colour	Shape	Apex	Base	Surface
Aconogonon rumicifolium	4-4.5x2.5-3	Dusty brown and shiny	Trigonous and elliptic	Acute	Cuneate	Faintly punctate
A. tortuosum var. *tortuosum*	2.5-3x1.5-2	Dull Brown and shiny	Trigonous and elliptic	Acute	Cuneate	Faintly ruminate
A. tortuosum var. *tibetanum*	2.5-3x1.5-2	Dull Brown and shiny	Trigonous and elliptic	Acute	Cuneate	Faintly ruminate
Atraphaxis spinosa	3-4x2.5-3	Dull Brown and Shiny	Bigonous and ovate	Emarginate	Obtuse	Smooth
Bistorta amplexicaulis	4.5-5x3-3.5	Golden brown and shiny	Trigonous elliptic	Acute	Cuneate	Centrally smooth, rugose at apex and base
Emex australis	2.5-3x1-1.5	Copper brown and unshiny	Trigonous with sharp angles and ovate	Acute	Obtuse	Favulariate
Fagopyrum tataricum	11-11.5x6-6.5	Dull Brown and Shiny	Lanceolate	Retuse	Cuneate	Rugose and longitudinally grooved
Fallopia convolvulus	3.5-4.5x2-2.5	Dull Brown-Black and unshiny	Trigonous and elliptic	Acute	Cuneate	Tuberculate
F. dumetorum	2-3x1.5-2	Black and shiny	Trigonous and elliptic	Acute	Cuneate	Tuberculate
Koenigia islandica	1-1.5x0.4-0.5	Dull Brown and unshiny	Bigonous and ovate- elliptic	Acute	Obtuse- cuneate	Appressedly tuberculate and punctate
Persicaria glabra	2-3x1.5-2	Dark brown-black and shiny	Bigonous and obovate	Acuminate	Obtuse	Faintly ruminate and puncticulate
P. lapathifolia var.*lapathifolia*	2-3x2-2.5	Dull Brown-black and shiny	Bigonous and obovate	Acuminate	Obtuse	Appressedly ruminate and puncticulate
P. lapathifolia var. *nodosa*	2.5-3x1.5-2	Dark brown and shiny	Bigonous and obovate	Acuminate	Obtuse	Smooth centrally depressed
P. longiseta	1.5-2x1-1.5	Light brown dark brown or black and shiny	Trigonous-bigonous, ovate and elliptic	Acuminate	Cuneate	Faintly puncticulate
P. maculosa	1.5-3x1.5-2	Dark brown- black and shiny	Trigounos- bigonous and ovate	Acuminate	Obtuse	Faintly puncticulate, rugose and foveolate
P. nepalensis	1.5-2x1.5-2	Dark brown and shiny	Bigonous and deltoid	Acuminate	Obtuse	Alveolate and tuberculate
Polygonum arenastrum	2-2.5x1-1.5	Dark brown and shiny	Trigonous and broadly elliptic	Acute	Cuneate	Appressedly granulate
P. argyrocoleum	1.5-2x1-1.5	Dull Brown and shiny	Trigonous and elliptic	Acute	Cuneate	Smooth centrally and faintly puncticulate
P. aviculare	2-2.5x1-1.5	Light brown-dark brown and shiny	Trigonous and elliptic	Acute	Cuneate	Sparsely granulate
P. biaristatum	2.5-3x1.5-2	Dark brown- black and shiny	Trigonous and ovate	Acute	Obtuse-cuneate	Puncticulate
P. cognatum ssp. *cognatum*	2.5-3x1.5-2	Black and Shiny	Bigonous-trigonous and ovate	Acute	Obtuse	Puncticulate
P. cognatum ssp. *chitralicum*	2.5-3x1.5-2	Dull Brown- black and shiny	Bigonous and ovate	Acute	Obtuse	Puncticulate
P. effusum	1.5-2x0.5-1	Black and shiny	Trigonous and elliptic	Acute	Cuneate	Puncticulate
P. maritimum	2-2.5x1-1.5	Dull Brown and shiny	Trigounus-bigonous and elliptic	Acute	Obtuse-cuneate	Ruminate and punctate
P. molliaeforme	1-1.5x0.5-1	Dull Brown and shiny	Bigonous and elliptic	Acute	Cuneate	Rugose and sparsely tuberculate
P. olivascens	2.5-3x1.5-2.5	Light brown and shiny	Trigonous and elliptic	Acute	Cuneate	Centrally smooth but sparsely granulate at apex
P. paronychioides	1.5-2x0.5-1	Golden brown- dark brown and shiny	Bigonous- trigonous and elliptic-ovate	Acute	Cuneate	Centrally smooth but rugose at apex
P. patulum	2.5-3x1-1.5	Brown-dark brown and shiny	Trigonous and elliptic	Acute	Cuneate	Prominently granulate
P. plebejum	1.5-2x0.5-1	Dark brown and unshiny	Trigonous and elliptic	Acute	Cuneate	Undulately lineate and foveate
P. polycnemoides	1.5-2x1-1.5	Black and shiny	Trigonous and elliptic	Acute	Cuneate	Foveolate and lineate
P. rottbeollioides var. *rottbeollioides*	2-2.5x2-2.5	Black and shiny	Trigonous and elliptic	Acute	Cuneate	Rugose-lineate
P. rottbeollioides var. *tibetica*	2-2.5x2-2.5	Dark brown and shiny	Trigonous and elliptic	Acute	Cuneate	Rugose-lineate and appressedly tuberculate
P. roylei	2-2.5x2-2.5	Dull Brown-black and shiny	Bigonous and deltoid	Acute	Obtuse	Centrally smooth, foveate at apex
P. sarobiense	1-1.5x1-1.5	Light brown-dark brown and shiny	Trigonous and ovate	Acute	Obtuse	Smooth-faintly lineate
Rumex acetosa	2-3x2-3	Dark brown-black and shiny	Trigonous and broadly elliptic with sharp angles	Acute	Cuneate	Faintly ruminate
R. chalepensis	3-3.5x3-3.5	Greenish brown-brown and shiny	Trigonous and elliptic with sharp angles	Acute	Cuneate	Faintly rugose
R. crispus	2-2.5x1.5-2	Dark brown and shiny	Trigonous and elliptic with sharp angles	Acute	Cuneate	Puncticulate
R. dentatus ssp. *klotzschianus*	1.5-2x1-1.5	Dark brown and shiny	Trigonous and elliptic with sharp angles	Acute	Cuneate	Puncticulate
R. hastatus	1.5-2x0.5-1	Light brown and shiny	Trigonous and elliptic with sharp angles	Acute	Cuneate	Ruminate
R. nepalensis	3.5-4x1.5-2	Dark brown and shiny	Trigonous and elliptic with sharp angles	Acute	Cuneate	Punctate

Key to the species

1 +	Seeds deltoid or obovate	2
-	Seeds ovate or elliptic	3
2 +	Seeds deltoid, surface alveolate and tuberculate	*P. nepalensis*
-	Seeds obovate, surface ruminate and puncticulate	*P. glabra, P. lapathifolia*
3 +	Seeds with obtuse base	*P. maculosa*
-	Seeds with cuneate base	*P. longiseta*

Polygonum L.

Seeds 1-3x0.5-2.5mm, bigonous, trigonous or bigonous-trigonous, elliptic, ovate, ovate-elliptic, deltoid-ovate or deltoid, light brown, dull brown, dark brown, light brown-dark brown, dark brown-black, dull brown-black or black, shiny or unshiny, apex acute or acuminate, base cuneate, obtuse or cuneate-obtuse, surface smooth or granulate, puncticulate, ruminate and punctate, rugose and tuberculate, undulately lineate and foveate, rugose-lineate, lineate, or centrally smooth and tuberculate, granulate,rugose or foveate towards the margins. Hilum basal (Plates 4 G-H, 5 A-H, 6 A-H, 7 A-H, 8 A-H, 9 A-B).

Presently represented by 18 taxa viz., *Polygonum arenastrum* Boreau, *P. argyrocoleum* Steud. ex Kunze, *P. aviculare* L., *P. biaristatum* Aitch. & Hemsl., *P. cognatum* Meisn. ssp. *cognatum, P. cognatum* Meisn. ssp. *chitralicum* (Rech.f. & Schiman-Czeika) Qaiser, *P. effusum* Meisn., *P. maritimum* L., *P. molliaeforme* Boiss., *P. olivascens* Rech.f. & Shiman-Czeika, *P. paronychioides* C.A. Mey. ex Hohen., *P. patulum* M.Bieb., *P. plebejum* R.Br., *P. polycnemoides* Jaub. & Spach, *P.rottboellioides* Jaub. & Spach var. *rottboellioides, P. rottboellioides* Jaub. & Spach var. *tibetica* (Hook.f.) R. R. Stewart, *P. roylei* Bab. and *P. sarobiense* Rech.f.

