5. RESULT

5.1. FLORISTIC SURVEY

5.1.1. General morphology of Polygonaceae

The members of Polygonaceae are characterized by herbs, shrubs, occasionally trees or climbing habit, leaves generally simple, alternate, stipules united to form a sheath like structure around the stem known as Ochreae, nodes clearly swollen. Ochreae membranous, hyaline, ciliate, fimbriate or tubular. Inflorescences are in spikes, fascicles or panicles. Flowers usually bisexual, rarely unisexual, actinomorphic, pedicel with distinct articulation; perianth biseriate, tepals 3–6, united below and sometimes distended in fruit; stamens 4–9, sporadically up to 16; ovary superior, unilocular, styles 2–4, stigma capitate or fimbriate and ovule 1, basal. Fruit trigonous or biconvex nut, often covered with persistent tepals, brown or black. Seeds with curved embryo.

5.1.2. Enumeration

Polygonaceae comprises about 1384 species and 59 genera worldwide (Sanchez & Kron 2008); 121 species, 29 varieties and 12 genera in India (Srivastava 2014). A Total of 35 taxa of Polygonaceae were collected from different moist and temperate habitats of West Bengal (Fig. 11; 12; 13). Based on considerable reliable and effortlessly conspicuous vegetative, flower and fruit characters artificial dichotomous keys were prepared for the recorded taxa. All the taxa were enumerated below alphabetically accompanied by protologue reference, local names, salient features, exsiccatus, availability status, flowering and fruiting periods, occurrence in West Bengal and world distribution.

Key to the Genera

1a. Phylloclade present .... ***Homalocladium***

1b. Phylloclade absent **2**

2a. Plant climbers; achenes not enclosed by winged perianth .... ***Antigonon***

2b. Plant erect herb or shrubs; achenes enclosed by winged perianth **3**

3a. Perennial herbs; ochreae tubular, acute - aristate, hyaline .... ***Bistorta***

3b. Annual or perennial herbs, sometimes shrubby; ochreae tubular, entire, dentate, acute - acuminate, mostly silvery or brownish **4**

4a. Lower leaves deltoid; inflorescence corymbose; pedicel papillose or pubescent; achenes as long as perianth .... ***Fagopyrum***

4b. Lower leaves variously shaped; inflorescence capitates head or solitary and axillary, raceme, panicle, spike, pedicel glabrous or pubescent or scabrous; achenes shorter than perianth **5**

5a. Mostly twining herbs; tepals keeled .... ***Fallopia***

5b. Prostrate, erect - suberect herbs; tepals not keeled **6**

6a. Inflorescence a spike, raceme ovoid or sub globose or sometimes a capitate head; stamens 4–8 .... ***Persicaria***

6b. Inflorescence solitary, axillary, in few flowered cluster or simple or branched receme; stamens 5 – 6 .... **7**

7a. Ochreae overlapping with leaves; perianth 3–5 partite .... ***Polygonum***

7b. Ochreae not overlapping with leaves; perianth 6 partite, arranged in two whorls, outer 3 small, inner 3 enlarged to form valves .... ***Rumex***

Antigonon **Endlicher**

Gen. Pl. 310.1837; Bentam & Hooker *f.*, Gen. Pl. 3: 103.1883. *Corculum* Stuntz in U.S. Dept. Agr. Bur. Pl. Ind. Bull. 282: 84. 1913.

Climbers. Leaves alternate, simple, lanceolate, cordate or deltoid. Flowers in raceme, cluster; tepals 5, pink; stamens 7–9, connate at base to form a tube; ovary trigonous. Achenes trigonous, tepals persistent.

Genus comprises about 3 species worldwide; native of Central America; 1 species was found in India; one species is recorded from West Bengal.

Antigonon leptopus Hooker & Arnott, Bot. Beechey Voy. 308. 1838; Maiti & Sikdar, Ind. J. Forestry 8(3): 197. 1985; Srivastava, Ind. J. Pl. Sc. 3(2): 113. 2014. *Corculum leptopus* (Hooker & Arnott) Stuntz, U. S. Dept. Agr. Bur. Pl. Ind. 282: 84. 1913. ***'Anantalata'***

Perennial, weak climbers. Stems pentagonal, usually 1.5–3.5 m long; Leaves opposite, lamina 8.5–9.5 × 11.8–14.09 cm, ovate-lanceolate, glabrous, margin ciliate, base truncate, acute. Flowers in axillary cymes; tepals 5, ovate, pink; stamens 7; ovary trigonous, styles reduced or rudimentary or absent, stigma 3, capitates. Achenes trigonous.

Flowering & Fruiting: July to November

Specimen examined: India. West Bengal: Malda District, Besides Malda Station, *Payel Paul & M. Chowdhury 0035*, dated 12.09.2015. Darjeeling District, Siliguri, *Payel Paul & M. Chowdhury 00135*, dated 17.10. 2018

Status: Common in roadside bushes

Distribution: India (Kerala, Karnataka, Rajasthan,Assam, Bihar, West Bengal), West Indies, Africa, N, C and S. America, Australia; native to Mexico; common in roadside bushes of Malda, Mursidabad, Bankura, Burdwan, Hoogly, Medinipur, Howrah (recently naturalized).

Note: The plant is used as ornamental plant worldwide.

Bistorta (Linnaeus) Scopoli

Meth. Pl. 24. 1754; Adans., Fam. 2: 277. 1763; Hara *et al*., Enum. Fl. Pl. Nepal 3: 173. 1982; Grierson & Long, Fl. Bhutan 1(1): 166. 1983; Munshi & Javeid, Syst. Stud. Polygon. Kashm. Himal. 58. 1986.

Perennial herbs or sub-shrubs. Root fibrous, rhizome thick. Stem erect, unbranched, glabrous. Leaves alternate, lower petiolate, upper sessile, linear, lanceolate to elliptic, oblong, acute or obtuse, entire, serrulate, crenate, glabrous usually with narrow margin. Ochreae tubular, thin, membranous, nerved. Inflorescence dense spikes, simple or branched. Flowers bisexual; tepals 5, entire-undulate, acute or obtuse; stamens 5–8, poorly developed, slightly or clearly exserted, anther dorsifixed or basifixed; ovary trigonous; styles 3, stigma minute. Achenes trigonous, ovoid, smooth, shiny and dark brown.

This genus comprises about 40 species in the world; 7 species in India; only 1 species was recorded from West Bengal.

Bistorta emodi (Meisner) H. Hara, FI. East. Himal. 69. 1966; Hara *et al*., Enum. Fl. Pl. Nepal 173. 1982; Grierson & Long, Fl. Bhutan l(1): 167. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 190. 1985. *Polygonum meissneri* Wallich, Cat. 1693. 1829, *nom. nud. Polygonum emodi* Meisner in Wall. Pl. Asia. Rar. 3: 51. 287. 1832; Hooker *f*., Fl. Brit. Ind. 5: 33. 1886; Steward, Contr. Gray Herb. 88: 29. 1930.

Perennial, branched, glabrous, prostrate herbs. Stem branched, 10–15 cm long, woody at base. Lamina 2.5–5 × 1.8–3 cm, lanceolate, acute and sessile. Ochreae 1.5–3 cm long, tubular, ovate, lacuminate or lacerate, membranous. Inflorescence erect, terminal, simple or branched, 3–4 cm. Flowers 1.8–2.9 mm across; tepals 4–5 parted, 4–5 mm long, oblanceolate, obtuse, deep red; stamens 8, filaments long, filiform; ovary 1–2 × 0.5–0.75 mm, trigonous, styles 3, free till middle, stigmas capitate. Achenes trigonous, glabrous, black, shining.

Flowering & Fruiting: July to September

Specimen examined: India. West Bengal: Darjeeling District, Tiger Hill, *Payel Paul & M. Chowdhury 0151*, dated 19.04.2019.

Status: Rarely occurring on the hilly slopes of Darjeeling Himalaya only

Distribution: India (Kashmir, Himachal Pradesh, Uttarakhand, West Bengal, Sikkim), Bhutan, W. China; Darjeeling hills (Tiger Hill to Sandakphu) at an antitude from 3500 m to 3636 m.

Fagopyrum Miller

Gard. Dict. Abr., ed. 4. 1754; Hooker *f*., Fl. Brit. Ind. 5: 54. 1886. D. A. Webb in Tutin et al., Fl. Europ. 1: 81. 1964; Hara *et al*., Enum. Fl. Pl. Nepal 3: 174. 1982; Grierson & Long, Fl. Bhutan 1(1): 171. 1983.

Annual or perennial, erect herbs. Stems round, branched, cylindrical. Leaves simple, alternate, petiolate, lamina entire, cordate or ovate, acute or acuminate, base cordate, hastate or deltoid. Ochreae entire, ciliate, oblique. Flowers in dense cyme or spike;

flowers pedicillate, tepals 5, white; stamens 5–8, attached at base; ovary trigonous, style 3, stigma capitates; Achenes trigonous, ovoid.

Genus comprises about 15 species worldwide; 6 species in India; only 2 species were recorded from West Bengal.

Key to the species

1a. Perennial, wild; sparsely pubescent herbs..... .... ***F. dibotrys***

1b. Annual, cultivated; glabrous herbs..... .... ***F. esculentum***

Fagopyrum dibotrys (D. Don) Hara, Fl. E. Himal. 69. 1966; Hara *et al*., Enum. Fl. Pl. Nepal. 3: 174. 1982; Grierson & Long, Fl. Bhutan 1(1): 171. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 197. 1985; Srivastava, Ind. J. Pl. Sc. 3(2): 115. 2014. *Polygonum dibotrys* D. Don, Prod. Fl. Nepal. 73: 1825. *Polygonum cymosum* Treviranus, Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur. 13: 177. 1826. *Fagopyrum cymosum* (Treviranus) Meisner in Wallich, Pl. As. Rar. 3: 63. 1832. ***'Ban Phappar'***

Perennial herbs. Stem branched, weak, green to brownish in colour. Leaves simple, alternate, petiolate, 0.7–1.8cm long, lamina 2.5–4.1 × 3.7–6.5 cm, deltoid, entire, acute; Ochreae 4.5 × 7.9 mm, brown, membranous; fimbriae present, no of the fimbriae 4, length 145.78µm. Flowers in terminal or axillary cymes, pedunculate; tepals 5, elliptic, white; stamens 8, anthers dorsifixed, bicelled; stigma 3, capitates, ovary trigonous. Achenes trigonous, smooth, black.

Flowering & Fruiting: June to September

Specimen examined: India. West Bengal: Darjeeling District, Lebong Road, *Payel Paul & M. Chowdhury 0081,* dated 21.09.2016; India. Darjeeling District, Tiger Hill Road *Payel Paul & M. Chowdhury 0087,* dated 22.02.2017.

Status: Abundantly found in temperate climates in Darjeeling and Kalimpong hills

Distribution: India (Jammu and Kashmir, Himachal Pradesh, West Bengal), Nepal, Bhutan, China, Tibet, Myanmar, Vietnam; temperate wet forest of Darjeeling upto meghma and tonglu in between the altitude ranges from 1600 m to 3636 m.

Note: Seeds, leaves used for treatment of colic, choleric diarrhoea and abdominal blockage troubles; young leaves used as vegetable.

Fagopyrum esculentum Moench, Meth. 290. 1794; Webb in Tutin *et al*., Fl. Europ. 1: 81. 1964; Grierson & Long, Fl. Bhutan 1(1): 171. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 197. 1985; Munshi & Javeid, Syst. Stud. Polygon. Kashm. Himal. 83. 1986; Srivastava, Ind. J. Pl. Sc. 3(2): 115. 2014. *Polygonum fagopyrum* Linnaeus, Sp. Pl. 1: 364. 1753. *Fagopyrum sagittatum* Gilibert, Exerc. Phyt. 2: 435. 1792. *Polygonum emarginatum* Roth, Catalect. B. 1: 48. 1797. *Fagopyrum vulgare* T. Nees, Gen. Fl. Germ. Monochl. 53. 1835. ***'Meethe Phaper*** or ***Titaphapur'***

Annual, erect herbs. Stems hollow, glabrous, green, nodes swollen. Leaves simple, alternate, petiolate, petiole 0.5–0.9 cm, lamina ovate-cordate, 2–4.8 × 3–5.5 cm. Ochreae funnel shaped, 0.7 × 0.6 cm; fimbriae present, no of the fimbriae 9, length 68.28µm. Flowers in axillary or terminal corymb; tepals 5, ovate, entire, obtuse, white or pink; stamens 8, anthers bicelled, dorsifixed; stigma 3 capitates; ovary trigonous. Achenes trigonous, ovoid, dark brown.

Flowering & Fruiting: May to October

Specimen examined: India. West Bengal: Jalpaiguri District, *Payel Paul & M. Chowdhury 0090*, dated 15.03.2017.

Status: Commonly cultivated species

Distribution: India (Jammu and Kashmir, Himachal Pradesh, West Bengal, Sikkim), Pakistan, Iran, China, Tibet, S Europe, N America; Darjeeling, Kalimpong, Jalpaiguri at an altitude ranges from 140 m to 1784 m.

Note: Leaves used as vegetable.

Fallopia Adans

Fam. 2: 274. 1763; emend. Holub, Folia Geobot. Phytotax. Praha, 6: 171. 1971; Hara *et al*., Enum. Fl. Pl. Nepal 3: 174. 1982; Grierson & Long, Fl. Bhutan 1(1): 169. 1983; Boulos, Fl. Egypt 1: 30. 1999.

Annual or perennial, herbs, Prostrate or twining. Stem branched, angular, ridged, glabrous or papillose. Leaves alternate, petiolate, ovate, base cordate, sagittate or hastate, entire. Ochreae usually tubular, deciduous. Flowers in axillary fascicles, racemes or panicle or spike, ochreolae tubular; tepals 5-parted, unequal, in 2 whorls; stamens 7–8, unequal; ovary trigonous, styles 3, stigmas capitate. Achenes trigonous, smooth or rough.

Genus comprises about 9 species worldwide; 4 species in India; only 1 species was recorded from West Bengal.

Fallopia convolvulus (Linneaus) A. Löve, Taxon. 19: 300. 1970; Holub, Folia Geobot. Phytotax. Praha 6: 176. 1971; Hara *et al*. Enum. Fl. Pl. Nepal 3: 174.1982; Grierson & Long, Fl. Bhutan l (1): 169. 1983; Ronse Decreane & Akeroyd, Bot. J. Linn. Soc. 98: 369. 1988. *Polygonum convolvulus* Linnaeus, Sp. Pl. 464. 1753; Hooker *f*., Fl. Brt. Ind. 5: 53.1886. *Bilderdykia convolvulus* (Linnaeus) Dumortum, Fl. Belg. 18: 1827; D.A.Webb in Tutin et al., Fl. Europ. 1: 81. 1964. *Fagopyrum convolvulus* (Linnaeus) H. Gross, Bull. Geogr. Bot. 23: 21. 1913; *Fagopyrum carinatum* Moench, Meth. 290. 1794. *Tiniaria convolvulus* (Linnaeus) Webb & Moq, Phyt. Canar. 3: 221. 1847.

Annual herbs. Stem twining, branched, angular, striate, slightly hairy, papillose at angles, light brown. Leaves alternate, petiole 1.2–3.0 cm long, lamina ovate or orbicular, 2–4 × 1–2 cm, glabrous-papillose, acute-acuminate, glabrous, midrib and vein network papillate, base cordate-sagitate, entire. Ochreae 2.3 × 4.8 mm long, tubular with slightly incised margins, membranous, glabrous, brown; fimbriae absent. Inflorescence is an axillary spike. Flower 4–5 × 2–2.3 mm, pedicillate; tepals 5, 4–5 × 1.2–1.8 mm, unequal, narrowly elliptic, slightly pubescent, persistent in fruit; stamens 8, unequal, anther bicelled, dorsifixed; ovary 1–3 × 0.6–2 mm, trigonous, styles 3, stigmas capitate. Achenes trigonous, ellipsoid, rough and brown.

Flowering & Fruiting: May to September

Specimen examined: India. West Bengal: Darjeeling District, Near Darjeeling Govt. College, *Payel Paul & M. Chowdhury 0058*, dated 21.06.2016.

Status: Rare occurrence; temperate climate in Darjeeling hills.

Distribution: Afghanistan, Kazakhstan, Pakistan, India (West Bengal, Sikkim), Nepal, Bhutan, Mongolia, Korea, Japan, Russia, Europe, introduced in N. America; Darjeeling and Kalimpong at an antitude from 1200m to 2800m.

Note: Seeds are used as nutritious food.

Homalocladium **(**F. Mueller) L .H. Bailey

Gentes Herb. 2 : 56. 1929.

Undershrubs, striate and glabrous phylloclades. Leaves alternate, lanceolate, entire. Flowers bisexual, sessile clusters at the joints; perianth 5- parted, accrescent in fruit; stamens 8–9, reduced to staminodes or absent in the female flowers; styles 3. stigmas 3, fimbriate; ovary trigonous. Achenes triangular, smooth.

Genus comprises about 23 species worldwide; 2 species in India; only 1 species was recorded from West Bengal.

Homalocladium platycladum (F. Mueller *ex* Hooker) L. H. Bailey, Gentes Herbarum. 2:56. 1929; R. R. Stewart, Ann. Cat. Vasc. Pl. W. Pak. & Kashm. 202. 1972; Maiti & Sikdar, Ind. J. Forestry 8(3): 197. 1985. *Coccoloba platyclada* F. J. Muel. *ex* Hooker, Bot. Mag. 5382. 1863; *Muehlenbeckia platyclada* (F. J. Muel. *ex* Hooker) Meisner, Bot. Zeit. 22: 313. 1865; Parker, For. Fl. Punj. Hazara 424. 1921 (reprint. ed.); Srivastava, Ind. J. Pl. Sc. 3(2): 116. 2014.

Perennial, erect, shrubs with broad, flat, thin, delicately striate, ribbon-like phylloclades. Leaves sessile, 0.9–1.2 × 1.7–2.3 cm, membranous, entire. Ochreae 1–2 mm long, ovate, obtuse. Flowers 1–6, sessile, bracteate, bracts ovate; perianth 5 segments, greenish, oblong, 1–2.3 mm long; stamens 8–9; ovary ovoid, 3-angular; styles 3. Achenes enclosed in the purplish perianth, black, rough.

Flowering & Fruiting: February to May

Specimen examined: India. West Bengal: Darjeeling District, NBU Campus, *Payel Paul & M. Chowdhury 0129*, dated 15.07.2018.

Status: Common; cultivated

General distribution: India (Various Botanical Gardens), Australia, Pacific Islands (New Zealand), America; Darjeeling, Howrah (cultivated)

Note: Entire plants are used for the treatment of anthracia, sores, snake bite, insect bite

Persicaria Miller

Gard. Dict. Abr. ed. 1754; Hooker *f.*, Fl. Brit. Ind. 5: 34. 1886; Grierson & Long, Fl. Bhutan 1(1): 159. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 196. 1985.

Annual or perennial, prostrate-suberect or erect, herbs. Stem herbaceous sometimes woody, simple or branched, round, angular, ridged, glabrous-scabrous or strigose. Leaves alternate, simple, petiolate or sessile or sub sessile, lamina linear-lanceolate or elliptic-ovate, glabrous or hairy, sometime dotted glands. Ochreae tubular, ciliate or sometime eciliate, hyaline, membranous, glabrous or strigose. Flowers in spike, raceme or capitate head; tepals 4–5, divided, occasionally glandular; stamens 5–8; stigmas capitates, ovary biconvex, trigonous. Achenes trigonous, ovoid, glabrous, brown-dark brown or blackish brown, smooth, shiny.

Genus comprises about 131 species worldwide; 56 species in India; 13 species was recorded from West Bengal.

Key to the species:

1a. Flowers on long recemes **2**

1b. Flowers on globose, condense head **3**

2a. Tepals 4; leaves glandular .... ***Persicaria lapathifolia***

2b. Tepals 5; leaves eglandular **4**

3a. Leaves heterophyllous, lamina oblanceolate-rhombate; ochreae glabrous; stamens 5 .. .. ***Persicaria nepalensis***

3b. Leaves homophyllous, lamina ovate; ochreae pubescent; stamens 8 .... ***Persicaria capitata***

4a. Ochreae ciliate **5**

4b. Ochreae not ciliate **6**

5a. Lamina linear - lanceolate; inflorescence terminal or axillary raceme **7**

5b. Lamina elliptic-ovate; inflorescence terminal spicate **8**

6a. Lamina elliptic - ovate **9**

6b. Lamina linear - elliptic **10**

7a. Stamen 6; apex acute - obtuse ..... ***Persicaria hydropiper***

7b. Stamen 8; apex acuminate - caudate ..... ***Persicaria posumbu***

8a. Leaf apex subacute - obtuse; ochreae glabrous; anther basifixed ..... ***Persicaria glabra***

8b. Leaf apex acute-acuminate; ochreae hispidus; anther dorsifixed **11**

9a. Base subcordate; penduncle eglandular; anthers dorsifixed ..... ***Persicaria chinensis***

9b. Base rounded; penduncle glandular; anthers basifixed ..... ***Persicaria campanulata***

10a. Anthers dorsifixed; achenes ellipsoid ..... ***Persicaria minor***

10b. Anthers basifixed; achenes trigonous ..... ***Persicaria tenella***

11a. Ochreae winged, broadly ovate; lamina ovate ..... ***Persicaria orientalis***

11b. Ochreae not winged, tubular; lamina elliptic..... **12**

12a. Lamina base cuneate; stamens 8 ..... ***Persicaria barbata***

12b. Lamina base saggitate; stamens 5–7 ..... ***Persicaria strigosa***

Persicaria barbata (Linnaeus) H. Hara, Fl. E. Himal. 70. 1966; Grierson & Long, Fl. Bhutan 1(1): 162. 1983; Maiti & Sikdar, Ind. J. Forestry 8 (3): 191. 1985. *Polygonum barbatum* Linnaeus, Sp. Pl. 1: 362. 1753; Hooker *f.*, Fl. Brit. Ind. 5: 37. 1886; Prain, Beng. Pl. 2: 663. 1903; Srivastava, Ind. J. Pl. Sc. 3(2): 123. 2014. *Polygonum hispidum* Buchanan-Hamilton *ex* D. Don, Prodr. Fl. Nepal. 71. 1825. ***'Bekh-unjubaz*** or ***Bish'***

Perennial, erect herbs. Stem glabrous, weak, branched, ridged, striated, greenish-brown. Leaves alternate, simple, sessile-subsessile, petiolate, lamina elliptic, 2.9–8.5

× 1.6–3.6 cm, tip acute-acuminate, base cuneate. Ochreae 1.8 × 0.8 cm long, tubular below margin ciliate, densely hispidulous, membranous, brown; fimbriae present, no of the fimbriae 7, length 108.65 µm. Inflorescence terminal, spicate, 2–10 cm long, 1–3 spikes aggregated, pedunculate. Flowers bisexual, glabrous, pedicelate; tepals 5, elliptic, obtuse, entire, unequal in two whorls, 3 outer and 2 inner; stamens 8, anther two celled, dorsifixed; styles 3, filiform, stigmas capitates; ovary broadly ovate, trigonous. Achenes ovoid, trigonous, smooth, shiny, blackish brown.

Flowering & Fruiting: August to October

Specimen examined: India. West Bengal: Darjeeling District, Lochka River Bed, *Payel Paul & M. Chowdhury 0092*, dated 17.03.2017; Jalpaiguri District, Kathambari beel *Payel Paul & M. Chowdhury 0120*, dated 22.05.2017

Status: Very common throughout the plains of West Bengal.

Distribution: Pakistan, India (throughout the temperatrate region), Nepal, Bhutan, Sri Lanka, Myanmar, Thailand, Vietnam, Malaysia, Indonesia, Philippines, China, New Guinea; moist and marshy areas of West Bengal plains.

Note: Watery sap from roots used as antiseptic.

Persicaria campanulata (Hooker *f*.) Ronse Decreane, Bot. J. Linn. Soc. 98: 367. *Aconogonon campanulatum* (Hooker *f*.) H. Hara, FI. East. Himal. 67. 1966; Maiti & Sikdar, Ind. J. Forestry 8 (3): 195. 1985. *Polygonum campanulatum* Hooker *f.* Fl. Brit. Ind. 5: 51. 1886; Srivastava, Ind. J. Pl. Sc. 3 (2): 123. 2014.

Perennial, herbs. Stems glabrous to pilose. Leaves deciduous, alternate, petiolate, lamina elliptic to ovate, 9.83–10.95 × 2.42–3.01 cm, acuminate, base rounded, appressed pilose above, margins entire. Ochreae persistent, tubular, 0.7 × 0.5 cm; fimbriae present, no of the fimbriae 8, length 112.25 µm. Inflorescences terminal, raceme like; peduncle present, glandular. Flowers bisexual; perianth non accrescent, white or pink, rotate, glabrous; tepals 5, connate, petaloid, slightly dimorphic, outer 2 smaller than inner 3; stamens 8, filaments distinct, free, anthers yellow to pink, basifixed; styles 3, erect or spreading, connate proximally, stigmas capitate. Achenes exserted, dark brown, unwinged, trigonous, glabrous

Flowering & Fruiting: July to August

Specimen examined: India. West Bengal: Darjeeling District, Tiger Hill, *Payel Paul & M. Chowdhury 0076,* dated 21.06.2016; Darjeeling, *Payel Paul & M. Chowdhury 0131,* dated 25.07.2018.

Status: Few plants found on the hilly slopes of Darjeeling Himalaya.

Distribution: India (West Bengal, Sikkim), Nepal, Bhutan, Myanmar; Hilly slopes of Darjeeling (Meghma, Tumling upto Sandakphu) at an altitude range from 2590m to 3636m.

Note: The plant is used as ornamental plant.

Persicaria capitata (Buchanan-Hamilton *ex* D. Don) H. Gross, Engl. Bot. Jahrb. 49. 277. 1913; H. Hara, FI. East. Himal. 70. 1966; Grierson & Long, Fl. Bhutan 1(1). 165. 1983; Maiti & Sikdar, Ind. J. Forestry 8 (3): 191. 1985. *Polygonum capitatum* Buchanan-Hamilton *ex* D. Don, Prodr. Fl. Nepal. 73.1825; Hooker *f*., Fl. Brit. Ind. 1: 44. 1886. Srivastava, Ind. J. Pl. Sc. 3 (2): 123. 2014. ***'Ratnyaule jhar'***

Perennial, decumbent herbs. Stem much branched, branches arising from base, reddish brown to black. Leaves alternate, simple, lamina broadly ovate, 2.5–3.14 × 1.21–1.82 cm, petiolate, entire, acute, base cuneate, serrate-undulate, both surfaces glabrous-slightly hairy. Ochreae ovate, tubular, 0.9 × 0.7 cm long, margin ciliate, membranous, pubescent; fimbriae present, no of the fimbriae 8, length 80.26µm. Inflorescence solitary, axillary, capitate head. Flowers pedunculate, hairy; tepals 5, oblanceolate, veins clearly visible, entire, obtuse; stamens 8, anther two celled, dorsifixed; styles 3, long, filiform, connate nearly to the middle, stigmas capitates, ovary trigonous. Achenes trigonous, smooth, black brown and shining

Flowering & Fruiting: May to September

Specimen examined: India. West Bengal: Darjeeling District, Ghoom, *Payel Paul & M. Chowdhury 0029,* dated 21.06.2015; Darjeeling, Lebong road, *Payel Paul & M. Chowdhury 0085,* dated 25.09.2016.

Status: Commonly found throughout the Darjeeling and Kalimpong hills.

Distribution: India (Arunachal Pradesh, Meghalaya, West Bengal, Sikkim), Nepal, Bhutan, Sri Lanka, Myanmar, Thailand, Vietnam, Malaysia; Darjeeling (Kurseong, Meghma), Kalimpong, at an altitude range from 1247m to 2600m.

Note: Ornamental, whole plant extract used as antidote in snakebite and insect sting.

Persicaria chinensis (Linnaeus) H. Gross, Engl. Bot. Jahrb. 49: 269, 277 & 315. 1913; H. Hara, FI. East. Himal. 70. 1966; Hara *et al*., Enum. Fl. Pl. Nepal 3: 175. 1982; Grierson & Long, Fl. Bhutan 1(1): 163. 1983; Maiti & Sikdar Ind. J. Forestry 8: 191. 1985.

Key to the variety:

1a. Ochreae and both surface of lamina glabrous **2**
1b. Ochreae and both surface of lamina hispidly hairy .... **var. *hispida***
2a. Lamina base truncate or sub-cordate; peduncle eglandular .... **var. *chinensis***
2b. Lamina base cordate; peduncle glandular .. .. **var. *ovalifolia***

Persicaria chinensis (Linnaeus) H. Gross var. ***chinensis*** in Engl. Bot. Jahrb. 49:269. 1913; H. Hara, FI. East. Himal. 70. 1966; Hara *et al*., Enum. Fl. Pl. Nepal 3: 175. 1982; Grierson & Long, Fl. Bhutan 1(1): 163. 1983; Maiti & Sikdar, Ind. J. Forestry 8: 191. 1985. *Polygonum chinense* Linnaeus, Sp. Pl. 1: 363. 1753; Meisnner in DC., Prodr. 14: 130. 1857; Hooker *f.*, Fl. Brit. Ind. 5: 44. 1886. *Ampelygonum chinense* (Linnaeus) Lindley, Bot. Reg. 24. 63. 1838. ***'Kakur thotne'***

Perennial herb or subshrubs, 30–40 cm tall. Stem erect-suberect, somewhat woody, much branched, round, ridged, glabrous, brownish green, internode 3.5–6 cm long. Lamina narrowly ovate-elliptic, lanceolate, 9.5–10.5 × 4.6–5 cm, petiole 5–9 mm long, acute-acuminate, base truncate or sub-cordate, ciliate, revolute, undulate, glabrous. Ochreae 3–4 cm long, glabrous, foliaceous, tubular below, slightly dentate above, lower portion brown and upper whitish in colour, veins clearly visible; fimbriae present, no of the fimbriae 6, length 147.75 µm. Inflorescence terminal or axillary corymb, peduncle eglandular, 3.5–4.5 cm long. Flowers 3–3.8 × 1.3–2.2 mm, pedicel 1 mm long; tepals 5 parted, 3–3.8 × 1–1.6 mm, ovate, entire, acute and glabrous. Stamen 8, filament 2–3 mm, slightly exserted, anther two celled,

dorsifixed; ovary 1.2–1.5 × 0.6–0.8 mm, trigonous, styles 3, 1.3–2 mm long, free above the middle. Nut 1–1.2 × 0.3–0.4 mm, ovoid, trigonous, dark brown.

Flowering & Fruiting: March to September

Specimen examined: India. West Bengal: Kalimpong district, Durpin, *Payel Paul & M. Chowdhury 0022*, dated 03.03.2015; Darjeeling district, Govt. College Road, *Payel Paul & M. Chowdhury 0057*, dated 03.07.2016.

***Status*:** Abundantly found throughout the northern part of the state.

Distribution: India (West Bengal, Sikkim, Karnataka, Kerala, Tamilnadu), Nepal, Bhutan, Sri Lanka, China, Myanmar, Philippines, Vietnam, Japan; introduced in Pakistan; Darjeeling, Kalimpong (Mirik), Jalpaiguri, Alipurduar ditricts in between the altitude ranges from 93 m upto 2042 m.

Note: Root used for fluxes, anthelminthic and neutralizes scorpion poisoning.

Persicaria chinensis (Linneaus) H. Gross var. ***hispida*** Kantachot, Thai. Bull. Bot. 38: 135: 2010. *Polygonum chinense* var. *hispidum* Hooker *f.*, Fl. Brit. Ind. 5: 45. 1886. *Polygonum chinense* var. *scabra* Gage, Rec. Bot. Surv. India 2: 408. 1903; Li *et al*., Fl. China 5. 301. 2003.

Perennial herbs. Stems erect, 84 cm tall, ligneous at base, much branched, striate, retrorsely hispid. Petiole 2 cm, lamina ovate-elliptic, 4–16 × 1.5–8 cm in diameter, apex shortly acuminate, base auriculate, base broadly cordate, both surface hispid, margin entire. Ochreae tubular, 1.2 cm long, membranous, hairy, much veined; fimbriae present, no of the fimbriae 7 – 8, length 156.78 µm. Inflorescence terminal, capitates, 4 mm long, aggregated, hispidly hairy; bract broadly ovate, each 3 flowered. Perianth white, 5-parted, tepals ovate, acrescent in fruit; stamens 8, included; style 3, connate. Achenes included in persistant perianth, black, opaque, broadly ovoid, trigonous, 3 mm long.

Flowering & Fruiting: August to November

Specimen examined: India. West Bengal: Kalimpong district, Durpin, Kalimpong, *Payel Paul & M. Chowdhury*, *0038*, *0040*, *0042*, dated 04. 10. 2015.

Status: Rarely occurring in hilly slopes of Durpin Monastry.

General distribution: India (Khasi Hills of Meghalaya, Kohima of Nagaland) Myanmar, Thailand, China; Kalimpong; Durpin Monastry (New Distributional Record) at an altitude 1372m.

Persicaria chinensis (Linnaeus) H. Gross var. ***ovalifolia*** (Linnaeus) H. Gross, Fl. E. Him. 71. 1966. Maiti & Sikdar, Ind. J. Forestry 8: 192. 1985. *Polygonum chinense* var. *ovalifolium* Meisner, Wall. P1. Asiat. Rar. 3: 60. 1832; Hooker *f*., Fl. Brit. Ind. 5: 45. 1886; Srivastava, Ind. J. Pl. Sc. 3(2): 125. 2014.

Perennial shrubs. Stems erect, much branched, striate, glabrous, and slightly woody. Petiole auriculate at base; lamina ovate, 10–21 × 4.3–9.2 cm, base cordate, margin entire, apex acuminate. Ochreae tubular, 2.7 cm long, glabrous, much veined; fimbriae present, no of the fimbriae 5, length 167.98 µm. Inflorescence terminal, capitates, aggregated penduncle glandular, hispid; Perianth white, 5-parted; tepals ovate, acrescent in fruit; stamens 8, included; style 3, connate. Achenes included in persistant perianth, black, opaque, broadly ovoid, trigonous

Flowering & Fruiting: July to November

Specimen examined: India. West Bengal: Darjeeling district, Kurseong (St Mary Hill), *Payel Paul & M. Chowdhury*, *0051*, *0056*, dated 14. 06. 2016.

Status: Rarely occurring on hilly slopes of Kurseong.

Distribution: India (West Bengal, Sikkim) Malaysia, Myanmar, Nepal, Thailand, S. Japan; Darjeeling (Kurseong) at an altitude of 1371m.

Persicaria glabra (Willdenow) M. Gómes, Ann. Inst. Segunda Ensef. Habana. 2: 278. 1896; Hara *et al*., Enum. Fl. Pl. Nepal. 3: 176. 1982; Grierson & Long, Fl. Bhutan 1(1): 161. 1983; Maiti & Sikdar, Ind. J. Forestry 8 (3): 192. 1985. *Polygonum glabrum* Willdenow, Sp. Pl. 2: 447. 1799; Meisner in DC., Prodr. 14: 115. 1856; Hooker *f*., Fl. Brit. Ind. 5: 34. 1886; Srivastava, Ind. J. Pl. Sc. 3(2): 123. 2014. **'*Bihagni*** or ***Seto Pire'***

Helophytes; perennial, erect herbs. Stem branched, glabrous, nodes swollen, reddish-dark brown. Leaves alternate, simple, petiolate, lamina entire, lanceolate or elliptic-oblong, 6.54–7.36 × 2.02–2.83 cm, acute-acuminate, base cuneate, glabrous on both surfaces. Ochreae tubular, 1.6 × 0.6 mm, margin ciliate, silvery, membranous, glabrous; fimbriae present, no of the fimbriae 9, length 94.96 µm. Inflorescence terminal, axillary, branched raceme. Tepals 5, overlapping, elliptic, entire, acute; stamens 6, anther two celled, basifixed; ovary ovoid, biconvex, styles 2, connate at the base, slightly exserted, stigmas capitate. Achenes biconvex, ovoid, smooth, shiny, brown.

Flowering & Fruiting: March to September

Specimen examined: India. West Bengal: Kalimpong district; Mirik, *Payel Paul & M. Chowdhury 0025*, dated 03.03.2015; Jalpaiguri district, Doumohani Beel, *Payel Paul & M. Chowdhury 0097*, dated 07.04.2017.

Status: Commonly found on the hilly slopes of Darjeeling Kalimpong Himalaya.

Distribution: India (West Bengal, Assam, Arunachal Pradesh), Bhutan, Bangladesh, Sri Lanka, Myanmar, Philippines, Thailand, Vietnam, Africa, Australia, N. and S. America, Pacific Islands; Moist areas throughout West Bengal at an altitudinal range from 9m upto 1495m.

Note: Plant juice and rootstock used in pneumonia, jaundice, fevers. Leaves are antispasmodic and are used for colic.

Persicaria hydropiper (Linnaeus) Spach, Hist. Veg. 10: 536. 1841; H. Hara, FI. East. Himal. 2: 23. 1971; Hara *et al.* Enum. Fl. Pl. Nepal. 3: 176. 1982; Grierson & Long, Fl. Bhutan1(1): 162. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 192. 1985. *Polygonum hydropiper* Linnaeus, Sp. Pl. 1: 361. 1753; Hooker *f.*, Fl. Brit. Ind. 5: 39. 1886; Webb & Chater in Tutin *et al*., Fl. Europ. 1:79. 1964; Srivastava, Ind. J. Pl. Sc. 3(2): 129. 2014. ***'Packur mul*** or ***Pire'***

Hyperhydrate, annual, erect or decumbent herbs. Stem simple or branched from base, glabrous, round, ridged, light brown-dark brown, nodes swollen, base woody. Leaves alternate, simple, petiolate, lamina 6.32–7.01 × 1.62–2.01 cm, lanceolate-

narrowly elliptic, acute-obtuse, ciliate, cuneate, both surfaces glabrous. Ochreae cylindrical, 18 × 9 mm, margin ciliate, cilia shorter than tubular portion, scabrous, fimbriae present, no of the fimbriae 12, length 70.79 µm. Inflorescence terminal spicate; flowers pedunculate. Tepals 5, entire, obtuse, elliptic, obovate; stamens 6, anther two celled, basifixed; styles 3, stigmas capitates, ovary trigonous. Achenes trigonous, dark brown and smooth.

Flowering & Fruiting: April to October

Specimen examined: India. West Bengal: Jalpaiguri district, Doumahoni Beel, *Payel Paul & M. Chowdhury 0050*, dated 02.04.2016; Darjeeling district, Kurseong, *Payel Paul & M. Chowdhury 0061*, dated 22.07.2016.

Status: Abundantly found on moist areas.

Distribution: Pakistan, India, Japan, Temperate Asia, N. and W. Africa, N. America, Europe; throughout marshy lands of West Bengal at an altitudinal range from 9 m to 1098 m (Humalaya).

Note: Seeds, leaves used for treatment of arthritis, bladder stone and cholera.

Persicaria lapathifolia (Linnaeus) S. F. Gray, Nat. Arr. Brit. Pl. 2: 270. 1821.

Key to the variety:

1a. Plant glabrous or sub glabrous, green ....**var. *lapathifolia***
1b. Plant sparsely pubescent, silvery .... **var. *lanata***

Persicaria lapathifolia (Linnaeus) S. F. Gray var. ***lapathifolia*** Nat. Arr. Brit. Pl. 2: 270. 1821; Hara *et al.* Enum. Fl. Pl. Nepal 3: 176. 1982; Grierson & Long, Fl. Bhutan 1(1): 161.1983. *Polygonum lapathifolium* Linnaeus Sp. Pl. 1: 360. 1753; Hooker *f*., Fl. Brit. Ind. 5: 35.1886; Maiti & Sikdar, Ind. J. Forestry 8(3): 189. 1985. Srivastava, Ind. J. Pl. Sc. 3(2): 130. 2014. *Polygonum lanatum* Roxburgh, Fl. Ind. 2: 285. 1832. *Polygonum nutans* Roxburgh, Fl. Ind. 2: 285. 1832.

Helophytes; Annual, erect herbs. Stem erect reddish brown to brown, upper portion leafy and hollow, base woody, round and ridged, swollen, glabrous or pubescent. Leaves alternate, simple, petiolate, lamina lanceolate-narrowly elliptic, 4–12.1 × 0.9–

3.4 cm, glandular, acute-subacute or obtuse, base attenuate-cuneate, entire, ciliate, upper surface glabrous or pubescent. Ochreae tubular, 2.4 × 0.8 cm, ovate, entire, dark brown, glabrous or pubescent; fimbriae present, no of the fimbriae 9, length 132.22 µm. Inflorescence axillary raceme, pedunculate. Tepals 4, in two whorls, whitish, elliptic, 2 tepals with acute apex and 2 obtuse, entire; stamens 6, unequal, filament thin, anther two celled and basifixed; styles 2, filiform, free above connate below, stigmas capitates; ovary biconvex. Achenes broadly ovate, biconvex, shining, blackish brown.

Flowering & Fruiting: March to September

Specimen examined: India. West Bengal: Darjeeling district, Ghoshpukur, *Payel Paul & M. Chowdhury 0045*, dated 20.03.2016; Doumahoni Beel, *Payel Paul & M. Chowdhury 0094*, dated 02.04.2017.

Status: Commonly found throughout the marshy land.

Distribution: India (West Bengal, Assam, Manipur, Tamilnadu), Pakistan, Temperate Asia, Japan, N. and W. Africa, N. America, Europe; throughout marshy lands of West Bengal at an altitudinal range from 9 m to 945 m (Himalaya).