Key to the species

1 +	Seeds with obtuse base	2
-	Seeds with obtuse-cuneate or cuneate base	3
2 +	Seeds deltoid	*P. roylei*
-	Seeds ovate	*P. sarobiense, P. cognatum*
3 +	Seeds smooth centrally	4
-	Seeds not as above	6
4 +	Seeds light brown	*P. olivascens*
-	Seeds golden brown or dull brown	5
5 +	Seed surface rugose at apex	*P. paronychioides*
-	Seed surface faintly puncticulate at apex	*P. argyrocoleum*
6 +	Seeds trigonous (rarely bigonous in *P. maritinum*)	7
-	Seeds bigonous	*P. molliaeforme*
7 +	Seeds elliptic	9
-	Seeds ovate	8
8 +	Seed surface ruminate and punctuate	*P. maritimum*
-	Seed surface puncticulate	*P. biaristatum*
9 +	Seeds shiny	10
-	Seeds unshiny	*P. plebejum*
10 +	Seed surface granulate	11
-	Seed surface not granulate	12
11 +	Seed surface prominently granulate	*P. patulum, P. aviculare*
-	Seed surface appressedly granulate	*P. arenastrum*
12 +	Seed surface puncticulate	*P. effusum*
-	Seed surface lineate-foveate, rugose-lineate or appressedly tuberculate	13
13 +	Seed surface rugose-lineate or appressedly tuberculate	*P. rottboellioides*
-	Seed surface lineate-foveate	*P. polycnemoides*

Rumex L.

Seeds 1.5-4x0.5-2mm, trigonous with sharp angles, elliptic, seed apex acute, base cuneate, light brown, dark brown, dark brown-black, dull brown or greenish brown, shiny, surface faintly rugose, faintly ruminate, punctate, puncticulate or favulariate. Hilum basal (Plates 9 C-H, 10 A-H).

Presently represented by 6 species viz., *Rumex acetosa* L., *R. chalepensis* Mill., *R. crispus* L., *R. dentatus* L. ssp. *klotzschianus* (Meisn.) Rech.f., *R. hastatus* D. Don and *R. nepalensis* Spreng.

Key to the species

1 +	Seeds 3-4 mm long …………………………………………………………………………………………….	2
-	Seeds 1.5-2.5 mm long …………………………………………………………………………………...…	3
2 +	Seed surface faintly rugose ……………………………………..……………………...………	*R. chalepensis*
-	Seed surface punctuate ………………………………….………………………………...…….	*R. nepalensis*
3 +	Seed surface ruminate ………………………………...……………………………….………….	4
-	Seed surface puncticulate or favulariate ………………………..………..	*R. crispus, R. dentatus* ssp. *klotzschianus*
4 +	Seeds light brown, 1.8-2 mm long …………………………………...………….……..………….	*R. hastatus*
-	Seeds dark brown-black, 2.5-3 mm long .…………………………………..………….….……….	*R. acetosa*

Table 1.2. List of characters, scored for cluster analysis for taxa of family Polygonaceae listed on Table.1.3.

No.	Character description
1.	Seed number
2.	Length (mm)
3.	Breadth (mm)
	Seed apex
4.	Acute: Absent (0), Present (1)
5.	Emarginate: Absent (0), Present (1)
6.	Retuse: Absent (0), Present (1)
7.	Acuminate: Absent (0), Present (1)
	Seed base
8.	Cuneate: Absent (0), Present (1)
9.	Obtuse: Absent (0), Present (1)
10.	Obtuse-cuneate: Absent (0), Present (1)
	Seed angle
11.	Bigonous: Absent (0), Present (1)
12.	Trigonous: Absent (0), Present (1)
13.	Bigonous-trigonous: Absent (0), Present (1)
	Seed shape
14.	Elliptic: Absent (0), Present (1)
15.	Ovate: Absent (0), Present (1)
16.	Lanceolate: Absent (0), Present (1)
17.	Obovate: Absent (0), Present (1)
18.	Deltoid: Absent (0), Present (1)
19.	Deltoid-ovate: Absent (0), Present (1)
20.	Ovate-elliptic: Absent (0), Present (1)
	Seed color
21.	Light brown: Absent (0), Present (1)
22.	Brown: Absent (0), Present (1)
23.	Dark brown: Absent (0), Present (1)
24.	Dust brown: Absent (0), Present (1)
25.	Copper brown: Absent (0), Present (1)
26.	Golden brown: Absent (0), Present (1)
27.	Brown-black: Absent (0), Present (1)
28.	Dark brown-black: Absent (0), Present (1)
29.	Golden brown-dark brown: Absent (0), Present (1)
30.	Greenish brown-brown: Absent (0), Present (1)
31.	Light brown-dark brown: Absent (0), Present (1)
32.	Black: Absent (0), Present (1)
	Seed surface
33.	Smooth: Absent (0), Present (1)
34.	Centrally smooth and rugose at edges: Absent (0), Present (1)
35.	Centrally smooth and granulate at edges: Absent (0), Present (1)
36.	Centrally smooth and puncticulate at edges: Absent (0), Present (1)
37.	Centrally smooth and foveate at edges: Absent (0), Present (1)
38.	Smooth-lineate: Absent (0), Present (1)
39.	Rugose: Absent (0), Present (1)
40.	Rugose and grooved: Absent (0), Present (1)
41.	Rugose and tuberculate: Absent (0), Present (1)
42.	Rugose-lineate: Absent (0), Present (1)
43.	Rugose-lineate and tuberculate: Absent (0), Present (1)
44.	Tuberculate: Absent (0), Present (1)
45.	Tuberculate and punctate: Absent (0), Present (1)
46.	Alveolate and tuberculate: Absent (0), Present (1)
47.	Punctate: Absent (0), Present (1)
48.	Puncticulate: Absent (0), Present (1)
49.	Puncticulate, rugose and foveolate: Absent (0), Present (1)
50.	Ruminate: Absent (0), Present (1)
51.	Ruminate and puncticulate: Absent (0), Present (1)
52.	Ruminate and punctate: Absent (0), Present (1)
53.	Undulately lineate and foveate: Absent (0), Present (1)
54.	Foveolate and lineate: Absent (0), Present (1)
55.	Favulariate: Absent (0), Present (1)
56.	Granulate: Absent (0), Present (1)

Discussion

Dendrogram (Fig. 1) of the family Polygonaceae based on seed morphological characters revealed 3 distinct groups. The first group is represented by a single species *Fagopyrum tataricum* which is characterized by the presence of 11-11.5mm long and lanceolate seeds, basal position of this group within the dendrogram is supported by the presence of larger seeds, which also point outs its primitiveness. The second group comprises 17 taxa and could be distinguished on the basis of ovate, obovate, deltoid, elliptic-obovate or elliptic seeds. This group is further splitted into 3 subgroups.

The first subgroup includes 7 taxa viz., *Atraphaxis spinosa, Persicaria glabra, P. maculosa, P. lapathifolia* var. *lapathifolia, P. lapathifolia* var. *nodosa, P. nepalensis,* and *P. roylei*. This group is characterized by having ovate, obovate or deltoid seeds. Within this subgroup *Atraphaxis spinosa* gets apart from the remaining taxa by having ovate seeds with emarginate apex. These findings are also supported by the previous findings of Anjen *et al*. (2003) where similar seeds were observed in *Atraphaxis spinosa*. Moreover the taxa *P. lapathifolia* var. *nodosa* and *P. nepalensis* show close affinity with each other due to the presence of dark brown seeds with acuminate apex and obtuse base but remain distinct due to different seed shapes. Similarly, *Persicaria glabra* and *P. maculosa* fall in a same cluster, as both share dark brown-black seeds with acute apex and obtuse base but could remain distinct by having different seed surfaces. The remaining taxa *P. lapathifolia* var. *lapathifolia* and *P. roylei* show strong affinity by sharing brown-black and bigonous seeds with acute apex and obtuse base. Both the above taxa could be further separated from each other on the basis of obovate seeds in *P. lapathifolia* var. *lapathifolia* and deltoid seeds were observed in *P. roylei*. Moreover, the second subgroup comprises 4 taxa viz., *Polygonum cognatum* ssp. *cognatum, P.cognatum* ssp. *chitralicum, P. biaristatum* and *Emex australis* and characterized by the presence of ovate seeds. Within this subgroup *Emex australis* gets apart from rest of the taxa by having sharply angled seeds. While the remaining 3 taxa show close affinity on the basis of similar seed shapes and colour. The third subgroup includes 6 taxa viz., *Koengia islandica, Polygonum maritimum, P. molliaeforme, P. paronychioides, P. sarobiense* and *Persicaria longiseta*. This group is characterized by the presence of elliptic-ovate, ovate or elliptic seeds. Within this group the 2 taxa *Polygonum sarobiense* and *Persicaria longiseta* form a common cluster as both share light-dark brown seeds but remain distinct on the basis of different seed shapes and surfaces. Similarly the remaining taxa viz., *Koengia islandica, Polygonum maritimum, P. molliaeforme* and *P. paronychioides* show close affinity with each other by sharing brown or golden brown seeds.