Note: Decoctions from root used as cathartic and emetic drug.

Persicaria lapathifolia (L.) Delarbre var. ***lanata*** (Roxb.) H. Hara, Enum. Fl. Pl. Nepal 3: 176 1982.

Annual, erect herbs. Stem erect reddish brown to brown, upper portion leafy and hollow, base woody, round and ridged, swollen, pubescent. Leaves alternate, simple, petiolate, lamina lanceolate-narrowly elliptic, 8.32–13.5 × 3.5–4.6 cm, entire, glandular, acute-subacute or obtuse, base attenuate-cuneate ciliate, upper surface pubescent. Ochreae tubular, 2.34 × 1.13 cm, ovate, entire, dark brown, glabrous; fimbriae present, no of the fimbriae 5, length 149.87 µm. Inflorescence axillary raceme, pedunculate. Tepals 4, in two whorls, whitish, elliptic, 2 tepals with acute apex and 2 obtuse, entire; stamens 6, unequal, filament thin, anther two celled and basifixed; styles 2, filiform, free above connate below, stigmas capitates; ovary biconvex. Achenes broadly ovate, biconvex, shining, blackish brown.

Flowering & Fruiting: March to November

Specimen examined: India. West Bengal: Jalpaiguri District, Kathambari beel, *Payel Paul & M. Chowdhury 0053*, dated 26.05.2016; Darjeeling district, Siliguri, *Payel Paul & M. Chowdhury 0125*, dated 12.04.2018.

Status: Commonly found throughout the marshy land.

Distribution: India (West Bengal), Pakistan, China, Temperate Asia, Japan, N. America, Europe; throughout marshy lands of West Bengal at an altitudinal range from 89 m upto 140 m.

Persicaria minor (Hudson) Opiz, Seznam 72. 1852; Maiti & Sikdar, Ind. J. Forestry 8(3): 185. 1985. *Peutalis minus* (Hudson) Rafinesque, Fl. Tellur. 3: 14. 1837. *Polygonum minus* Hudson, Fl. Angl. 148. 1762.

Annual, creeping herbs. Stem glabrous. Lamina linear-lanceolate, 12.32–19.78 × 8.5–9.6 cm, scabrid below. Ochrea 7–10 mm long, shortly bristled at mouth. Inflorescence racemes like, 3 cm long, cylindrical, terminal; fimbriae present, no of the fimbriae 3 – 4, length 65.78µm. Flowers closely packed; tepals 5, pink, obtuse, ovate, united at base; stamens 5, anthers bicelled, dorsifixed; stigma capitates. Achenes biconvex, ellipsoid, brown, shining.

Flowering & Fruiting: April to August

Specimen examined: India. West Bengal: Jalpaiguri district, Doumohini beel, *Payel Paul & M. Chowdhury 0129*, dated 10.07.2018.

Status: Few species are found in small water bodies.

Distribution: India (West Bengal, Kerala), Malaysia, Thailand, Vietnam, Indonesia, Australia; throughout marshy lands of North Bengal at an altitude range from 24 m to 89 m.

Note: Young shoot and leaves are edible; Decoctions from leaves has been used in post-natal tonics and for treatment of digestion oil has been used for aromatherapy and in treatments for dandruff.

Persicaria nepalensis (Meisner) H. Gross, Bot. Jahrb. 49(2): 277. 1913; Hara *et al*., Fl. East. Himal. 72. 1966; Grierson & Long, Fl. Bhutan 1(1):164. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 193. 1985. *Polygonum nepalense* Meisner, Monog. Polyg. 84. 1826; Hooker *f*., Fl. Brit. Ind. 5: 41. 1886; Srivastava, Ind. J. Pl. Sc. 3(2): 132. 2014. *Polygonum punctatum* Buchanan-Hamilton *ex* D. Don, Prodr. Fl. Nepal. 73. 1825. ***'Ratnaaulo*** or ***Priya Ghaans*** or ***Raunne'***

Annual herbs. Stem simple or branched, round, glabrous, sometime upper portion of branches bear hair like structures with glandular tip. Leaves heterophyllous, petiole slightly winged, upper leaves oblanceolate-rhombate, lower leaves broadly ovate-rhomboid, 1.8–5.09 × 1.23–3.5 cm, base auricled, base truncate, margin entire-slightly hairy, gland dots are present. Ochreae tubular, 0.56 × 0.21 cm, truncate, upper portion glabrous, lower strigose, brownish; fimbriae absent. Inflorescence corymbose head, axillary, pedunculate. Flowers shortly pedicellate; tepals 4, obtuse, obovate; stamens 5, filament unequal, anther two celled, basifixed; ovary biconvex, styles 2, united below, stigmas capitate. Achenes biconvex, smooth, shining, light brown to dark enclosed in perianth.

Flowering & Fruiting: June to September

Specimen examined: India. West Bengal: Darjeeling district, Kurseong, *Payel Paul & M. Chowdhury 0065*, dated 22.07.2016; Darjeeeling district, Tumling, *Payel Paul & M. Chowdhury 0121*, dated 15.04.2018.

Status: Commonly found on the hilly slopes of Darjeeling Kalimpong Himalaya.

Distribution: Pakistan, Afghanistan, India (Arunachal Pradesh, Meghalaya, Kashmir to Sikkim), Nepal, Bhutan, China, Japan, Malaysia, Thailand, Indonesia, Philippines, Korea, Russia, New Guinea, Tropical Africa; Darjeeling (Kurseong upto Meghma), Kalimpong at an altitude range from 1250m to 2600m.

Note: Whole plant extract used in the treatment of swelling.

Persicaria orientalis (Linnaeus) Spach, Syst. Veg. 537. 1841; Grierson & Long, Fl. Bhutan 1(1): 161. 1983. *Persicaria orientale* Assenov, FI. Reipubl. Popul. Bulgar. 3: 250. 1966; Maiti & Sikdar, Ind. J. Forestry 8(3): 193. 1985. *Polygonum orientale*

Linnaeus, Sp. Pl. 1: 362. 1753; Hooker *f.*, Fl. Brit. Ind. 5: 30. 1886; Prain, Beng. Pl. 2: 663. 1903; Srivastava, Ind. J. Pl. Sc. 3(2): 133. 2014. *Persicaria pilosum* Roxburgh, Fl. Ind. 2: 286. 1832. *Persicaria tibetica* Rendle, J. Bot. 428. 1900. *Amblyogonum orientale* (Linnaeus) Nakai in Mori., Enum. Pl. Cor. 192. 1922. '***Bishkatala'***

Helophytes; annual, erect herbs. Stem round and ridged, strigose, olive green-brown, nodes clearly swollen, base woody. Leaves alternate, simple, petiolate, densely strigose, lamina broadly ovate, 5.5–14 × 2.9–6.2 cm, acute-acuminate, base truncate, ciliate, entire-undulate. Ochreae tubular, broadly ovate, margin ciliate, strigose. Inflorescence terminal raceme, pedunculate, hirsute. Tepals 5, unequal, gland dotted, lanceolate-ovate, entire, obtuse; stamens 7, filament unequal, anther two celled, basifixed; styles 2, united up to middle, stigmas capitates, ovary biconvex. Achenes trigonous, biconvex, brownish black.

Flowering & Fruiting: May to September

Specimen examined: India. West Bengal: Jalpaiguri district, Doumohini beel, *Payel Paul & M. Chowdhury 0031*, dated 17.07.2015; Malda district, Nayagram beel, *Payel Paul & M. Chowdhury 0101*, dated 16.04.2017.

Status: Abundantly grows on moist areas.

Distribution: India (West Bengal, Asssam, Kerala), China, Japan, Korea, Malaysia, Thailand, Indonesia, Philippines; throughout moist areas of the West Bengal at an altitudinal range from 25m to 142m.

Note: Ornamental; nuts are used in tuberculous swellings and flatulence; decoction of the ripe fruits is used in the treatment of hepatitis, sloughing ulcers, tympanites and cancer.

Persicaria posumbu (Buchanon-Hamilton *ex* D. Don) H. Gross, Engl. Bot. Jahrb. 49: 313. 1913; H. Hara, FI. East. Himal. 73. 1966; Hara *et al*., Enum. Fl. Pl. Nepal 3: 177. 1982; Grierson & Long, Fl. Bhutan 1(1): 162. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 193. 1985. *Polygonum posumbu* Buchanon-Hamilton *ex* D. Don, Fl. Nepal. 71. 1825; Hooker *f.*, Fl. Brit. Ind. 5: 38. 1886; R. R. Stewart, Ann. Cat. Vasc.

Pl. W. Pak. & Kashm. 211. 1972; Srivastava, Ind. J. Pl. Sc. 3(2): 136. 2014. *Polygonum caespitosum* Blume, Bijdr. 532. 1826; *Polygonum donii* var. *tenerum* Meisn. in Wall. Pl. As. Rar. 3: 58. 1832.

Perennial, herbs. Stem erect, decumbent, angular, ridged, glabrous, light brown. Leaves alternate, petiolate, slightly pubescent, lamina narrowly ovate or elliptic - lanceolate, 1.7–4.5 × 1.2–1.5 cm, acuminate-caudate, base cuneate, entire, pubescent, on upper surface midrib vein network sparsely strigose. Ochreae 1.8–3.1 cm, hyaline, membranous, tubular below, ciliate, cilia shorter, glabrous; fimbriae present, no of the fimbriae 6–7, length 81.38 µm. Inflorescence axillary or terminal, raceme with variable number of flowers, pedunclate, glabrous. Tepals 5-parted, 2–3 × 1.9–2.3 mm, obtuse, slightly undulate; stamens 8, unequal, exserted, filament long, anther to celled and basifixed; ovary trigonous, oblong with 3 styles which are united below, stigmas capitate. Achenes trigonous, ovoid, blackish brown, smooth and shiny.

Flowering & Fruiting: May to October

Specimen examined: India. West Bengal: Malda district, Nayagram beel, *Payel Paul & M. Chowdhury 0140*, dated 21.08.2018.

Status: Commonly occurring in marshy land.

Distribution: India (West Bengal, Sikkim, Assam, Arunachal Pradesh, Meghalaya, Manipur, Nagaland), Nepal, Bhutan, China, Bangladesh, Malaysia; Marshy areas of North Bengal plains at an altitudinal range from 17m to 1560 m.

Note: Decoction is used in the treatment of dysentery, enteritis, boils and abscesses; aromatic leaves are added to other vegetables for flavor.

Persicaria strigosa (R. Brown) Nakai, Rigakkwai 24: 299 1926; Maiti & Sikdar, Ind. J. Forestry 8(3): 194. 1985. *Polygonum bodinieri* H. Léveille & Vaniot, Bull. Acad. Int. Géogr. Bot. 11: 343 1902. *Polygonum strigosum* R. Brown, Prodr. Fl. Nov. Holl. 420 1810; Hooker *f.*, Fl. Brit. Ind. 5: 47. 1886; Prain, Beng. Pl. 2: 664. 1903; Srivastava, Ind. J. Pl. Sc. 3(2): 139. 2014. *Tracaulon strigosum* (R. Brown) Greene, Leafl. Bot. Observ. Crit. 1: 22 1904.

Hyperhydrate; annual, erect or decumbent herbs. Stems branched, angulate. Leaves alternate, simple, petiolate, laminaelliptic or lanceolate, 17– 23.34 × 4.2–8.5 cm, glabrous or sparsely strigose adaxially, acuminate or acute, base sub sagittate or hastate margin ciliate. Ochreae tubular, 1.7 × 0.6 cm, membranous, with dense strigose at base, apex truncate, long ciliate; fimbriae present, no of the fimbriae 8, length 132.85 µm. Inflorescence spicate; peduncle branched, 2 or 3-flowered, densely pubescent, sparsely glandular hairy; bracts elliptic or ovate, usually strigose. Tepals 5-parted, elliptic, pinkish; stamens 5–7; styles 2–3, stigmas capitate. Achenes biconvex or trigonous, perianth persistent, dark brown, dull, nearly orbicular.

Flowering & Fruiting: May to October

Specimen examined: India. West Bengal: Darjeeling district, Ghoom, *Payel Paul & M. Chowdhury 0037*, dated 15.07.2015; Jalpaiguri district, Kathambari beel, *Payel Paul & M. Chowdhury 0091*, dated 15.03.2017.

Status: Commonly found on moist places.

Distribution: India (West Bengal, Himalchal Pradesh, Uttarakhand) Nepal, Bhutan, Bangladesh, Myanmar, Malaysia, Thailand, Indonesia, Vietnam, Australia, New Guinea; Darjeeling (Kurseong, Tiger hill), marshy areas of Jalpaiguri at an altitudinal range from 89m to 3260m.

Note: Tender roasted shoots are used for the dysentery of cattles

Persicaria tenella (Blume) Hara, J. Jap. Bot. 44: 375. 1969; Hara *et al.*, Fl. E. Himal. 2: 23. 1971; Grierson & Long, Fl. Bhutan 1(1): 163. 1983. *Polygonum tenellum* Blume, Bijdr. 530. 1825. *Polygonum minus* Hooker *f.*, Fl. Brit. Ind. 5: 36. 1886. *Polygonum kawagoeanum* Makino, Bot. Mag. Tokyo 28: 115. 1914; Srivastava, Ind. J. Pl. Sc. 3(2): 130. 2014. *Persicaria kawagoeana* (Makino) Nakai, Rigakukai 24: 12. 1926; Prain, Beng. Pl. 2: 663. 1903; Munshi & Javeid, Polygon. Syst. Stud. Kashm. Himal. 64. 1986; Maiti & Sikdar, Ind. J. Forestry 8(3): 192. 1985. *Polygonum tenellum* var. *kawagoeanum* (Makino) Murata, Acta Physt. Geobot. 26: 88. 1974.

Helophytes; annual, erect-ascending herbs. Stem, terete, ridged, reddish, internode. Leaves alternate, simple, sessile-subsessile, lamina linear-lanceolate, oblong, 1.5–6.9 × 0.3–1.4 cm, subacute-obtuse, base attenuate, ciliate, glabrous above and below. Ochreae tubular, 0.5 × 0.6 cm, membranous, papery, margin shortly ciliate; fimbriae present, no of the fimbriae 10, length 104.85 µm. Inflorescence axillary or terminal raceme, pedunculate. Tepals 5, unequal, oblanceolate, acute, entire; stamens 5, anthers two celled, basifixed; style 3, connate below stigmas capitates; ovary orbicular. Achenes biconvex, trigonous, smooth, shining, dark brown.

Flowering & Fruiting: March to September

Specimen examined: India, West Bengal: Kalimpong district, Kalimpong College campus, *Payel Paul & M. Chowdhury 0033*, Dated 17.07.2015; Darjeeling district, Lochka River Bed, *Payel Paul & M. Chowdhury 0043*, Dated 08.03.2016.

Status: Abundantly grows on moist land.

Distribution: India (Himachal Pradesh, Jammu and Kashmir, N. E. India specially Assam, Manipur, Meghalaya, Sikkim, Uttarakhand, Tamilnadu), Pakistan, Nepal, China, Japan, Bangladesh, Myanmar, Malaysia, Europe; throughout the moist lands of North Bengal plains at an altitude range from 65m to 1750m.

Polygonum Linnaeus

Sp. Pl. 359. 1753; Hooker *f*., Fl. Brit. Ind. 5:23. 1886.

Marshland, annual or perennial, prostrate-erect, sometimes shrubby, simple or branched herbs. Stem branched from base with procumbent or decumbent branches, round or angular, smooth or ridged, glabrous or scabrous with variable colours. Leaves small, sessile or subsessile, lamina linear, lanceolate, elliptic – oblong, acute or acuminate-aristate or obtuse, cuneate, entire, revolute, undulate, pubescent or scabrous. Ochreae small, silvery or whitish, hyaline, membranous, tubular, lacerate, sometimes so numerous giving the whole plant whitish appearance. Inflorescence axillary, solitary or in few flowered cluster. Tepals 5–6, elliptic-ovate, lanceolate or of variable shape, may be unequal in size; stamens 5–6 or 8, filaments short, may be unequal, dilated at the base, anther two celled, dorsifixed or basifixed; 2–3 styles

with capitate stigmas; ovary ovate, trigonous,. Nuts biconvex, ovate, trigonous, dark brown, black, shining, smooth, striated, sometimes hairy.

Genus comprises about 60 species worldwide; 38 species in India; 7 species was recorded from West Bengal.

Key to the species:

1a. Lamina pinnatified, runcinate..... .... ***Polygonum runcinatum***
1b. Lamina not pinnatified, elliptic – lanceolate or ovate – oblong **2**
2a. Ochreae glabrous **3**
2b. Ochreae pubescent **4**
3a. Stem retrosely prickled; lamina triangular, peltate .... ***Polygonum perfoliatum***
3b. Stem glabrous; lamina elliptic – lanceolate **5**
4a. Aromatic; hairs glandular, viscous; bracts pubescent…….. ……. ……... ..... ***Polygonum viscosum***
4b. Non aromatic; hairs non glandular, bracts glabrous .... …… ……. ……. …..... ***Polygonum pubescens***
5a. Petioles winged, not auriculate; lamina base cordate ..... …….. ……... ***Polygonum microcephalum***
5b. Petioles not winged, auriculate; lamina base cuneate **6**
6a. Flowers on axillary fascicles; prostrate small herbs.... ... . ……. ……... ……..... ***Polygonum plebeium***
6b. Flowers on panicle; erect, large bushy shrubs .... ***Polygonum molle***

Polygonum microcephalum D. Don, Prodr. Fl. Nepal. 72. 1825; Hooker *f.*, Fl. Brit. Ind. 5:42. 1886; Srivastava, Ind. J. Pl. Sc. 3(2): 131. 2014. *Persicaria microcephala* (D. Don) H. Gross in Engler, Bot. Jahrb. 49: 277. 1913; Hara *et al.*, FI. East. Himal. 72. 1966; Maiti & Sikdar, Ind. J. Forestry 8(3): 193. 1985.

Perennial, erect or decumbent herbs. Rhizomes stout. Stems angulate, branched. Leaves alternate, simple, petiole winged, lamina broadly ovate or triangular-ovate, 18.5–23.33 × 5.02–7.67 cm, both surfaces glabrous-pilose, acuminate, base subrounded, decurrent along petiole forming a wing, margin entire, ciliate. Ochreae tubular, 1.8 × 0.4 cm, pubescent, apex truncate, ciliate; fimbriae present, no of the fimbriae 7, length 89.25 µm. Inflorescence terminal, usually geminate, capitates;

peduncle glabrous or glandular hairy; bracts ovate, apex acute. Tepals 5-parted, white or pinkish, elliptic; stamens 8; styles 3, connate to below middle; stigmas capitate. Achenes black-brown, opaque, broadly ovoid, trigonous, punctuate.

Flowering & Fruiting: April to October

Specimen examined India. West Bengal: Darjeeling district, Govt. College road, *Payel Paul & M. Chowdhury 0073*, dated 21.06.2016; Darjeeling district, Singamari, *Payel Paul & M. Chowdhury 0133*, dated 25.07.2018.

Status: Rarely occuring on the hilly slopes of Darjeeling - Kalimpong Himalaya.

Distribution: India (Assam, Meghalaya, Nagaland, Sikkim), Nepal, Bhutan, China, Bangladesh; Temperate hilly areas of Darjeeling, Kalimpong at an altitude range from 1260 m to 3456 m.

Note: Young shoot and seeds are used as vegetable and condiment respectively.

Polygonum molle D. Don Prodr. Fl. Nepal. 72. 1825; Hooker *f*., Fl. Brit. Ind. 5: 50. 1886; Maiti & Sikdar, Ind. J. Forestry 8(3): 195. 1985; Srivastava, Ind. J. Pl. Sc. 3(2): 132. 2014. *Aconogonum molle* (D. Don) H. Hara, Fl. E. Himal. 68. 1966. *Persicaria mollis* (D. Don) H. Gross, Bull. Géogr. Bot. 23: 31. 1913. *Polygonum molle* var. *frondosum* (Meisner) A. J. Li, Fl. Xizangica. 1: 622. 1983. ***'Tuknu*** or ***Patusua'***

Annual, erect or sometimes ascending, bushy subshrubs. Stems much branched, retrorsely hirsute or glabrous. Leaves alternate, simple, petiolate, densely pubescent or glabrous, lamina elliptic or elliptic-lanceolate, 19.87–23.36 × 15.33–16.09 cm, acuminate, base cuneate, entire, both surfaces glabrous. Ochreae dark brown, 0.7 × 0.4 cm, tubular, membranous, oblique, glabrous; fimbriae present, no of the fimbriae 8, length 116.87 µm. Inflorescence spreading, paniculate. Tepal 5-parted, white, elliptic, accrescent and fleshy in fruit, darkened; stamens 8; styles 3, free, stigmas capitate. Achenes trigonous, ovoid, slightly exceeding perianth, black, shiny.

Flowering & Fruiting: August to November

Specimen examined: India. West Bengal: Kalimpong district, Durpin, *Payel Paul & M. Chowdhury 0024*, dated 03.03.2015; Darjeeling district, Kurseong, *Payel Paul & M. Chowdhury 0066*, dated 22.07.2016; Darjeeling district, Sandhakphu, *Payel Paul & M. Chowdhury 0122*, dated: 15.04.2018.

Status: Abundantly grown on the temperate hilly region.

Distribution: India (Arunachal Pradesh, Sikkim), Nepal, Bhutan, N Myanmar, Thailand, Indonesia; throughout the temperate hilly areas of Darjeeling (Kurseong, Tumling, Meghma upto Sandakphu), Kalimpong at an altitude range from 1267 m to 3636 m.

Note: The whole plant used as astringent; young shoot, leaves and seeds are edible

Polygonum perfoliatum Linnaeus, Syst. Nat., ed. 10, 2:1006. 1759; Hooker *f*., Fl. Brit. India 5: 46. 1886; Prain, Beng. Pl. 2: 664. 1903; Srivastava, Ind. J Pl. Sc. 3(2): 134. 2014. *Persicaria perfoliata* (L.) H. Gross in Engl., Bot. Jahrb. 49: 275. 1913; Hara *et al*., FI. East. Himal. 72. 1966; Maiti & Sikdar, Ind. J. Forestry 8(3): 193. 1985. *Ampelygonum perfoliatum* (Linnaeus) Roberty & Vautier, Boissiera 10: 31. 1964. *Fagopyrum perfoliatum* (Linnaeus) Raffinose, Fl. Tellur. 3: 10. 1837. *Truellum perfoliatum* (Linnaeus) Soják, Preslia 46: 148. 1974.

Annual, weak, large marshland herbs. Stems trailing, branched, angulate, with retrorse prickles along angles, red-brown. Leaves alternate, simple, petiolate, sparsely retrorsely prickly, lamina triangular-peltate, 3.5–5.49 × 1.3–2.97 cm, abaxially usually sparsely retrorsely prickly along veins, adaxially glabrous, subacute, base truncate or subcordate. Ochreae tubular, 1.34 × 0.63 cm, with green herbaceous orbicular wing at apex; fimbriae present, no of the fimbriae 3, length 62.59 µm. Inflorescence terminal or axillary, spicate, bracts ovate-orbicular, each 2–4 flowered. Tepals 5-parted, elliptic, white or pinkish, in fruit dark blue, accrescent, fleshy; stamens 8, in 2 whorls, included; styles 3, connate at middle. Achenes with persistent perianth, black, shiny, globose

Flowering & Fruiting: June to October

Specimen examined: India. West Bengal: Alipurduar district, Palasbari, *Payel Paul & M. Chowdhury 0126*, dated 13.06.2018.

Status: Rarely occurring.

Distribution: India (Himachal Pradesh, Jammu and Kashmir, Uttarakhand West Bengal, Sikkim, Arunachal Pradesh), Nepal, Bhutan, China, Japan, Korea, Bangladesh, Vietnam, Malaysia, Thailand, Indonesia, Philippines, New Guinea, Russia, N. America; Darjeeling Himalaya, Coochbeher at an altitude range 48 m upto 2080 m.

Note: Tender leaves, shoots and fruit are edible; whole plant is depurative, diuretic, febrifuge and also used to stimulate blood circulation; decoction is used in the treatment of dysentery, enteritis, boils and abscesses, poisonous snake bites, haematuria, cloudy urine and traumatic injuries.

Polygonum plebeium R. Brown, Prodr. Fl. Nov. Holl. 420. 1810; Hooker *f*., Fl. Brit. Ind. 5: 27. 1886; Prain, Beng. Pl. 2: 662 1903; Hara *et al*., FI. East. Himal.75. 1966; Maiti & Sikdar, Ind. J. Forestry 8(3): 189. 1985; Srivastava, Ind. J. Pl. Sc. 3(2): 132. 2014. *Avicularia indica* Didrichs, Bot. Not. 1850: 187. 1850. *Polygonum changii* Kitagawa, J. Jap. Bot. 40(2): 54. 1965. *Polygonum herniarioides* Sprengel, Syst. Veg. 2: 256. 1825. *Polygonum roxburghii* Meisner, Prodr. 14: 93. 1856. ***'Chemti sag*** or ***Bethe'***

Annual, prostrate herbs. Stems much branched at base. Leaves alternate, simple, sessile or sub-sessile, lamina narrowly elliptic or oblanceolate, 0.5–1.0 × 0.1–0.2 cm, entire, obtuse or acute, base narrowly cuneate. Ochreae white, 0.5 × 0.8 cm, membranous, apex lacerate; fimbriae present, no of the fimbriae 11, length 68.41 µm. Flowers in axillary fascicles; bracts membranous; tepals 5-parted, narrowly elliptic, abaxially with prominent veins; stamens 5, filaments included; styles 3, rarely 2, very short, stigmas capitates. Achenes broadly ovoid, trigonous or biconvex, smooth, persistent perianth, black-brown, shiny.

Flowering & Fruiting: May to August

Specimen examined: India. West Bengal: Darjeeling district, Sukna forest, *Payel Paul & M. Chowdhury 0063, 0064*, dated 15.07.2016.

Status: Commonly found throughout the plains.

Distribution: Kazakhstan, India (Andhra Pradesh, Assam, Daman, Goa, Gujarat, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, West Bengal), Nepal, Myanmar, Philippines, Indonesia, Thailand, Japan, N. Africa, Australia, Russia, Europe (introduced); throughout the plains of West Bengal at an altitude ranges from 20 m upto 140 m.

Note: Leaves used for the treatment of pneumonia and young leaves are used as vegetable; roots are used in treatment of baldness.

Polygonum pubescens Blume, Bijdr. F1. Ned. Ind. 532. 1826. *Polygonum flaccidum* Meisner, Prodr. 14(1): 107. 1856; Hooker *f.*, Fl. Brit. Ind. 5: 39.1886; Prain, Beng. Pl. 2: 664. 1903; Srivastava, Ind. J. Pl. Sc. 3(2): 136. 2014. *Persicaria pubescens* (Blume) H. Hara, J. Jap. Bot. 17(6): 335. 1941; Maiti & Sikdar, Ind. J. Forestry 8(3): 193. 1985. *Polygonum hydropiper* var. *flaccidum* (Meisner) Steward, Contr. Gray Herb. 88: 59 1930.*Polygonum hydropiper* var. *hispidum* (Buchanan-Hamilton *ex* D. Don) Steward, Contr. Gray Herb.88: 60 1930.

Annual, erect, marshland herbs. Stems erect, sparsely hispid, branched above, swollen at nodes. Leaves, alternate, simple, petiolate, lamina ovate-lanceolate or broadly lanceolate, 21.32–23.0×8.76–9.58 cm, apex acuminate-acute, base broadly cuneate, both surfaces densely hispidulous, margin ciliate. Ochreae tubular, 1.1 × 0.8 cm, membranous, hispid, apex truncate, stoutly long ciliate; fimbriae present, no of the fimbriae 5, length 109.87 µm. Inflorescence terminal or axillary spicate, interrupted below; bracts green, funnel-shaped, margin sub membranous, ciliate, each 3- or 4-flowered; pedicels longer than bracts, slender. Tepals 5-parted, green, red above, glandular punctuate, elliptic; stamens 8; styles 3, connate to below middle. Achenes ovoid, trigonous, persistent perianth, black.

Flowering & Fruiting: August to November

Specimen examined: India. West Bengal: Darjeeling district, Lochka River Bed, *Payel Paul & M. Chowdhury 036*, dated 12.09.2015; Darjeeling district, Lebong road, *Payel Paul & M. Chowdhury 0100*, dated 22.04.2017.

Status: Few plants occur on the moist places.

Distribution: India (West Bengal, Kashmir, Himachal Pradesh), Bhutan, Indonesia, Japan, Korea; throughout moist areas of West Bengal at altitude range of 10 m to 3125 m.

Note: Leaves and seeds are edible; decoction of the plant, combined with onion, is used as a styptic; bruised plant is applied locally to blistered and swollen feet.

Polygonum runcinatum Buchanan-Hamilton *ex* D. Don, Prodr. Fl. Nepal. 73 1825; Hooker *f.*, Fl. Brit. Ind. 5:43.1886; Srivastava, Ind. J. Pl. Sc. 3(2): 138. 2014. *Persicaria runcinata* (Buchanan-Hamilton *ex* D. Don) H. Gross in Englar, Bot. Jahrb. 49: 277. 1913; Hara *et al*., FI. East. Himal. 74. 1966; Maiti & Sikdar, Ind. J. Forestry 8(3): 194. 1985. *Polygonum panduriforme* H. Léveilli & Vaniot, Bull. Acad. Int. Géogr. Bot. 11: 343. 1902. ***'Seto pire'***

Perennial, suberect or ascending herbs. Rhizomes stout. Stems angulate, pilose or subglabrous, usually nodes retrorsely appressed hispid. Leaves simple, alternate, petiolate, narrowly winged, base auriculate, lamina pinnatifid, terminal lobe triangular, large, 18.76–23.34×11.76–15.58 cm, apex acuminate, lateral lobes smaller, margin shortly ciliate, both surfaces sparsely strigose or glabrous. Ochreae tubular, 0.6 × 0.3 cm, membranous, pubescent, apex truncate, ciliate; fimbriae absent. Inflorescence terminal, corymbose or paniculate, peduncle glandular hairy; bracts narrowly ovate, margin membranous; pedicels shorter than bracts, slender. Tepals 5-parted, pinkish or white; narrowly ovate; stamens usually 8; anthers purple; styles 3. Achenes ovoid, trigonous, persistent perianth, black-brown, opaque.

Flowering & Fruiting: July to September

Specimen examined: India. West Bengal: Darjeeling district, Lebong Road, *Payel Paul & M. Chowdhury 0069*, dated 27.07.2016; Darjeeling district, Govt. College Road, *0139*, dated 19.07.2018

Status: Commonly found on temperate hilly slopes.

Distribution: India (Jammu and Kashmir, Nagaland, Sikkim, Assam, Tamilnadu), Nepal, Myanmar, Malaysia, Philippines, Thailand, Indonesia (Sumatra); Temperate parts of Darjeeling (Kurseong), Kalimpong (Mirik) at an altitude range from 1540 m to 3437 m.

Note: Leaves are edible.

Polygonum viscosum Buchanan-Hamilton *ex* D. Don, Prodr. Fl. Nepal. 71. 1825; Hooker *f.*, Fl. Brit. India 5: 36. 1886; Prain, Beng. Pl. 2: 663. 1903; Srivastava, Ind. J. Pl. Sc. 3(2): 141. 2014. *Persicaria viscosa* (Buchanan-Hamilton *ex* D. Don) Nakai, Rigakkai 24: 300. 1926; Hara, Fl. East. Himal. 24. 1971; Maiti & Sikdar, Ind. J. Forestry 8(3): 194. 1985. *Polygonum kuekenthalii* H. Léveilli, Cat. Pl. Yun-Nan. 207. 1916. ***'Bishkatali'***

Annual, erect or ascending, herbs. Stems much branched, densely hirsute and glandular hairy. Leaves alternate, simple, seseelie or sub-sessile, lamina ovate-lanceolate or elliptical-lanceolate, 25.65 – 29.87× 11.87 – 14.09 cm, both surfaces hispid, densely so along veins, margin entire, densely shortly ciliate. Ochreae tubular, 1.9 × 0.6 cm, membranous, densely glandular hairy and hirsute, apex truncate, long ciliate; fimbriae present, no of the fimbriae 10, length 112.22 µm. Inflorescence terminal or axillary spicate, usually several spikes aggregated and panicle-like; peduncles densely hirsute and glandular hairy; bracts funnel-shaped, hirsute and glandular hairy, margin sparsely long ciliate, each 3–5 flowered; pedicels longer than bracts; tepals 5-parted, pinkish, elliptic; stamens 8, styles 3, connate to below middle. Achenes broadly ovoid, trigonous, persistent perianth, black-brown, shiny.

Flowering & Fruiting: July to October

Specimen examined: India. West Bengal: Jalpaiguri district, Doumohani Beel, *Payel Paul & M. Chowdhury 0077*, dated 16.09.2016.

Status: Commonly found on moist places.

Distribution: India (West Bengal, Assam) Nepal, Japan, Korea, Russia; moist areas of plains of Darjeeling, Jalpaiguri, Burdwan at an altitude range from 30 m to 1020 m.

Note: Aerial parts have antiHIV1, anticholinergic, analgesic and CNS depressant activities and significant cytotoxicity against the ovarian cancer cell line.

Rumex Linnaeus

Sp. Pl. 1: 333. 1753; Gen. Pl. ed. 5: 156. 1754.

Annual or perennial herb, rarely shrubs; Root rhizomatous. Stem erect, branched. Leaves simple, alternate, cauline, undulate. Ochreae tubular. Flowers in terminal or axillary, raceme or panicle; tepals 6, in two whorls, persistent, margin entire often dentate; stamens 6, anthers basifixed; style 3, ovary trigonous, stigma penicillate. Achenes trigonous; embryo lateral, straight.

Genus comprises about 200 species worldwide; 22 species in India; 5 species were recorded from West Bengal.

Key to the species

1a. Flowers unisexual .... ***Rumex acetosella***
1b. Flowers bisexual **2**
2a. Fruiting perianth margin entire, smooth **3**
2b. Fruiting perianth margin toothed **4**
3a. Perennial shrubs..... .... ***Rumex hastatus***
3b. Annual herbs .... ***Rumex maritimus***
4a. Lamina oblong to elliptic, leaf base truncate or subcordate; annual .....
……. ……. ……. ..……... ***Rumex dentatus***
4b. Lamina ovate, leaf base cordate; perennial .... ***Rumex nepalensis***

Rumex acetosella Linnaeus, Sp. Pl. 1: 338. 1753; Hooker *f.*, Fl. Brit. India 5: 61. 1886; Grierson & Long, Fl. Bhutan 1(1): 174. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 196. 1985; Srivastava, Ind. J. Pl. Sc. 3(2): 144. 2014. *Acetosella acetosella* (Linnaeus) Small, Man. S. E. Fl. 446. 1933. *Acetosella vulgaris* Fourreau Ann. Soc. Linn. Lyon ser. 2, 17: 145. 1869. *Acetosa hastata* Moench, Methodus. 357. 1794. ***'Tok Palong'*** or ***'Hale'***

Perennial, dioecious herbs. Rhizome horizontal. Stem weak, slender, greenish to reddish, glabrous. Leaves alternate, simple, lamina glabrous, trilobed, terminal lobe lanceolate, 5.6–14.6 × 0.6–2.5 cm, lateral lobe small, margin entire, base cordate, acute to obtuse; Ochreae membranous, greenish, 1.2 cm × 0.7 cm. Flowers in terminal panicle; unisexual, pedicillate; *Male flower*: tepals 6, in two whorl, outer tepals small, inner tepals elliptic; stamen 6, filament short; *Female flower:* tepals 6, outer tepals lanceolate, inner tepals enlarged in fruit; stigma 3, stellate. Achenes trigonous, brown

Flowering & Fruiting: January to April

Specimen examined: India. West Bengal: Malda district, Nayagram beel, *Payel Paul & M. Chowdhury 0088*, dated 30.03.2017.

Status: Commonly cultivated.

Distribution: India, Kazakhstan, China, Japan, Korea, Mongolia, Russia, Europe, N. America; Darjeeling, Jalpaiguri, Malda at an altitude ranges between 25 m to 140 m.

Note: Leaves used as vegetable.

Rumex dentatus Linnaeus, Mant. Pl. Altera. 226. 1771; Hooker *f.*, Fl. Brit. Ind. 5: 59. 1886; Prain, Beng. Pl. 2: 665. 1903; Rechinger *f.* in Tutin *et al.*, Fl. Europ. 1: 88.1964; Maiti & Sikdar, Ind. J. Forestry. 8(3): 196. 1985; Munshi & Javeid, Syst. Stud. Polygon. Kashm. Himal. 96. 1987; Srivastava, Ind. J. Pl. Sc. 3(2): 147. 2014. *Rumex klotzschianus* Meisnner, Prodr. 14: 1856. *Rumex dentatussensu* Hooker *f.*, Fl. Brit. Ind. 5: 59. 1890; Forbes, J. Linn. Soc. 26: 356. 1891. *Rumex nipponicus* Franch & Savat, Pl. Japan 2: 471. 1879. *Rumex dentatus* subsp. *halacsyi* (Rechinger) Rechinger *f.*, Beih. Bot. Centralbl. 49(2): 18 1932. ***'Ban Pate* or *Ban Palungo'***

Annual, erect herbs. Stem greenish to brown, glabrous. Leaves alternate, simple, petiolate, lamina oblong to elliptic, 4.3–12.2 × 1–3.1 cm, glabrous, acute, base sub cordate, entire to slightly undulate. Ochreae tubular, 0.6 × 0.4 cm, glabrous, brown. Flowers in axillary or terminal panicle; bisexual, pedicelate; tepals 6, in two whorls, 3 outer tepals elliptic, entire, acute, 3 inner longer than outer tepals, in fruiting stage, valves are enlarged, broadly ovate, triangular, membranous, finely reticulate, acute,

base rounded, each margin with 2–4 teeth; stamens 6, anther two celled, basifixed; styles 3, stigmas penicillate, ovary trigonous. Achenes ovoid, trigonous with narrow base and acute apex, broadest in the middle, smooth, shiny and blackish.

Flowering & Fruiting: May to August

Specimen examined: India. West Bengal: West Burdwan district, *Payel Paul & M. Chowdhury 0049*, dated 24.05.2016.

Status: Very few species grows on moist places.

Distribution: India (Jammu and Kashmir to Sikkim), Afghanistan, Kazakhstan, Nepal, Russia, N. Africa, S. E. Europe; Darjeeling, Jalpaiguri, Malda, Burdwan, Howrah, Hoogly at an altitude ranges from 7 m upto 140 m.

Note: Root extract used as an astringent and dye.

Rumex hastatus D. Don, Prodr. Fl. Nepal. 74. 1825; Meisnner in DC., Prodr. 14: 72. 1856; Hooker *f*., Fl. Brit. Ind. 5: 60. 1886; Rech. *f*., Candollea 12: 21. 1949; Kitamura, Fl. Afgh. 95. 1960; Hara *et al*., Enum. Fl. Pl. Nepal 3: 179. 1982. Srivastava, Ind. J. Pl. Sc. 3 (2): 147. 2014. *Acetosa hastiformis* Love & Kapoor, Taxon 16: 521. 1967. *Acetosa hastata* Moench, Meth. 357. 1794.

Perennial shrubs. Stem erect, much branched, glabrous, round, woody, nodes swollen, light brown. Leaves petiolate, glabrous sometimes glandular, deltoid, hastate with three lobes, 0.6–3.2 × 0.3–2.7 cm, entire or slightly wavy, revolute, whitish or papillate. Ochreae, fugacious, tubular, brown and glabrous. Inflorescence terminally branched, paniculate, 2–7 flowers in each axil. Flower bisexual; tepals 6 arranged in two whorls of three each, elliptic - ovate, obtuse, reflexed back in fruits; stamens 6, in two whorls of 3 each, filament very short, anther bicelled, basifixed; ovary trigonous, styles 3, free above connate below, stigmas very small. Achenes triquetrous, apex and base pointed, broad below the middle, smooth and dark brown.

Flowering & Fruiting: June to October

Specimen examined: India. West Bengal: Jalpaiguri District, Kathambari beel, *Payel Paul & M. Chowdhury 0142, 0145*, dated 03.09.2018.

Status: Few plants are growing in small water bodies.

Distribution: India (Kashmir, Uttarakhand, Chandigarh, Himachal Pradesh), Kazakhstan, Kyrgyzstan, Mongolia, Russia, Tajikistan, Europe; throughout the North Bengal plains at an altitude ranges from 35 m to 876 m.

Note: Leaf extract applied on wounds and cuts to check bleeding and for nettle sting; root is laxative and anti rheumatic and also be used in skin disease.

Rumex maritimus Linnaeus, Sp. Pl. 1: 335. 1753; Hooker *f*., Fl. Brit. Ind. 5: 59. 1886; Prain, Beng. Pl. 2: 665. 1903; Maiti & Sikdar, Ind. J. Forestry 8(3): 196. 1985; Srivastava, Ind. J. Pl. Sc. 3 (2): 147. 2014. *Rumex maritimus* var. *persicarioides* (Linnaeus) R. S. Mitch, Brittonia 30(2): 295. 1978. *Rumex maritimus* var. *fueginus* (Philippe) Dusén, Svensk. Exp. Mag. 3(5): 194. 1900. ***'Bunpalung'***

Annual herbs. Stems erect, branched below middle, grooved, glabrous or weakly shortly papillose. Leaves alternate, simple, lamina lanceolate or lanceolate-oblong, 4–19.2 × 0.5–7.5 cm, acute, base cuneate, both surfaces glabrous or shortly papillose below, entire, smooth, occasionally slightly undulate. Ochreae fugacious, 0.75 × 0.38 cm, membranous; fimbriae present, no of the fimbriae 6, length 116.23 µm. Flowers in panicle; bisexual, pedicelate; outer tepals elliptic, inner tepals enlarged in fruit base; stamens 6, anther two celled, basifixed; styles 3, stigmas capitates, ovary trigonous. Achenes yellow brown, shiny, ellipsoid, sharply trigonous.

Flowering & Fruiting: May to July

Specimen examined: India. West Bengal: Darjeeling district, Lochka River Bed, *Payel Paul & M. Chowdhury 0044*, dated 05.06.2016; Kalimpong district, Durpin, *Payel Paul & M. Chowdhury 0154*, dated 21.04.2019.

Status: Commonly found on marshy places.

Distribution: India (West Bengal, Assam, Kerala), Kazakhstan, Myanmar, Mongolia, Russia, Europe, N. America; Darjeeling, Jalpaiguri, Burdwan, Howrah at an altitude ranges from 7 m upto 550 m.

Note: Leaves are applied externally to burns; leaves and seed extract are also used as aphrodisiac, astringent and carminative.

Rumex nepalensis Sprengel, Syst. 2: 159. 1825; Hooker *f.*, Fl. Brit. Ind. 5: 60. 1886; Hara *et al.*, Fl. Pl. Nepal. 3: 179. 1982; Grierson & Long, Fl. Bhutan 1(1): 173. 1983; Maiti & Sikdar, Ind. J. Forestry 8(3): 196. 1985; Munshi & Javeid, Syst. Stud. Polygon. Kashm. Himal. 95. 1986; Srivastava, Ind. J. Pl. Sc. 3(2): 148. 2014. *Rumex peregrinus* Boissier, Diagn. Pl. Or. Nov. Ser. 1(5): 46. 1844. ***'Pahari palang* or *Halahale* or *Jangali Palak'***

Perennial herbs. Stem erect, stout or leafy, branched above, deeply grooved, glabrous, slightly papillose just beneath node, sometimes lower internodes papillose at ridges, nodes clearly swollen, reddish brown-brown or olive green. Leaves alternate, simple, basal leaves dimorphic, upper broadly ovate, 5.5–17.1 × 2.2–8.7 cm, petiolate, glabrous-papillose, acute-sub acute, base cordate-sub cordate, undulate-dentate, basal lamina oblong, obtuse, truncate, slightly undulate, cauline leaves shortly petiolate, lamina lanceolate, acute-acuminate, truncate-cuneate. Ochreae tubular, 1.8 × 0.6 cm, membranous, fugacious; fimbriae present, no of the fimbriae 7, length 114.56 µm. Flowers in panicle; bisexual, pedicelate; tepals 6, in two whorls, outer tepals elliptic, entire, acute, valves oblong-ovate, acute-attenuate, truncate, finely reticulate, circinately curled inward at their apices; stamens 6, anther two celled, basifixed; styles 3, stigma penecilliate, ovary trigonous. Nut trigonous, shiny, blackish brown, apex acute with narrow base, broadest below.

Flowering & Fruiting: September to March

Specimen examined: India. West Bengal, Kalimpong district, Durpin monastry road, *Payel Paul & M. Chowdhury 0015*, dated 03.03.2015; Darjeeling district, hilly slopes of Tumling *Payel Paul & M. Chowdhury 0123*, dated 15.04.2018.

Status: Very common in Darjeeling and Kalimpong Himalaya.

Distribution: S.W. Asia, Pakistan, Afghanistan, Tajikistan, India (Assam, Kashmir, Meghalaya, Khasmir), Nepal, Bhutan, Myanmar, Indonesia, Vietnam, Japan (introduced); Darjeeling (Sandakphu, Meghma, Tumling Kurseong), Kalimpong at an altitude ranges from 1540 m upto 3636 m.

Note: Leaves used for treatment of colic, headache and body pain.

5.1.3. Phytogeographical distribution of Polygonaceae

Phytogeographically there are 5 major floristic zones in West Bengal *viz.,* The Darjeeling Himalaya, Terai-Duars Region, North Bengal and South Bengal plains, Western undulating highland and plateau and the Gangetic Delta with diversified vegetation types. Members of Polygonaceae are mostly moist loving species and found to grow near by marshy and wet areas especially in plains. The high altitude species were widely growing in moist forests.

Most of the recorded taxa were primarily distributed in The Darjeeling Himalaya and Terai-Duars Region. Few taxa are uniformly distribution throughout the 5 floristic zones of the state. Least number of taxa is found in the Western undulating highland and plateau (Table 6). All the recorded taxa of Polygonaceae along with their distribution area within the boundary of West Bengal were mentioned in table 6 and district wise species distribution map (Fig. 9) were constructed for easy understading of their distributions pattern within the state.

Table 6: Phytogeographical distribution of different taxa of Polygonaceae in West Bengal

SL No.	Name of the Taxa	Area of Distribution	Floristic region
1.	*Antigonon leptopus* Hooker & Arnott	Malda, Mursidabad, Bankura, Burdwan, Hoogly, Howrah (recently naturalized)	North & South Bengal plains Western undulating highland and plateau Gangetic Delta
2.	*Bistorta emodi* (Meisn.) H. Hara	Darjeeling	Darjeeling-Kalimpong Himalaya
3.	*Fagopyrum dibotrys* (D. Don) Hara	Temperate forest of Darjeeling	Darjeeling - Kalimpong Himalaya
4.	*Fagopyrum esculentum* Moench	Darjeeling, Kalimpong, Jalpaiguri	Darjeeling - Kalimpong Himalaya Terai-Duars Region
5.	*Fallopia convolvulus* (Linnaeus) A. Love	Darjeeling	Darjeeling - Kalimpong Himalaya
6.	*Homalocladium platycladum* (F. Mueller) L. H. Bailey	Darjeeling, Howrah (cultivated)	Darjeeling - Kalimpong Himalaya Gangetic Delta
7.	*Persicaria barbata* (Linnaeus) H. Hara	Moist areas	All the 5 regions

SL No.	Name of the Taxa	Area of Distribution	Floristic region
8.	*Persicaria campanulata* (Hooker *f*.) Ronse Decreane	Hilly slopes of Darjeeling (Meghma, Tumling upto Sandakphu)	Darjeeling - Kalimpong Himalaya
9.	*Persicaria capitata* (Buchanan-Hamilton *ex* D. Don) H. Gross	Darjeeling (Kurseong, Meghma), Kalimpong	Darjeeling Kalimpong Himalaya
10.	*Persicaria chinensis* (Linnaeus) H. Gross var *chinensis*	Darjeeling, Kalimpong (Mirik), Jalpaiguri, Alipurduar	Darjeeling - Kalimpong Himalaya Terai-Duars Region
11.	*Persicaria chinensis* (Linneaus) H. Gross var *hispida* Kantachot	Kalimpong (New Distributional Record)	Darjeeling - Kalimpong Himalaya
12.	*Persicaria chinensis* (Linneaus) H. Gross var *ovalifolia* (Linneaus) H. Gross	Darjeeling (Kurseong)	Darjeeling - Kalimpong Himalaya
13.	*Persicaria glabra* (Willdenow) M. Gómes	Darjeeling, Kalimpong (Mirik), Jalpaiguri, Alipurduar	Darjeeling - Kalimpong Himalaya Terai-Duars Region
14.	*Persicaria hydropiper* (Linnaeus) Spach	Throughout marshy lands	All the 5 regions
15.	*Persicaria lapathifolia* (Linnaeus) S. F. Gray var. *lapathifolia*	Throughout marshy lands	All the 5 regions
16.	*Persicaria lapathifolia* (Linnaeus) Delarbre *var. lanata* (Roxb.) H.Hara	Throughout marshy lands	All the 5 regions
17.	*Persicaria minor* (Hudson) Opiz	Marshy lands of N. Bengal	North Bengal and South Bengal plains
18.	*Persicaria nepalensis* (Meisner) H. Gross	Darjeeling (Kurseong upto Meghma), Kalimpong	Darjeeling - Kalimpong Himalaya
19.	*Persicaria orientalis* (Linnaeus) Spach	Throughout moist areas	All the 5 regions
20.	*Persicaria posumbu* (Buchanon-Hamilton *ex* D. Don) H. Gross	Marshy areas of Jalpaiguri	Terai-Duars Region
21.	*Persicaria strigosa* (R. Brown) Nakai	Darjeeling (Kurseong), Marshy areas of Jalpaiguri	Darjeeling - Kalimpong Himalaya Terai-Duars Region
22.	*Persicaria tenella* (Blume) Hara	Throughout the moist lands of N. Bengal plains	North & South Bengal plains

SL No.	Name of the Taxa	Area of Distribution	Floristic region
23.	*Polygonum microcephalum* D. Don	Temperate hilly areas of Darjeeling, Kalimpong	Darjeeling - Kalimpong Himalaya
24.	*Polygonum molle* D. Don	Throughout the temperate hilly areas of Darjeeling (Kurseong, Tumling, Meghma upto Sandakphu), Kalimpong	Darjeeling - Kalimpong Himalaya
25.	*Polygonum perfoliatum* Linnaeus	Darjeeling Himalaya, Coochbeher	Darjeeling - Kalimpong Himalaya Terai-Duars Region
26.	*Polygonum plebeium* R. Brown	Throughout the plains	All the 5 regions
27.	*Polygonum pubescens* Blume	Throughout moist areas	All the 5 regions
28.	*Polygonum runcinatum* Buchanan-Hamilton *ex* D. Don	Temperate parts of Darjeeling (Kurseong, Mirik), Kalimpong	Darjeeling - Kalimpong Himalaya
29.	*Polygonum viscosum* Buchanan-Hamilton *ex* D. Don	Moist areas of plains of Darjeeling, Jalpaiguri, Burdwan	Darjeeling - Kalimpong Himalaya Terai-Duars Region Western undulating highland and plateau
30.	*Rheum nobile* Hooker & Thomson	Darjeeling	Darjeeling - Kalimpong Himalaya
31.	*Rumex acetosella* Linnaeus	Darjeeling, Jalpaiguri, Malda	Darjeeling - Kalimpong Himalaya Terai-Duars Region North and South Bengal Plain
32.	*Rumex dentatus* Linnaeus	Darjeeling, Jalpaiguri, Malda, Burdwan, Howrah, Hoogly	Darjeeling - Kalimpong Himalaya Western undulating highland and plateau Terai-Duars Region Gangetic Delta
33.	*Rumex hastatus* D. Don	North Bengal	North and South Bengal plains
34.	*Rumex maritimus* Linnaeus	Darjeeling, Jalpaiguri, Burdwan, Howrah	Darjeeling - Kalimpong Himalaya Western undulating highland and plateau Terai-Duars Region Gangetic Delta
35.	*Rumex nepalensis* Sprengel	Darjeeling (Kurseong, Meghma, Tumling), Kalimpong	Darjeeling - Kalimpong Himalaya

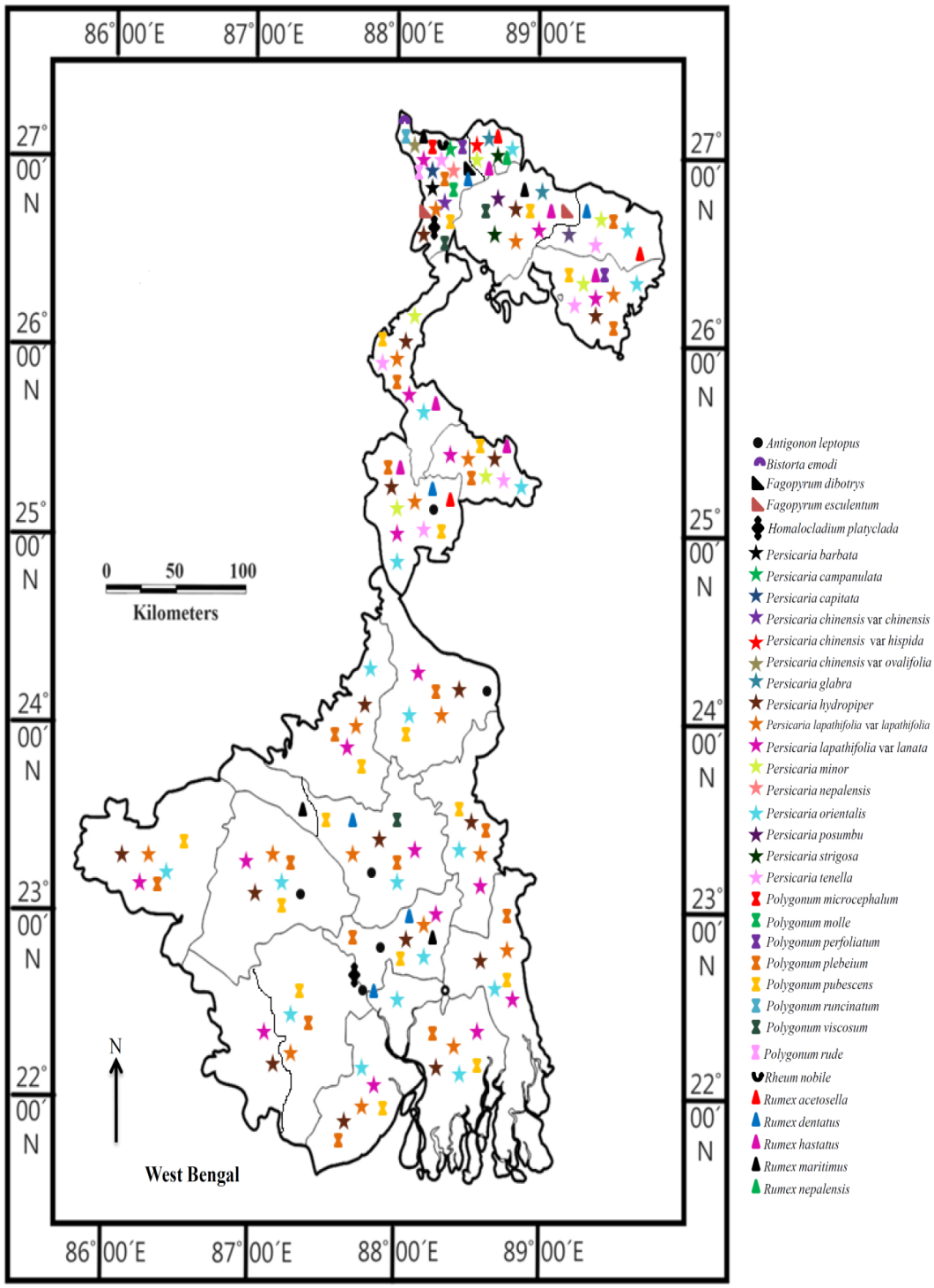


Fig. 9: District wise distribution of different taxa of Polygonaceae in West Bengal

5.1.4. Importance

Present study revealed that several economically valuable species of Polygonaceae served as resources in the vegetation of West Bengal. More than 80% of taxa recorded from this region are used for wide-ranging purposes (Fig. 10). It has been documented during survey that majority of the taxa have ethno medicinal property. Remaining taxa are used in different other purpose *viz.*, cattle feed, fire wood, bio-pesticide, cosmectics, flavouring agents; while few taxa are also used in the different parts of the state as leafy vegetables *i.e.* young leaves of *Fagopyrum esculentum* sold in the local market of Darjeeling and Kalimpong and Jalpaiguri districts, young leaves of *Rumex acetosella* (*tak palang)* sold in the local market of Central and Northern parts of west Bengal; spices and condiment i.e, roasted seeds of *Polygonum microcephalum* used as condiments in N.E. India. Dried leaves of *Rheum nobile* are used as the substitute of tobacco by some etnic community of Sandakphu, Meghma and Tumlimg regions of Darjeeling district. Details of all the ethno-botanically and economically important members of Polygonaceae are carefully accounted along with their parts used and necessary uses in table 7.

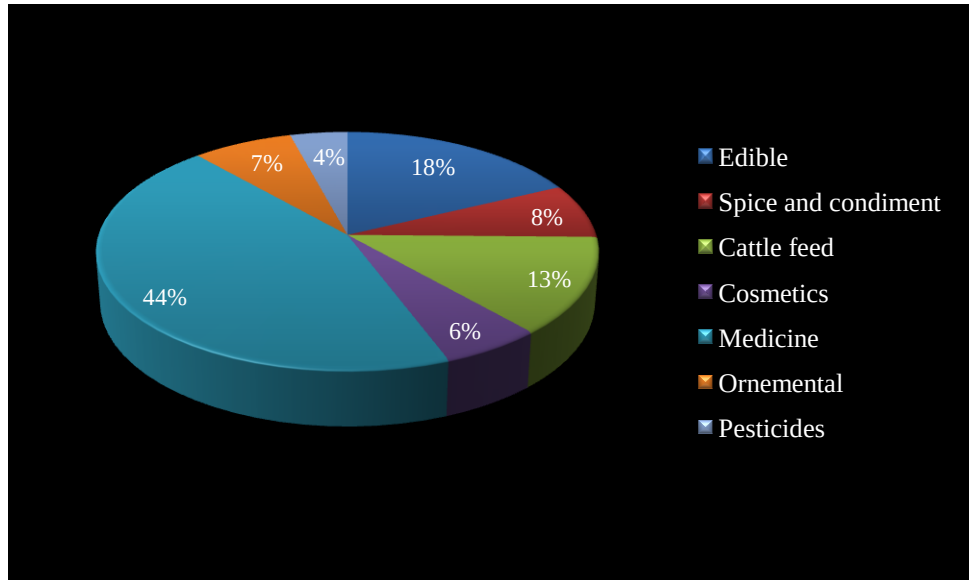


Fig. 10: Uses of Polygonaceae for different purposes

Table 7: Ethnic and commercial uses of different taxa of Polygonaceae in West Bengal

Taxa	Ethnic/ Commercial uses
Antigonon leptopus Hooker & Arnott	Ornamental
Fagopyrum dibotrys (D. Don) Hara	Seeds, leaves used for treatment of colic, choleric diarrhea and abdominal blockage troubles; young leaves used as vegetable
Fagopyrum esculentum Moench	Leaves used as vegetable
Fallopia convolvulus (Linnaeus) A. Love	Seeds are used as nutritious food
Homalocladium platycladum (F. Mueller) L. H. Bailey	Entire plants are used for the treatment of anthracia, sores, snake bite, insect bite
Persicaria barbata (Linnaeus) H. Hara	Watery sap from roots used as antiseptic
Persicaria campanulata (Hooker *f*.) Ronse Decreane	Ornamental
Persicaria capitata (Buchanan-Hamilton *ex* D. Don) H. Gross	Ornamental, whole plant extract used as antidote in snakebite and insect sting
Persicaria chinensis (Linnaeus) H. Gross var *chinensis*	Root used for fluxes, anthelminthic and neutralizes scorpion poisoning
Persicaria glabra (Willdenow) M. Gómes	Plant juice and rootstock used in pneumonia, jaundice, fevers. Leaves are antispasmodic and are used for colic
Persicaria hydropiper (Linnaeus) Spach	Seeds, leaves used for treatment of arthritis, bladder stone, cholera
Persicaria lapathifolia (Linnaeus) S. F. Gray var. *lapathifolia*	Decoctions from root used as cathartic and emetic drug
Persicaria minor (Hudson) Opiz	Young shoot and leaves are edible; Decoctions from leaves has been used in post-natal tonics and for treatment of digestion oil has been used for aromatherapy and in treatments for dandruff
Persicaria nepalensis (Meisner) H. Gross	Whole plant extract used in the treatment of swelling
Persicaria orientalis (Linnaeus) Spach	Ornamental; nuts are used in tuberculous swellings and flatulence; decoction of the ripe fruits is used in the treatment of hepatitis, sloughing ulcers, tympanites and cancer
Persicaria posumbu (Buchanon-Hamilton *ex* D. Don) H. Gross	Decoction is used in the treatment of dysentery, enteritis, boils and abscesses; aromatic leaves are added to other vegetables for flavor
Persicaria strigosa (R. Brown) Nakai	Tender roasted shoots are used for the dysentery of cattles
Polygonum microcephalum D. Don	Young shoot and seeds are used as vegetable and condiment respectively

Taxa	Ethnic/ Commercial uses
Polygonum molle D. Don	The whole plant used as astringent; young shoot, leaves and seeds are edible
Polygonum perfoliatum Linnaeus	Tender leaves, shoots and fruit are edible; whole plant is depurative, diuretic, febrifuge and also used to stimulate blood circulation; decoction is used in the treatment of dysentery, enteritis, boils and abscesses, poisonous snake bites, haematuria, cloudy urine and traumatic injuries
Polygonum plebeium R. Brown	Leaves used for the treatment of pneumonia and young leaves are used as vegetable; roots are used in treatment of baldness
Polygonum pubescens Blume	Leaves and seeds are edible; decoction of the plant, combined with onion, is used as a styptic; bruised plant is applied locally to blistered and swollen feet
Polygonum runcinatum Buchanan-Hamilton *ex* D. Don	Leaves are edible
Polygonum viscosum Buchanan-Hamilton *ex* D. Don	Aerial parts have antiHIV1, anticholinergic, analgesic and CNS depressant activities and significant cytotoxicity against the ovarian cancer cell line
Rheum nobile Hooker & Thomson	Young stems are used for salads; flowering stem used in the treatment of swellings and fullness of the abdomen; dried leaves used as a substitute for tobacco; root extract used as antiemetic, astringent, carminative, depurative, diuretic, laxative
Rumex acetosella Linnaeus	Leaves used as vegetable
Rumex dentatus Linnaeus	Root extract used as an astringent and dye
Rumex hastatus D. Don	Leaf extract applied on wounds and cuts to check bleeding and for nettle sting; root is laxative and anti rheumatic and also be used in skin disease
Rumex maritimus Linnaeus	Leaves are applied externally to burns; leaves and seed extract are also used as aphrodisiac, astringent and carminative
Rumex nepalensis Sprengel	Leaves used for treatment of colic, headache and body pain

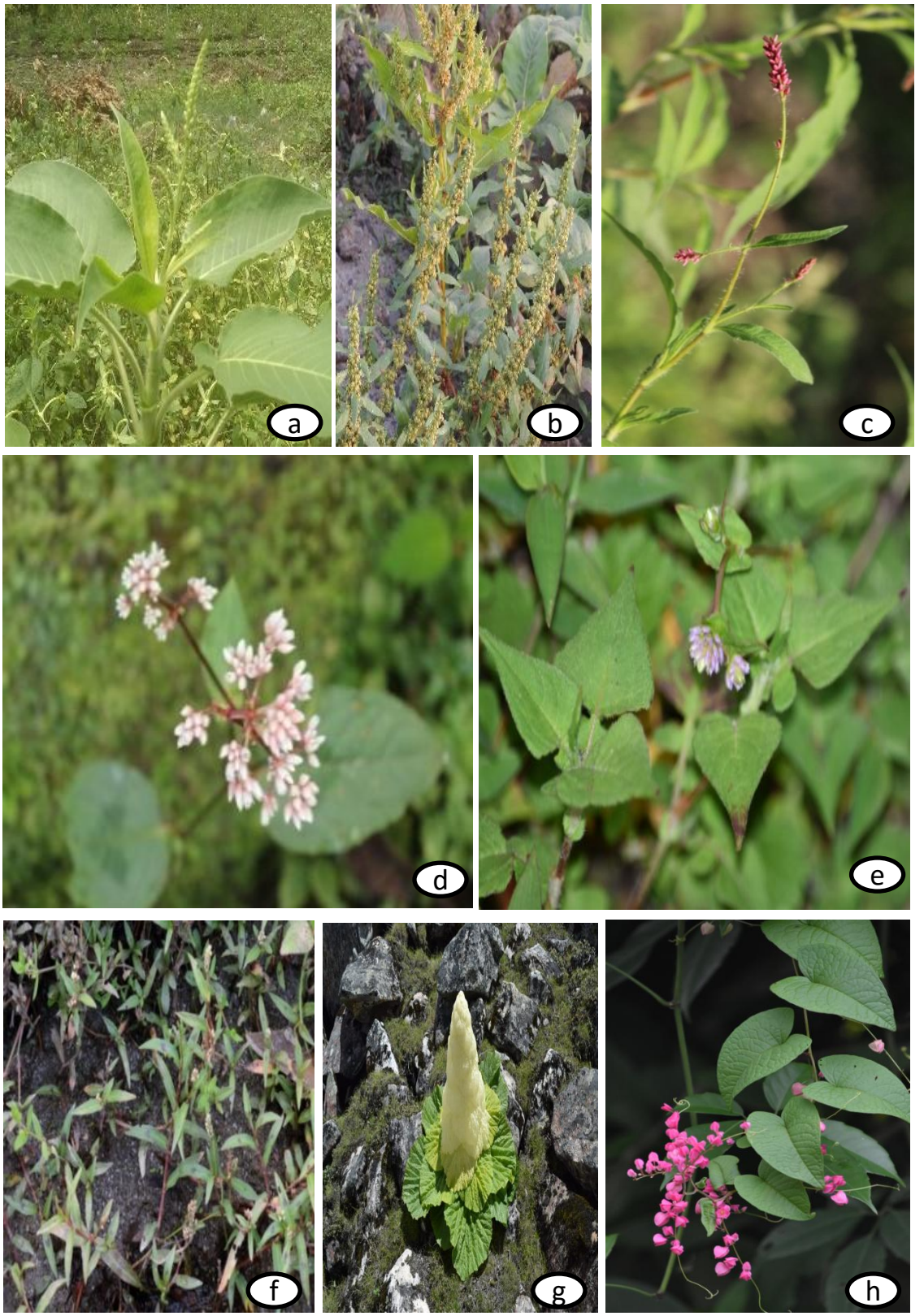


Fig. 11: Different taxa of Polygonaceae in their natural habitat **a.** *Persicaria orientalis* **b.** *Rumex dentatus* **c.** *Polygonum viscosum* **d.** *Persicaria campanulata* **e.** *Persicaria nepalensis* **f.** *Persicaria tenella* **g.** *Rheum nobile* **h.** *Antigonon leptopus*

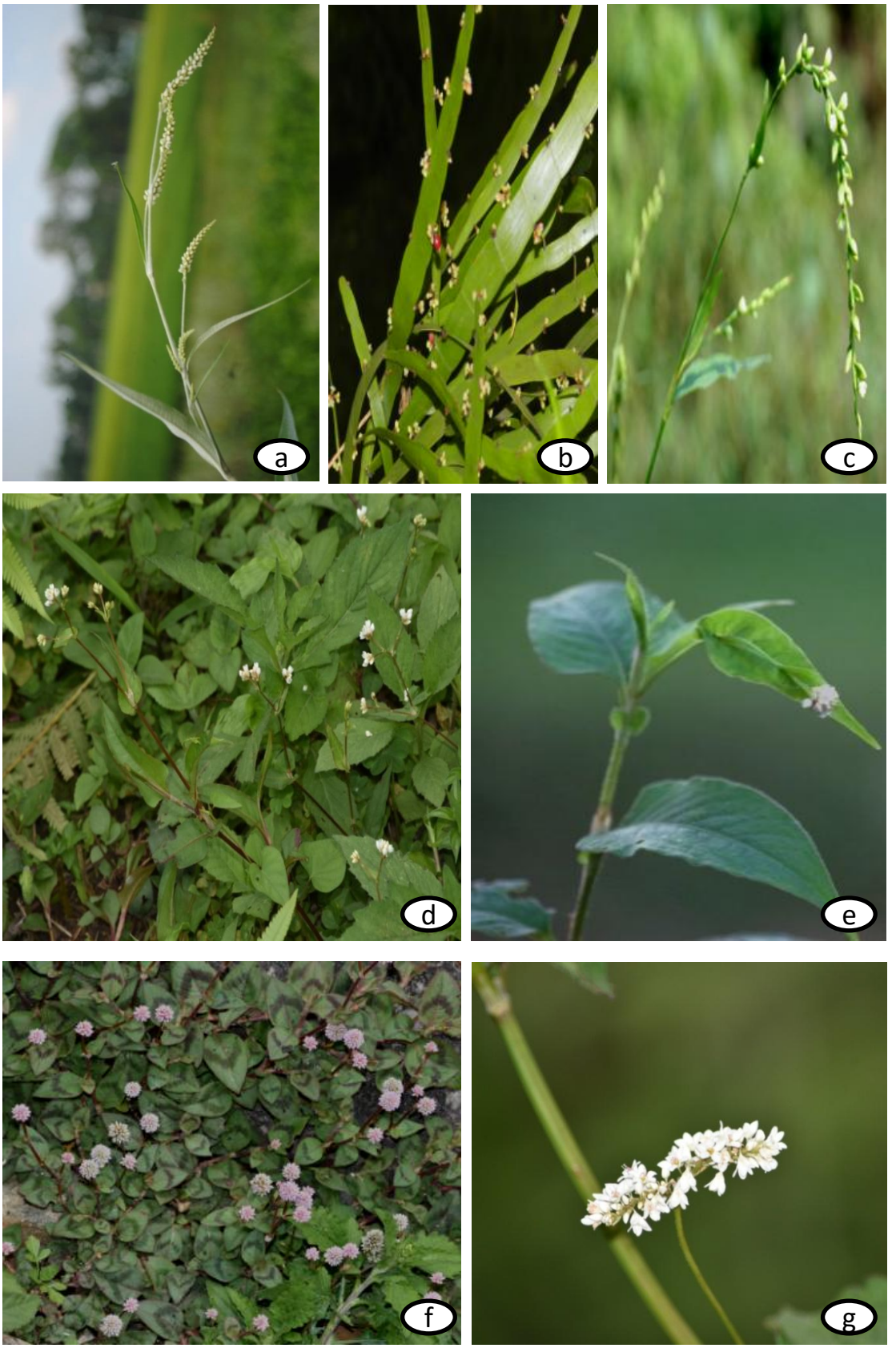


Fig. 12: Different taxa of Polygonaceae in their natural habitat **a.** *Persicaria lapathifolia* var. *lanata* **b.** *Homalocladium platyclada* **c.** *Persicaria hydropiper* **d.** *Persicaria chinensis* var. *chinensis* **e.** *Persicaria chinensis* var. *hispida* **f.** *Persicaria capitata* **g.** *Fagopyrum dibotrys*



Fig. 13: Different taxa of Polygonaceae in their natural habitat **a.** *Polygonum plebeium* **b.** *Rumex maritimus* **c.** *Rumex nepalensis* **d.** *Polygonum molle* **e.** *Persicaria runcinatum* **f.** *Persicaria glabra*

5.2. FOLIAR MACRO & MICRO MORPHOLOGY

Foliar macro and micro morphological studies were carried out for all the collecred taxa of the family Polygonaceae from West Bengal. Both qualitative and quantitative characters of lamina were examined very carefully for all the taxa to understand the peculierities and variation pattern in their shape, sizes, stomata, vein and trichomes. The accumulated macro and micro-morphological features were found quite interesting and significantly varies species to species even in varietal level. All the recorded data and their calculated results were summarized below.

5.2.1. Foliar macro morphology

Leaves are flattened lateral outgrowths of the stem and form the foliage of a plant. Leaves bear a huge number of peculiar and interesting characters that has crucial role in species level identifical especially in sterile condition. Morphological characteristic attributes of leaves are more precisely known as foliar macro morphology. Macro-morphological study for each specimen was done as per Hickey's Manual. The leaf attachment and organization, petiole feature, mean lamina length, width, area, blade class, lamina shape, symmetry, base and apex angle, shape, petiole attachment, margin type, lobation for all specimens were observed. All these parameters of the lamina vary from species to species also in varietal level and play a significant role in the identificarion of sterile specimens. Therefore, study of foliar macro morphology is quite significant for identification of the different taxa of Polygonaceae as the flowers and fruits are produced for a very brief period.

Opposite phyllotaxy was observed in *Antigonon leptopus*. Laminar shapes were assorted from ovate to lanceolate and lamina apex and base angle was more or less acute <90º (Table 8). Lamina apex shapes were varied from acute to acuminate whereas base shape was truncate (Table 8).

Alternate phyllotaxy was observed in both the recorded species of *Fagopyrum i.e.*, *F. dibotrys* and *F. esculentum* where leaves were simple. Laminar size (Table 8) varied much in these two species therefore they can be categorized under different blade class; apex and base angle was more or less same in both species *i.e.*, wide

obtuse; lamina apex shapes were varied from acute (*F. dibotrys*) to acuminate (*F. esculentum*) whereas base shape was same (Table 8).

Alternate phyllotaxy was observed in all the recorded taxa of *Persicaria*. Laminar size (Table 8) varied much in different taxa therefore they can be categorized under different blade class *viz*., nanophyll (*P. tenella*), microphyll (*Persicaria barbata, P. campanulata, P. capitata, P. glabra, P. hydropiper, P. lanigera, P. lapathifolia* var *lapathifolia, P. lapathifolia* var *lanata, P. microcephala, P. minor, P. nepalensis, P. perfoliata, P. strigosa*), notophyll (*P. chinensis* var *chinensis, P. chinensis* var *hispida, P. chinensis* var *ovalifolia, P. orientalis*) and mesophyll (*P. posumbu*); lamina apex and base angle were also varied in all taxa (Table 8) *i.e.*, acute, obtuse, wide obtuse etc.; apex shapes were varied from acute to acuminate sometimes it was appeared to be straight; whereas base shape was also diverse in different taxa (Table 8) such as lobate, rounded, cuneate, saggitate, decurrent etc.

Phyllotaxy was opposite in all five recorded species of *Polygonum* expect in *Polygonum viscosum* where it was alternate. Recorded taxa of *Polygonum* were placed under different blade class *viz*., nanophyll (*P. plebeium*), microphyll (*P. molle, P. pubescens, P. runcinatum*) and notophyll (*P. viscosum*) due to the variation of their laminar size; lamina apex and base angle were also varied in all the taxa; base shape were varied from sagittate to decurrent (Table 8) whereas apex shape was same for all the taxa *i.e.*, acuminate except for *Polygonum plebeium*, here it was straight.

Alternate phyllotaxy was observed in all the recorded four species of *Rumex* but the taxa were placed under different blade class due to variable lamina sizes (Table 8); apex and base angle were varied from acute (*R. dentatus, R. maritimus*), obtuse (*R. acetosella*) to wide obtuse (*R. nepalensis*); base shape was same i.e, decurrent except in *Rumex nepalensis* where it was lobate whereas apex shape were different in all taxa (Table 8).

Table 8: Macro morphological data of all the studied taxa of Polygonaceae from West Bengal, India

Taxa	Mean lamina length(mm)	Mean lamina width(mm)	Lamina area(mm)	Blade class	Lamina shape	Base angle	Base shape	Apex shape	Margin type	Lobation
Antigonon leptopus	78.67	29.87	2349.87	Notophyll	Ovate	Obtuse	Decurrent	Accuminate	Entire	Unlobed
Fagopyrum dibotrys	29.22	24.14	705.37	Microphyll	Ovate	Obtuse	Decurrent	Accuminate	Entire	Unlobed
Fagopyrum esculentum	82.20	28.00	2301.6	Notophyll	Oblong	Wide obtuse	Decurrent	Accuminate	Entire	Unlobed
Fallopia convolvulus	39.00	17.00	663.00	Microphyll	Ovate	Acute	Saggitate	Accuminate	Entire	Unlobed
Homalocladium platycladum	31.33	11.33	236.65	Microphyll	Ovate	Acute	Deccurent	Straight	Erose	Unlobed
Persicaria barbata	90.16	20.12	1814.01	Microphyll	Elliptic	Obtuse	Rounded	Straight	Entire	Unlobed
Persicaria campanulata	98.32	24.25	1573.25	Microphyll	Oblong	Wide obtuse	Decurrent	Accuminate	Entire	Unlobed
Persicaria capitata	25.00	18.00	450	Microphyll	Ovate	Acute	Rounded	Accuminate	Entire	Unlobed
Persicaria chinensis* var. *chinensis	95.50	30.00	2865.00	Notophyll	Oblong	Obtuse	Lobate	Accuminate	Erose	Unlobed
Persicaria chinensis* var. *hispida	97.89	32.14	3123.23	Notophyll	Oblong	Obtuse	Lobate	Convex	Erose	Unlobed
Persicaria chinensis* var. *ovalifolia	99.89	41.21	4116.47	Notophyll	Oblong	Obtuse	Rounded	Convex	Erose	Unlobed
Persicaria glabra	73.67	23.33	1096.7	Microphyll	Oblong	Wide obtuse	Sagittate	Straight	Entire	Unlobed
Persicaria hydropiper	70.00	16.00	1120	Microphyll	Elliptic	Acute	Decurrent	Accuminate	Erose	Unlobed
Persicaria lanigera	85.64	15.09	1292.30	Microphyll	Oblong	Obtuse	Decurrent	Convex	Erose	Unlobed
Persicaria lapathifolia* var. *lanata	82.32	13.56	823.76	Microphyll	Elliptic	Acute	Decurrent	Acute	Erose	Unlobed
Persicaria lapathifolia* var. *lapathifolia	76.00	10.11	768.36	Microphyll	Elliptic	Acute	Decurrent	Accuminate	Erose	Unlobed
Persicaria minor	87.3	19.11	1668.30	Microphyll	Elliptic	Acute	Cuneate	Straight	Entire	Unlobed
Persicaria nepalensis	29.00	18.00	522.00	Microphyll	Rhomboid	Obtuse	truncate	Acute	Erose	Unlobed
Persicaria orientalis	95.30	75.00	4839.9	Notophyll	Ovate	Wide obtuse	Lobate	Accuminate	Erose	Unlobed
Persicaria perfoliata	54.98	29.87	1642.25	Microphyll	Oblong	Obtuse	Decurrent	Straight	Entire	Unlobed
Persicaria posumbu	101.65	85.65	8706.32	Mesophyll	Ovate	Wide obtuse	Cuneate	Accuminate	Erose	Unlobed
Persicaria strigosa	73.67	23.33	1096.7	Microphyll	Oblong	Wide obtuse	Sagittate	Straight	Entire	Unlobed
Persicaria tenella	30.60	4.20	128.52	Nanophyll	Ovate	Acute	Decurrent	Accuminate	Entire	Unlobed
Polygonum microcephalum	73.67	22.33	1096.7	Microphyll	Oblong	Wide obtuse	Decurrent	Accuminate	Entire	Unlobed
Polygonum molle	112.20	28.60	3208.9	Notophyll	Ovate	Obtuse	Sagittate	Accuminate	Erose	Unlobed
Polygonum pubescens	95.50	23.00	2192	Notophyll	Oblong	Obtuse	Decurrent	Convex	Erose	Unlobed
Polygonum runcinatum	23.33	15.33	238.4	Microphyll	Elliptic	Wide obtuse	Sagittate	Accuminate	Entire	Lobed
Polygonum viscosum	133.00	32.00	4256	Notophyll	Elliptic	Wide obtuse	Lobate	Accuminate	Entire	Unlobed
Polygonum plebeium	15.20	8.00	121.6	Nanophyll	Elliptic	Acute	Decurrent	Straight	Entire	Unlobed
Rheum nobile	182.1	212.35	38668.94	Macrophyll	Ovate	Wide obtuse	Cordate	Rounded	Entire	Unlobed
Rumex maritimus	130.66	36.30	4742.95	Mesophyll	Ovate	Acute	Decurrent	Entire	Erose	Unlobed
Rumex nepalensis	70.00	13.33	622.1	Microphyll	Ovate	Wide obtuse	Lobate	Accuminate	Entire	Unlobed
Rumex acetosella	180.0	39.00	5420	Mesophyll	Elliptic	Obtuse	Decurrent	Accuminate	Entire	Unlobed
Rumex dentatus	130.30	36.30	4690.8	Mesophyll	Ovate	Acute	Deccurent	Straight	Erose	Unlobed

5.2.2. Morphology of Stomata

Stomata are recognized as small openings in the epidermal surface which engage with gaseous exchange among intercellular spaces of sub-epidermal cells and the atmosphere. These are enclosed by guard cells, which organize the pore size. The morphology of stomata had been regarded as a valuable taxonomic decisive factor not only morphology but also their distribution and arrangement were still taxonomically significant for the identification of different taxa. The study of stomatal complexes becomes extremely valuable to understand the evolutionary relationship of taxa.

Among the studied taxa four prominent type of stomata like anisocytic (containing single ring of 3 cells enclosing the guard cells), paracytic (2 cells completely enclosing the guard cells with their long axis parallel to long axis of guard cells), pericytic (one cell encloses both guard cells) and anomocytic (subsidiary cells same as normal epidermal cells) were observed (Fig. 14). Most of the taxa were amphistomatic *i.e.*, stomata were observed on both adaxial and abaxial surfaces of the lamina. Significant stomata variations were observed in their sizes, types, frequency and density.

Anomocytic stomata were observed in six taxa *i.e., Antigonon leptopus, Fagopyrum dibotrys, Persicaria pubescens, P. orientalis, P. strigosa* and *Polygonum viscosum* (Fig. 15). The stomata were circular to elliptical and were to be found at the same level as the epidermal cells. Guard cells were kidney shaped and the cell lumen between them is narrow at the equatorial region. Stomata were regularly distributed on both surface of the lamina.

Anisocytic stomata were observed in seven taxa *viz., Homalocladium platycladum, Persicaria chinensis* var. *chinensis, P. chinensis* var. *hispida, P. chinensis* var. *ovalifolia, P. microcephala, Polygonum runcinatum* and *P. molle* (Fig. 15, 16). In this case stomata remain surrounded by subsidiary or accessory cells and whose common wall is at right angles to the guard cells.