Table.1.3. Data matrix of Polygonaceae scored for 56 characters present in table.1.2.

Name of taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Aconogonon rumicifolium	1	4.25	2.8	1	0	0	0	1	0	0	0	1	0	1
A. tortuosum var. *tortuosum*	1	2.75	1.8	1	0	0	0	1	0	0	0	1	0	1
A. tortuosum var. *tibetanum*	1	2.75	1.8	0	0	0	0	1	0	0	0	1	0	0
Atraphaxis spinosa	1	3.5	2.75	0	1	0	0	0	1	0	1	0	0	0
Bistorta amplexicaulis	1	4.75	3.4	1	0	0	0	1	0	0	0	1	0	1
Emex australis	1	2.75	1.4	1	0	0	0	0	1	0	0	1	0	0
Fagopyrum tataricum	1	11.2	6.25	0	0	1	0	1	0	0	1	0	0	0
Fallopia convolvulus	1	4	2.25	1	0	0	0	1	0	0	0	1	0	1
F. dumetorum	1	2.5	1.65	1	0	0	0	1	0	0	0	1	0	1
Koenigia islandica	1	1.35	0.45	1	0	0	0	0	0	1	1	0	0	0

Name of taxa	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Aconogonon rumicifolium	0	0	0	0	0	0	0	0	0	1	0	0	0	0
A. tortuosum var. *tortuosum*	0	0	0	0	0	0	0	1	0	0	0	0	0	0
A. tortuosum var. *tibetanum*	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Atraphaxis spinosa	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Bistorta amplexicaulis	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Emex australis	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Fagopyrum tataricum	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Fallopia convolvulus	0	0	0	0	0	0	0	0	0	0	0	0	1	0
F. dumetorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Koenigia islandica	0	0	0	0	0	1	0	1	0	0	0	0	0	0

Name of taxa	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Aconogonon rumicifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. tortuosum var. *tortuosum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. tortuosum var. *tibetanum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atraphaxis spinosa	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Bistorta amplexicaulis	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Emex australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fagopyrum tataricum	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Fallopia convolvulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. dumetorum	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Koenigia islandica	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Name of taxa	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Aconogonon rumicifolium	0	0	0	0	1	0	0	0	0	0	0	0	0	0
A. tortuosum var. *tortuosum*	0	0	0	0	0	0	0	1	0	0	0	0	0	0
A. tortuosum var. *tibetanum*	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Atraphaxis spinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bistorta amplexicaulis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emex australis	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Fagopyrum tataricum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fallopia convolvulus	0	1	0	0	0	0	0	0	0	0	0	0	0	0
F. dumetorum	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Koenigia islandica	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Table.1.3.Data matrix of Polygonaceae scored for 56 characters present in table.1.2.

Name of taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Persicaria glabra	1	2.5	1.65	0	0	0	1	0	1	0	1	0	0	0
P. lapathifolia var. *lapathifolia*	1	2.5	2.25	0	0	0	0	0	1	0	1	0	0	0
P. lapathifolia var. *nodosa*	1	2.75	1.9	0	0	0	1	0	1	0	1	0	0	0
P. longiseta	1	1.85	1.1	0	0	0	1	1	0	0	0	0	1	1
P. maculosa	1	2.25	1.75	0	0	0	1	0	1	0	0	0	1	0
P. nepalensis	1	1.85	1.95	0	0	0	1	0	1	0	1	0	0	0
Polygonum arenastrum	1	2.4	1.25	1	0	0	0	1	0	0	0	1	0	1
P. argyrocoleum	1	1.8	1.25	1	0	0	0	1	0	0	0	1	0	1
P. aviculare	1	2.25	1.35	1	0	0	0	1	0	0	0	1	0	1
P. biaristatum	1	2.75	1.9	1	0	0	0	0	0	1	0	1	0	0

Name of taxa	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Persicaria glabra	0	0	0	0	0	0	0	0	0	0	0	0	0	1
P. lapathifolia var. *lapathifolia*	0	0	0	0	0	0	0	0	0	0	0	0	1	0
P. lapathifolia var. *nodosa*	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P. longiseta	1	0	0	0	0	0	0	0	0	0	0	0	0	0
P. maculosa	1	0	0	0	0	0	0	0	0	0	0	0	0	1
P. nepalensis	0	0	0	1	0	0	0	0	1	0	0	0	0	0
Polygonum arenastrum	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P. argyrocoleum	0	0	0	0	0	0	0	1	0	0	0	0	0	0
P. aviculare	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. biaristatum	1	0	0	0	0	0	0	0	0	0	0	0	0	1

Name of taxa	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Persicaria glabra	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. lapathifolia var. *lapathifolia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. lapathifolia var. *nodosa*	0	0	0	0	1	0	0	0	0	0	0	0	0	0
P. longiseta	0	0	1	0	0	0	0	0	0	0	0	0	0	0
P. maculosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. nepalensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonum arenastrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. argyrocoleum	0	0	0	0	0	0	0	1	0	0	0	0	0	0
P. aviculare	0	0	1	0	0	0	0	0	0	0	0	0	0	0
P. biaristatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Name of taxa	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Persicaria glabra	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P. lapathifolia var. *lapathifolia*	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P. lapathifolia var. *nodosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. longiseta	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P. maculosa	0	0	0	0	0	0	1	0	0	0	0	0	0	0
P. nepalensis	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Polygonum arenastrum	0	0	0	0	0	0	0	0	0	0	0	0	0	1
P. argyrocoleum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. aviculare	0	0	0	0	0	0	0	0	0	0	0	0	0	1
P. biaristatum	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Table.1.3.Data matrix of Polygonaceae scored for 56 characters present in table.1.2.

Name of taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
P. cognatum ssp. *cognatum*	1	2.9	1.95	1	0	0	0	0	1	0	0	0	1	0
P. cognatum ssp. *chitralicum*		2.9	1.9	1	0	0	0	0	1	0	0	1	0	0
P. effusum	1	1.6	0.95	1	0	0	0	1	0	0	0	1	0	1
P. maritimum	1	2.25	1.45	1	0	0	0	0	0	1	0	0	1	0
P. molliaeforme	1	1.45	0.75	1	0	0	0	1	0	0	1	0	0	0
P. olivascens	1	2.75	1.9	1	0	0	0	1	0	0	0	1	0	1
P. paronychioides	1	1.6	0.95	1	0	0	0	1	0	0	0	0	1	0
P. patulum	1	2.75	1.25	1	0	0	0	1	0	0	0	1	0	1
P. plebejum	1	1.65	0.95	1	0	0	0	1	0	0	0	1	0	1
P. polycnemoides	1	1.75	1.1	1	0	0	0	1	0	0	0	1	0	1

Name of taxa	15	16	17	18	19	20	21	22	23	24	25	26	27	28
P. cognatum ssp. *cognatum*	1	0	0	0	0	0	0	0	0	0	0	0	0	0
P. cognatum ssp. *chitralicum*	1	0	0	0	0	0	0	0	0	0	0	0	1	0
P. effusum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. maritimum	1	0	0	0	0	0	0	1	0	0	0	0	0	0
P. molliaeforme	1	0	0	0	0	0	0	1	0	0	0	0	0	0
P. olivascens	0	0	0	0	0	0	1	0	0	0	0	0	0	0
P. paronychioides	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P. patulum	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P. plebejum	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P. polycnemoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Name of taxa	29	30	31	32	33	34	35	36	37	38	39	40	41	42
P. cognatum ssp. *cognatum*	0	0	0	1	0	0	0	0	0	0	0	0	0	0
P. cognatum ssp. *chitralicum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. effusum	0	0	0	1	0	0	0	0	0	0	0	0	0	0
P. maritimum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. molliaeforme	0	0	0	0	0	0	0	0	0	0	0	0	1	0
P. olivascens	0	0	0	0	0	0	1	0	0	0	0	0	0	0
P. paronychioides	1	0	0	0	0	0	1	0	0	0	0	0	0	0
P. patulum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. plebejum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. polycnemoides	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Name of taxa	43	44	45	46	47	48	49	50	51	52	53	54	55	56
P. cognatum ssp. *cognatum*	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P. cognatum ssp. *chitralicum*	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P. effusum	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P. maritimum	0	0	0	0	0	0	0	0	0	1	0	0	0	0
P. molliaeforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. olivascens	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. paronychioides	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. patulum	0	0	0	0	0	0	0	0	0	0	0	0	0	1
P. plebejum	0	0	0	0	0	0	0	0	0	0	1	0	0	0
P. polycnemoides	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Table.1.3. Data matrix of Polygonaceae scored for 56 characters present in table.1.2.