Paracytic stomata were observed in eight taxa *viz., Fagopyrum esculentum, Persicaria barbata, P. campanulata, P. lanigera, P. minor, P. nepalensis, P. posumbu* and *P. tenella*. In this case, the guard cell enlarges and become kidney

shaped (Fig. 15; 16; 17). Stomata remain surrounded by the two subsidiary cells that were placed parallel to the stoma. Here the stomata were present mainly on the abaxial surface of leaf.

Pericytic stomata had been shown only in five taxa *viz., Fallopia convolvulus, Persicaria lapathifolia* var. *lapathifolia*, *P. lapathifolia* var. *lanata*, *P. capitata* and *Rumex maritimus*.

More than one type of stomata were also found in some taxa of *Persicaria, Polygonum, Rheum* and *Rumex* such as in *Persicaria glabra* three different types of stomata (anisocytic, paracytic and staurocytic), in *Persicaria hydropiper* two different types of stomata (ansiocytic and paracytic), in *Persicaria perfoliata* two types of stomata (anomocytic, cyclocytic), in *Polygonum plebeium* two types of stomata (anisocytic and pericytic), in *Rheum nobile* two types of stomata (anomocytic and paracytic) and in *Rumex acetosella, R. dentatus, R. nepalensis* two different types of stomata (ansiocytic and pericytic) were observed.

Stomatal index (SI) on basal portion of lamina was ranged from 8.65 to 31.62% in *Persicaria capitata* and *Persicaria barbata* respectively, while on apex portion from 9.26 to 32.07% in *Polygonum viscosum* and *Persicaria barbata* respectively (Table 9). Significant variation in length of stomatal pore was reported from 6.06 to 32.86 µm in *Polygonum molle* and *Polygonum pubescence* respectively. Size of stomata also showed great variation within the studied taxa maximum size of stomata was observed in *Persicaria campanulata* (33.96 × 25.08 µm) and minimum size was observed in *Rumex dentatus* (18.32 × 13.20 µm).

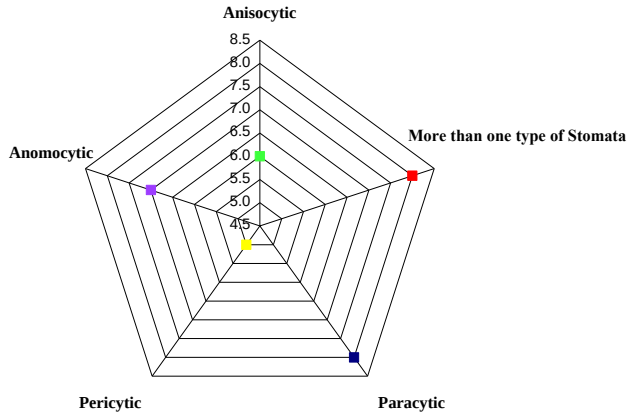


Fig. 14: Graphical representation of different type of stomata observed in Polygonaceae

Table 9: Quantitative stomatal morphology of the family Polygonaceae based on light microscopy [Abbreviation used S= Stoma; GC= Guard Cell; SC= Subsidiary Cell]

Taxa	Part of lamina	Mean length of S (µm)	Mean bradth of S(µm)	Mean length of S+GC (µm)	Mean breadth of S+GC (µm)	Mean length of GC (µm)	Mean breadth of GC (µm)	Mean length of S+SC (µm)	Mean breadth of S+SC (µm)	Mean length of SC (µm)	Mean breadth of SC (µm)	Stomatal frequency (no. of stomata /mm²)	Stomatal index(S*100/E+S)
Antigonon leptopus	Apex	11.87	9.08	21.09	15.87	9.22	6.79	25.67	19.01	4.58	3.14	98.71±4.71	11.21%
	Middle	14.31	10.71	22.34	17.65	8.03	6.94	29.81	21.17	7.47	3.52	81.60±5.11	10.69%
	Base	16.32	13.2	22.79	16.52	6.47	3.32	30.98	23.45	8.19	6.93	107.86±7.78	12.31%
Persicaria chinensis var. *chinensis*	Apex	14.89	11.46	29.82	25.22	14.93	8.02	45.54	52.74	15.72	27.52	122.70±13.17	14.39%
	Middle	21.78	8.02	28.66	26.38	6.88	11.46	47.84	55.04	19.18	28.66	181.54±3.59	16.26%
	Base	25.22	14.58	35.54	27.2	10.32	6.88	46.7	56.18	11.16	28.98	176.69±13.33	19.38%
Persicaria chinensis var. *hispida*	Apex	14.69	6.88	24.08	22.94	9.39	5.74	44.72	58.48	20.64	35.54	318.66±11.05	23.47%
	Middle	20.64	8.02	25.21	19.5	4.57	3.44	43.58	57.34	22.94	37.84	281.50±17.93	22.18%
	Base	22.94	6.88	26.38	20.64	3.44	4.58	44.72	52.74	18.34	32.1	193.11±4.38	26.45%
Persicaria chinensis var. *ovalifolia*	Apex	23.71	17.65	35.91	21.19	12.2	3.54	46.78	49.08	10.87	27.78	345.74±13.95	29.81%
	Middle	22.98	15.42	33.2	26.65	10.22	11.23	42.91	51.42	9.71	24.77	312.12±12.01	24.34%
	Base	25.29	19.01	37.87	22.9	12.58	3.89	49.08	47.98	11.21	25.08	208.88±4.24	19.76%
Persicaria minor	Apex	11.56	5.78	17.34	14.45	5.78	8.67	63.58	43.35	46.24	28.9	132.40±10.33	15.09%
	Middle	13.48	4.81	15.37	15.48	1.89	10.67	43.35	57.8	27.98	42.32	167.40±10.52	17.63%
	Base	17.34	2.89	20.45	11.63	3.11	8.72	52.25	49.13	31.8	37.5	189.01±11.59	19.42%
Persicaria posumbu	Apex	19.87	14.32	24.43	18.9	4.56	4.58	42.21	35.54	17.78	16.64	156.63±11.54	15.67%
	Middle	17.67	14.23	21.29	19.87	3.62	5.64	40.76	31.09	19.47	11.22	220.47±3.24	18.76%
	Base	15.43	12.31	22.9	17.65	7.47	5.34	43.21	29.08	20.31	11.43	182.84±9.24	16.49%
Persicaria strigosa	Apex	16.06	9.18	28.66	21.78	12.6	12.6	42.42	50.46	13.76	28.68	153.17±18.66	14.87%
	Middle	17.2	9.18	24.08	21.78	6.88	12.6	40.14	50.46	16.06	28.68	127.77±5.70	14.38%
	Base	18.34	5.74	25.22	14.89	6.88	9.15	42.23	49.29	17.01	34.4	141.42±10.46	16.24%
Persicaria orientalis	Apex	14.89	3.44	28.66	17.02	13.77	13.58	41.25	53.96	12.59	36.94	168.42±12.92	16.15%
	Middle	12.62	6.88	25.22	19.5	12.6	12.62	35.98	51.6	10.76	32.1	232.90±21.93	18.14%
	Base	6.88	9.18	26.38	14.89	19.5	5.71	37.54	52.74	11.16	37.85	216.99±15.39	19.27%
Persicaria barbata	Apex	14.89	6.88	24.08	22.94	9.19	16.06	42.42	58.48	18.34	35.54	378.07±19.33	32.07%
	Middle	20.64	8.02	25.21	19.5	4.57	11.48	44.72	57.36	19.51	37.86	374.05±10.19	31.76%
	Base	22.94	6.88	26.38	20.64	3.44	13.76	43.56	52.74	17.18	32.1	387.02±12.34	31.62%
Persicaria lanigera	Apex	11.89	7.34	19.87	15.64	7.98	8.3	27.65	29.09	7.78	13.45	92.14±6.77	10.96%
	Middle	12.31	8.76	17.67	14.43	5.36	5.67	28.43	31.1	10.76	16.67	105.11±3.67	11.17%
	Base	15.45	10.98	20.89	17.31	5.44	6.33	25.45	26.38	4.56	9.07	126.55±6.57	13.12%
Persicaria lapathifolia var. *lapathifolia*	Apex	16.06	5.74	22.94	18.33	6.88	12.59	44.72	41.28	21.78	22.95	169.17±16.83	23.28%
	Middle	19.5	8.02	26.38	22.94	6.88	14.92	75.69	43.58	49.31	20.64	227.77±5.33	25.10%

Taxa	Part of lamina	Mean length of S (µm)	Mean bradth of S(µm)	Mean length of S+GC (µm)	Mean breadth of S+GC (µm)	Mean length of GC (µm)	Mean breadth of GC (µm)	Mean length of S+SC (µm)	Mean breadth of S+SC (µm)	Mean length of SC (µm)	Mean breadth of SC (µm)	Stomatal frequency (no. of stomata /mm²)	Stomatal index(S*100/E+S)
	Base	20.64	9.18	22.35	24.08	1.71	14.9	77.98	45.86	55.63	21.78	209.27±8.42	25.22%
Persicaria lapathifolia var.	Apex	17.86	6.75	26.45	22.56	8.59	15.81	79.89	47.28	53.44	24.72	218.10±8.39	24.78%
lanata	Middle	22.33	5.65	25.67	24.67	3.34	19.02	76.45	48.97	50.78	24.3	242.89±20.12	27.67%
	Base	19.87	6.13	24.87	26.78	5.98	20.65	81.21	45.78	56.34	19	195.57±3.32	27.54%
Persicaria hydropiper	Apex	21.78	5.74	28.66	25.22	6.88	19.48	66.99	44.72	38.33	19.5	425.45±20.22	26.52%
	Middle	27.52	3.44	28.66	24.08	1.14	20.64	45.85	45.86	17.19	21.78	354.85±18.23	25.46%
	Base	14.08	4.58	24.04	26.38	9.96	21.8	50.46	55.86	26.42	29.48	397.17±22.81	25.75%
Persicaria tenella	Apex	14.89	3.44	33.36	19.5	18.47	16.06	35.54	51.6	2.18	32.1	229.27±14.17	26.37%
	Middle	13.76	6.88	29.82	14.89	16.06	8.01	37.84	52.74	8.02	37.85	181.44±13.72	24.87%
	Base	11.46	4.58	25.22	22.94	13.76	18.36	36.7	50.46	11.48	27.52	245.05±19.62	27.99%
Persicaria glabra	Apex	13.76	8.02	32.09	14.5	18.33	6.48	44.72	52.74	12.63	38.24	253.42±13.08	25.90%
	Middle	26.38	9.18	27.52	20.64	1.14	11.46	45.65	55.04	18.13	34.4	203.06±6.72	23.52%
	Base	24.08	5.74	28.66	24.08	4.58	18.34	44.72	58.48	16.06	34.4	262.94±2.50	26.05%
Persicaria campanulata	Apex	16.06	8.02	33.96	25.08	17.9	17.06	37.49	52.74	3.53	27.66	145.74±16.79	14.26%
	Middle	20.64	9.18	29.85	21.56	9.21	12.38	44.74	55.09	14.89	33.53	83.87±9.92	9.11%
	Base	21.78	5.74	24.25	24.22	2.47	18.48	36.76	58.46	12.51	34.24	114.83±19.13	12.71%
Persicaria capitata	Apex	21.78	5.36	28.36	24.08	6.58	18.72	44.72	42.61	16.36	18.53	144.96±19.90	11.25%
	Middle	22.25	7.02	28.66	25.22	6.41	18.2	43.56	43.96	14.9	18.74	286.02±10.62	21.22%
	Base	24.25	5.26	25.36	24.08	1.11	18.82	44.78	45.87	19.42	21.79	244.94±17.96	8.65%
Persicaria nepalensis	Apex	16.54	4.56	27.09	18.65	10.55	14.09	35.67	29.98	8.58	11.33	93.15±5.12	9.87%
	Middle	18.09	7.65	28.98	17.42	10.89	9.77	37.96	30.09	8.98	12.67	111.13±8.68	10.95%
	Base	14.67	6.81	26.1	13.28	11.43	6.47	39.02	29.65	12.92	16.37	155.84±2.59	13.21%
Persicaria perfoliata	Apex	17.65	7.65	22.76	11.87	5.11	4.22	31.18	35.56	8.42	23.69	188.74±8.97	25.01%
	Middle	12.98	9.8	26.57	13.2	13.59	3.4	32.97	34.53	6.4	21.33	150.15±7.86	23.31%
	Base	17.54	3.87	24.98	15.09	7.44	11.22	29.08	30.91	4.1	15.82	158.22±17.10	23.98%
Polygonum runcinatum	Apex	11.46	9.18	28.66	22.94	17.2	13.76	44.72	58.22	16.06	35.28	326.27±16.94	23.47%
	Middle	13.76	9.18	25.22	18.33	11.46	9.15	40.14	55.04	14.92	36.71	285.57±10.23	22.19%
	Base	16.06	6.88	26.38	19.5	10.32	12.62	38.98	56.18	12.6	36.68	387.00±11.76	26.45%
Polygonum plebium	Apex	16.25	3.44	28.66	18.33	12.41	14.89	37.84	58.48	9.18	40.15	58.10±8.06	20.47%
	Middle	23.84	6.88	24.08	15.26	10.24	8.38	42.25	57.25	18.17	41.99	64.11±7.49	25.21%
	Base	20.64	9.18	25.22	22.94	4.58	13.76	41.25	51.25	16.03	28.31	170.38±2.49	23.18%
Polygonum molle	Apex	6.06	3.44	33.26	22.94	27.2	19.5	40.14	54.36	6.88	31.42	242.23±23.46	24.25%
	Middle	20.64	4.58	29.82	25.22	9.18	20.64	38.98	57.34	9.16	32.12	217.23±8.82	21.25%
	Base	21.78	8.02	25.22	18.33	3.44	10.31	37.84	52.65	12.62	34.32	234.31±24.22	25.25%
Polygonum viscosum	Apex	12.63	8.02	25.52	22.94	12.89	14.92	39.85	51.67	14.33	28.73	334.62±13.18	9.36%

Taxa	Part of lamina	Mean length of S (µm)	Mean bradth of S(µm)	Mean length of S+GC (µm)	Mean breadth of S+GC (µm)	Mean length of GC (µm)	Mean breadth of GC (µm)	Mean length of S+SC (µm)	Mean breadth of S+SC (µm)	Mean length of SC (µm)	Mean breadth of SC (µm)	Stomatal frequency (no. of stomata /mm²)	Stomatal index(S*100/E+S)
	Middle	20.95	9.18	25.98	19.65	5.03	10.47	34.45	42.85	8.47	23.2	257.42±10.22	7.25%
	Base	19.06	6.88	24.08	20.42	5.02	13.54	34.95	50.37	10.87	29.95	345.07±6.55	19.25%
Polygonum pubescens	Apex	23.67	7.56	29.13	29.17	5.46	21.61	41.17	49.65	12.04	20.48	330.77±13.10	22.14%
	Middle	24.89	6.98	27.68	31.82	2.79	24.84	38.36	50.13	10.68	18.31	277.11±15.01	25.11%
	Base	29.01	8.54	32.86	19.45	3.85	10.91	43.02	49.78	10.16	30.33	396.13±4.98	29.45%
Rumex maritimus	Apex	13.76	8.02	32.09	17.2	18.33	9.18	40.14	50.45	8.05	33.25	150.50±7.12	14.26%
	Middle	11.46	9.18	26.38	21.78	14.92	12.6	38.98	49.29	12.6	27.51	77.63±8.72	9.11%
	Base	16.06	6.88	24.08	17.02	8.02	10.14	37.84	53.9	13.76	36.88	128.40±11.20	12.71%
Rumex dentatus	Apex	13.75	5.74	21.25	26.38	7.5	20.64	75.69	43.75	34.44	37.37	343.97±14.05	14.33%
	Middle	11.46	8.25	18.32	13.2	6.86	4.95	77.56	45.96	59.24	32.76	312.36±12.04	15.21%
	Base	16.06	10.25	24.08	21.78	8.02	11.53	66.89	45.73	42.81	23.95	329.77±14.93	9.36%
Rumex nepalensis	Apex	15.26	8.26	32.25	25.89	16.99	17.63	36.56	48.26	4.31	22.37	245.34±23.16	11.25%
	Middle	20.25	7.23	25.36	22.56	5.11	15.33	44.12	51.96	18.76	29.4	251.22±17.60	14.96%
	Base	21.26	8.98	24.25	23.12	2.99	14.14	36.25	54.87	12	31.75	156.21±4.74	11.89%
Rumex acetosella	Apex	14.89	5.25	21.94	17.02	7.05	11.77	44.56	50.49	22.62	33.47	237.40±25.64	21.33%
	Middle	13.76	3.44	18.56	19.5	4.8	16.06	50.25	48.31	31.69	28.81	269.43±12.08	14.78%
	Base	11.43	4.25	25.66	14.89	14.23	10.64	41.25	51.92	15.59	37.03	246.26±17.87	11.25%
Rheum nobile	Apex	18.92	9.82	26.57	17.61	7.65	7.79	42.87	54.32	16.3	36.71	74.47±6.16	8.45%
	Middle	22.98	8.09	29.54	16.54	6.56	8.45	43.87	50.87	14.33	34.33	84.55±4.02	8.89%
	Base	24.34	9.08	30.94	15.52	6.6	6.44	42.09	51.19	11.15	35.67	93.80±6.81	9.51%
Fallopia convolvulus	Apex	11.21	4.37	21.19	13.23	9.98	8.86	34.32	39.08	13.13	25.85	97.98±6.27	10.09%
	Middle	14.31	5.65	19.08	14.09	4.77	8.44	35.52	37.61	16.44	23.52	115.42±8.90	11.76%
	Base	15.09	6.05	22.39	15.42	7.3	9.37	32.98	35.54	10.59	20.12	143.32±2.34	15.45%
Fagopyrum dibotrys	Apex	16.06	9.18	28.66	21.78	12.6	12.6	42.42	50.46	13.76	28.68	219.21±3.43	26.37%
	Middle	17.2	9.18	24.08	21.78	6.88	12.6	40.14	50.46	16.06	28.68	183.33±11.96	24.87%
	Base	18.34	5.74	25.22	14.89	6.88	9.15	38.98	49.29	13.76	34.4	264.83±5.33	27.99%
Fagopyrum esculentum	Apex	14.89	3.44	28.66	17.02	13.77	13.58	37.84	53.9	9.18	36.88	182.62±12.47	21.39%
	Middle	12.62	6.88	25.22	19.5	12.6	12.62	42.42	51.6	17.2	32.1	146.27±7.48	20.36%
	Base	6.88	9.18	26.38	14.89	19.5	5.71	41.28	52.74	14.9	37.85	222.90±7.62	23.09%
Homalocladium platycladum	Apex	13.76	3.44	24.08	20.64	10.32	17.2	36.7	49.29	12.62	28.65	134.04±9.69	20.11%
	Middle	16.06	3.44	20.64	22.94	4.58	19.5	42.42	53.9	21.78	30.96	131.50±14.57	20.52%
	Base	17.2	4.58	26.38	17.2	9.18	12.62	40.14	49.29	13.76	32.09	150.12±16.35	23.03%

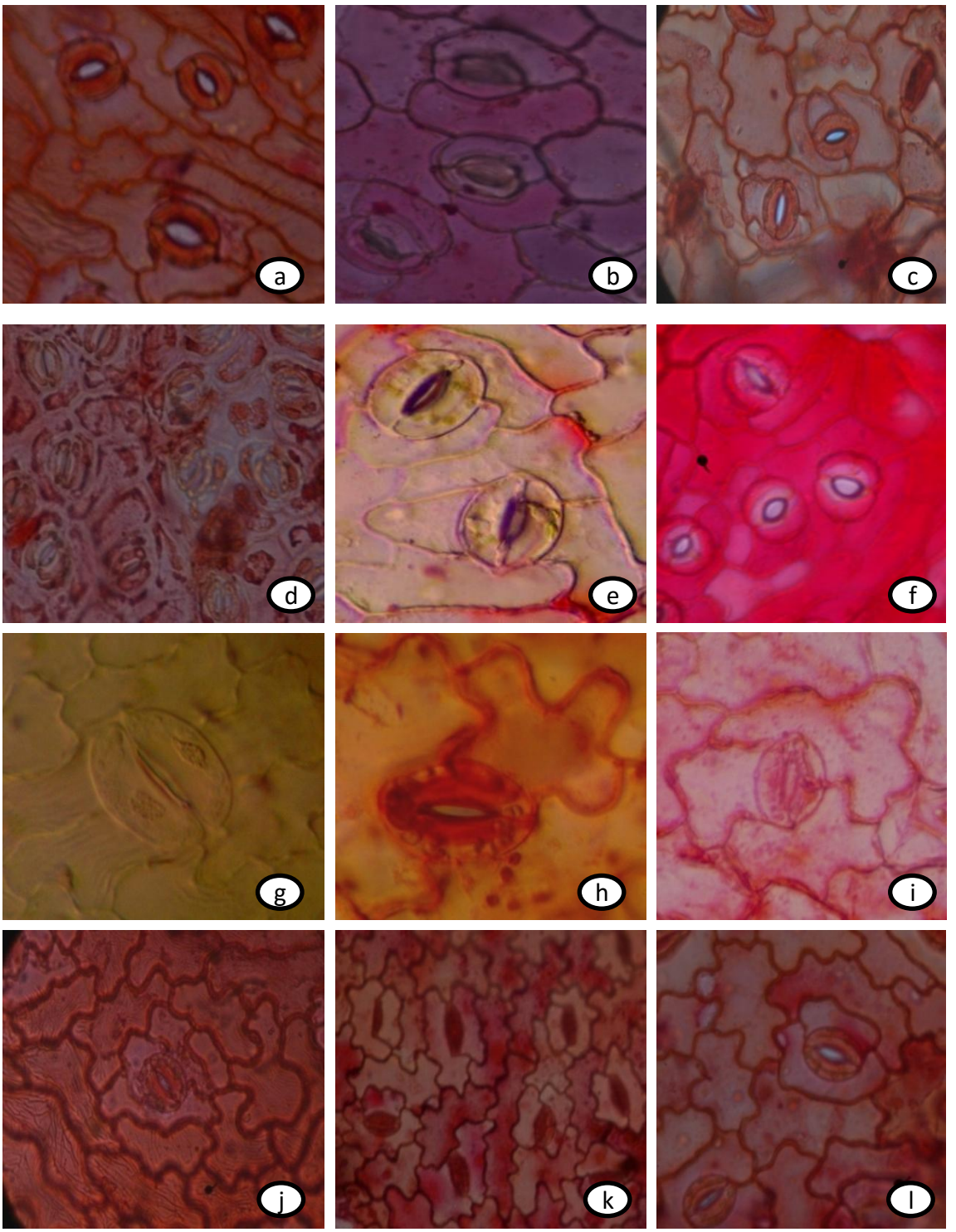


Fig. 15: Light micrographs of stomata **a.** *Persicaria chinensis* var. *chinensis* **b.** *Persicaria strigosa* **c.** *Persicaria orientalis* **d.** *Persicaria barbata* **e.** *Persicaria campanulata* **f.** *Polygonum molle* **g.** *Fagopyrum dibotrys* **h.** *Fallopia convolvulus* **i.** *Persicaria capitata* **j.** *Persicaria chinensis* var. *hispida* **k.** *Persicaria lapathifolia* var. *lapathifolia* **l.** *Persicaria lapathifolia* var. *lanata*

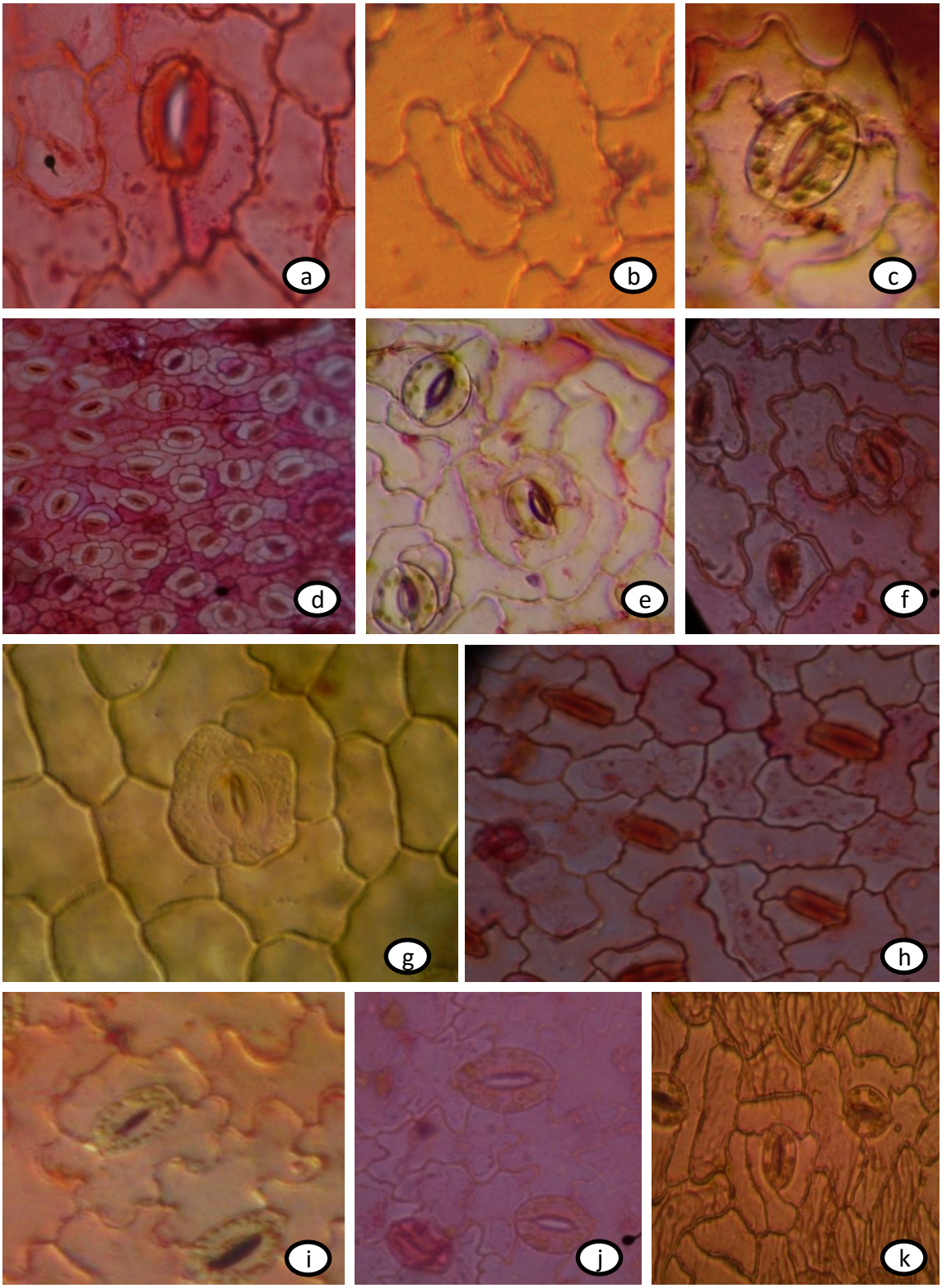


Fig. 16: Light micrographs of stomata **a.** *Rumex maritimus* **b.** *Rumex acetosella* **c.** *Persicaria chinensis* var. *ovalifolia* **d.** *Persicaria hydropiper* **e**. *Persicaria posumbu* **f.** *Persicaria tenella* **g.** *Polygonum pubescens* **h.** *Persicaria lanigera* **i.** *Persicaria minor* **j.** *Polygonum runcinatum* **k.** *Persicaria microcephala*

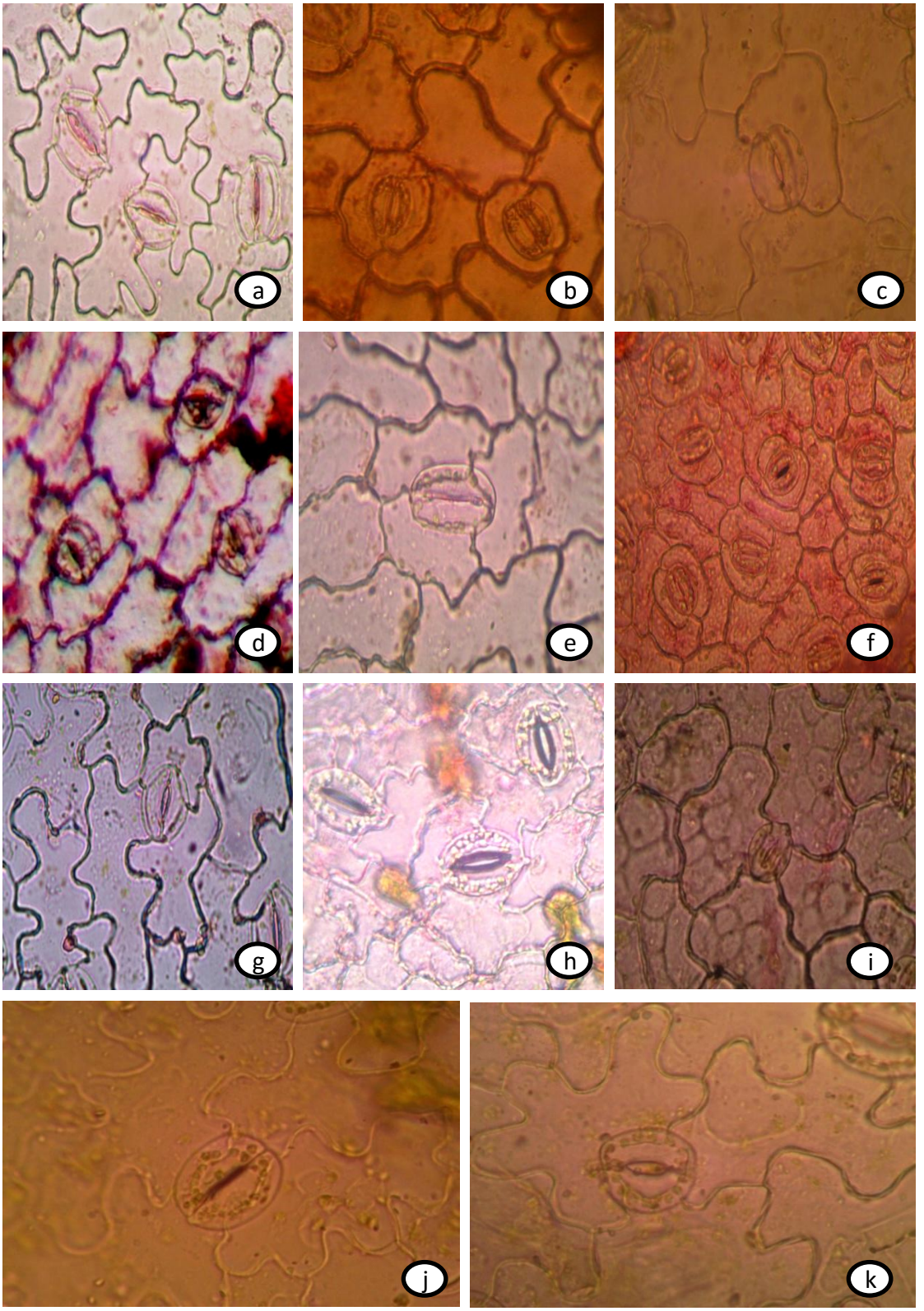


Fig. 17: Light micrographs of stomata **a.** *Homalocladium platyclada* **b.** *Rumex nepalensis* **c.** *Antigonon leptopus* **d.** *Persicaria perfoliata* **e.** *Polygonum plebeium* **f.** *Persicaria glabra* **g.** *Persicaria nepalensis* **h.** *Fagopyrum esculentum* **i.** *Rumex dentatus* **j.** *Rheum nobile* **k.** *Polygonum viscosum*

5.2.3. Venation pattern

The veins and veinlets which form the vasculature, called the ‘venation’ and the pattern of venations are of unique for various species. Venation patterns are important characteristics attributes used to determine many controversies in plant taxonomy.

5.2.3.1. Major venation pattern

The first step in describing venation is to recognize the first three orders of veins. In general the primary and secondary veins are the major structural veins of the lamina. The mid-vein or primary vein is the thickest vein of the lamina and thickness decrease gradually toward the apex. This also includes the study of inter 2º veins (veins similar to 2º and do not reach the margin), and agrophic veins (comb like complex comprising of lateral 1º or 2º veins). The primary vein or 1º vein was categorized and it was slightly different in the studied taxa where in majority of the taxa it was pinnate. In rest of the taxa, it was observed to be basal i.e., primary veins were run from the basal portion of the lamina (Table 10). The 1º vein spacing was more or less similar in all the taxa except in *Persicaria strigosa*, it was increased towards the base. In the entire taxa 2º vein category were same *i.e*., Festooned brochidodromous (one or more additional sets of loops outside of the main brochidodromous loop) (Fig. 18; 19; 20; 21; 22).

5.2.3.2. Minor venation pattern

Major differences were observed up to high order venation pattern in all the studied taxa. 3º vein category were quite variable and three major types *i.e*., alternate percurrent (tertiaries cross between adjacent secondaries with an offset), regular polygonal reticulate (tertiaries anastomose with other 3º veins to form polygons of similar size and shape) and random reticulate (rejoin with other 3º veins or 2º veins at random angles) were observed in various studied taxa (Table 10). Polygonal reticulate was most common type that found in 18 taxa (*Fagopyrum esculentum*, *Homalocladium platycladum*, *Persicaria barbata*, *Persicaria campanulata*, *Persicaria chinensis* var. *chinensis*, *Persicaria chinensis* var. *hispida*, *Persicaria chinensis* var. *ovalifolia*, *Persicaria glabra*, *Persicaria hydropiper*, *Persicaria lanigera*, *Persicaria lapathifolia* var. *lapathifolia*, *Persicaria lapathifolia* var.

lanata, *Persicaria minor*, *Persicaria tenella*, *Persicaria microcephala*, *Polygonum plebeium*, *Polygonum molle* and *Polygonum viscosum*) followed by alternate percurrent that was observed in 8 taxa (*Antigonon leptopus*, *Fagopyrum dibotrys*, *Persicaria capitata*, *Polygonum pubescens*, *Polygonum runcinatum*, *Rumex maritimus* and *Rumex dentatus*) and random reticulate type was observed in 7 taxa (*Fallopia convolvulus*, *Persicaria nepalensis*, *Persicaria perfoliata*, *Persicaria posumbu*, *Persicaria orientalis*, *Persicaria strigosa* and *Rumex nepalensis*). Highest excurrent vein was 4º vein categories except in *Rumex acetosella* where it was 2º. The 4º vein category was also diverse in all the studied taxa (Fig. 18; 19; 20; 21; 22). Four different types of vein categories (Table 10) were observed such as regular polygonal reticulate (*Fagopyrum dibotrys*, *Fallopia convolvulus*, *Homalocladium platycladum*, *Persicaria barbata*, *Persicaria chinensis* var. *chinensis*, *Persicaria chinensis* var. *hispida*, *Persicaria chinensis* var. *ovalifolia*, *Persicaria glabra*, *Persicaria lanigera*, *Persicaria minor*, *Persicaria nepalensis*, *Persicaria perfoliata*, *Persicaria strigosa*, *Persicaria tenella*, *Persicaria microcephala*, *Polygonum plebeium* and *Rumex nepalensis*), alternate percurrent (*Antigonon leptopus*, *Persicaria campanulata*, *Polygonum pubescens*, *Polygonum runcinatum*, *Rumex maritimus* and *Rumex dentatus*), dichotomizing (*Fallopia convolvulus*, *Persicaria capitata*, *Persicaria hydropiper*, *Persicaria lapathifolia* var. *lapathifolia*, *Persicaria lapathifolia* var. *lanata*, *Polygonum molle*, *Polygonum viscosum*, *Rumex acetosella* and *Rheum nobile*) and regular (*Persicaria posumbu* and *Persicaria orientalis*).