Name of taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14
P. rottboellioides var. *rottboellioides*	1	2.4	0.9	1	0	0	0	1	0	0	0	1	0	1
P. rottboellioides var. *tibetica*	1	2.35	1.6	1	0	0	0	0	0	0	0	1	0	1
P. roylei	1	2.4	1.9	1	0	0	0	0	1	0	1	0	0	0
P. sarobiense	1	1.35	0.9	1	0	0	0	0	1	0	0	1	0	0
Rumex acetosa	1	2.75	1.75	1	0	0	0	1	0	0	0	1	0	0
R. chalepensis	1	3.25	1.75	1	0	0	0	1	0	0	0	1	0	1
R. crispus	1	2.25	1.65	1	0	0	0	1	0	0	0	1	0	1
R. dentatus ssp. *klotzschianus*	1	1.85	1.4	1	0	0	0	1	0	0	0	1	0	1
R. hastatus	1	1.75	0.95	1	0	0	0	1	0	0	0	1	0	1
R. nepalensis	1	3.9	1.85	1	0	0	0	1	0	0	0	1	0	1
Name of taxa	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
P. rottboellioides var. *rottboellioides*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. rottboellioides var. *tibetica*	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P. roylei	0	0	0	1	0	0	0	0	0	0	0	0	1	0
P. sarobiense	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex acetosa	0	0	0	0	0	0	0	0	0	0	0	0	0	1
R. chalepensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. crispus	0	0	0	0	0	0	0	0	1	0	0	0	0	0
R. dentatus ssp. *klotzschianus*	0	0	0	0	0	0	0	0	1	0	0	0	0	0
R. hastatus	0	0	0	0	0	0	1	0	0	0	0	0	0	0
R. nepalensis	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Name of taxa	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**
P. rottboellioides var. *rottboellioides*	0	0	0	1	0	0	0	0	0	0	0	0	0	1
P. rottboellioides var. *tibetica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. roylei	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P. sarobiense	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Rumex acetosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. chalepensis	0	1	0	0	0	0	0	0	0	0	1	0	0	0
R. crispus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. dentatus ssp. *klotzschianus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. hastatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. nepalensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Name of taxa	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**
P. rottboellioides var. *rottboellioides*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. rottboellioides var. *tibetica*	1	0	0	0	0	0	0	0	0	0	0	0	0	0
P. roylei	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. sarobiense	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex acetosa	0	0	0	0	0	0	0	1	0	0	0	0	0	0
R. chalepensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. crispus	0	0	0	0	0	1	0	0	0	0	0	0	0	0
R. dentatus ssp. *klotzschianus*	0	0	0	0	0	1	0	0	0	0	0	0	0	0
R. hastatus	0	0	0	0	0	0	0	1	0	0	0	0	0	0
R. nepalensis	0	0	0	0	1	0	0	0	0	0	0	0	0	0

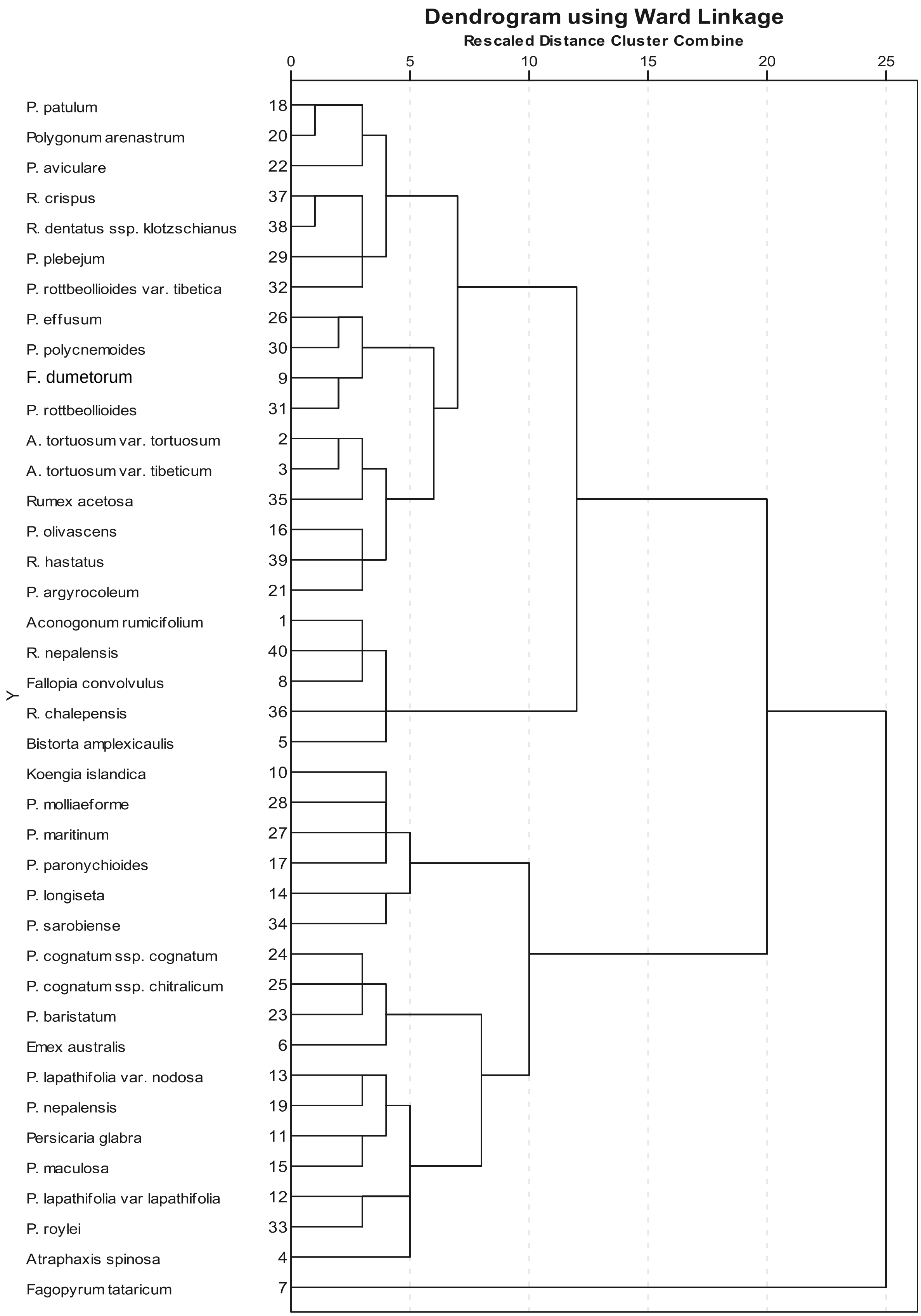

Fig. 1. Dendrogram showing the relationships within the taxa of the family Polygonaceae.

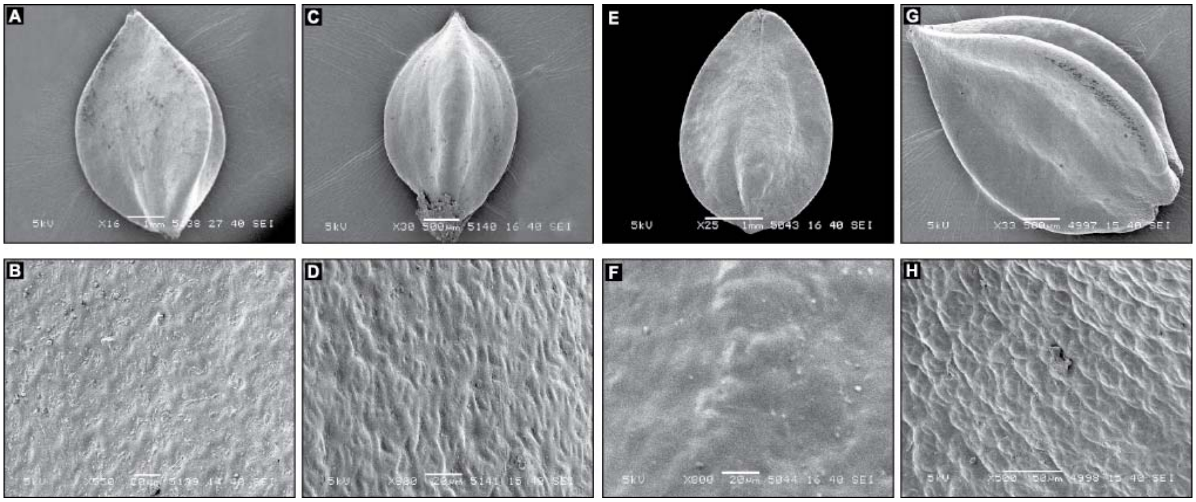

Plate 1. Scanning electron micrographs. *Aconogonum rumicifolium*: A, seed; B, surface. *A.tortuosum* var. *tibeticum*: C, seed; D, surface. *Atraphaxis spinosa*: E, seed; F, surface. *Bistorta amplexicaule*: G, seed; H, surface. (Scale bars: A, C=1mm; C, D=500µm; H=50 µm; B, D, F=20 µm).

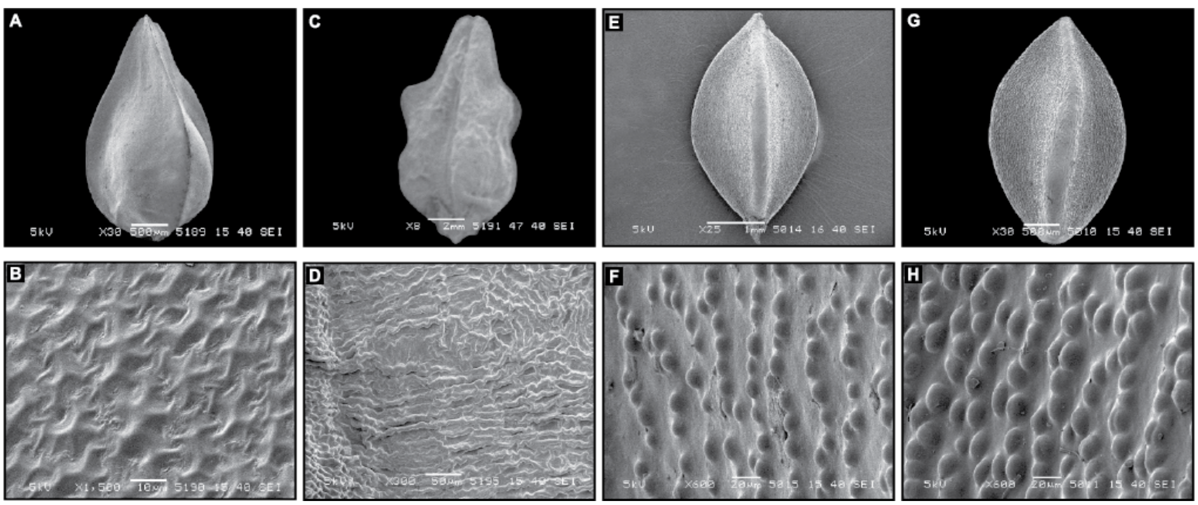

Plate 2. Scanning electron micrographs. *Emex australis*: A, seed; B, surface. *Fagopyrum tataricum*: C, seed; D, surface. *Fallopia convolvulus*: E, seed; F, surface. *F. dumetorum*: G, seed; H, surface. (Scale bars: C=2mm; E=1mm; A, G=500 µm; D=50 µm; F, H=20 µm; B=10 µm).

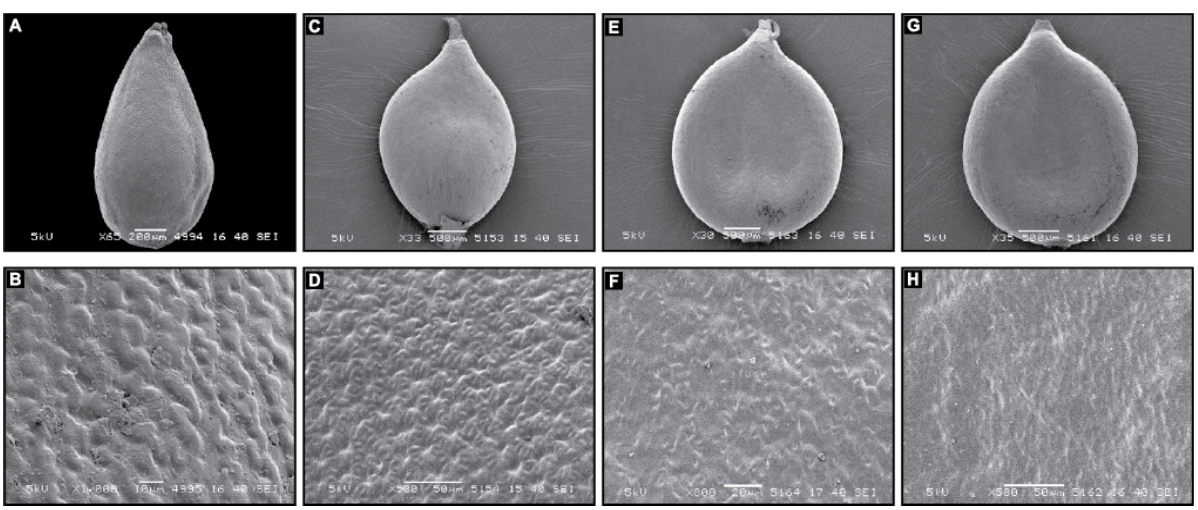

Plate 3. Scanning electron micrographs. *Koengia islandica*: A, seed; B, surface. *Persicaria glabra*: C, seed; D, surface. *P. lapathifolia* var. *lapathifolia*: E, seed; F, surface. *P. lapathifolia* var. *nodosa*: G, seed; H, surface. (Scale bars: C, E, G=500 µm; A=200 µm; D, H=50 µm; F=20 µm; B=10 µm).

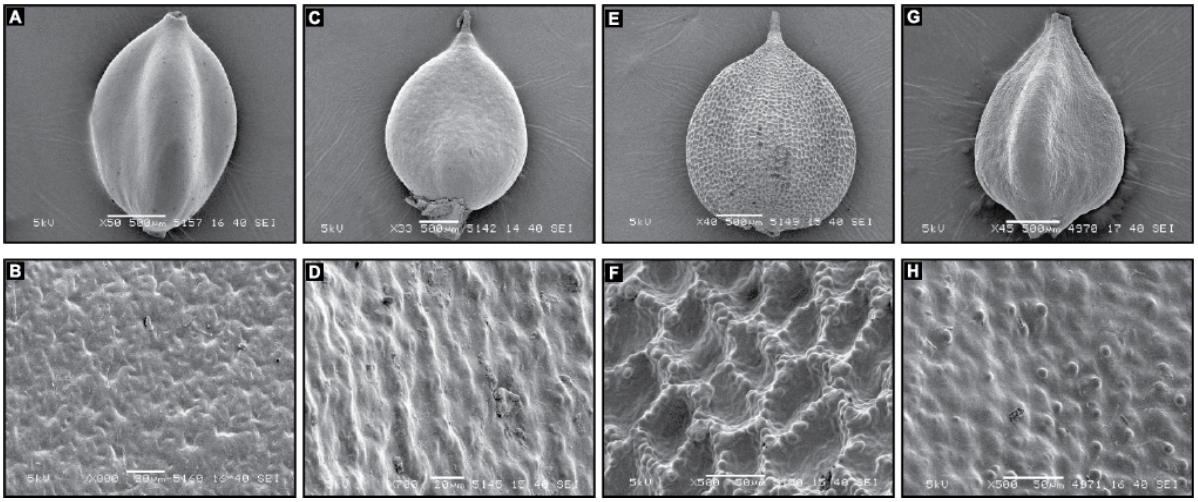

Plate 4. Scanning electron micrographs. *P. longiseta*: A, seed; B, surface. *P. maculosa*: C, seed; D, surface. *P. nepalensis*: E, seed; F, surface. *Polygonum arenastrum*: G, seed; H, surface. (Scale bars: A, C, E, G=500 µm; F, H=50 µm; B, D=20 µm).