Table 10: Major and minor venation pattern in lamina of studied taxa of Polygonaceae based on light microscopy

TAXA	1° vein category	1° vein spacing	2° vein category	2° vein spacing	3° vein category	4° vein category
Antigonon leptopus	Pinnate	Irregular	Festooned brochidodromous	Irregular	Alternate percurrent	Alternate percurrent
Fagopyrum dibotrys	Pinnate	Irregular	Festooned brochidodromous	Irregular	Alternate percurrent	Regular polygonal reticulate
Fagopyrum esculentum	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Dichotomizing
Fallopia convolvulus	Supra basal	Irregular	Festooned brochidodromous	Irregular	Random reticulate	Regular polygonal reticulate
Homalocladium platycladum	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria barbata	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria campanulata	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Alternate percurrent
Persicaria capitata	Pinnate	Regular	Festooned brochidodromous	Irregular	Alternate percurrent	Dichotomizing
Persicaria chinensis* var. *chinensis	Basal	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria chinensis* var. *hispida	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria chinensis* var. *ovalifolia	Basal	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria glabra	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria hydropiper	Pinnate	Regular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Dichotomizing
Persicaria lanigera	Pinnate	Irregular	Festooned brochidodromous	Irregular	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria lapathifolia* var. *lapathifolia	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Dichotomizing
Persicaria lapathifolia* var. *lanata	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Dichotomizing
Persicaria minor	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria nepalensis	Pinnate	Regular	Festooned brochidodromous	Irregular	Random reticulate	Regular polygonal reticulate
Persicaria perfoliata	Supra basal	Irregular	Festooned brochidodromous	Irregular	Random reticulate	Regular polygonal reticulate

TAXA	1° vein category	1° vein spacing	2° vein category	2° vein spacing	3° vein category	4° vein category
Persicaria posumbu	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Random reticulate	Regular
Persicaria orientalis	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Random reticulate	Regular
Persicaria strigosa	Basal	Decrease towards base	Festooned brochidodromous	Strong intersecondaries	Random reticulate	Regular polygonal reticulate
Persicaria tenella	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Persicaria microcephala	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Regular polygonal reticulate
Polygonum plebeium	Pinnate	Irregular	Festooned brochidodromous	Irregular	Regular polygonal reticulate	Regular polygonal reticulate
Polygonum pubescens	Basal	Irregular	Festooned brochidodromous	Strong intersecondaries	Alternate percurrent	Alternate percurrent
Polygonum molle	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Dichotomizing
Polygonum viscosum	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Regular polygonal reticulate	Dichotomizing
Polygonum runcinatum	Basal	Irregular	Festooned brochidodromous	Strong intersecondaries	Alternate percurrent	Alternate percurrent
Rumex nepalensis	Pinnate	Irregular	Festooned brochidodromous	Strong intersecondaries	Random reticulate	Regular polygonal reticulate
Rumex maritimus	Basal	Irregular	Festooned brochidodromous	Strong intersecondaries	Alternate percurrent	Alternate percurrent
Rumex dentatus	Basal	Irregular	Festooned brochidodromous	Strong intersecondaries	Alternate percurrent	Alternate percurrent
Rumex acetosella	Basal	Irregular	Festooned brochidodromous	Irregular	-	-
Rheum nobile	Supra basal	Irregular	Festooned brochidodromous	Irregular	Alternate percurrent	Dichotomizing

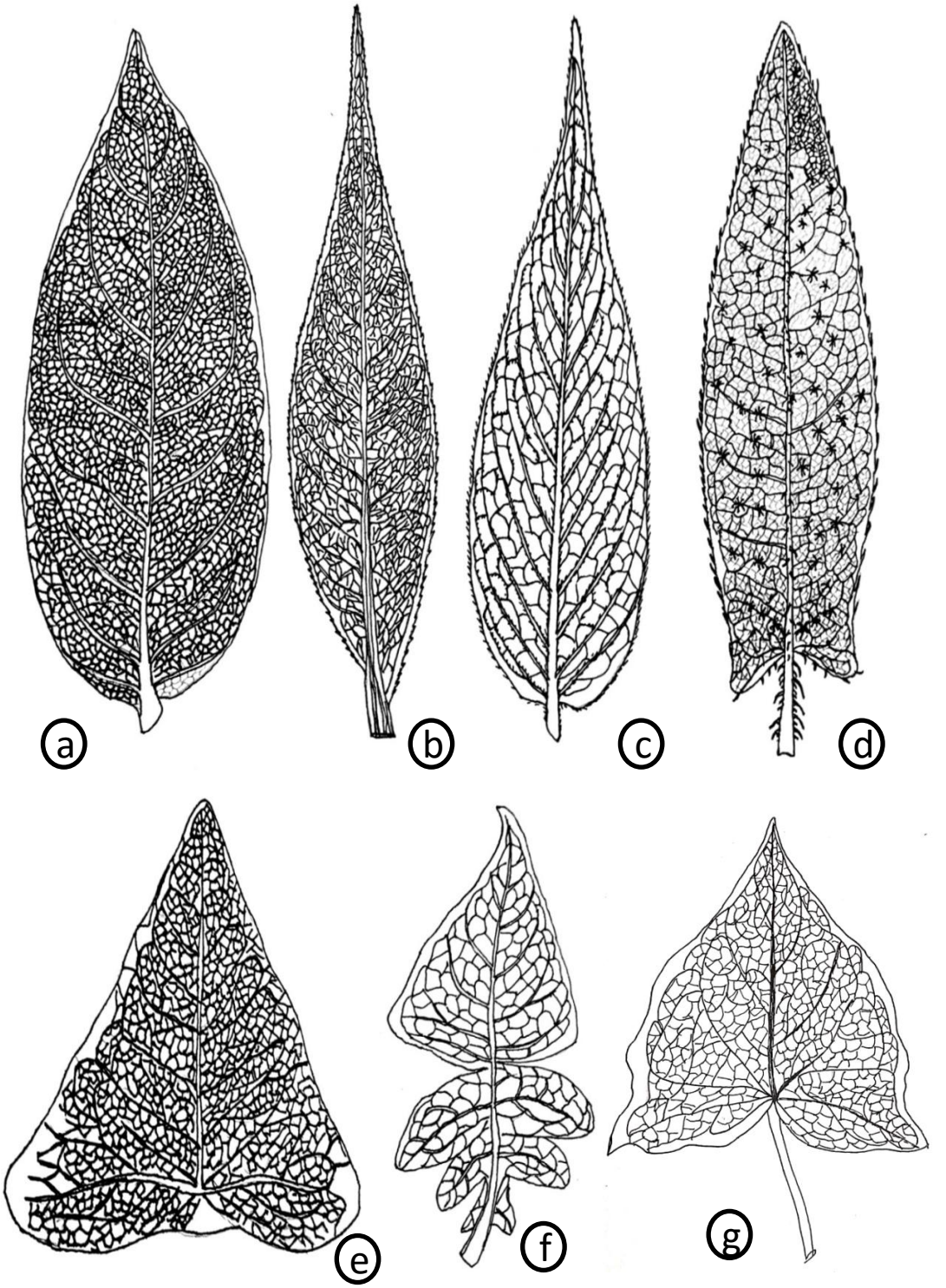


Fig. 18: Illustration of venation pattern **a.** *Persicaria chinensis* var. *chinensis* **b.** *Persicaria hydropiper* **c.** *Persicaria orientalis* **d.** *Persicaria strigosa* **e.** *Persicaria perfoliata* **f.** *Polygonum runcinatum* **g.** *Fagopyrum dibotrys*

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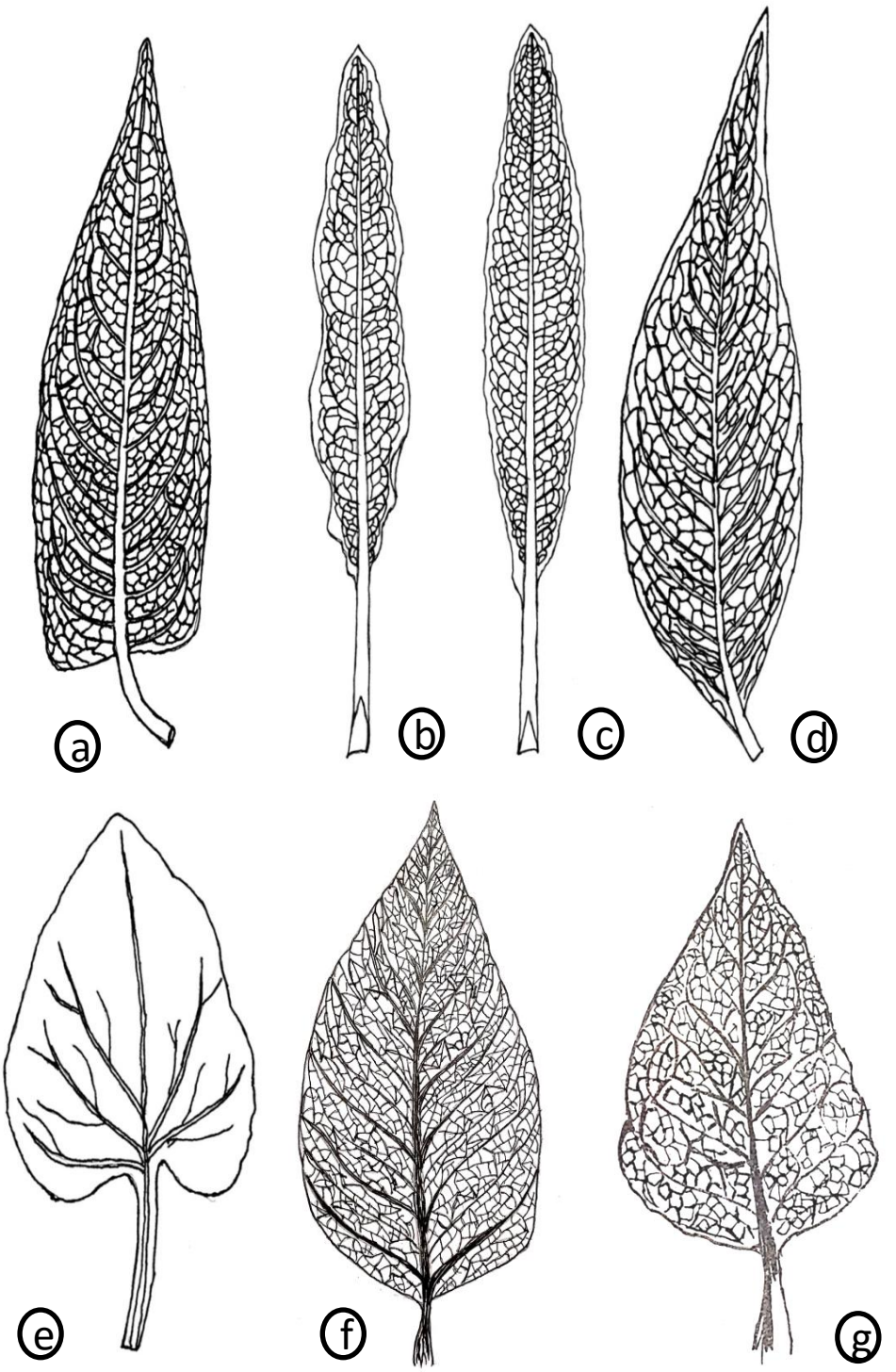


Fig. 19: Illustration of venation pattern **a.** *Rumex nepalensis* **b.** *Rumex dentatus* **c.** *Rumex maritimus* **d.** *Polygonum pubescens* **e.** *Rumex acetosella* **f.** *Persicaria campanulata* **g.** *Persicaria nepalensis*

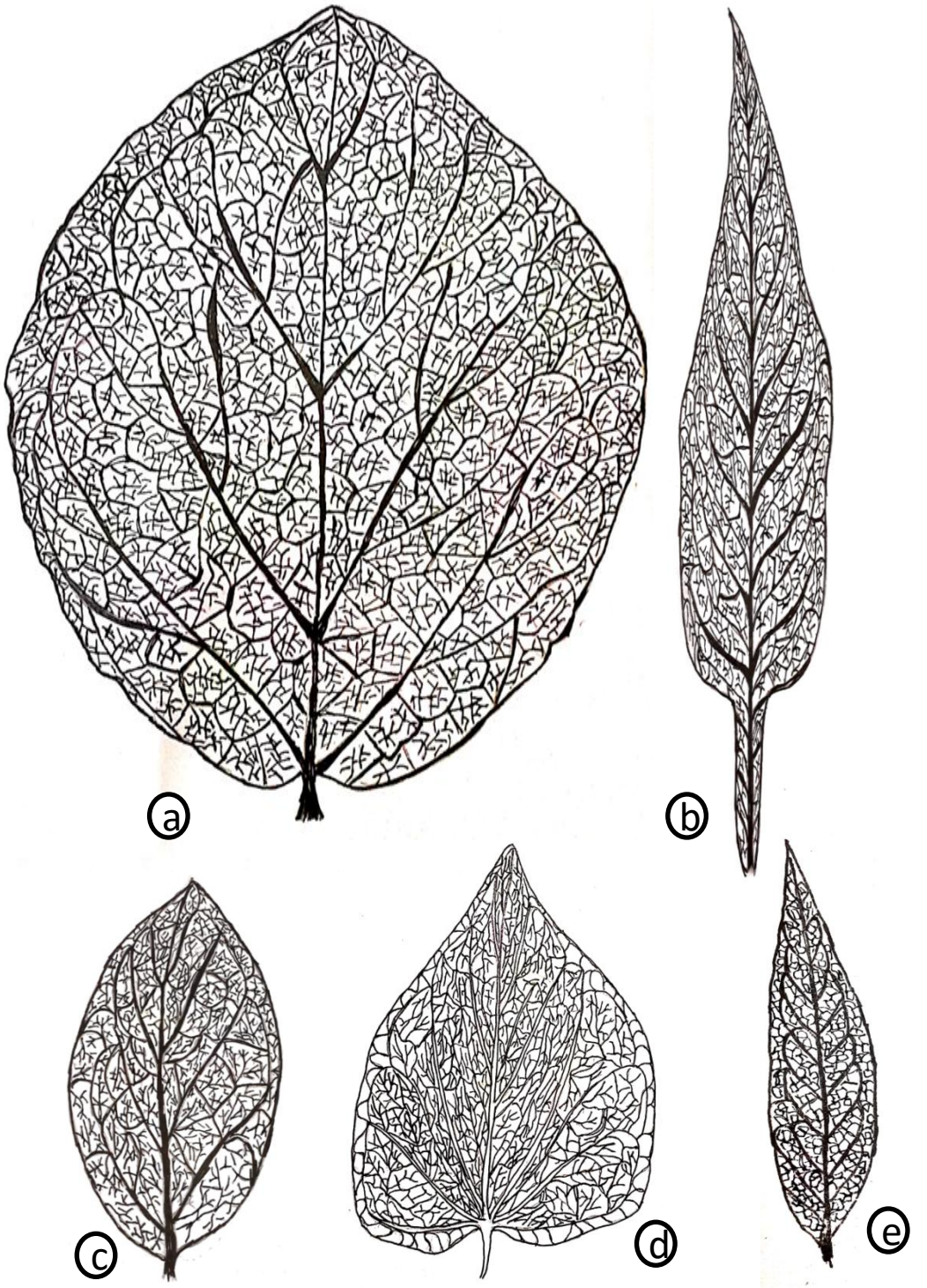


Fig. 20: Illustration of venation pattern **a.** *Rheum nobile* **b.** *Polygonum viscosum* **c.** *Perssicaria capitata* **d.** *Fagopyrum esculentum* **e.** *Persicaria minor*

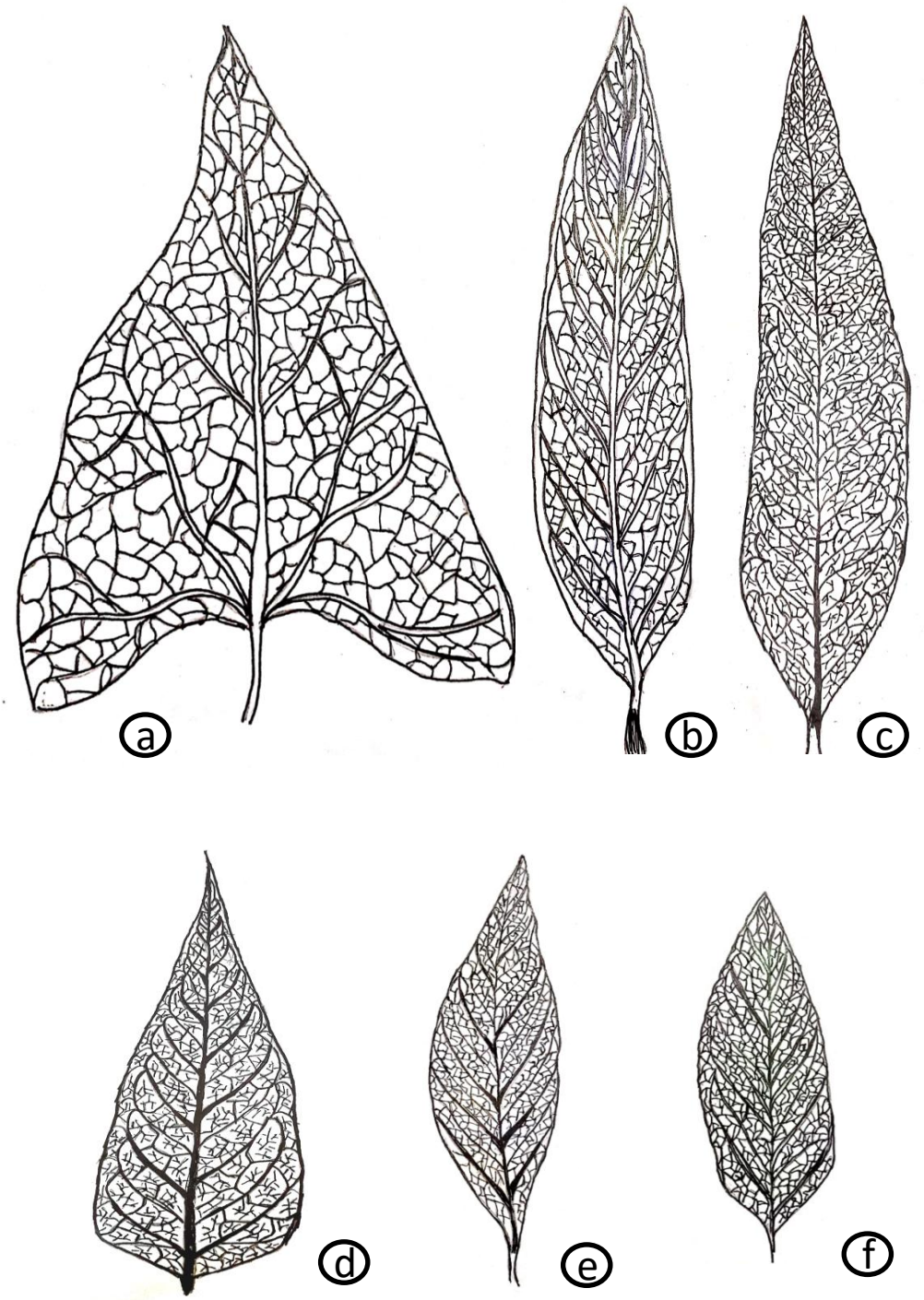


Fig. 21: Illustration of venation pattern **a.** *Fallopia convolvulus* **b.** *Persicaria barbata* **c.** *Persicaria lapathifolia* var. *lapathifolia* **d.** *Persicaria lapathifolia* var**.** *lanata* **e.** *Persicaria glabra* **f.** *Homalocladium platycladum*

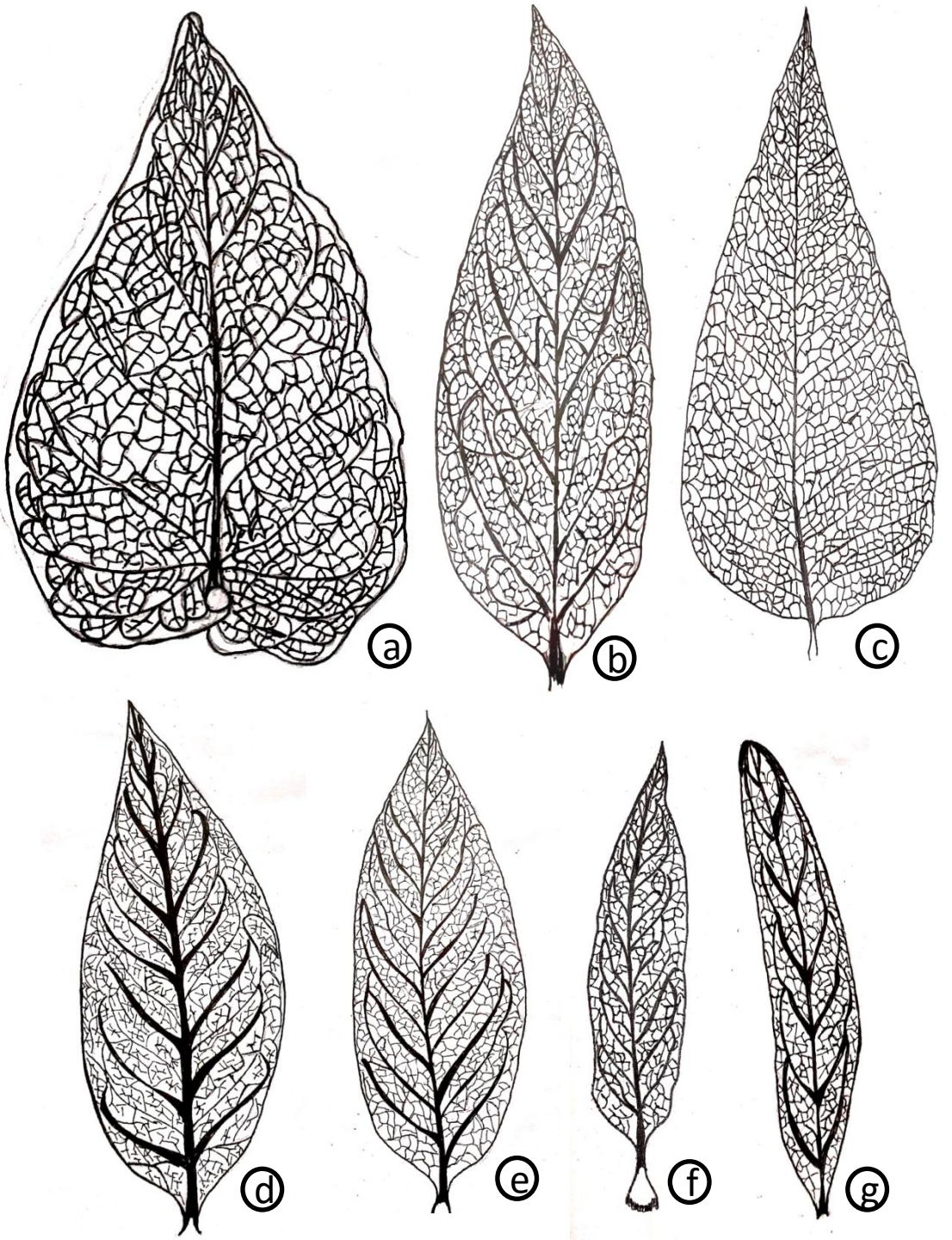


Fig. 22: Illustration of venation pattern **a.** *Antigonon leptopus* **b.** *Persicaria lanigera* **c.** *Persicaria posumbu* **d.** *Polygonum molle* **e.** *Persicaria microcephala* **f.** *Persicaria tenella* **g.** *Polygonum plebeium*

5.2.4. Morphology of Indumentums

Indumentums or trichomes are the epidermal outgrowths of various kinds. Hair is a common type of trichomes, it may be unicellular or multicellular, branched or unbranched, glandular or eglandular whereas, scale or peltate hair is a shield shaped cluster of cells attached directly to the surface or sometimes with stalk. Indumentums could be considered as valuable criteria in field of species identification as the presence and absence and location of indumentums are major diagnostic attributes in plant taxonomy. Although they are rarely found preserved in fossils but their bases are commonly found and in some cases, their cellular structure also plays important role in identification of ancient flora.

In this study, it was noticed that indumentums were entirely absent in some taxa (Table 11) but all other taxa bears two basic type of trichomes on abaxial and adaxial lamina surfaces i.e., glandular (G) and nonglandular (NG). On the basis of cell shape trichomes are further divided into two forms i.e., elongated-slender and globular (Table 11). The trichomes are distributed on both abaxial and adaxial surface of the investigated species. Trichomes are originated from some specific area and/or on entire lamina. In some taxa *i.e., Homalocladium platyclada*, *Persicaria strigosa*, *P. orientalis*, *P. perfoliata*, *P. lapathifolia* var. *lanata*, *Polygonum runcinatum*, *Rumex dentatus* trichomes were originated from the entire lamina (Fig. 22; 23) whereas in four taxa *i.e., Fagopyrum dibotrys*, *Fagopyrum esculentum*, *Polygonum plebeium* and *Rumex maritimus*, it was originated from the middle of the lamina only and in rest of the taxa it was along with the margin of lamina (Table 11; Fig. 23; 24). Longest trichomes observed in *Polygonum lanigera* (260.12µm ±8.94), whereas smallest one observed in *Rumex maritimus* (15.71µm ±0.62). The characteristic features of the trichome also showed great variation in the studied taxa (Table 11). Peltate hair was found in some taxa *i.e., Persicaria barbata*, *P. chinensis* var. *hispida*, *P. glabra*, *Polygonum plebeium* and *Fagopyrum dibotrys*. Strigose and stellate hairs were also a unique feature of this family and found in 3 taxa i.e. *Persicaria chinensis* var. *hispida*, *Persicaria strigosa* and *Rumex dentatus*.

Table 11: Qualitative and quantitative study on morphology of Indumentums of Polygonaceae based on light microscopy

Taxa	Origin	Type	Shape	Branching	Gland	Length (µm)	Features
Antigonon leptopus	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Fallopia convolvulus	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Fagopyrum dibotrys	Middle of lamina	Multicelled	Globular	Unbranched	Non glandular	37.06±1.09	Peltate hair present
Fagopyrum esculentum	Middle of lamina	Multiseriate	Slender	Unbranched	Non glandular	109.82±2.87	Long with blunt tip
Homalocladium platycladum	Entire lamina	Multiseriate	Slender, curved	Branched	Non glandular	115.6±4.98	Long, dense with blunt tip
Persicaria barbata	Lamina margin	Multiseriate	Elongated, slender	Unbranched	Non glandular	53.92±0.98	Soft, dense, slender with blunt end , peltale hair present
Persicaria campanulata	Lamina margin	Multiseriate	Elongated, slender	Unbranched	Non glandular	76.32±9.57	Long, dense
Persicaria capitata	Lamina margin	Multiseriate	Elongated, slender	Unbranched	Non glandular	62.69±5.06	Long, fine, not so dense
Persicaria chinensis* var. *chinensis	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Persicaria chinensis* var. *hispida	Entire lamina	Uniseriate	Slender, curved	Unbranched	Glandular	26.01±1.76	Strigose and stellate hairs and also peltate scale present
Persicaria chinensis* var. *ovalifolia	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Persicaria glabra	Lamina margin	Multiseriate	Elongated, slender	Unbranched	Glandular	78.89±1.98	Long, dense, tip very sharp, peltate hair present
Persicaria hydropiper	Lamina margin	Multiseriate	Elongated, slender	Unbranched	Non glandular	101.09±5.97	Long, fine, not so dense
Persicaria lanigera	Lamina margin	Uniseriate	Elongated, slender	Unbranched	Non glandular	260.12±8.94	Long, slender, not dense.
Persicaria lapathifolia* var. *lapathifolia	Lamina margin	Multiseriate	Slender	Unbranched	Non glandular	37.01±0.87	Short , not so dense
Persicaria lapathifolia* var. *lanata	Entire lamina	Multiseriate	Slender	Unbranched	Non glandular	29.32±1.02	Short , dense
Persicaria microcephala	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Persicaria minor	Lamina margin	Multiseriate	Slender	Unbranched	Glandular	43.35±2.13	Short, not so dense.

Taxa	Origin	Type	Shape	Branching	Gland	Length (µm)	Features
Persicaria nepalensis	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Persicaria orientalis	Entire lamina	Multiseriate	Slender	Unbranched	Nonglandular	35.98±2.21	Short, soft, dense, erect
Persicaria perfoliata	Entire lamina	Uniseriate	Elongated, slender	Unbranched	Non glandular	130.05±7.34	Long, fine not so dense
Persicaria posumbu	Lamina margin	Uniseriate	Elongated, slender	Unbranched	Non glandular	98.26±3.09	Many, spiny, dense, slender
Persicaria strigosa	Entire lamina	Multiseriate	Elongated, slender	Unbranched	Nonglandular	48.44±2.94	Both strigose & stellate hairs present
Persicaria tenella	Lamina margin	Multiseriate	Elongated, slender	Unbranched	Non glandular	68.72±1.32	Short, dense, slender
Polygonum molle	Lamina margin	Multiseriate	Elongated, slender	Unbranched	Non glandular	86.32±5.57	Long, dense with sharp tip
Polygonum pubescens	Lamina margin	Multiseriate	Elongated, slender	Unbranched	Non glandular	62.02±2.09	Long, slender
Polygonum runcinatum	Entire lamina	Multiseriate	Elongated, slender	Unbranched	Non glandular	55.01±5.66	Short, dense, slender
Polygonum viscosum	Lamina Margin	Multiseriate	Elongated, slender	Unbranched	Glandular	46.76±0.76	Short, dense, slender
Polygonum plebeium	Middle of lamina	Multicelled	Globular	N.A.	N.A.	21.98±1.11	Peltate hair present
Rheum nobile	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Rumex acetosella	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Rumex dentatus	Entire lamina	Multicelled	Round	Unbranched	Non glandular	26.01±1.98	Stellate, devide into four parts
Rumex maritimus	Middle of lamina	Two celled	Elongated, slender	Unbranched	Non glandular	15.71±0.62	Short, dense, slender
Rumex nepalensis	Absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

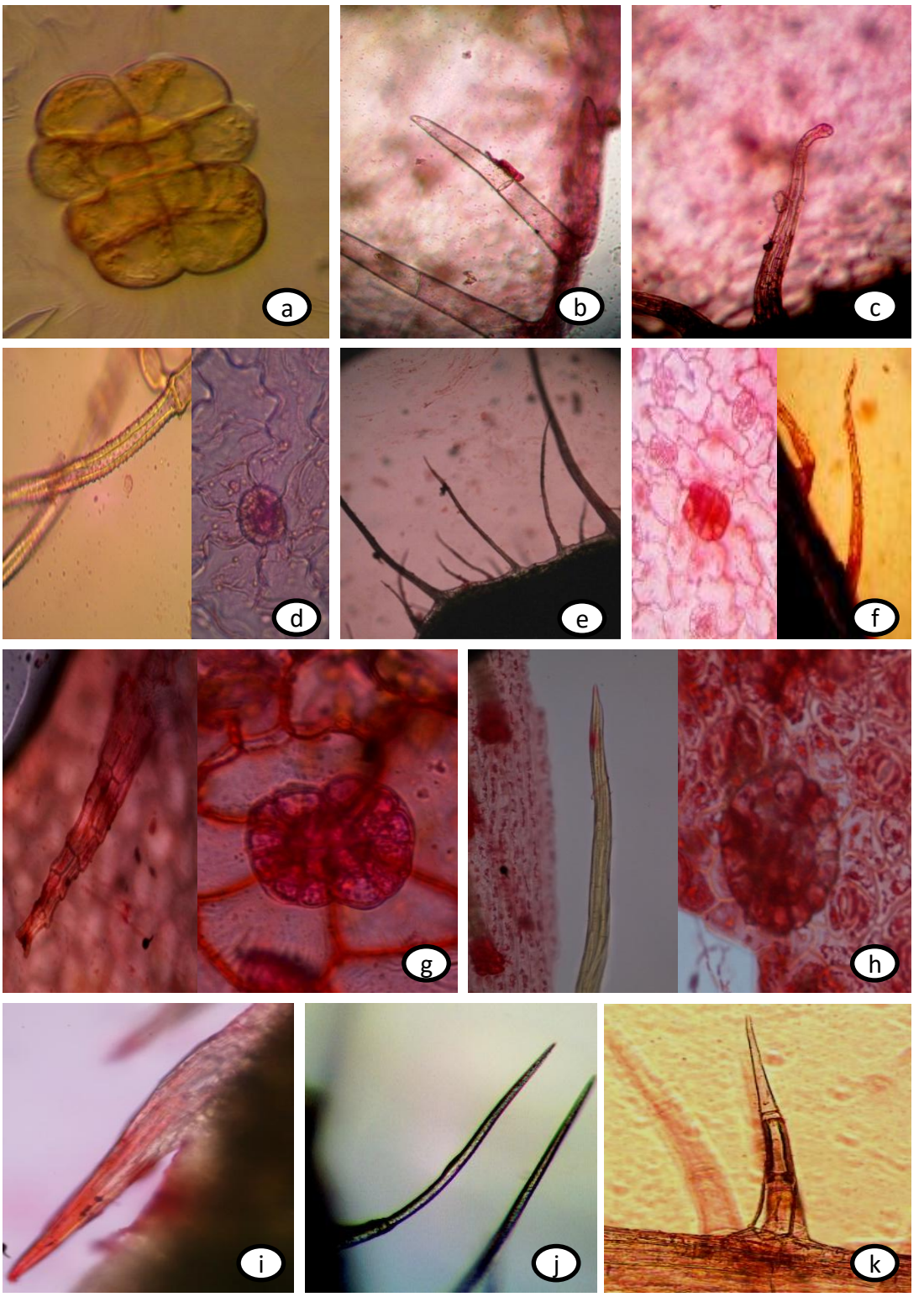


Fig. 23: Light micrographs of different types of Indumentums **a.** *Fagopyrum dibotrys* **b.** *Fagopyrum esculentum* **c.** *Homalocladium platyclada* **d.** *Persicaria barbata* **e.** *Persicaria campanulata* **f.** *Persicaria capitata* **g.** *Persicaria chinensis* var. *hispida* **h.** *Persicaria glabra* **i.** *Persicaria hydropiper* **j.** *Persicaria lanigera* **k.** *Persicaria lapathifolia* var. *lanata*

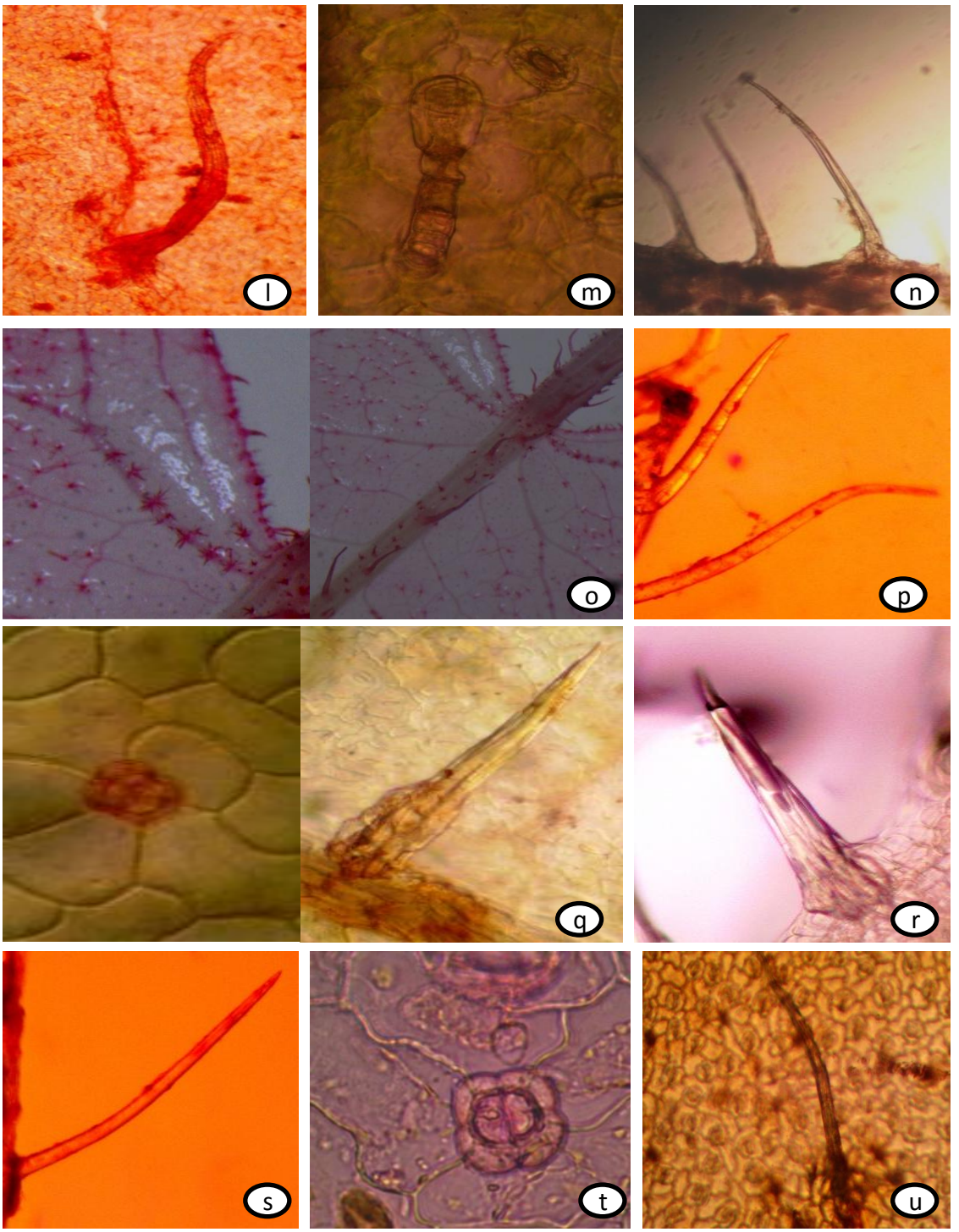


Fig. 24: Light micrographs of different types of Indumentums **l.** *Persicaria lapathifolia* var. *lapathifolia* **m.** *Persicaria minor* **n.** *Persicaria orientalis* **o.** *Persicaria strigosa* **p.** *Persicaria tenella* **q.** *Polygonum pubescens* **r.** *Polygonum runcinatum* **s.** *Polygonum viscosum* **t.** *Rumex dentatus* **u.** *Rumex maritimus*

5.2.5. Statistical analysis

Statistical analysis was conducted for collective interpretation of all the studied macro and micro morphological data. Current study was summarized under three statistical interpretations namely ANOVA, Principal component analysis (PCA) and Correlation study. Through ANOVA analysis, comparison of data sets was conducted for determining the significance level among the different attributes under study by determining variability among the samples and within the samples. PCA was conducted for reducing the complexity in the data pattern by projecting the studied parameters into different geometrical dimensions called principal components. For determining the prevalence and the relationships among the studied variables Pearson correlation study was conducted which tests the strength between two continuous variables by measuring the degree of significance among them.

5.2.5.1. ANOVA analysis

Two-way ANOVA without replicates were performed taking all the attributes under study (Table 12). From analysis it was found that the p-value for all the taxa and parameters were 0.181848 and 9.68×10^{-23} respectively.

Table 12: ANOVA analysis representing the significance level among different macro & micro morphological parameters

Source of Variation	SS	df	MS	F	P-value	F crit
Species	72948110	33	2210549	1.225131	0.181848	1.451846
Attributes	3.19E+08	23	13885747	7.695763	9.68E-23	1.543515
Error	1.37E+09	759	1804337			
Total	1.76E+09	815				

Significant at $p < 0.01$

5.2.5.2. Principal Component Analysis (PCA)

Principle Component Analysis was done to correlate different attributes under study by group clustering. PCA separates correlated attributes from uncorrelated ones. Eigen analysis results and loading scores of three principal components were showing in table 13 and 14 and score plot was shown in Fig. 25. The first principal component (PC1) was dominated by lamina length (LL), lamina breadth (LB), lamina area (LA), stomatal frequency (SF), 2º vein category (2º) and the second principal component (PC2) was dominated by blade class (BC), lamina Shape (LS),

base angle (BA), base shape (BS), apex shape (AS), margin type (MT), Lobation (LO), stomatal index (SI), 1˚ vein category (1º), 3˚ vein category (3º), 4˚ vein category (4º), origin of indumentum (OI), gland (GL), length of indumentums (LI), Cilia (CI), length of stipule (LS), breadth of stipule (BS), number of frimbrae (NF), length of frimbrae (LF). The distribution of total variation in PC1 and PC2 was 21.63% and 19.42% respectively.

Table 13: Eigen analysis of Correlation matrix

	PC1	PC2	PC3
Eigen value	5.1906	4.6604	2.2797
Variability (%)	21.6273	19.4182	9.4988
Cumulative %	21.6273	41.0456	50.5444

Table 14: The variable loading scores for each principal component (PC1 – PC3) for 34 taxa of Polygonaceae from West Bengal, India

Variables	PC1	PC2	PC3
Lamina length (LL)	0.2416	0.2311	0.0705
Lamina breadth (LB)	0.3142	0.2718	-0.0846
Lamina area (LA)	0.3350	0.2285	-0.1320
Blade Class (BS)	-0.3255	0.0145	0.0402
Lamina Shape (LS)	0.1566	0.1664	0.1936
Base Angle (BA)	-0.0207	0.2140	0.2583
Base Shape (BS)	0.0240	0.2182	0.2566
Apex Shape (AS)	0.0950	0.1871	-0.1804
Margin Type (MT)	0.0111	0.1531	0.4005
Lobation (LO)	-0.0497	-0.0881	0.1714
Stomatal Frequency (SF)	0.3352	0.2295	-0.1306
Stomatal Index (SI)	-0.2864	0.1293	-0.0123
1˚ vein category (1˚)	-0.0045	-0.1093	0.3567
2˚ vein category (2˚)	0.0251	-0.0482	0.3429
3˚ vein category (3˚)	-0.0448	0.1124	-0.3961
4˚ vein category (4˚)	-0.1345	0.2222	-0.2407
Origin of Indumentum (IO)	-0.2431	0.1343	0.0713
Gland (G)	-0.3103	0.1705	-0.0902
Length of Indumentum (IL)	-0.3047	0.1421	-0.0917
Cilia (CI)	-0.1526	0.1544	-0.1745
Length of Stipule (SL)	-0.0204	0.3702	0.1326
Breadth of Stipule (SB)	-0.0175	0.3898	0.0794
Number of Frimbrae (NF)	-0.2416	0.1982	-0.0388
Length of Frimbrae (FL)	-0.2047	0.2606	0.1489

On comparing the taxa by PCA (Fig. 26) it was observed that the first axis (PC1) was dominated by 21 taxa viz. *Fagopyrum dibotrys*, *F. esculentum*, *Persicaria barbata*, *P. campanulata*, *P. capitata*, *P. chinensis* var. *chinensis*, *P. glabra*, *P. hydropiper*, *P. lapathifolia* var. *lanata*, *P. lapathifolia* var. *lapathifolia*, *P. minor*, *P. perfoliata*, *P. strigosa*, *P. tenella*, *Polygonum pubescens*, *P. plebeium*, *Rheum nobile*, *Rumex acetosella*, *R. dentatus*, *R. maritimus* and *R. nepalensis*. The second axis (PC2) was dominated by 13 taxa viz., *Antigonon leptopus*, *Fallopia convolvulus*, *Homalocladium platycladum*, *P. chinensis* var. *hispida*, *P. chinensis* var. *ovalifolia*, *P. lanigera*, *P. microcephala*, *P. nepalensis*, *P. orientalis*, *P. posumbu*, *Polygonum molle*, *P. runcinatum*, and *P. viscosum*

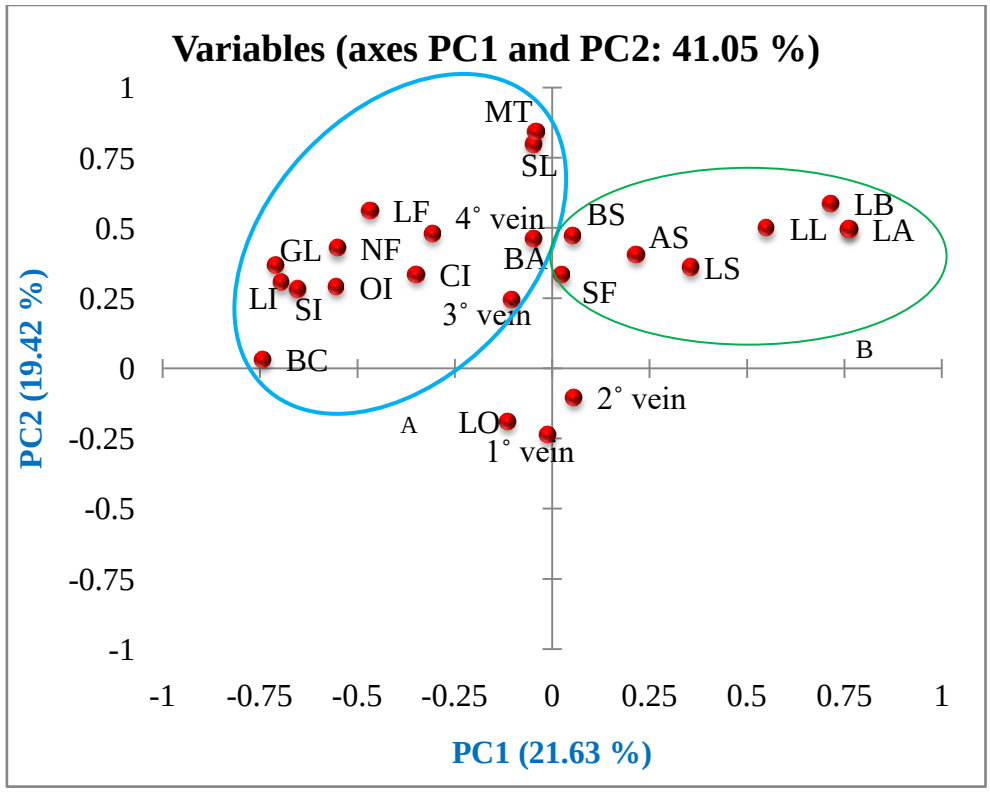


Fig. 25: Principal component analysis score plot showing the macro & micro morphological variation for studied taxa of Polygonaceae

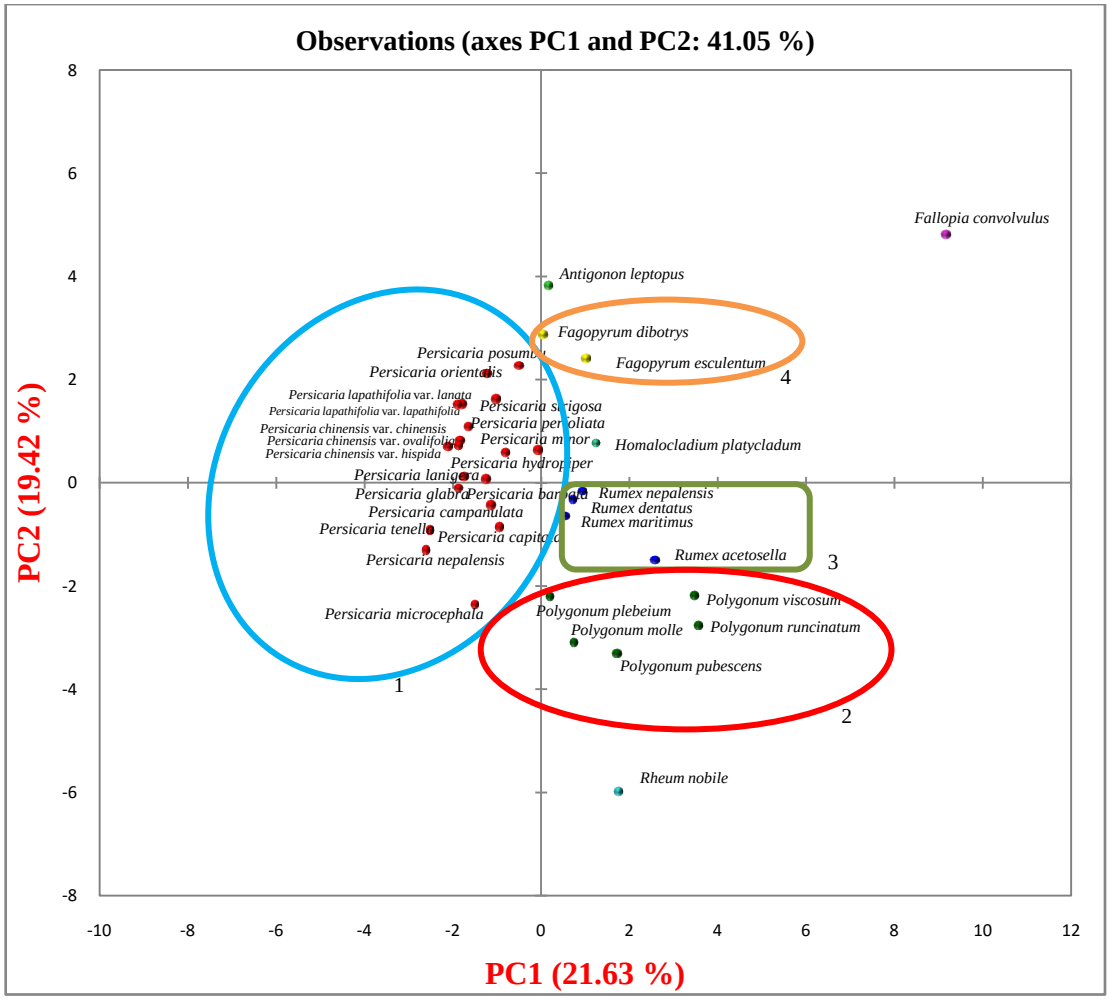


Fig. 26: Principal component analysis score plot showing the interrelationships among studied taxa

5.2.5.3. Correlation matrix analysis

Pearson correlation matrix for quantitative variables for studied taxa (Table 15) were quite distinct and stomatal frequency (SF) correlates positively with lamina length (LL) (r = 0.614), lamina width (LW) (r = 0.969) and lamina area (LA) (r = 1). Stomatal index (SI) correlates positively and significantly with blade class (r = 0.42). Indumentum length (IL) positively and significantly correlates with blade class (r = 0.48) and the origin of indementum (IO) (r = 0.63). Stipule length (SL) correlates with lamina length (r = 0.346), lamina breadth (r = 0.35) and margin type (r = 0.37). All these parameters were correlated with each other at $p < 0.01$.

Table 15: Pearson correlation matrix for quantitative macro & micro morphological variables among the studied taxa of Polygonaceae

	LL	LW	LA	Blade class	LS	BA	BS	AS	Margin type	Lobation	SF	SI	1º vein	2º vein	3º vein	4º vein	IO	Gland	IL	Cilia	SL	SB	FN
LL		***0.607**																					
LA	***0.609**	***0.968**	LA																				
Blade class	***-0.447**	***-0.521**	***-0.533**	Blade class																			
LS	.183	****0.383**	.284	-.052	LS																		
BA	.326	.163	.093	.123	****0.371**	BA																	
BS	.204	.248	.161	.089	***0.481**	.306	BS																
AS	.261	****0.39**	****0.377**	.062	.142	.092	.237	AS															
Margin type	.299	.086	.011	.064	.262	.296	.199	-.005	Margin type														
Lobation	-.229	-.075	-.078	.092	-.211	.012	.204	.114	-.123	Lobation													
SF	***0.614**	***0.969**	***1**	***-0.533**	.285	.095	.162	****0.378**	.014	-.079	SF												
SI	-.235	-.271	-.312	****0.423**	-.275	.235	.027	-.190	.108	.138	-.312	SI											
1º vein	.043	-.136	-.100	.065	-.155	.270	-.046	-.113	.191	.290	-.100	-.106	1º vein										
2º vein	.083	.048	-.028	-.120	.101	-.146	.313	-.321	.100	****0.376**	-.027	-.169	.247	2º vein									
3º vein	.051	.100	.125	.052	-.004	-.010	-.009	.180	-.178	-.211	.124	.112	-.149	-.226	3º vein								
4º vein	-.043	.060	.012	.337	.149	.156	****0.35**	.298	-.072	.036	.012	****0.411**	****-0.412**	-.215	**0.539**	4º vein							
IO	-.215	-.054	-.172	****0.356**	-.115	.189	.056	.005	.120	.277	-.172	****0.347**	.163	.160	.035	.217	IO						
Gland	-.149	-.186	-.230	***0.465**	-.310	.151	.037	.078	.021	.107	-.230	****0.39**	.115	-.009	.320	.322	***0.692**	Gland					
IL	-.270	-.153	-.210	***0.476**	-.210	.134	.084	.009	-.076	.143	-.211	**0.475**	.012	.028	.229	.237	****0.625**	***0.796**	IL				
Cilia	.165	.074	-.025	.096	-.173	.118	-.162	-.067	-.098	-.112	-.023	.338	-.241	.040	.127	.069	**0.459**	***0.519**	***0.455**	Cilia			
SL	****0.346**	****0.345**	.267	-.029	.176	.309	.335	.172	****0.368**	-.146	.269	.304	-.165	-.032	-.010	.263	.147	.231	.071	.224	SL		
SB	.275	**0.471**	****0.376**	-.019	.226	.271	.255	.236	****0.36**	-.160	****0.378**	.298	-.132	-.077	.022	.208	.307	.290	.260	.244	***0.843**	SB	
FN	-.019	-.206	-.245	****0.419**	-.052	-.015	.198	.064	.004	-.265	-.244	.314	-.246	-.048	.035	.260	.161	***0.475**	***0.488**	.295	****0.399**	***0.393**	FN
FL	.102	-.194	-.232	.319	.139	.316	.282	-.008	.299	-.272	-.229	****0.428**	-.167	-.106	.038	****0.355**	.178	.329	.278	.092	***0.62**	***0.528**	***0.668**

*, **; significant at p = 0.05, 0.01 respectively

+1 0 -1

5.2.6. Cluster analysis

All the accumulated phenetic data were futher taken in single head to analyzed numerically and finally generate the Pearson similarity co-efficient dendrogram to understand the inter-relationship among the studied taxa. The dendrogram (Fig. 27) showed two major constant clusters with closely related taxa where the first cluster was further divided into four sisters clades. The first sister clade consisted of *Homalocladium platycladum* whereas in second sister clade consist of all the taxa of *Polygonum* (*P. plebeium, P. molle, P. runcinatum, P. pubescens, P. viscosum*). The third sister clade was further subdivided into two clades where one clade consisted of *Rumex nepalensis, R. dentatus, R. maritimus, R. acetosella* and *Rheum nobile*, *Antigonon leptopus* and *Fallopia convolvulus* whereas other one composed of 19 taxa of *Persicaria* (*P. chinensis* var. *ovalifolia*, *P. chinensis* var. *chinensis*, *P. chinensis* var. *hispida*, *P. capitata*, *P. tenella*, *P. perfoliata*, *P. minor*, *P. campanulata, P. nepalensis, P. posumbu, P. glabra, P. microcephala, P. barbata, P. hydropiper, P. orientalis, P. strigosa, P. lanigera, P. lapathifolia* var. *lapathifolia* and *P. lapathifolia* var. *lanata*) showing very close proximity among them. In second cluster, only two taxa of *Fagopyrum* (*F. esculentum* and *F. dibotrys*) were placed. Present phenogram clearly showing that the *Fagopyrum* was distantly allied with rest of the studied genera based on their phenetic characters. The entire dendrogram was found quite significant and genera wise they were forming separate cluster s and nearby cluster denotes the very close proximity among the genera.

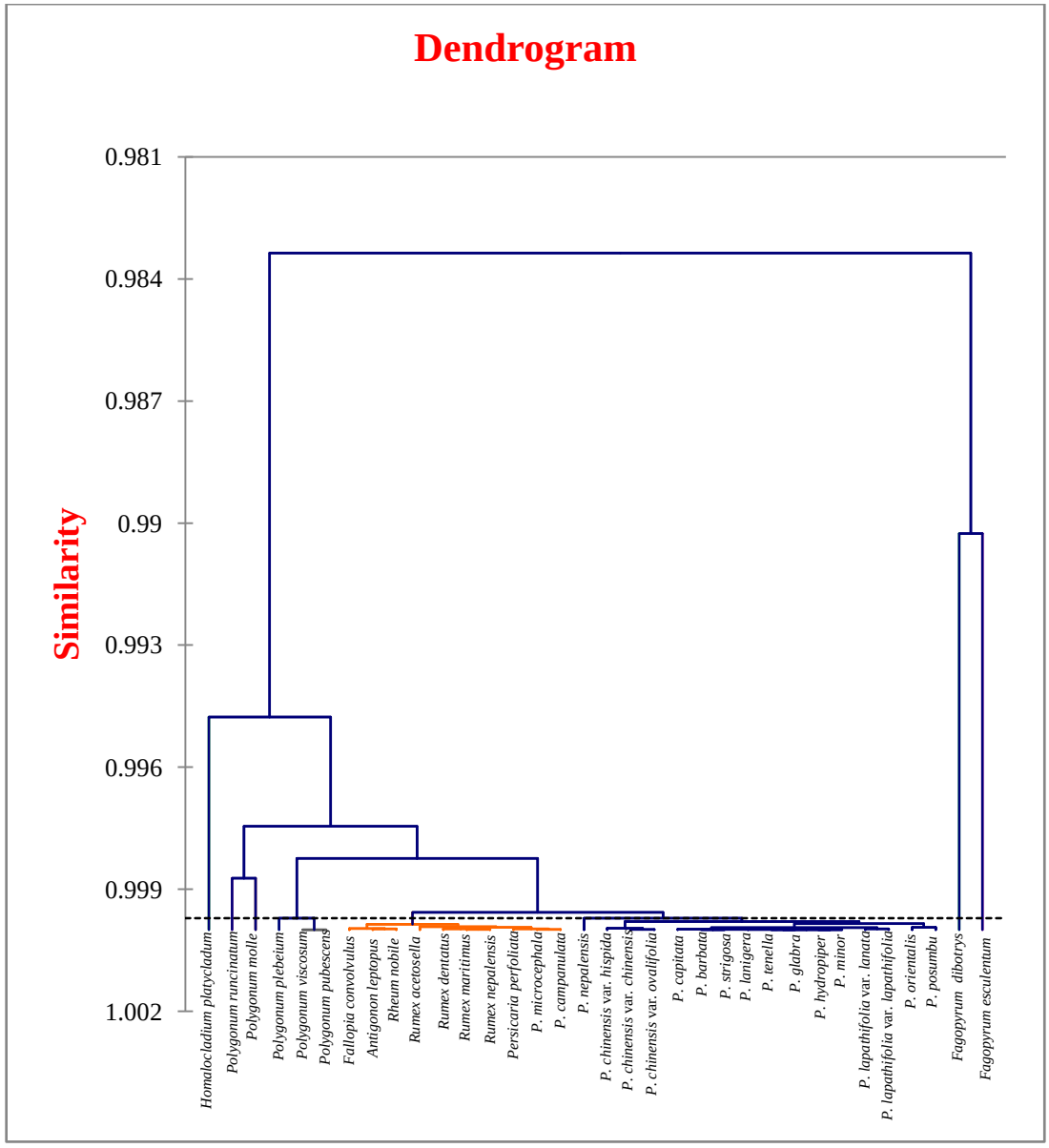


Fig. 27: Dendrogram showing inter-relationship among the taxa of Polygonaceae based on studied phenetic characters

5.2.7. Artificial identification key

Using various distinctive macro and mico morphological characters an easy identification dichotomous key was constructed for studied taxa under study from this part of the world. This key is clearly reflecting the importance of qualitative and quantitative characters that functioned as unique identification tool for taxa upto varietal level.

1a. Opposite phyllotaxy …… ……. …….. ….……..… **2**

1b. Alternate phyllotaxy …… …….. ……. ……. …… ..….. **3**

2a. Lamina unlobed …… …….. ……..…. **4**

2b. Lamina lobed ……. ……...…… ***Poygonum runcinatum***

3a. Margin entire …… …… ……. ……. …..... **5**

3b. Margin erose ……. ……. ……. ……..... **6**

4a. Base angle obtuse - wide obtuse …….. …….. ……. ..… **7**

4b. Base angle acute …….. …… …….. ……... **8**

5a. 1º vein basal or supra basal …….. ……. …….. ….. **9**

5b. 1º vein pinnate …….. ……..…… …….. . **10**

6a. 1º vein spacing irregular …….. …… ……. ……... …...……. **11**

6b. 1º vein spacing regular ……. ……..… ***Persicaria hydropiper***

7a. Apex shape accuminate …… ……... …… ….... **12**

7b. Apex shape convex …….. ……..…….. … ***Polygonum pubescens***

8a. Base shape decurrent …… …….. …….. …… ….. **13**

8b. Base shape saggitate …….. ……..…. ***Fallopia convolvulus***

9a. Blade class microphyll …… ……. ……..….. **14**

9b. Blade class mesophyll ……. …… ..…..…..... ***Rumex acetosella***

10a. 1º vein spacing irregular …… …… ……. **15**

10b. 1º vein spacing regular …… …… … ***Persicaria capitata***

11a. 2º vein spacing irregular …… ……. …… **16**

11b. 2º vein spacing strong intersecondaries …….. ……. …. **17**

12a. Anomocytic stomata ……. …….. ***Antigonon leptopus***

12b. Anisocytic stomata ……. …..…. ***Persicaria microcephala***

13a. Peltate hair present …… …..…… ***Polygonum plebeium***

13b. Peltate hair absent ……..……..… ***Homalocladium platycladum***

14a. Stellate hair present ……. .…… ***Persicaria strigosa***

14b. Stellate hair absent …… ……. ….. ***Persicaria perfoliata***

15a. Indumentums present …….…… ……. **18**

15b. Indumentums absent …….. ……..…… ***Rumex nepalensis***

16a. More than one morphotype in stomata ……...…….. ***Rheum nobile***

16b. Stomata paracytic ……. …… ……. … **19**

17a. 1º vein basal …… …….…….. ……..…. …. **20**

17b. 1º vein pinnate …… ……...… ……. **21**

18a. Indumentums glandular …… …….…….… ...…. **22**

18b. Indumentums non glandular ……... ……..……. … **23**

19a. Indumentums absent …….. …….. ***Persicaria nepalensis***

19b. Indumentums present …….. ....……. .. ***Persicaria lanigera***

20a. 4º vein alternate percurrent …….. …..…… …… **24**

20b. 4º vein regular polygonal reticulate ……. .…… ……. **25**

21a. Base angle obtuse - wide obtuse …….….. …….…….. .. **26**

21b. Base angle acute ……. ……..... ……...… …. **27**

22a. Lamina shape elliptic ……. …….……. …..….. …… **28**

22b. Lamina shape oblong …….. …..…….. ……... ***Persicaria glabra***

23a. Base shape decurrent ……..…..… …… **29**

23b. Base shape rounded …….. ……. …….…… **30**

24a. Stellate hair present …..... …….…… .. ***Rumex dentatus***

24b. Stellate hair absent ……. ……..…….. . ***Rumex maritimus***

25a. Base shape lobate ……. …….. …. ***Persicaria chinensis* var. *chinensis***

25b. Base shape rounded …..….. ……..…….. ***Persicaria chinensis* var. *ovalifolia***

26a. 3º vein random reticulate …….. ……..…….. **31**

26b. 3º vein regular polygonal reticulate……...…. ***Persicaria chinensis* var. *hispida***

27a. Apex shape acuminate ……..... ***Persicaria lapathifolia* var. *lapathifolia***

27b. Apex shape acute ……...…….…… ***Persicaria lapathifolia* var. *lanata***

28a. Base shape cuneate …… ……. …… ……. ***Persicaria minor***

28b. Base shape lobate …….. …….. .. ***Polygonum viscosum***

29a. 3º vein regular polygonal reticulate …….…… …… …. **32**

29b. 3º vein alternate percurrent ……..…….. ***Fagopyrum dibotrys***

30a. 4º vein regular polygonal reticulate ……..…….…… ***Persicaria barbata***

30b. 4º vein alternate percurrent ……....…. ***Persicaria campanulata***

31a. Stomata anomocytic ……. ……..……...…. ***Persicaria orientalis***

31b. Stomata paracytic …… ……...…..…….. ***Persicaria posumbu***

32a. Blade class nanophyll …….…….…… ***Persicaria tenella***

32b. Blade class notophyll …… ……....…. ***Fagopyrum esculentum***

5.3. POLLEN MORPHOLOGY

Pollen grains are the extremely reduced male gametophyte enclosed inside the microspore wall of seed plants or flowering plants. It is major unit of a flowering plant as through pollen grains the entire male genetic attributes are transmitted to the next generation. The term Palynology was devoted to the study of external morphological features of mature pollen grains. Pollen morphological attributes such as aperture number, type, shape, size and the exine ornamentations have played significant role in delimiting the different taxa as they are moderately conserved.

In the present study all the collected taxa were considered for the investigation of pollen morphology under LM (Light microscopy) and SEM (Scanning Electron Microscopy) to revealed different types of pollen grains. The investigation on pollen morphology gives emphasis to read data from pollen grains unit, dimensions, shape class, polarity and symmetry, apertures and exine ornamentation.

5.3.1. Pollen description

Pollen grains were monad, isopolar, radio symmetric and length of equatorial diameter (ED) size varies from 15.85 µm – 43.16 µm. Three different types of pollen grains *viz*., **pantoporate**, **tricolpate** and **tricolporate** (Table 16 and 17) and four shapes class *viz*., **prolate** (P), **sub prolate** (SP), **prolate-spheroidal** (PS) and **spheroidal** (S) were observed (Fig. 31 and 32). Exine ornamentation of all the pollen grains were not uniform but various pattern such as reticulate with pitted texture, micro reticulate, striate reticulate, micro echinate, granulate etc were observed. In case of tricolpate and tricolporate pollen grains colpi length varies from 9.17 µm to 33.84 µm. Thickness of exine varies from minimum 1.04 µm in *Persicaria capitata* to maximum 4.16 µm in *Persicaria posumbu*.

5.3.2. Pollen types

Pollen grains of all the studied taxa of Polygonaceae were broadly classified into three major types based on their apertures such as pantoporate, tricolpate and tricolporate. Species wise detailed pollen grain features were elaborated below:

5.3.2.1. Tricolpate type: Microspore or pollen grains with three colpi (Table 16)

***5.3.2.1.1. Reticulate subtype*:** Exine sculpturing as ridges arranged in network which has gaps. The taxa under reticulate subtype had been further divided into two subtypes on the basis on minute variation their network like aggangemnts of exine.

Subtype I: reticulate patterns where lumina greater than 1µm in diameter (Fig. 29 a, b, g)

Persicaria capitata (Buchanan-Hamilton *ex* D. Don) H. Gross: Pollen grains were monad, isopolar, radiosymmetric. The shape of the pollen grains was prolate spheroidal. ED: 27.44µm – 35.35µm; PA: 27.31µm – 32.73µm; colpi length varies from 21.15µm – 25.56µm, non lacunate; ora indistinct; exine reticulate - rugulate, 0.86µm – 1.15µm thick; endocolpium circular.

Persicaria tenella (Blume) Hara: Pollen grains were monad, isopolar, radiosymmetric; Grains were prolate spheroidal in equatorial view and spheroidal in polar view. ED: 22.13µm – 30.12µm; PA: 25.02µm – 31.06µm; colpi length varies from 13.78µm – 17.86µm, lacuna absent; ora indistinct; exine reticulate, 1.05µm – 1.46µm thick.

Persicaria campanulata (Hooker *f.*) Ronse Decraene: Pollen grains were monad, isopolar, radiosymmetric. The shape of the pollen grains was prolate spheroidal; ED: 25.12µm – 33.12µm; PA: 28.65µm – 34.56µm; colpi length varies from 20.76µm – 25.09µm; exine reticulate, 2.13µm – 3.04µm thick.

Subtype II: reticulate patterns where lumina less than 1µm in diameter (Fig. 27 a, 28 h)

Antigonon leptopus Hooker & Arnott: Pollen grains were monad, isopolar, radiosymmetric; shape sub prolate; ED: 21.14µm – 34.12µm; PA: 26.73µm – 33.35µm; colpi slit like, long, extending pole to pole, length varies from 17.49µm – 21.88µm; ora lolongate; exine reticulate with pitted texture, 1.58µm – 1.94µm thick.

Polygonum molle D. Don: Pollen grains were monad, isopolar, radiosymmetric; shape sub prolate; ED: 19.26µm – 34.11µm; PA: 24.23µm – 30.39µm; colpi long,

length varies from 11.09µm – 15.76µm; ora lalongate; exine micro reticulate, 1.55µm – 1.99µm thick.

***5.3.2.1.2. Granulate subtype*:** Exine sculptural element less than 1µm in diameter (Fig. 28 c)

Polygonum plebeium R. Brown: Pollen grains were monad, isopolar and radiosymmetric; grains were prolate in equatorial view; the outline of the grains were circular in polar view; ED: 13.61µm – 25.12µm; PA: 23.65µm – 29.55µm; colpi long, narrow, length varies from 15.45µm – 19.69µm; ora lalongate; exine granulates with microspinules, 2.57µm – 3.16µm thick.

5.3.2.2. Tricolporate type: Microspore or pollen grains with three colpi and a central pore in each colpi (Table 16)

***5.3.2.2.1. Micro reticulate Subtype*:** Exine sculpturing as ridges arranged in network which has gaps less than 1µm in diameter (Fig. 28 b, c, e, f)

Homalocladium platycladum (F. Muellar) L. H. Bailey: Pollen grains were monad, isopolar and radiosymmetric; grains were prolate spheroidal in equatorial view; ED: 22.33µm – 36.33µm; PA: 20.32µm – 24.12µm; colpi long, slit like, narrow, extending pole to pole, length varies from 14.52µm – 18.65µm; ora lalongate; exine microreticulate with bacula, 1.11µm – 1.65µm thick.

Fagopyrum dibotrys (D. Don) Hara: Pollen grains were monad, isopolar and radiosymmetric; grains were prolate spheroidal in equatorial view; the outline of the grains were circular in polar view; ED: 30.12µm – 47.26µm; PA: 40.32µm – 46.69µm; colpi medium, narrow, depressing at their lengths, length varies from 25.56µm – 30.26µm; ora lolongate; exine microreticulate, heterobrochate, 3.86µm – 4.27µm thick, lumina present, muri with bluntb spinules and thick.

Fagopyrum esculentum Moench: Pollen grains were monad, isopolar and radiosymmetric; grains were prolate spheroidal in equatorial view; the outline of the grains were circular in polar view; ED: 33.15µm – 47.16µm; PA: 43.21µm – 47.86µm; colpi medium to long, acute, tapering at the end, length varies from 30.25µm – 37.15µm; ora lolongate; exine microreticulate, heterobrochate, 3.10µm – 3.79µm thick, lumina present, muri with blunt spinules and thick.

Rumex maritimus Linnaeus: Pollen grains were monad, isopolar and radiosymmetric; grains were prolate in equatorial view; triangular in polar view; ED: 25.63µm – 30.01µm; PA: 25.19µm – 34.53µm; colpi medium to long, narrow, length varies from 12.12µm – 15.98µm; ora lolongate, pores oval; exine microreticulate, 1.98µm – 2.28µm thick.

Rumex acetosella Linnaeus: Pollen grains were monad, isopolar and radiosymmetric; grains were subprolate in equatorial view; ED: 13.89µm – 28.36µm; PA: 21.32µm – 29.65µm; colpi medium, narrow, length varies from 7.35µm – 11.21µm; ora lolongate, pores oval; exine striate - reticulate, 1.11µm – 1.34µm thick.

***5.3.2.2.2. Granulate Subtype*:** Exine sculptural element less than 1µm in diameter (Fig. 28 h)

Rumex dentatus Linnaeus: Pollen grains were monad, isopolar and radiosymmetric; prolate spheroidal in equatorial view; spheroidal in polar view; ED: 20.19µm – 33.26µm; PA: 25.35µm – 30.63µm; colpi narrow, length varies from 11.01µm – 13.65µm; ora lolongate; exine granulate, 1.91µm – 2.19µm thick.

***5.3.2.2.3. Microechinate - punctuate Subtype*:** Pointed sculpturing elements (echini) less than 1µm in height with small perforation (Fig. 28 d)

Fallopia convolvulus (Linnaeus) A. Love: Pollen grains were monad, isopolar and radiosymmetric; prolate spheroidal in equatorial view; triangular in polar view; ED: 14.22µm – 25.64µm; PA: 18.56µm – 23.65µm; colpi narrow with blunt end, length varies from 10.08µm – 14.29µm; ora lalongate; exine microechinate - punctate, 2.24µm – 2.98µm thick.

***5.3.2.2.4. Perforate - punctate Subtype*:** Surface having small holes or depressions less than 1µm in diameter (Fig. 28 g)

Rumex nepalensis Sprengel: Pollen grains were monad, isopolar and radiosymmetric; subprolate in equatorial view; spheroidal in polar view; ED: 24.22µm – 37.45µm; PA: 34.56µm – 37.02µm; colpi medium to long, acute, narrow, tapering at the end, length varies from 15.98µm – 20.65µm; ora lolongate; exine perforate - punctate, 1.34µm – 1.98µm thick.

***5.3.2.2.5. Striated baculate Subtype*:** Rod-shaped sculpturing elements (bacula), longer than wide and greater than 1µm high (Fig. 29 e)

Rheum nobile Hooker *f.* & Thompson: Pollen grains were monad, isopolar and radiosymmetric; prolate in equatorial view; spheroidal in polar view; ED: 25.41µm – 40.87µm; PA: 20.56µm – 36.66µm; colpi long, narrow, length varies from 13.63µm – 28.45µm; ora lalongate; exine striated baculate, 2.55µm – 3.09µm thick.

5.3.2.3. Pantoporate type: Pollen grain with pores spread over the surface. Taxa bearing pantoporate pollen grains were further subdivided into five subtypes on the basis of their lumina shape (Table 17)

5.3.2.3.1. Subtype I (Lumina pentagonal* and *hexagonal): (Fig. 29 k, f, j; 29 a, b, d, e, f, j)

Persicaria barbata (Linnaeus) H. Hara: Pollen grains were monad, isopolar, radiosymmetric spheroidal and non lacunate type; diameter of the pollen grain ranges from 38.17 µm to 43.93 µm; exine uniformly reticulate, 3.86 – 4.23 µm thick, muri simple; lumina large with pentagonal bacula.

Persicaria chinensis (Linnaeus) H. Gross var. ***chinensis***: Pollen grains were monad, isopolar, radiosymmetric, spheroidal and non lacunate type; diameter of the pollen grain ranges from 31.25 µm to 36.32 µm; exine reticulate, heterobrochate, 2.13 – 2.99 µm thick, massive columellae, muri thick, curvimuate, lumina of various shapes generally pentagonal to hexagonal.

Persicaria chinensis (Linnaeus) H. Gross var. ***ovalifolia*** (Linnaeus) H. Gross: Pollen grains were monad, isopolar, radiosymmetric spheroidal and non lacunate type; diameter of the pollen grain ranges from 30.39 µm to 37.96 µm; exine reticulate, heterobrochate, 2.25 – 3.01 µm thick, muri thick with irregular folds and slit, lumina of various shape.

Table 16: Pollen morphology data of tricolpate and tricolporate grains with their Polar Axis (PA), Equatorial diameter (ED), Co-efficient variance (CV), Ratio of Polar Axis and Equatorial Diameter (ED), Size, Class, Shape, Colpi length (CL), Exine ornamentation, Exine thickness. All the measurements were taken in µm [Abbreviation used: Sub prolate =SP, Prolate spheroidal =PS, Prolate=P]

Taxa	PA (µm)	CV%	ED (µm)	CV%	P/E	Size	Class	Shape	CL (µm)	Exine type	Exine Thickness(µm)
Antigonon leptopus	30.04±1.36	4.54	26.30±3.45	13.14	1.14	Medium	Tricolpate	SP	19.43±1.20	Microreticulate	1.73±0.08
Fagopyrum dibotrys	43.49±1.84	4.24	39.44±4.83	12.24	1.10	Medium	Tricolporate	PS	28.27±1.37	Microreticulate	4.06±0.09
Fagopyrum esculentum	45.70±1.38	3.02	40.38±3.32	8.23	1.13	Medium	Tricolporate	PS	33.84±2.17	Microreticulate	3.39±0.18
Fallopia convolvulus	20.75±1.27	6.10	19.80±3.48	17.55	1.04	Small	Tricolporate	PS	12.11±1.18	Microechinate-Punctate	2.58±0.13
Persicaria capitata	30.52±1.54	5.06	31.08±2.72	8.75	0.98	Medium	Tricolpate	PS	22.63±1.40	Reticulate-rugulate	1.04±0.07
Persicaria tenella	28.12±1.70	6.04	25.50±2.54	9.97	1.11	Medium	Tricolpate	PS	15.08±1.80	Reticulate	1.25±0.11
Persicaria campanulata	32.26±1.68	5.20	29.17±2.33	7.98	1.10	Medium	Tricolpate	PS	23.37±1.52	Reticulate	2.53±0.22
Polygonum molle	28.06±1.87	6.67	24.14±3.34	13.82	1.16	Medium	Tricolpate	SP	13.08±1.17	Micro reticulate	1.78±0.11
Polygonum plebeium	27.39±1.44	5.26	19.70±3.27	16.59	1.39	Small	Tricolpate	P	17.61±1.11	Granulate with microspinules	2.90±0.15
Rumex acetosella	24.98±2.53	10.14	21.26±4.25	19.99	1.17	Small	Tricolporate	SP	9.17±0.97	Microreticulate	1.22±0.06
Rumex dentatus	28.12±1.62	5.76	27.46±3.28	11.93	1.02	Medium	Tricolporate	PS	12.60±0.76	Granulate	2.02±0.07
Rumex maritimus	29.83±1.93	6.46	23.15±4.05	17.49	1.28	Small	Tricolporate	P	13.80±0.98	Microreticulate	2.11±0.07
Rumex nepalensis	36.12±0.67	1.86	29.83±4.34	14.56	1.21	Medium	Tricolporate	SP	17.73±1.57	Perforate-punctate	1.63±0.18
Rheum nobile	29.18±3.81	13.05	34.04±3.97	11.67	0.85	Medium	Tricolporate	P	19.93±3.89	Striated baculate	2.88±0.14
Homalocladium platycladum	22.09±0.99	4.49	27.45±3.64	13.25	0.80	Medium	Tricolporate	PS	16.64±1.17	Microreticulate	1.47±0.13

Persicaria glabra (Willdenow) M. Gómez: Pollen grains were monad, isopolar, radiosymmetric spheroidal and non lacunate type; diameter of the pollen grain ranges from 40.98 µm to 44.23 µm; exine reticulate, 1.11 – 1.98 µm thick, muri thick, curvimurate, lumina of various shapes (generally pentagonal to hexagonal) and size, sporadically with few baculae.

Persicaria hydropiper (Linnaeus) Delarbre: Pollen grains were monad, isopolar, radiosymmetric and non lacunate type; pollen grains were spheroidal in equatorial view; the outline of the grains were circular in polar view; diameter of the pollen grain ranges from 38.56 µm to 47.12 µm; exine reticulate, 3.87 – 4.65 µm thick, muri irregularly shaped, curvimurate, lumina of various shapes.

Persicaria lapathifolia (Linnaeus) Delarbre var. ***lapathifolia***: Pollen grains were monad, isopolar, radiosymmetric and non lacunate type; pollen grains were spheroidal in equatorial view; the outline of the grains were circular in polar view; diameter of the pollen grain ranges from 26.89 µm to 31.49 µm; exine reticulate, 1.85 – 2.56 µm thick, muri with longitudinal folds and slits, lumina with irregular pentagonal shape.

Persicaria lapathifolia (Linnaeus) Delarbre var. ***lanata*** (Roxburgh) H. Hara: Pollen grains were monad, isopolar, radiosymmetric, spheroidal and non lacunate type; diameter of the pollen grain ranges from 23.45 µm to 30.56 µm; exine reticulate, 2.01 – 2.97 µm thick, muri thick, lumina with irregular pentagonal shape.

Persicaria microcephala **(**D. Don) H. Gross: Pollen grains were monad, isopolar, radiosymmetric and non lacunate type; pollen grains were spheroidal in equatorial view; pores ellipsoidal; diameter of the pollen grain ranges from 32.89 µm to 37.65 µm; exine reticulate, 2.76 – 3.96 µm thick, muri with longitudinal folds and heavy slits, lumina with irregular shape.

Persicaria nepalensis (Meissner) Miyabe: Pollen grains were monad, isopolar, radiosymmetric, spheroidal and non lacunate type; diameter of the pollen grain ranges from 30.45 µm to 33.06 µm; exine reticulate, 2.03 – 2.88 µm thick, muri thick, lumina with hexagonal shape.

Persicaria posumbu (Buchanon-Hamilton *ex* D. Don) H. Gross: Pollen grains were monad, isopolar, radiosymmetric and non lacunate type; pollen grains were spheroidal in equatorial view; pores spheroidal; diameter of the pollen grain ranges from 34.12 µm to 35.98 µm; exine reticulate, 4.05 – 4.29 µm thick, lumina with hexagonal shape.

Polygonum pubescens Blume: Pollen grains were monad, isopolar, radiosymmetric and non lacunate type; pollen grains were spheroidal in equatorial view; pores spheroidal; diameter of the pollen grain ranges from 13.73 µm to 17.95 µm; exine reticulate, 0.84 – 1.36 µm thick, lumina with pentagonal and hexagonal shape.

5.3.2.3.2. Subtype II (Lumina with longitudinal folds)*:* (Fig. 29 i, d)

Persicaria chinensis (Linnaeus) H. Gross var. ***hispida*** Kantachot : Pollen grains were monad, isopolar, radiosymmetric, spheroidal and non lacunate type; diameter of the pollen grain ranges from 29.69 µm to 34.56 µm; exine reticulate, 2.99 – 3.75 µm thick, muri thick, lumina broad having longitudinal folds.

Persicaria minor (Hudson) Opiz: Pollen grains were monad, isopolar, radiosymmetric, spheroidal and non lacunate type; diameter of the pollen grain ranges from 28.12 µm to 30.98 µm; pores ellipsoidal; exine reticulate, 2.45 – 2.98 µm thick, muri thick, lumina broad having longitudinal folds.

5.3.2.3.3. Subtype III (Lumina broad)*:* (Fig. 30 c)

Persicaria lanigera (R. Brown) Sojak: Pollen grains were monad, isopolar, radiosymmetric, spheroidal and non lacunate type; diameter of the pollen grain ranges from 30.65 µm to 32.78 µm; exine reticulate, 3.01 – 3.21 µm thick, muri thin, lumina broad.

5.3.2.3.4. Subtype IV (Lumina with baculae)*:* (Fig. 30 g, k)

Persicaria orientalis (Linnaeus) Spach: Pollen grains were monad, isopolar, radiosymmetric, spheroidal and non lacunate type; diameter of the pollen grain ranges from 37.12 µm to 41.26 µm; pores oval to ellipsoidal; exine reticulate, 3.26 – 4.36 µm thick; lumina granulose; muri thick, regularly shaped

Polygonum viscosum Buchanon-Hamilton *ex* D. Don: Pollen grains were monad, isopolar, radiosymmetric, non lacunate, spheroidal in shape; diameter of the pollen grain ranges from 21.15 µm to 27.89 µm; exine 3.06 – 3.65 µm thick, muri regularly shaped, lumina with baculae having slit and longitudinal fold.

5.3.2.3.5. Subtype V (Lumina with baculoid rod)*:* (Fig. 30 h, i)

Polygonum runcinatum Buchanon-Hamilton *ex* D. Don: Pollen grains were monad, isopolar, radiosymmetric, non lacunate, spheroidal in shape; diameter of the pollen grain ranges from 22.56 µm to 29.03 µm; exine reticulate, 2.03 – 2.80 µm thick, lumina with baculoid rods.

Persicaria strigosa (R. Brown) Nakai: Pollen grains were monad, isopolar, radiosymmetric, non lacunate, spheroidal in shape; diameter of the pollen grain ranges from 17.63 µm to 21.95 µm; exine uniformly reticulate, 1.54 – 1.99 µm thick, muri studded with loose bacula, lumina large.

5.3.3. Statistical analysis

Statistical analysis was conducted for all the studied pollen morphological data to determine the significance and inter-relationship among them. In the present study three statistical analyses namely ANOVA, Principal component analysis (PCA) and Correlation study was taken into consideration. Through ANOVA analysis, comparision of data sets was performed for determining the significance level (P-value) among the different attributes as well as among the different taxa under study by determining inconsistency between the samples and within the samples. PCA was conducted for reducing the intricacy in the data pattern by projecting the studied parameters as well as taxa into different geometrical dimensions which were konown as principal components. For determining the pervasiveness and the relationships among the studied variables Pearson correlation study was conducted which examined the strength between two continuous variables by measuring the degree of significance among them.