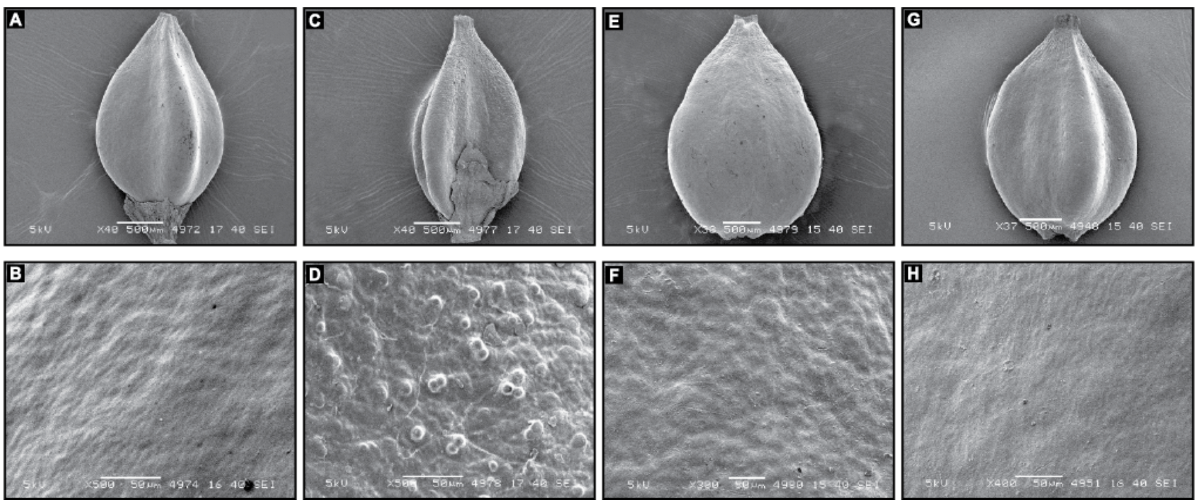

Plate 5. Scanning electron micrographs. *P. argyrocoleum*: A, seed; B, surface. *P. aviculare*: C, seed; D, surface. *P. biaristatum*: E, seed; F, surface. *P. cognatum* ssp. *cognatum*: G, seed; H, surface. (Scale bars: A, C, E, G=500 µm; B, D, F, H=50 µm).

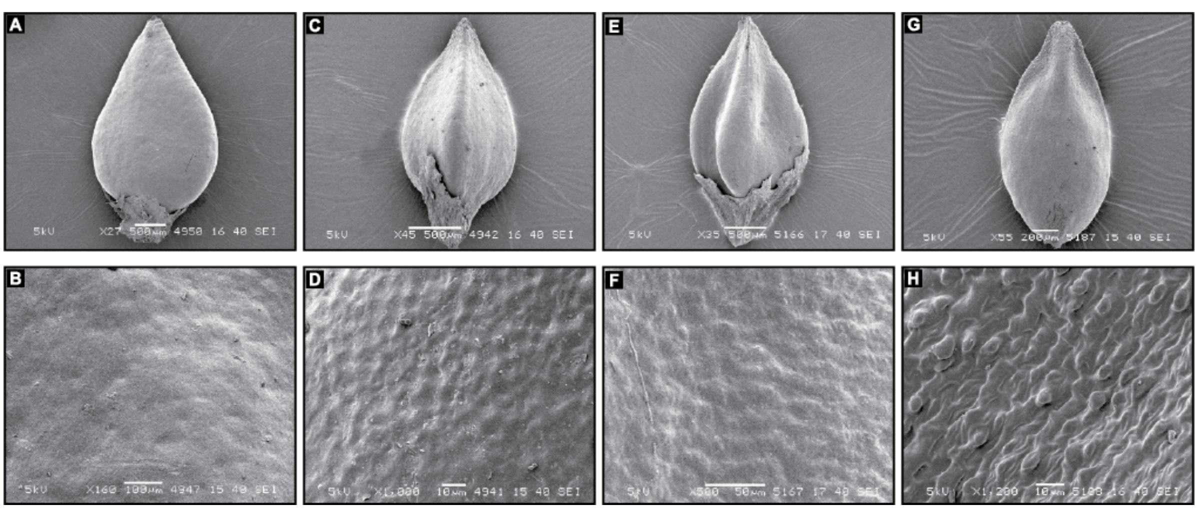

Plate 6. Scanning electron micrographs. *P. cognatum* ssp. *chitralicum*: A, seed; B, surface. *P. effusum*: C, seed; D, surface. *P. maritimum*: E, seed; F, surface. *P. molliaeforme*: G, seed; H, surface. (Scale bars: A, C, E=500 µm; G=200 µm; B=100 µm; F=50 µm; D, H=10 µm).

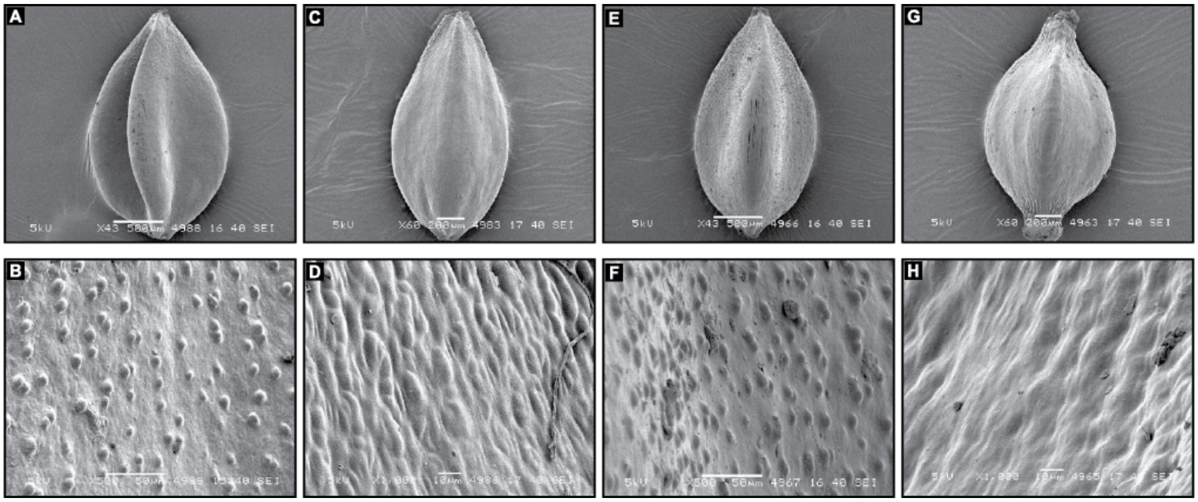

Plate 7. Scanning electron micrographs. *P. olivascens*: A, seed; B, surface. *P. paronychioides*: C, seed; D, surface. *P. patulum*: E, seed; F, surface. *P. plebejum*: G, seed; H, surface. (Scale bars: A, E=500 µm; C, G=200 µm; B, F=50 µm; D, H=10 µm).

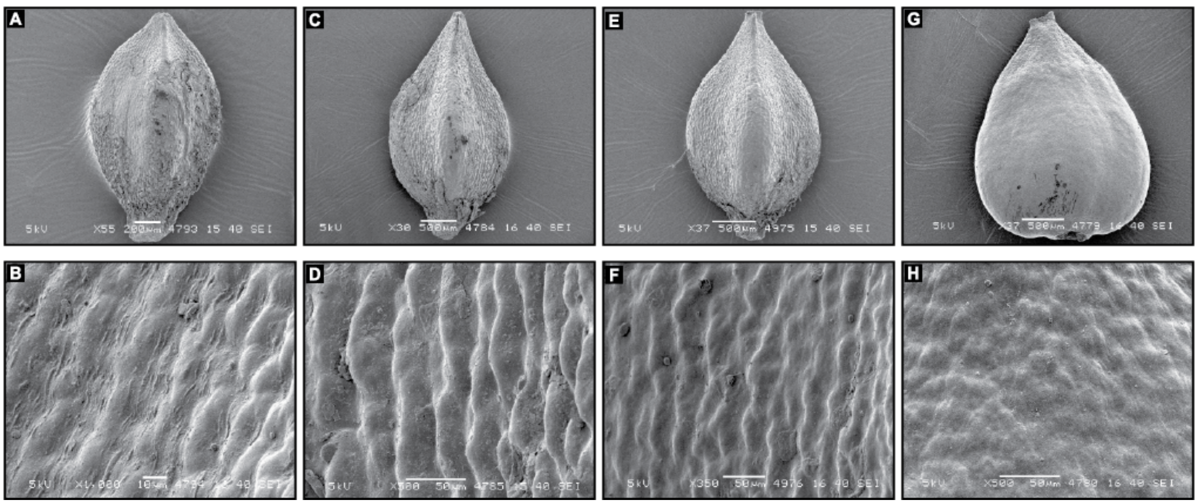

Plate 8. Scanning electron micrographs. *P. polycnemoides*: A, seed; B, surface. *P. rottboellioides* var. *rottboellioides*: C, seed; D, surface. *P. rottboellioides* var. *tibetica*: E, seed; F, surface. *P. roylei*: G, seed; H, surface. (Scale bars: C, E, G=500 µm; A=200 µm; D, F, H=50 µm; B=10 µm).