Table 17: Pollen morphology data of pantoporate grains pollen diameter (PD), co-efficient variance (CV), size, shape, exine ornamentation, exine thickness. All the measurements were taken in µm

Taxa	PD (µm)	CV%	Size	Shape	Exine type	Exine Thickness (µm)
Persicaria chinensis* var *chinensis	33.50±1.07	3.21	Medium	Spheroidal	Reticulate	2.66± 0.18
Persicaria chinensis* var *hispida	31.99±1.28	3.99	Medium	Spheroidal	Coarsely reticulate	3.37± 0.16
Persicaria chinensis* var *ovalifolia	34.67±2.04	5.87	Medium	Spheroidal	Reticulate	2.77± 0.19
Persicaria barbata	41.06±1.74	4.25	Medium	Spheroidal	Reticulate	4.05± 0.10
Persicaria glabra	42.97±1.04	2.42	Medium	Prolate spheroidal	Reticulate	1.45± 0.23
Persicaria hydropiper	43.16±2.57	5.95	Medium	Spheroidal	Reticulate	3.37± 0.13
Persicaria lanigera	31.84±0.06	2.13	Medium	Spheroidal	Reticulate	3.12± 0.06
Persicaria lapathifolia* var *lapathifolia	29.31±1.41	4.80	Medium	Spheroidal	Reticulate	2.18± 0.16
Persicaria lapathifolia* var *lanata	27.16±2.08	7.66	Medium	Spheroidal	Reticulate	2.50± 0.27
Persicaria nepalensis	26.25±1.60	6.09	Medium	Spheroidal	Reticulate	2.34± 0.21
Persicaria orientalis	39.30±1.10	2.81	Medium	Spheroidal	Reticulation murate	3.87± 0.29
Persicaria strigosa	19.63±1.43	7.26	Small	Prolate spheroidal	Uniformly reticulate	1.74± 0.13
Persicaria microcephala	35.46± 2.35	6.62	Medium	Spheroidal	Reticulate	3.45± 0.23
Persicaria minor	29.33±0.74	2.52	Medium	Spheroidal	Reticulate	2.65±0.13
Persicaria posumbu	35.62±0.76	2.13	Medium	Spheroidal	Reticulate	4.16±0.06
Polygonum pubescence	15.85±1.07	6.75	Small	Spheroidal	Reticulate	1.11± 0.14
Polygonum runcinatum	25.83±1.72	6.64	Medium	Prolate spheroidal	Uniformly reticulate	2.32± 0.34
Polygonum viscosum	25.57±1.58	6.20	Medium	Prolate spheroidal	Reticulation murate	3.27± 0.11

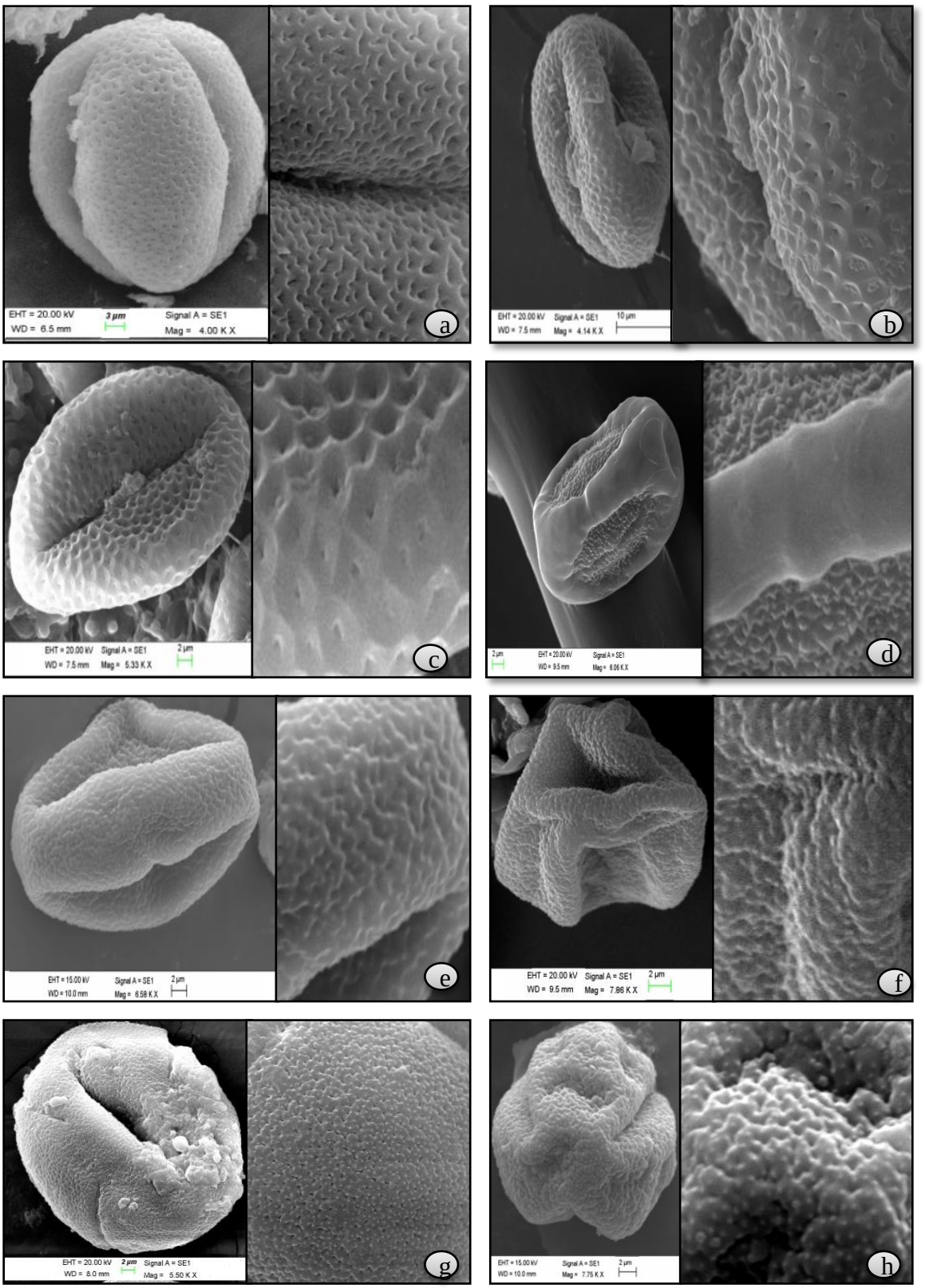


Fig 28: SEM micrographs of pollen grains a. *Antigonon leptopus* b. *Fagopyrum dibotrys* c. *Fagopyrum esculentum* d. *Fallopia convolvulus* e. *Rumex acetosella* f. *Rumex maritimus* g. *Rumex nepalensis* h. *Rumex dentatus*

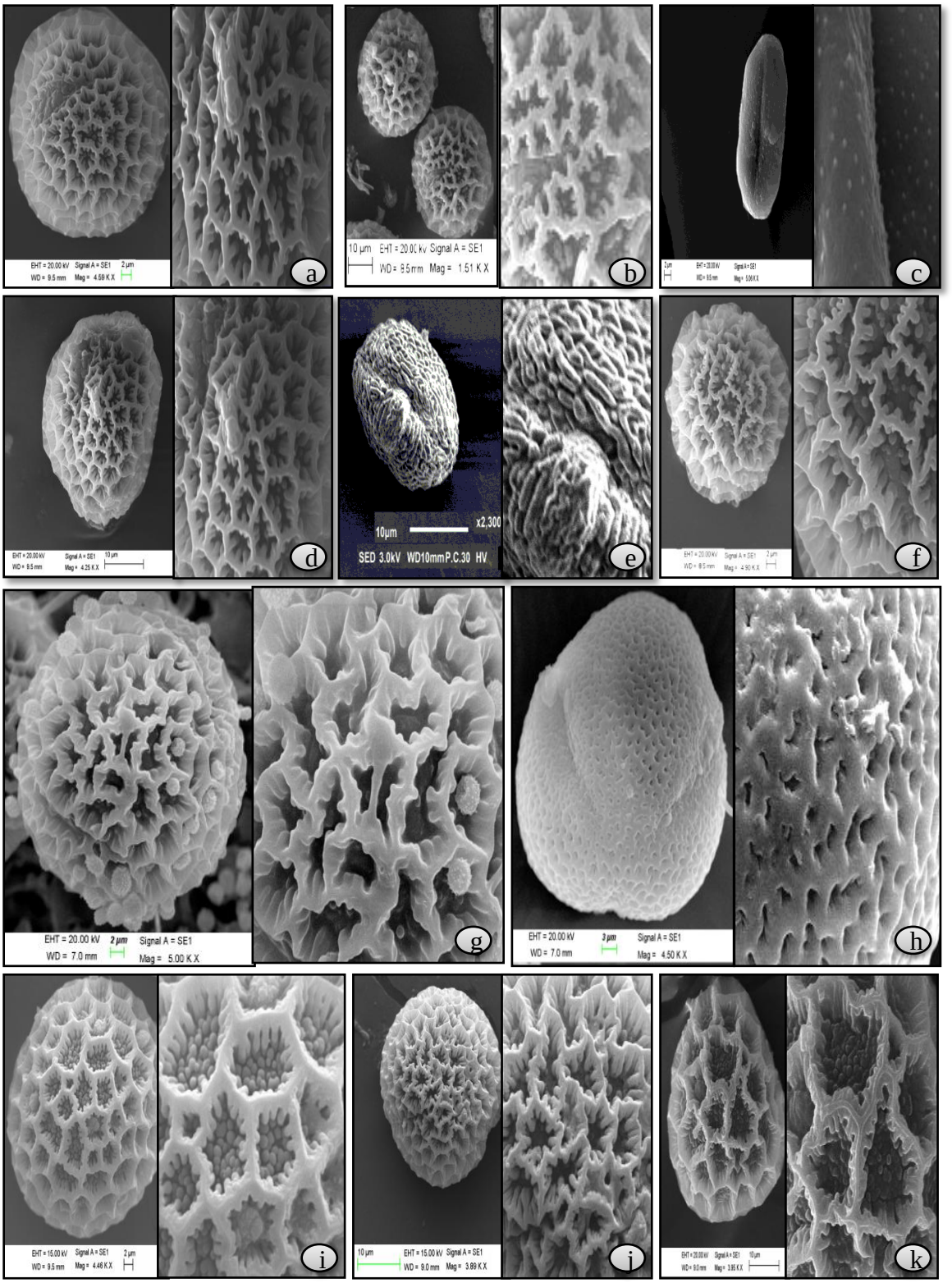


Fig. 29: SEM micrographs of pollen grains **a.** *Persicaria capitata* **b.** *Persicaria tenella* **c.** *Polygonum plebeium* **d.** *Persicaria minor* **e.** *Rheum nobile* **f.** *Persicaria chinensis* var. *chinensis* **g.** *Persicaria campanulata* **h.** *Polygonum molle* **i.** *Persicaria chinensis* var. *hispida* **j.** *Persicaria chinensis* var. *ovalifolia* **k.** *Persicaria barbata*

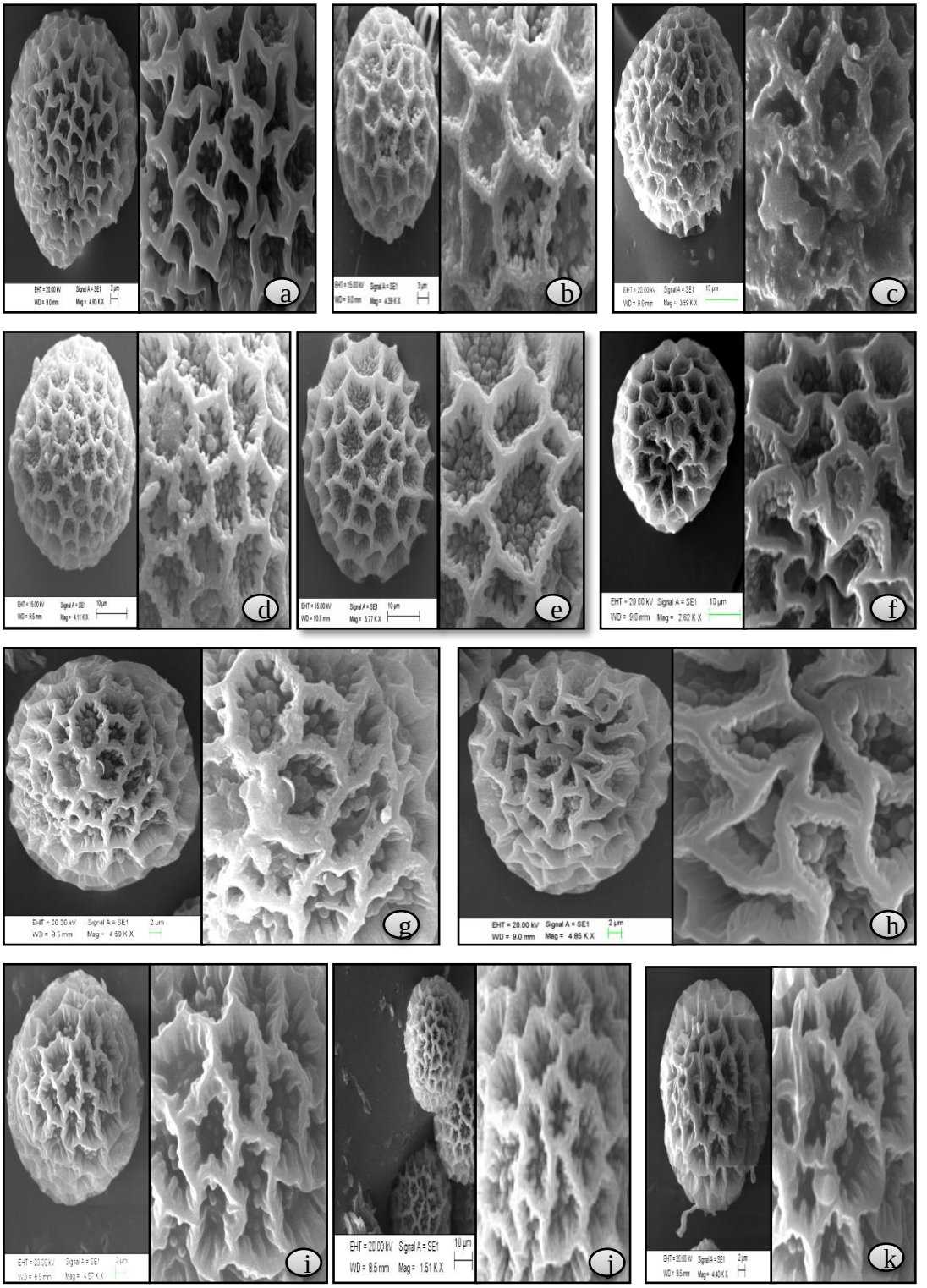


Fig. 30: SEM micrographs of pollen grains **a.** *Persicaria glabra* **b.** *Persicaria hydropiper* **c.** *Persicaria lanigera* **d.** *Persicaria lapathifolia* var. *lapathifolia* **e.** *Persicaria lapathifolia* var. *lanata* **f.** *Persicaria nepalensis* **g.** *Persicaria orientalis* **h.** *Polygonum runcinatum* **i.** *Persicaria strigosa* **j.** *Persicaria microcephala* **k.** *Polygonum viscosum*

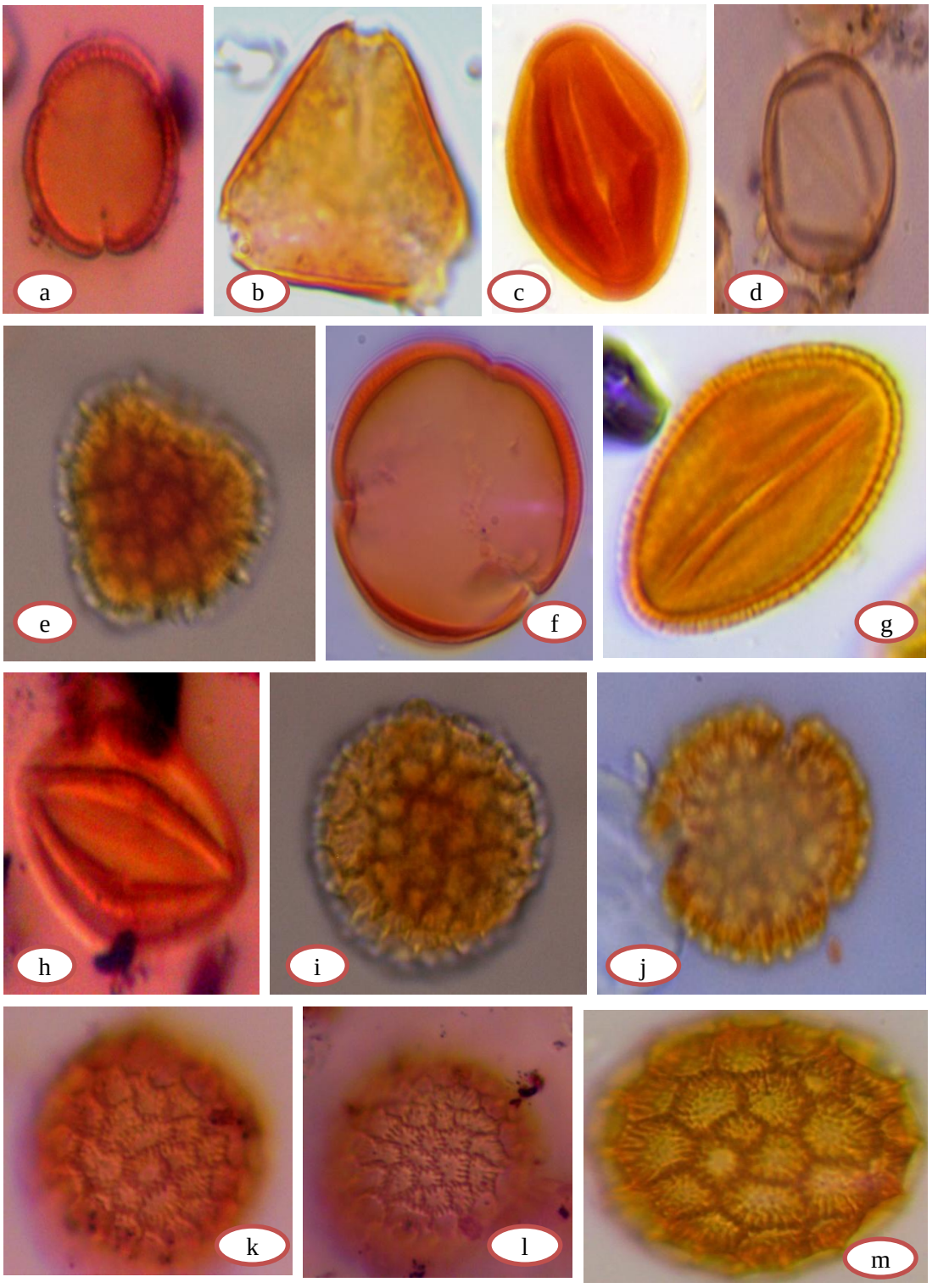


Fig. 31: Light micrographs of pollen grains **a**. PV of *Polygonum molle* **b**. PV of *Rumex maritimus* **c**. EV of *Rumex dentatus* **d**. EV of *Rumex nepalensis* **e**. *Persicaria barbata* **f**. PV of *Rumex acetosella* **g**. EV of *Fagopyrum dibotrys* **h**. EV of *Polygonum plebeium* **i**. *Polygonum runcinatam* **j**. *Persicaria capitata* **k**. *Persicaria campanulata* **l**. *Persicaria lapathifolia* var *lapathifolia* **m**. *Polygonum viscosum*

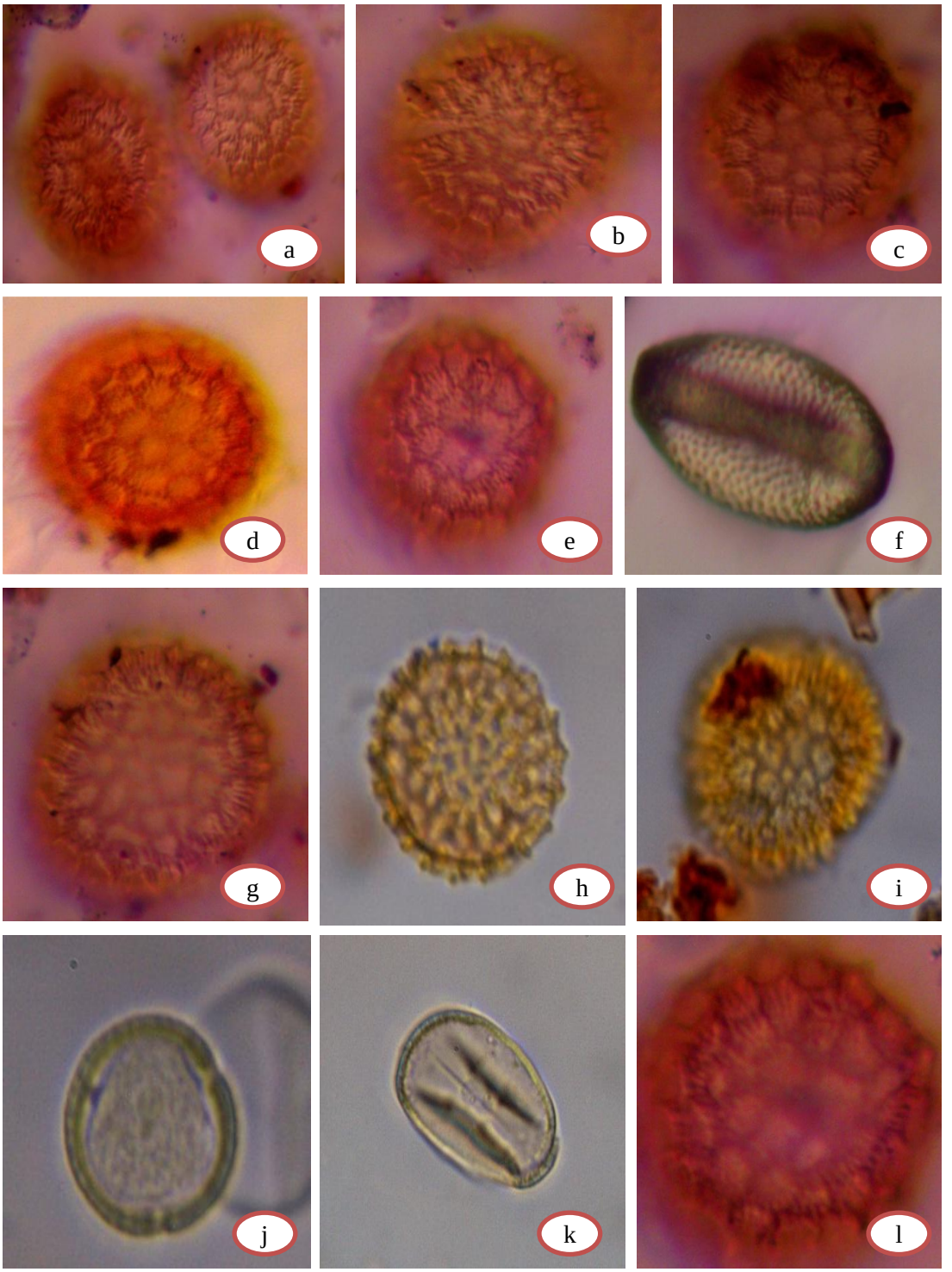


Fig. 32: Light micrographs of pollen grains **a**. *Persicaria lanigera* **b**. *Persicaria tenella* **c**. *Persicaria chinensis* var *chinensis* **d**. *Persicaria strigosa* **e**. *Persicaria chinensis* var *hispida* **f**. EV of *Fallopia convolvulus* **g**. *Persicaria hydropiper* **h**. *Persicaria minor* **i**. *Persicaria microcephala* **j**. PV of *Rheum nobile* **k**. EV of *Fagopyrum esculentum* **l**. *Persicaria posumbu*

5.3.3.1. ANOVA analysis

Two-way ANOVA without replicates were performed taking all the attributes under study (Table 18). From analysis it was found that the p-value of taxa and parameters under study were 1.16×10^{-5} and 1.5×10^{-133} respectively.

Table 18: ANOVA analysis representing the significance level among different Pollen morphological parameters under study

Source of Variation	SS	df	MS	F	P-value	F crit
Species	5225.947	32	163.3108	2.740155	1.16E-05	1.504061
Parameters	290591.7	6	48431.96	812.6287	1.5E-133	2.14605
Error	11443.03	192	59.59913			
Total	307260.1	230				

Significant at $p < 0.01$

5.3.3.2. Principal component analysis (PCA)

Principle Component Analysis was done to correlate different attributes under study by group clustering. PCA separates correlated attributes from uncorrelated ones. Eigen analysis results and loading scores of three principal components were showing in table 19 and 20 and score plot was shown in Fig. 33. The first principal component (PC1) was dominated by colpi length, shape, polar axis, polar axis/ equatorial axis ratio (P/E) and the second principal component (PC2) was dominated by aperture type, equatorial diameter and exine thickness. The distribution of total variation in PC1 and PC2 was 44.96% and 21.67% respectively.

On comparing the taxa under study by PCA (Fig. 34) it was observed that the first axis (PC1) was dominated by 25 taxa viz., *Antigonon leptopus, Fallopia convolvulus, Homalocladium platycladum, Persicaria barbata, P. campanulata, P. capitata, P. chinensis* var. *chinensis, P. chinensis* var. *hispida, P. chinensis* var. *ovalifolia, P. glabra, P. lanigera, P. lapathifolia* var. *lanata, P. lapathifolia* var. *lapathifolia, P. microcephala, P. minor, P. nepalensis, P. orientalis, P. posumbu, Polygonum molle, P. plebeium, P. viscosum, Rheum nobile, Rumex acetosella R. maritimus* and *R. nepalensis*. The second axis (PC2) was dominated by 8 taxa viz., *Fagopyrum dibotrys, F. esculentum, Persicaria hydropiper, P. strigosa, P. tenella, Polygonum pubescens, P. runcinatum,* and *Rumex dentatus*.

Table 19: Eigen analysis of Correlation matrix

	PC1	PC2	PC3
Eigenvalue	3.1469	1.5172	1.0174
Variability (%)	44.9554	21.6743	14.5349
Cumulative %	44.9554	66.6297	81.1646

Table 20: The variable loading scores for each principal component (PC1 – PC3) for studied taxa of Polygonaceae from West Bengal, India

Variable	PC1	PC2	PC3
ED	-0.2119	0.5964	-0.3049
PA	0.5150	0.2558	0.0249
Shape	0.4980	0.0123	-0.0111
Exine thickness	-0.2270	0.4888	-0.4461
Colpi length	0.4815	0.3109	-0.0308
Aperture	0.0313	0.4653	0.7070
P/E	0.3969	-0.1633	-0.4545

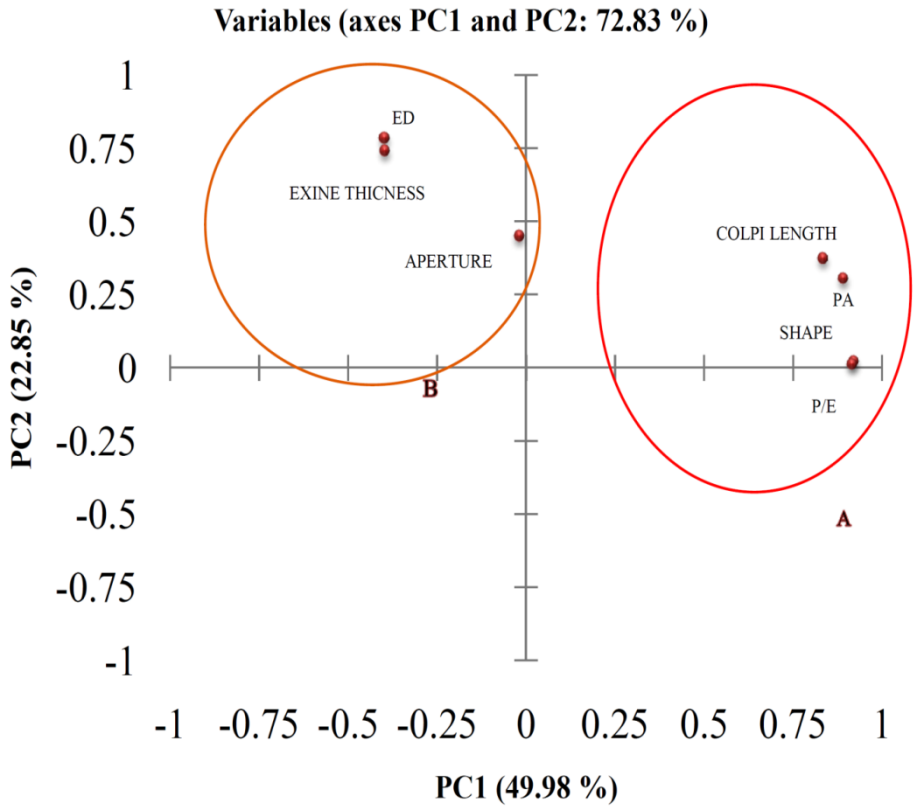


Fig. 33: Principal component analysis score plot showing the pollen morphological variation among the studied taxa of Polygonaceae

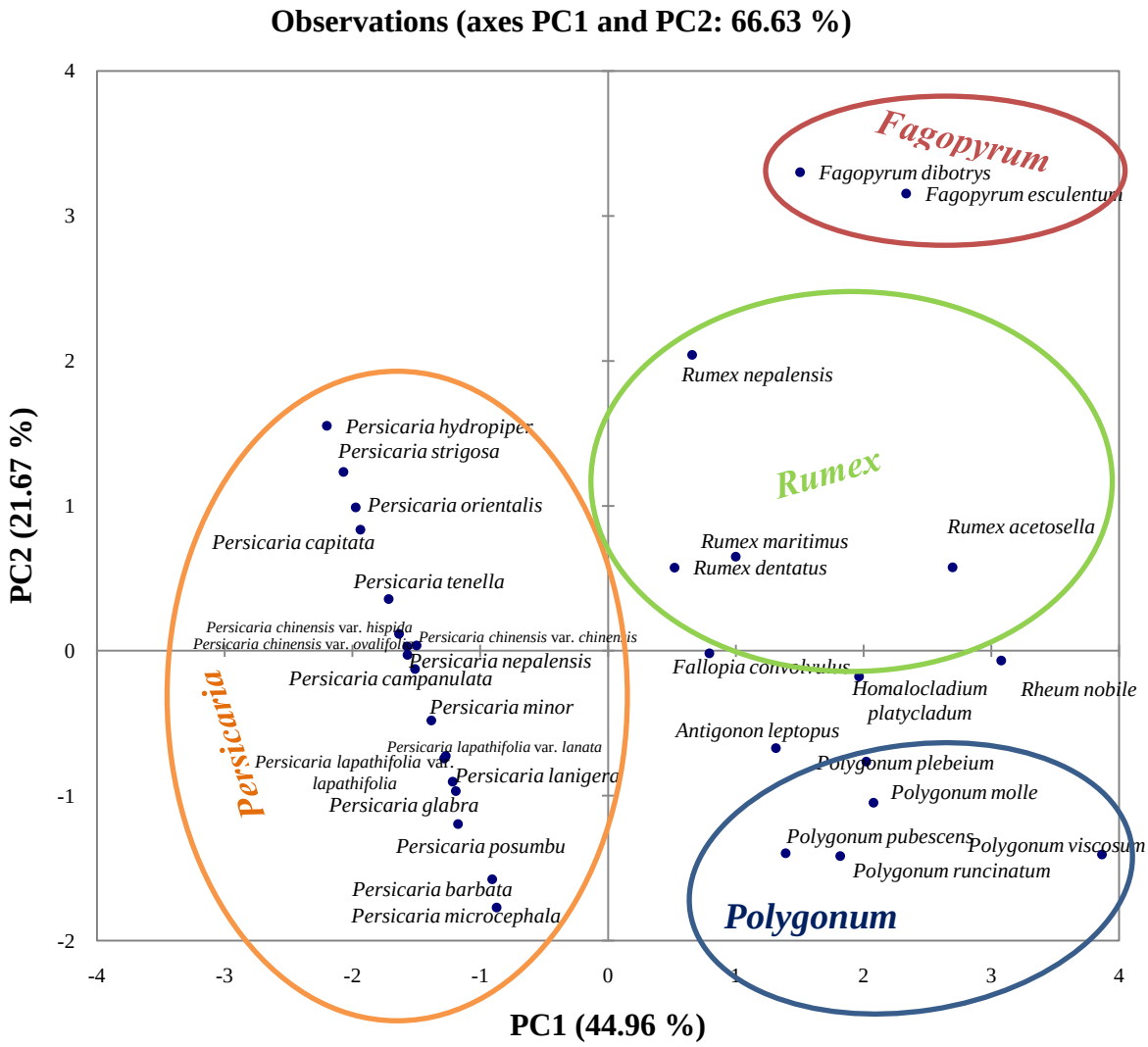


Fig. 34: Principal component analysis score plot showing the interrelationships among the taxa based on pollen morphological characters

5.3.3.3. Correlation matrix analysis

Pearson correlation matrix for quantitative variables for studied taxa (Table 21) were quite distinct and equatorial diameter (ED) correlates positively with exine thickness (r = 0.4952). Polar axis (PA) correlates positively and significantly with pollen grains shape (r = 0.7170), colpi length (r = 0.9697). Shape correlates with colpi length (r = 0.6623), P/E (r = 0.6253). All these parameters were correlated with each other at $p < 0.001$.

Table 21: Pearson correlation matrix for quantitative variables among the studied taxa of Polygonaceae

	ED	PA	Shape	Exine thickness	Colpi length	Aperture
PA	-0.0996					
Shape	-0.3353	***0.7170				
Exine thickness	***0.4952	-0.2454	-0.2584			
Colpi length	-0.0085	***0.9697	***0.6623	-0.1689		
Aperture	0.1031	0.1790	-0.0976	0.1192	0.1252	
P/E	-0.3106	**0.5020	***0.6253	-0.1253	*0.4042	-0.2144

+1 0 -1

*, **, *** are significant at p = 0.05, 0.01 and 0.001 respectively

5.3.4. Cluster analysis

Accumulated data were analyzed numerically to generate the Pearson similarity co-efficient dendrogram for studied taxa of Polygonaceae to understand their interrelationship. The dendrogram (Fig. 35) showed two major constant clades with closely related taxa where the first clade was further divided into three sisters clades. The first sister clade consisted of *Rumex nepalensis*, *R. dentatus*, *R. maritimus*, *R. acetosella*, *Rheum nobile*, *Fagopyrum esculentum* and *F. dibotrys*. In second sister clade, all the taxa of *Polygonum* (*P. plebeium*, *P. molle*, *P. runcinatum*, *P. pubescens*, *P. viscosum*) and *Homalocladium platycladum* were placed. The third sister clade was further subdivided into two clades where one clade consisted of *Antigonon leptopus* and *Fallopia convolvulus* and the second clade composed of 18 taxa of *Persicaria* (*P. chinensis* var. *ovalifolia*, *P. chinensis* var. *chinensis*, *P. chinensis* var. *hispida*, *P. capitata*, *P. tenella*, *P. minor*, *P. campanulata*, *P. nepalensis*, *P. posumbu*, *P. glabra*, *P. microcephala*, *P. barbata*, *P. hydropiper*, *P. orientalis*, *P. strigosa*, *P. lanigera*, *P. lapathifolia* var. *lapathifolia* and *P. lapathifolia* var. *lanata*) showing very close proximity. The entire dendrogram was quite significant and all taxa of same genera forming separate cluster and nearby cluster denotes the close proximity among genera.

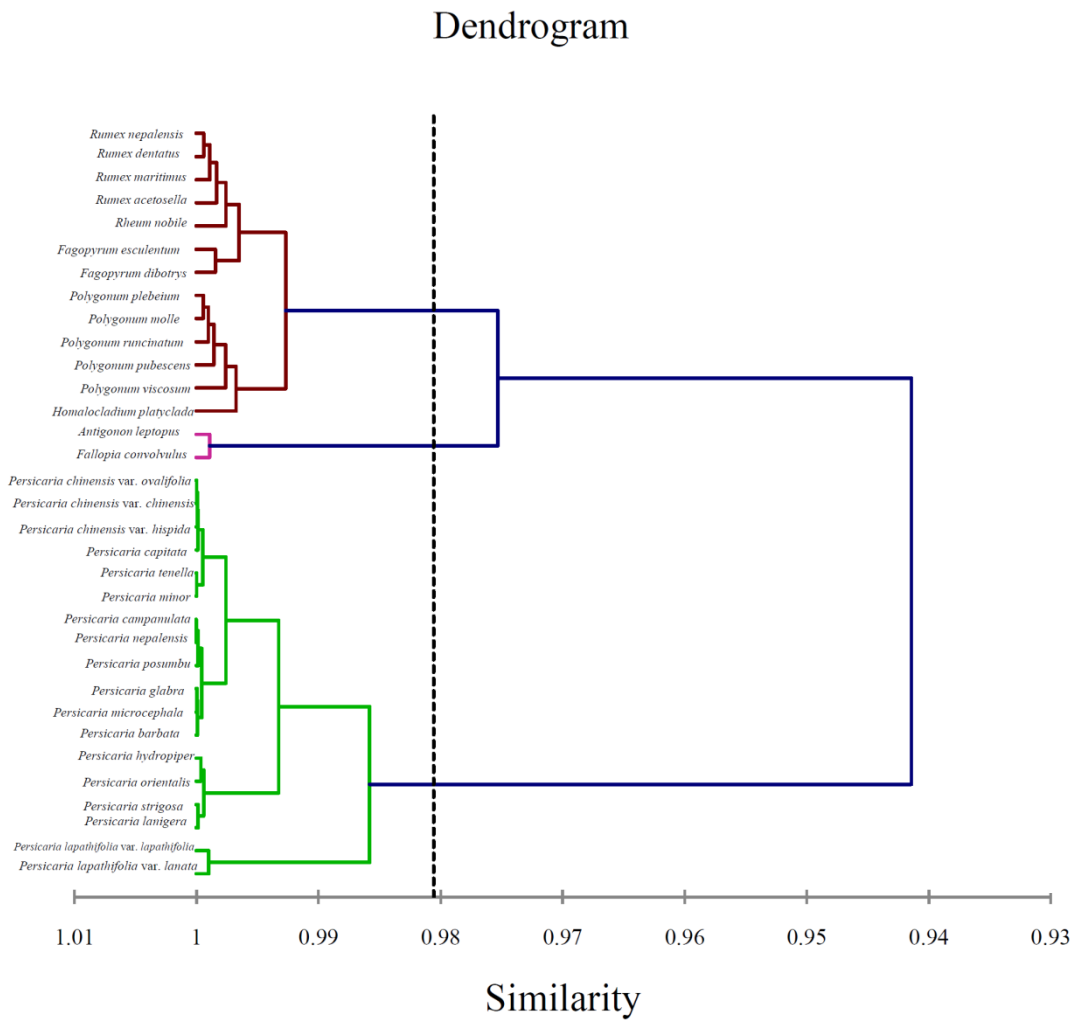


Fig. 35: Dendrogram showing inter-relationship among taxa based on pollen morphological characters

5.3.5. Artificial identification key

Using various distinctive pollen grain characters an easy identification dichotomous key was constructed for studied taxa under study from this part of the world. This key is clearly reflecting the importance of qualitative and quantitative characters that functioned as unique identification tool for taxa upto varietal level.

1 + Pollen grains with colpi **2**

- Pollen grains without colpi **3**

2 + Colpi with pore **4**

- Colpi without pore **5**

3 + Pollen grains small in size (15.85µm – 19.63 µm) **6**

- Pollen grains medium in size (33.24µm – 42.16 µm) **7**

4 + Ora lalongate .... ……..…… **8**

- Ora lolongate **9**

5 + Pollen grains small .... ***Polygonum plebeium***

- Pollen grains medium **10**

6 + Pollen grains prolate sphroidal in shape ....…..... ***Persicaria strigosa***

- Pollen grains spheroidal in shape ..... ***Polygonum pubescens***

7 + Lumina with baculae **11**

- Lumina granulose .... …..... . ***Persicaria orientalis***

8 + Pollen grains prolate spheroidal in shape …….. ……..... …….. .. **12**

- Pollen grains prolate in shape…… ……. ***Rheum nobile***

9 + Colpi long narrow **13**

- Colpi with tapering end ..... ***Rumex nepalensis***

10 + Pollen grains subprolate in equatorial view **14**

- Pollen grains prolate spheroidal in equatorial view **15**

11 + Exine thicknesss 1.45 µm .... ***Persicaria glabra***

- Exine thickness more than 1.45 µm **16**

12 + Exine micro echinate – punctuate …… .. ***Fallopia convolvulus***

- Exine micro reticulate ……. ……..…… ***Homalocladium platycladum***

13+ Exine reticulate **17**

- Exine granulate .... ***Rumex dentatus***

14 + Exine micro reticulate .... ***Polygonum molle***

- Exine reticulate with pitted texture .... ***Antigonon leptopus***

15 + P/E ratio 1.10 .... ***Persicaria campanulata***

- P/E ratio less than 1.10 .... **18**

16 + Exine granulate to reticulate ..... ***Persicaria chinensis* var. *chinensis***

- Exine reticulate **19**

17 + Pollen grains small in size (24.95 µm – 28.96 µm) **20**

- Pollen grains medium in size (43.38 µm – 45.74 µm) **21**

18 + Exine reticulate – regulate .... ***Persicaria capitata***

- Exine reticulate .... ***Persicaria tenella***

19 + Muri thin, regularly shaped **22**

- Muri thick irregularly shaped .... ……..……..... . **23**

20 + Shape subprolate in equatorial view ..... ***Rumex acetosella***

- Shape prolate in equatorial view .... ***Rumex maritimus***

21+ Colpi length 33.84 µm .... ***Fagopyrum esculentum***

- Colpi length 28.27 µm .... ***Fagopyrum dibotrys***

22 + Pollen grains diameter 25.57 µm .... ***Polygonum viscosum***

- Pollen grains diameter more than 25.57 µm **24**

23 + Lumina broad having longitudinal folds .... ……..……..... **25**

- Lumina mostly hexagonal, pentagonal **26**

24 + Exine not uniformly reticulate …… …… ***Persicaria lanigera***

- Exine uniformly reticulate …….. ……..... . .. ***Polygonum runcinatum***

25 + Pollengrains diameter 29.33µm .. ….. ……..…… ***Persicaria minor***

- Pollen grains diameter 31.99µm ……...… ***Persicaria chinensis* var. *hispida***

26 + Exine 4.16 µm thick .... ***Persicaria posumbu***

- Exine less than 4.16 µm **27**

27 + Pollen grains average diameter 43.16µm ..... ***Persicaria hydropiper***

- Pollen grains diameter less than 43.16µm **28**

28 + % of Co-efficient variance (CV) >5 .... **29**

- % of Co-efficient variance (CV) <5 .... **30**

29 + Intine indistinct ..... ***Persicaria chinensis* var. *ovalifolia***

- Intine distinct **31**

30 + Exine 2.18 µm thick .... ***Persicaria lapathifolia* var. *lapathifolia***

- Exine 4.05 µm thick .... ***Persicaria barbata***

31 + Muri curvimurate ……..... . ……..……. **32**

- Muri with longitudinal folds .... ***Persicaria microcephala***

32 + Pollen grains diameter 26.25µm ……..... . ***Persicaria nepalensis***

- Pollen grains diameter 27.16 µm .... ***Persicaria lapathifolia* var. *lanata***

5.4. MORPHOLOGICAL PHENOGRAM

All the accumulated macro, micro morphology and pollen morphological data were analyzed numerically to generate the Pearson similarity co-efficient dendrogram for studied taxa of Polygonaceae to understand their interrelationship. The dendrogram (Fig. 36) showed that all the studied genera forming separate cluster. *Homalocladium platycladum* was forming separate clade from the other taxa. All the taxa of *Polygonum* (*P. plebeium*, *P. molle*, *P. runcinatum*, *P. pubescens*, *P. viscosum*) were clustered together and showed close proximity with *Fallopia convolvulus*. The third sister clade was further subdivided into two cluster where all 18 taxa of *Persicaria* (*P. chinensis* var. *ovalifolia*, *P. chinensis* var. *chinensis*, *P. chinensis* var. *hispida*, *P. capitata*, *P. tenella*, *P. minor*, *P. campanulata*, *P.*

nepalensis, *P. posumbu*, *P. glabra*, *P. microcephala*, *P. barbata*, *P. hydropiper*, *P. orientalis*, *P. strigosa*, *P. lanigera*, *P. lapathifolia* var. *lapathifolia* and *P. lapathifolia* var. *lanata*) and all the four taxa of *Rumex* (*R. nepalensis*, *R. dentatus*, *R. maritimus*, *R. acetosella*) were showing sister relationships. *Rheum nobile*, *Fagopyrum esculentum* and *F. dibotrys* forming separate cluster and was showing very close proximity. The entire dendrogram was quite significant and all taxa of same genera forming separate cluster and nearby cluster denotes the close proximity among genera.