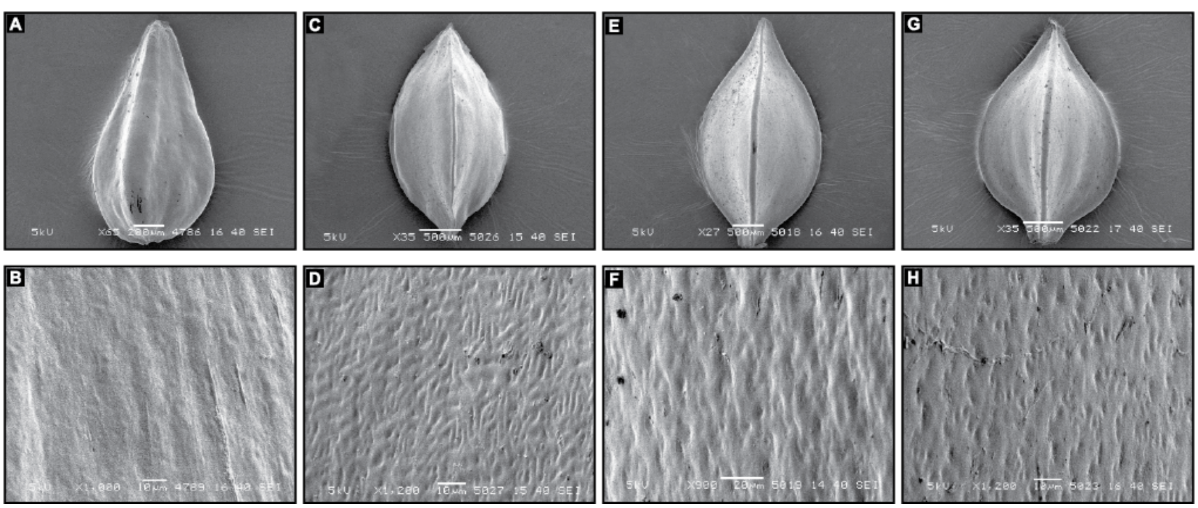

Plate 9. Scanning electron micrographs. *P. sarobiense*: A, seed; B, surface. *Rumex acetosa*: C, seed; D, surface. *R. chalepensis*: E, seed; F, surface. *R. crispus*: G, seed; H, surface. (Scale bars: C, E, G=500 µm; A=200 µm; F=20 µm; B, D, H=10 µm).

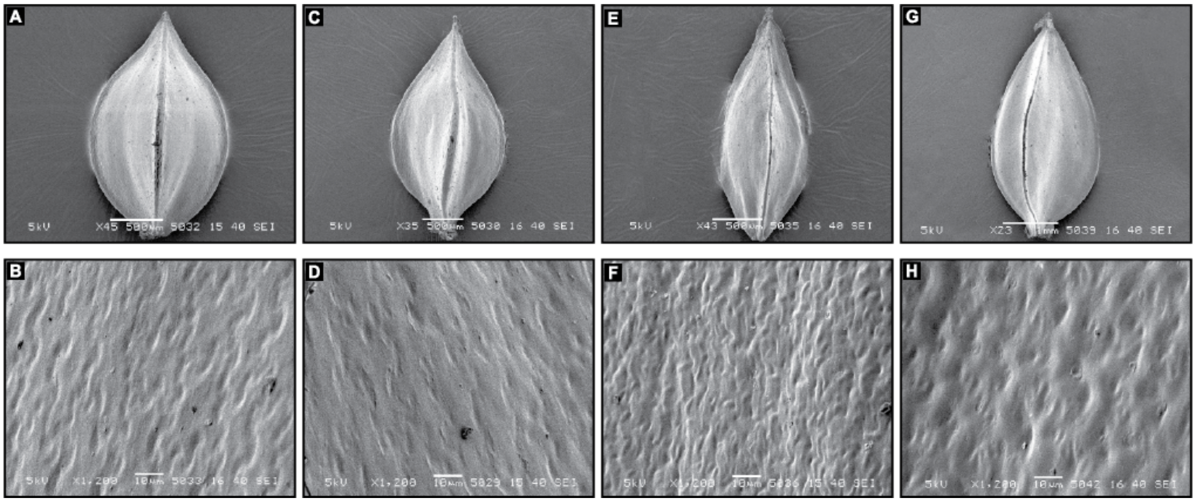

Plate 10. Scanning electron micrographs. *R. dentatus* ssp. *klotzchianus*: A, C, seeds; B, D, surface. *R. hastatus*: E, seed; F, surface. *R. nepalensis*: G, seed; H, surface. (Scale bars: G=1mm; A, C, E=500 µm; B, D, F, H=10 µm).

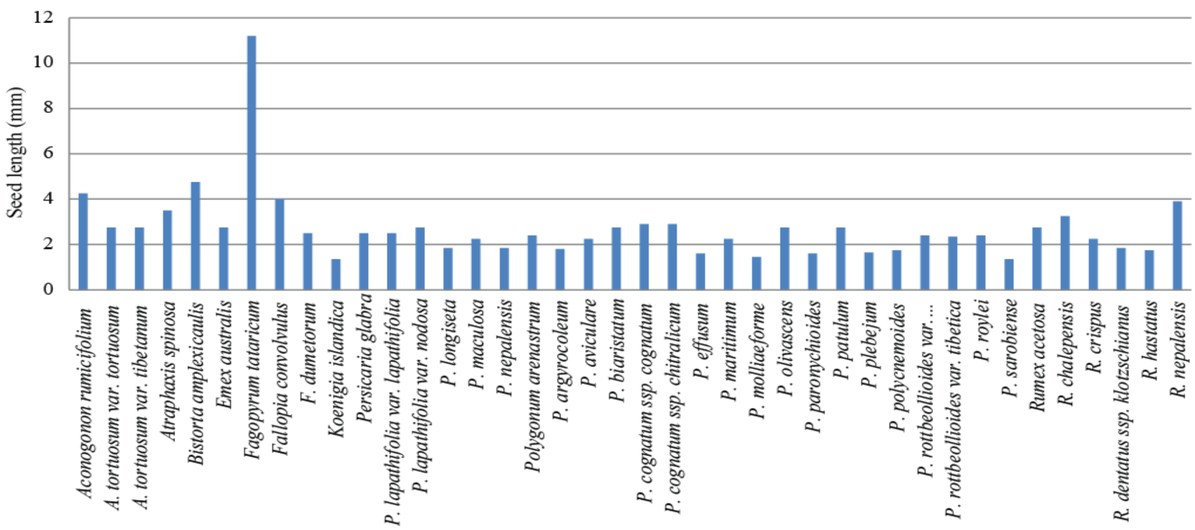

Fig. 2. Bar diagram showing variation in average seed length within different taxa of the family Polygonaceae.

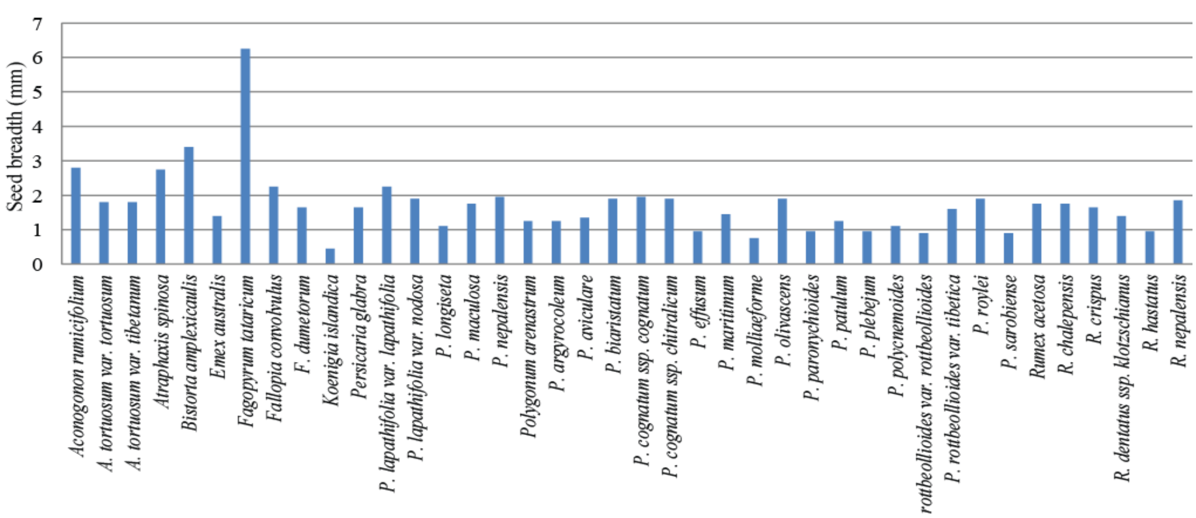

Fig. 3. Bar diagram showing variation in average seed breadth within different taxa of the family Polygonaceae.

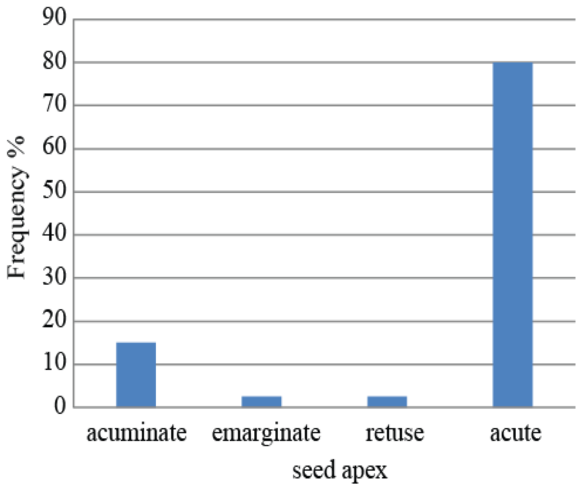

Fig. 4. Bar diagram showing the variation in seed apex within the family Polygonaceae.

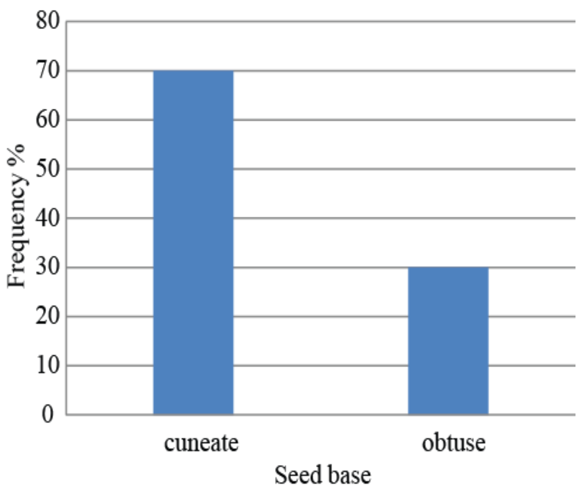

Fig. 5. Bar diagram showing the variation in seed base within the family Polygonaceae.

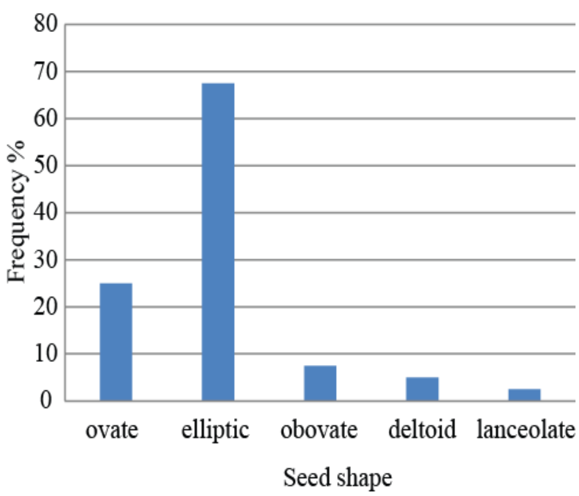

Fig. 6. Bar diagram showing the variation in seed shape within the family Polygonaceae.

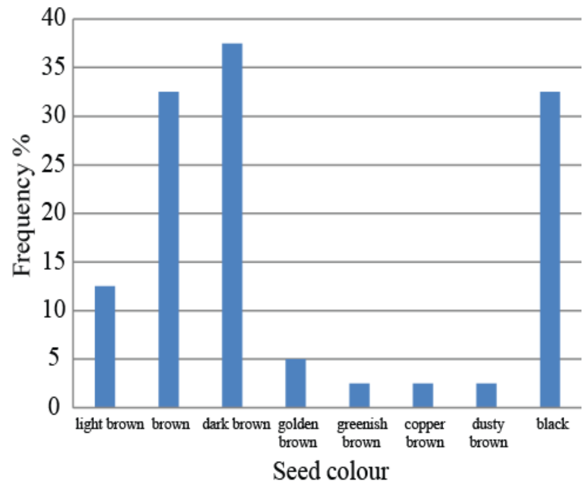

Fig. 7. Bar diagram showing the variation in seed colour within the family Polygonaceae.

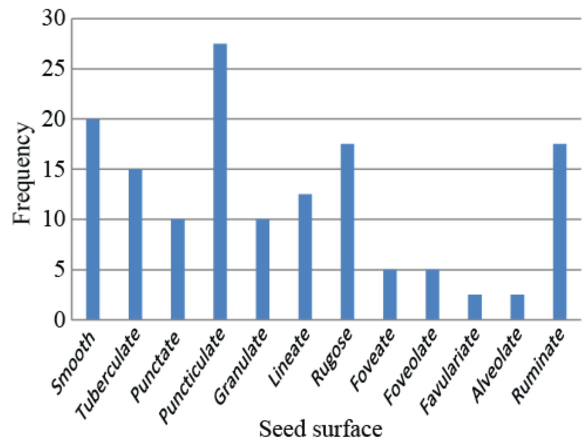

Fig. 8. Bar diagram showing the variation in seed surface within the family Polygonaceae.

The third main group includes 22 taxa and characterized by elliptic seeds. This group is separated into 3 subgroups. The first subgroup comprises 5 taxa viz., *Aconogonon rumicifolium, Bistorta amplexicaulis, Fallopia convolvulus, Rumex chalepensis* and *R. nepalensis*. Within this group the 2 taxa viz., *Bistorta amplexicaulis* and *R. nepalensis* having close affinity as both share rugose seed surface. However, the remaining 3 taxa viz., *Aconogonon rumicifolium, Fallopia convolvulus* and *Rumex chalepensis* have punctuate or tuberculate seed surface. Within this group elliptic seeds have been observed in the genus *Fallopia* which contradicts the earlier findings of Anjen *et al*. (2003) where ovoid seeds were observed. In the second subgroup the 3 taxa viz., *Polygonum argyrocoleum, P. olivascens* and *Rumex hastatus* show close affinity and fall in a common cluster by characterizing the light-dark brown seeds. Among them *Rumex hastatus* remains distinct with sharply angled seeds. While the remaining 2 taxa *Polygonum argyrocoleum* and *P. olivascens* have bluntly angled seeds. The taxa viz., *Aconogonon tortuosum* var. *tortuosum, Aconogonon tortuosum* var.

tibetanum and *Rumex acetosa* grouped within a common cluster as all the above taxa having ruminate seed surface. Among them *Aconogonon tortuosum* var. *tortuosum* and *Aconogonon tortuosum* var. *tibetanum* are more closely related due to bluntly angled seeds. However, *Rumex acetosa* has an exclusive sharply angled seed which makes its position distinct from rest of the taxa. Moreover, the remaining taxa of this subgroup viz., *Polygonum effusum, P. polycnemoides, P. rottboellioides* var. *rottboellioides* and *Fallopia dumetorum* are grouped within a single cluster as all of the above taxa share black seeds. Moreover, *Polygonum effusum* and *Fallopia dumetorum* evolve from the common point while *Polygonum polycnemoides* shows more affinity with *P. effusum* as both the taxa share trigonous and elliptic seeds.

Within the third subgroup taxa viz., *Rumex crispus, Polygonum plebejum* and *P. rottboellioides* var. *tibetica* evolved from the common point and characterized by the presence of dark brown seeds. However, *Rumex dentatus* ssp. *klotzschianus* is closely related to *Rumex crispus* by sharing sharply angled seeds. The remaining 3 taxa viz., *Polygonum arenastrum, P. aviculare* and *P. patulum* fall in a common cluster by having similar seed shape and surface. Presently elliptic seeds are observed in all the above taxa which are in contrast to the previous findings of Anjen *et al.* (2003) where ovoid seeds were observed. It is also noteworthy that the genera *Polygonum, Persicaria* and *Rumex* arise from the different points within the dendrogram, which pointouts their paraphyletic nature.

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