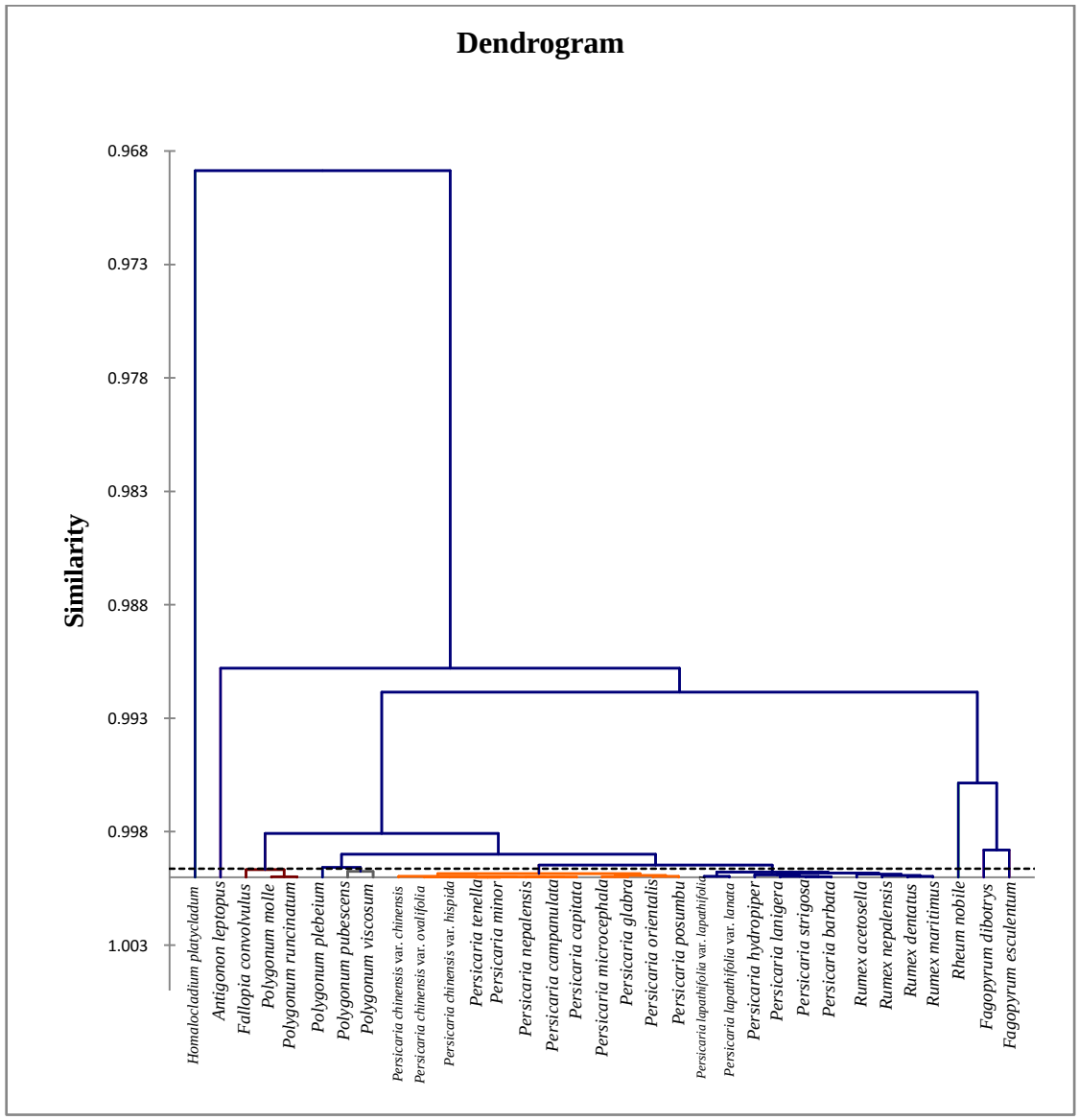


Fig. 36: Dendrogram showing inter-relationship among taxa based on macro, micro and pollen morphological characters

5.5. MOLECULAR DOCUMENTATION

Fresh leaf sample for all the collected taxa of Polygonaceae were collected from their natural habitats of different parts of West Bengal. The present study extended the knowledge of some previous researchers by sequencing conserved chloroplast region of several members of Indian Polygonaceae (*viz*., 6 sequence of *rbcL*, 17 sequences of *trnL-F* and 10 sequences of *matK* from 19 species of Polygonaceae) that were not sequenced earlier. Based on these sequences of three chloroplast DNA region, phylogeny of the eight genera of Himalayan *Polygonum* sensu lato were re-evaluated.

5.5.1. Sequence analysis

The *rbcL, matK* and *trnL-F* gene sequences of different taxa of eight genera *viz*., *Persicaria, Rheum, Rumex, Antigonon, Fagopyrum, Fallopia, Muehlenbeckia* and *Polygonum* were compared with other sequences available and submitted to GenBank (Appendix 1). Altogether 33 sequences were submitted to GenBank including 6 sequences of *rbcL* genes, 10 sequences of *matK* genes and 17 sequences of *trnL-F* genes following BLASTn analysis. Sequencing of the five *Persicaria-rbcL* genes showed 99% nt identity with other *Persicaria* species available in the GenBank whereas, the *Rumex-rbcL* gene showed 98% nt identity with *R. flexuous*. The *matK* sequences of the nine *Persicaria* species showed 97-99% nt identity with other *Persicaria-matK* sequences found in the GenBank and the *Rumex-matK* gene showed 99% nt identity with *R. patientia* sequence. The *trnL-F* sequences of the *Prisecaria* species also showed 97-99% nt identity with other *Persicaria-trnL-F* sequences. The *Antigonon, Fagopyrum, Muehlenbeckia, Rumex* and *Polygonum trnL-F* sequences showed 93%, 98%, 98%, 98-99% and 99% nt identity respectively with the other *trnL-F* sequences available in the GenBank (Table 22).

Table 22: List of sequences submitted to GenBank from 19 taxa of Polygonaceae, their accession number and nt identity with other related taxa.

Isolate	Place of collection	GenBank Accession No.	BLAST similarity	Most similar isolate
a. *rbcL*				
1. *Persicaria lapathifolia var. lanata*	Kathambari beel, Jalpaiguri	MH757120	99%	*Persicaria hydropiperoides* (HM850244)
2. *Persicaria lanigera*	Gabgachi-chatral beel, Malda	MK015865	99%	*Persicaria capitata* (FM883623)
3. *Persicaria glabra*	Domohani beel, Jalpaiguri	MH824149	99%	*Persicaria longiseta* (FM883631)
4. *Persicaria strigosa*	Kathambari beel, Jalpaiguri	MG808037	99%	*Persicaria meisneriana* (EF653772)
5. *Persicaria tenella*	Lochka River Bed, Darjeeling	MF447884	99%	*Persicaria tinctoria* (EU554023)
6. *Rumex dentatus*	Burdwan, West Burdwan	MG766137	98%	*Rumex flexuosus* (KT626844)
b. *matK*				
1. *Persicaria microcephala*	Singamari, Darjeeling	MH757121	99%	*Persicaria sieboldii* (AB038185)
2. *Persicaria strigosa*	Kathambari beel, Jalpaiguri	MG808036	99%	*Persicaria perfoliata* (HM357916)
3. *Persicaria tenella*	Lochka River Bed, Darjeeling	MF371114	99%	*Persicaria posumbu* (KF224975)
4. *Persicaria lapathifolia var. lanata*	Kathambari beel, Jalpaiguri	MH757119	99%	*Persicaria tinctoria* (KJ939220)
5. *Persicaria lanigera*	Gabgachi-chatral beel, Malda	MK044697	97%	Persicaria capitata (HM851074)
6. *Persicaria glabra*	Domohani beel, Jalpaiguri	MH834391	98%	*Persicaria posumbu* (KF224975)
7. *Persicaria nepalensis*	Pankhabari road, Kurseong	MH324414	97%	*Persicaria sieboldii* (AB038185)
8. *Persicaria campanulata*	Tiger Hill, Darjeeling	MH324415	99%	*Polygonum chinense* (GQ434134)
9. *Persicaria barbata*	Lochka River Bed, Darjeeling	MK015867	99%	Persicaria pensylvanica (KY978033)
10. *Rumex nepalensis*	Lebong Road, Darjeeling	MH898986	99%	*Rumex patientia* (KY377980)

c. *trnL–F*				
1. *Antigonon leptopus*	Malda Station Road, Malda	MG913344	93%	*Triplaris americana* (AJ312251)
2. *Fagopyrum dibotrys*	Sukhiapokhri Road, Darjeeling	MH854502	98%	*Fagopyrum tataricum* (HQ843172)
3. *Muehlenbeckia platyclada*	NBU campus, Darjeeling	MH674191	98%	*Muehlenbeckia australis* (JF831303)
4. *Persicaria barbata*	Lochka River Bed, Darjeeling	MH824148	99%	*Persicaria kawagoeana* (EU197025)
5. *Persicaria hydropiper*	Domohani beel, Jalpaiguri	MH854504	99%	*Persicaria hydropiper* (HQ843164)
6. *Persicaria microcephala*	Singamari, Darjeeling	MH824147	99%	*Persicaria nepalensis* (JN235056)
7. *Persicaria glabra*	Domohani beel, Jalpaiguri	MH834392	98%	*Persicaria japonica* (HQ843162)
8. *Persicaria lanigera*	Gabgachi-chatral beel, Malda	MK015866	99%	*Persicaria sphaerocephala* (HQ843171)
9. *Persicaria lapathifolia var. lanata*	Kathambari beel, Jalpaiguri	MH674192	99%	*Persicaria maculosa* (EU024781)
10. *Persicaria tenella*	Lochka River Bed, Darjeeling	MG575521	99%	*Persicaria minor* (EU197033)
11. *Persicaria strigosa*	Kathambari beel, Jalpaiguri	MG821320	99%	*Persicaria meisneriana* (EF653798)
12. *Persicaria runcinata*	Darjeeling Govt. College	MH854501	97%	*Persicaria sphaerocephala* (HQ843171)
13. *Persicaria orientalis*	Nayagram beel, Malda	MH854503	99%	*Polygonum orientale* (HQ843155)
14. *Polygonum molle*	Tonglu, Darjeeling	MH674190	99%	*Aconogonon molle* (EF653790)
15. *Rumex nepalensis*	Lebong Road, Darjeeling	MK034859	98%	*Rumex crispus* (KR537741)
16. *Rumex maritimus*	Lochka River Bed, Darjeeling	MG780830	99%	*Rumex patientia* (AF303432)
17. *Rumex dentatus*	Burdwan, West Burdwan	MG780829	99%	*Rumex crispus* (KR537741)

5.5.2. Phylogenetic analysis

Results for separate analyses of the chloroplast data (*rbcL, matK* and *trnL-F*) showed well-supported differences in relationships. Both Bayesian (BI) and maximum likelihood (ML) analyses produced trees with similar topologies.

5.5.2.1. *rbcL* Analysis

In the ML tree of the *rbcL* gene of the eight genera of the Polygonaceae (Fig. 37) *Persicaria, Rumex, Rheum, Fagopyrum* and *Antigonon* formed separate clusters, whereas, *Polygonum, Muehlenbeckia* and *Fallopia* clustered together. *Oxygonum sinuatum* was taken as outgroup. *Rheum* was closely related to *Fagopyrum* whereas *Rumex* was closely related to *Persicaria*. Although some of taxa of *Polygonum* were clustered with *Perasicaria.* From the ML tree it was clearly observed that *Persicaria* was monophyletic in origin while *Polygonum* was paraphyletic in origin. The phylogenetic tree reconstructed with BI analysis (Fig. 38) showed that all the eight genera *i.e., Persicaria, Rumex, Rheum, Fagopyrum, Antigonon, Polygonum, Muehlenbeckia* and *Fallopia* formed separate clusters. Here also *Rheum* shows sister relationship with *Fagopyrum*. *Antigonon* were closely related with *Fagopyrum*. It was clearly observed also from BI analysis that *Persicaria* was monophyletic in origin while *Polygonum* was paraphyletic in origin. The results of BI analysis were similar to the results of ML analysis. The pairwise similarities of these sequences have been presented in the colour-coded matrix (Fig. 39).

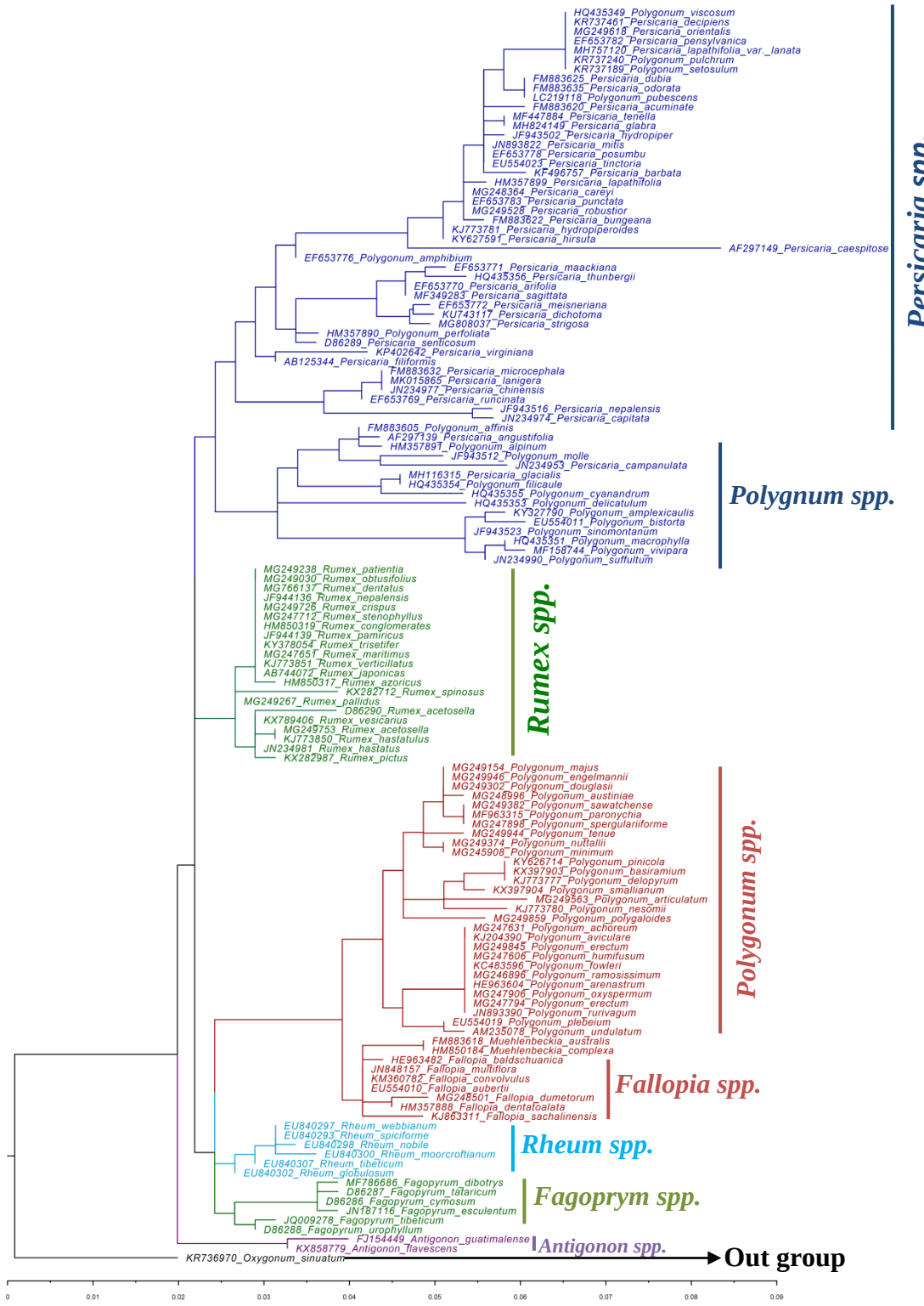


Fig. 37: Phylogenetic tree generated by Maximum Likelihood (ML) method consisting of *rbcL* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. GenBank accession numbers along with the species have been indicated

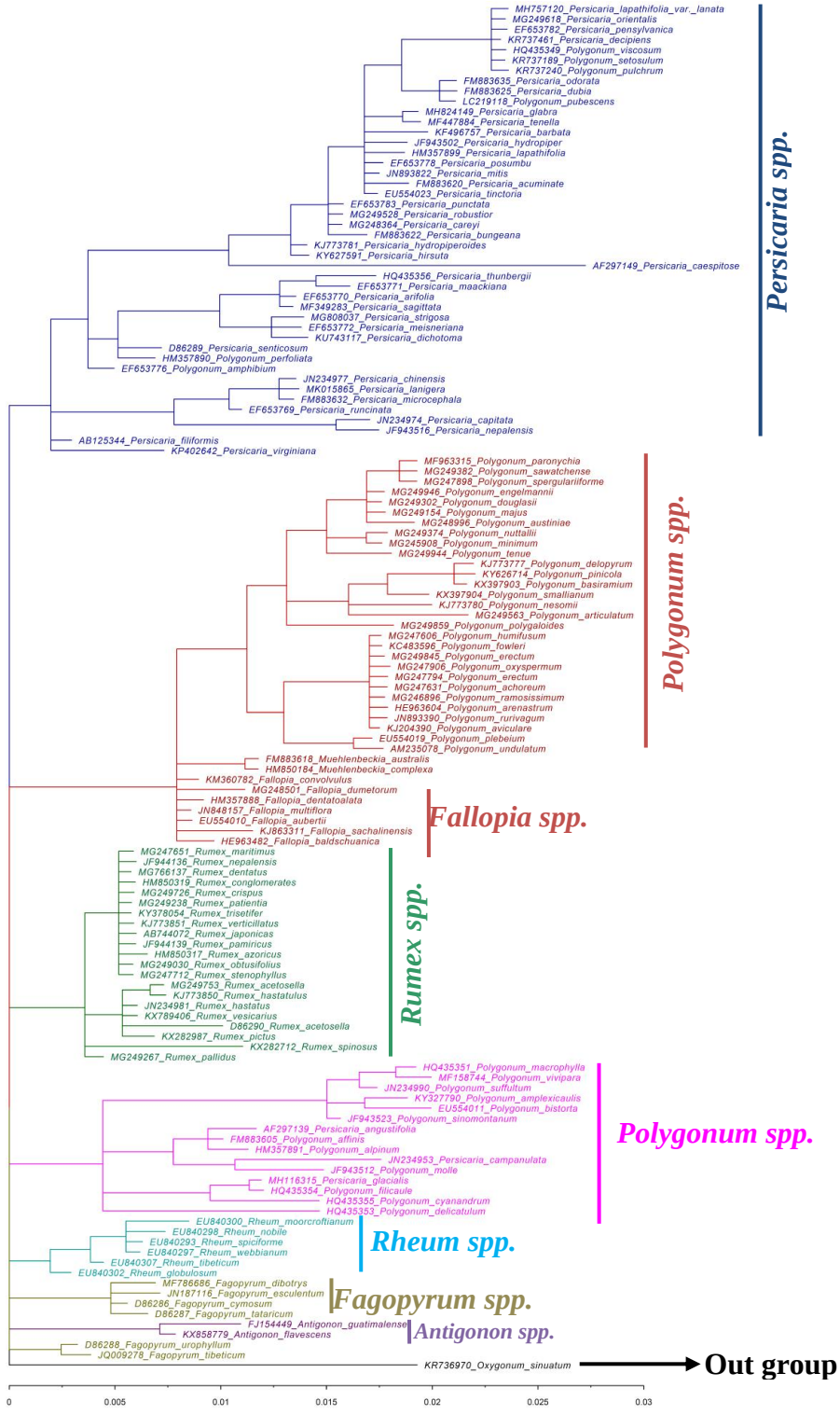


Fig. 38: Phylogenetic tree generated by Bayesian phylogenetic inference (BI) method consisting of *rbcL* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. GenBank accession numbers along with the species have been indicated

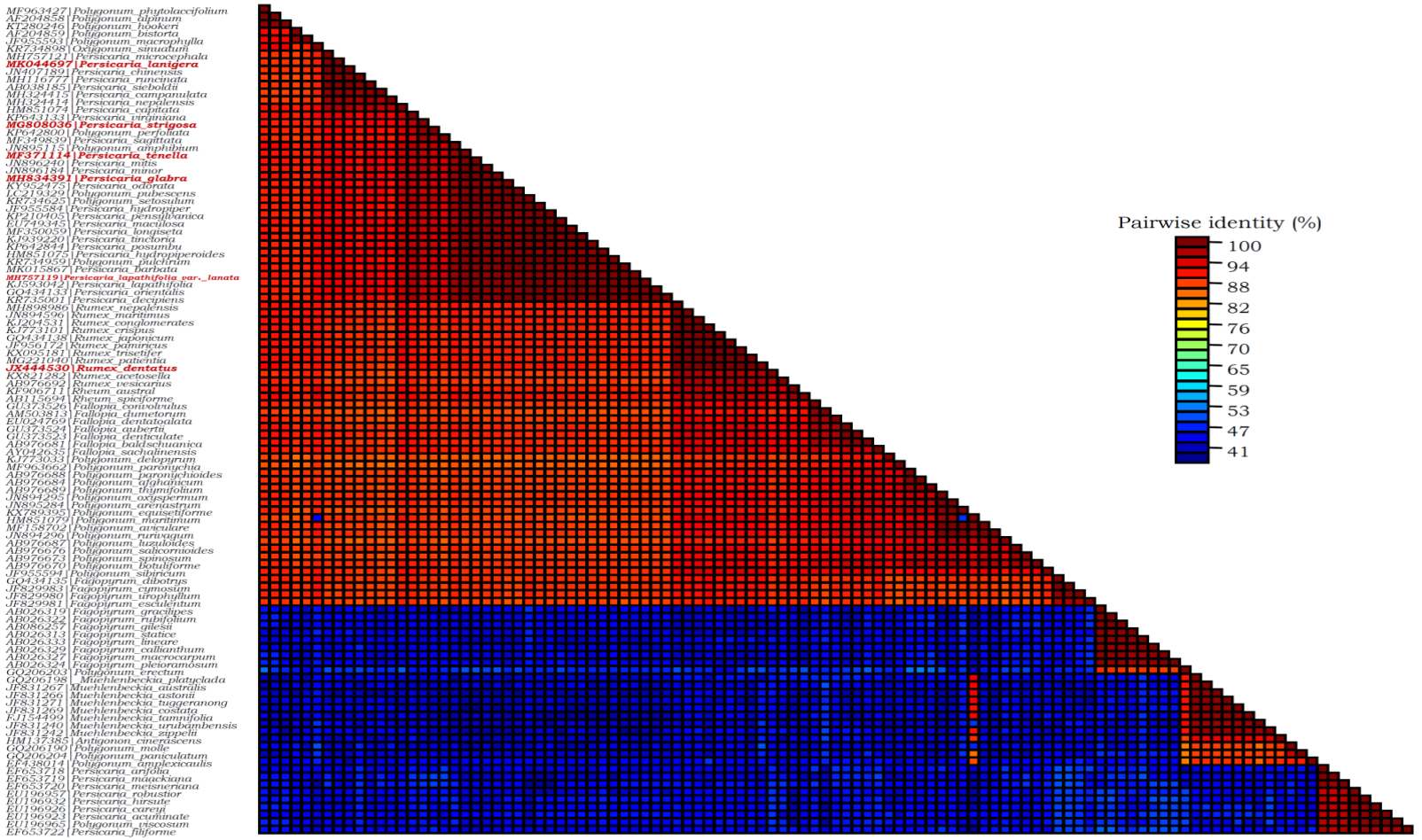


Fig. 39: Nucleotide sequence identity matrix of *rbcL* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. Identity percentages are indicated on the right side corner of the matrix

5.5.2.2. *matK Analysis*

Another ML tree was generated using the *matK* gene of the eight genera of the Polygonaceae (Fig. 40), where all the eight genera formed separate clusters, although *Polygonum*, *Persicaria* and *Fagopyrum* formed more than one clusters. However, *Muehlenbeckia* was closely related to *Polygonum*. *Fallopia* was also found to be closely related to *Polygonum* but distantly related to *Fagopyrum*. *Rumex* and *Rheum* showed close relationship with *Fagopyrum* just like *rbcL* analysis. The phylogenetic tree reconstructed with BI analysis (Fig. 41) showed similar clustering pattern supporting the ML trees such as *Muehlenbeckia* was closely related to *Polygonum*; *Fallopia* was also found to be closely related to *Polygonum.* But *Rumex* and *Rheum* were showimg different clustering pattern *i.e.*, in ML analysis they were closely related to *Fagopyrum* whereas in BI analysis they were distantly related to *Fagopyrum*. *Polygonum*, *Persicaria* and *Fagopyrum* formed more than one clusters also in this analysis. The pairwise similarities of these sequences have been presented in the colour-coded matrix (Fig. 42).

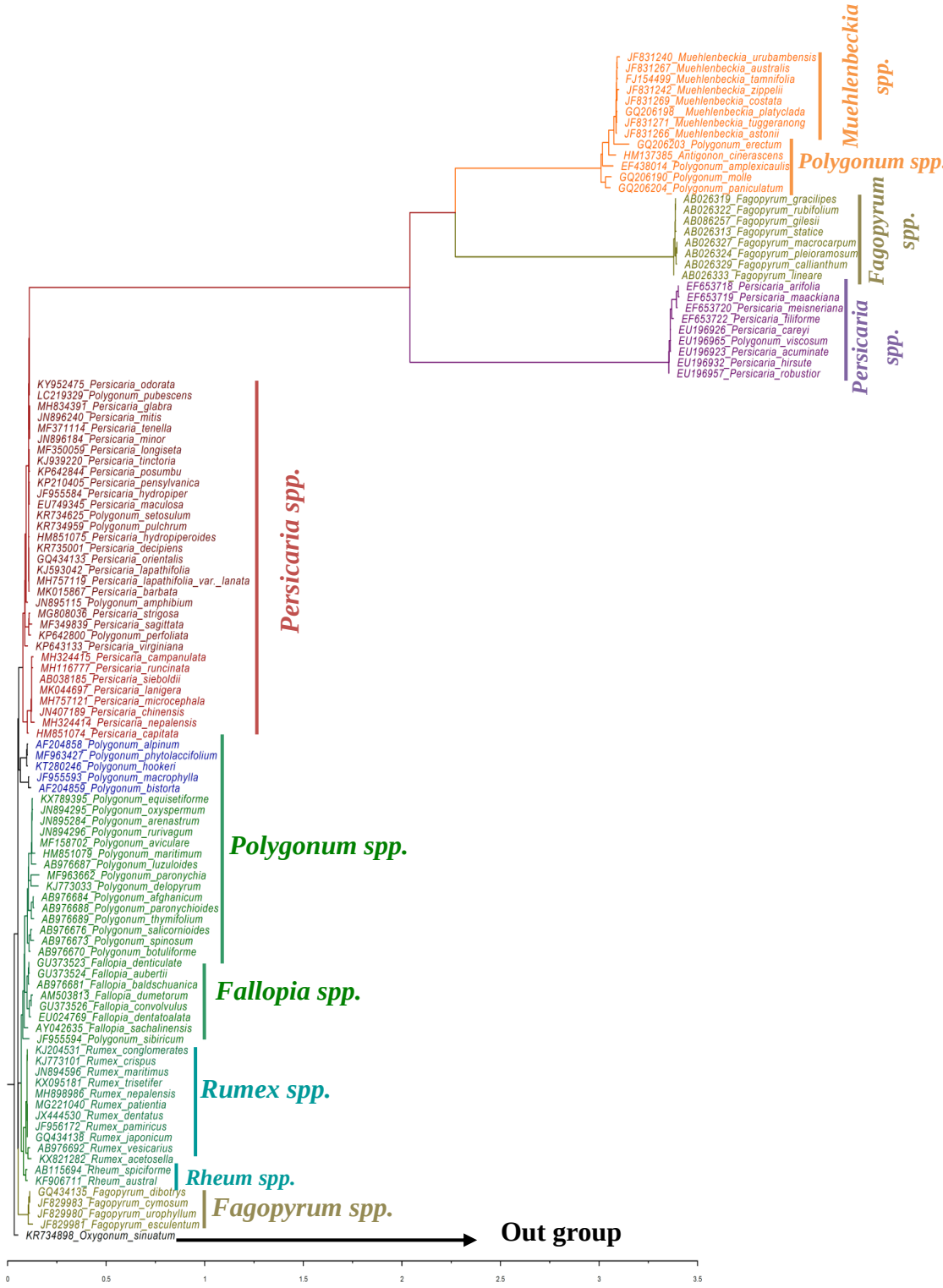


Fig. 40: Phylogenetic tree generated by Maximum likelihood (ML) method consisting of *matK* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. GenBank accession numbers along with the species have been indicated

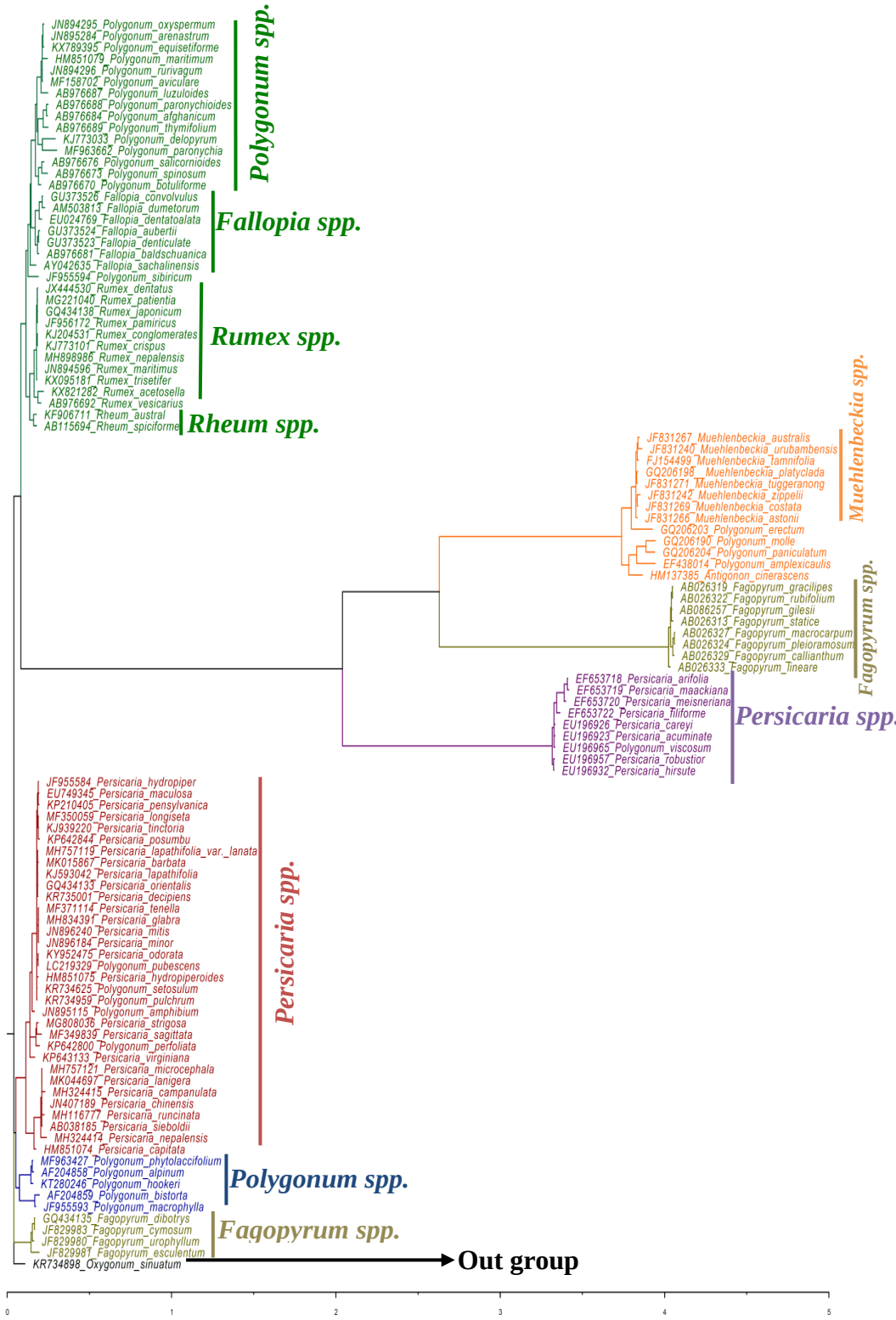


Fig. 41: Phylogenetic tree generated by Bayesian phylogenetic inference (BI) method consisting of *matK* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. GenBank accession numbers along with the species have been indicated

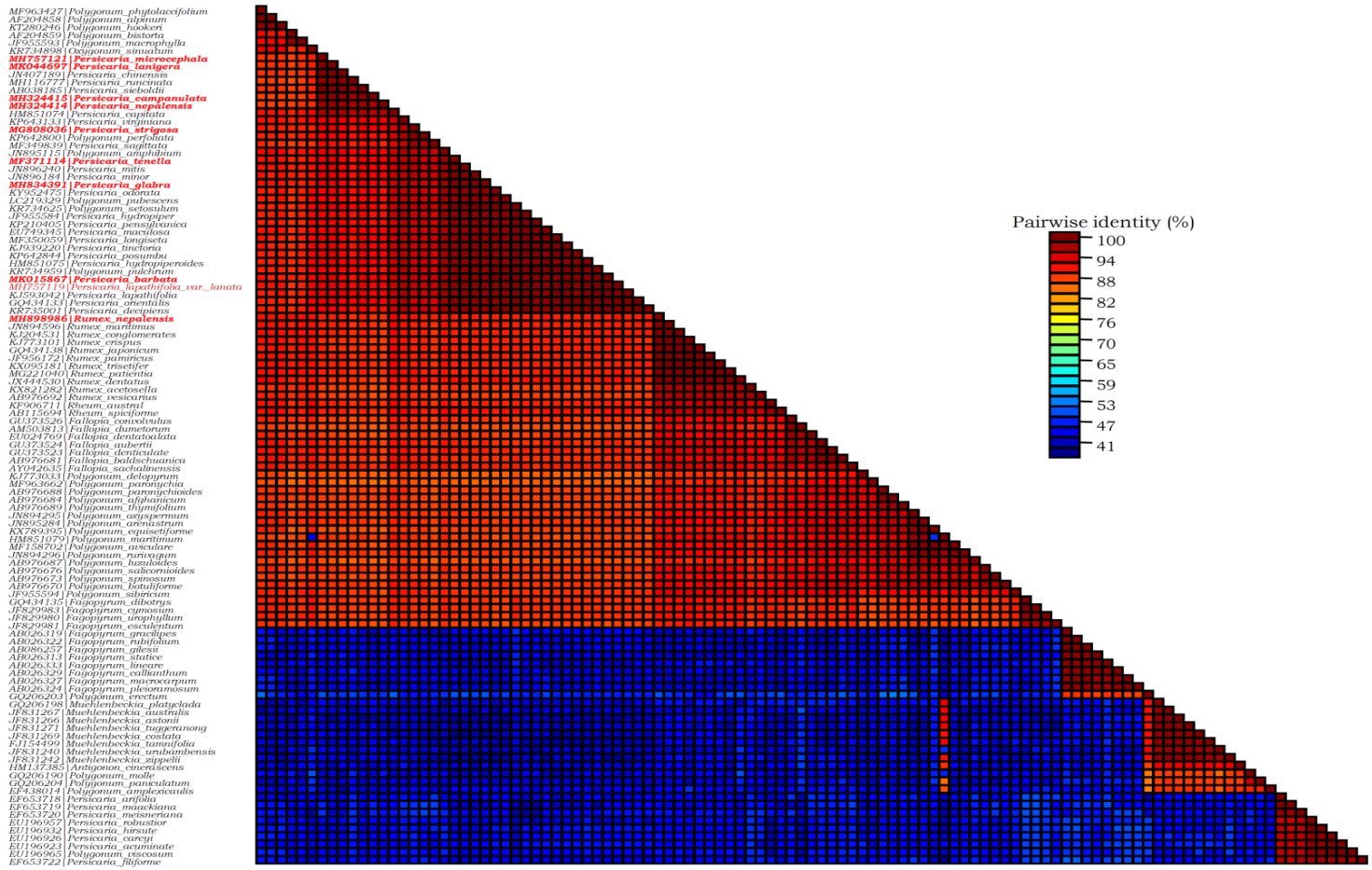


Fig. 42: Nucleotide sequence identity matrix of *matK* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. Identity percentages are indicated on the right side corner of the matrix

5.5.2.3. *trnL-F Analysis*

The phylogenetic ML tree based on *trnL-F* genes of Polygonaceae (Fig. 43) revealed more or less similar results with *rbcL* and *matK* data analysis. Here also *Fallopia*, *Muehlenbeckia* and *Polygonum* clusters form a single group outgrouped with *Antigonon*. Other four genera *Persicaria*, *Rumex*, *Rheum* and *Fagopyrum* formed separate clusters where *Rumex* and *Rheum* closely related to *Fagopyrum. Polygonum* also formed one separate cluster which strongly supports its polyphyletic origin. The phylogenetic trees reconstructed with BI analysis (Fig. 44) showed more or less similar clustering pattern supporting the ML tree analysis. In this analysis all the taxa of *Fallopia* were nested within the cluster of *Muehlenbeckia*. In BI analysis, *Rumex* and *Rheum* were also showing close relationship to *Fagopyrum*. *Fallopia*, *Muehlenbeckia* and *Polygonum* clusters also form a single group outgrouped with *Antigonon* in BI analysis. From these analyses it was clearly observed that *Polygonum* was polyphyletic in origin whereas all the other taxa were monophyletic in origin. The pairwise similarities of these sequences have been presented in the colour-coded matrix (Fig. 45).

In the entire phylogenetic analysis the *Persicaria* cluster was comprised of several *Polygonum* species. However, in all the cases (*rbcL*, *matK* and *trnL-F*) most of the genera were found to be polyphyletic in origin.

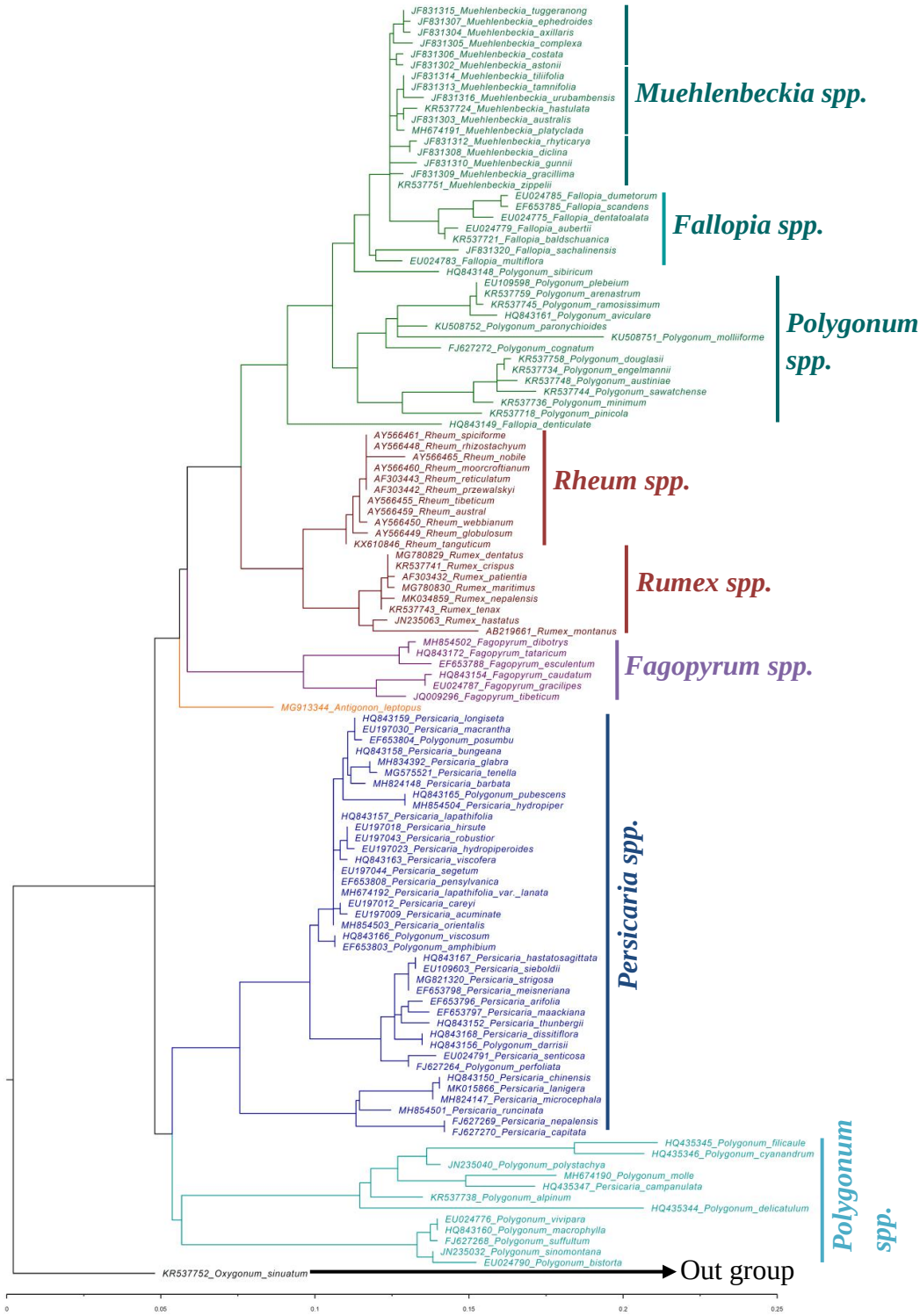


Fig. 43: Phylogenetic tree generated by Maximum likelihood method consisting of *trnL-F* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. GenBank accession numbers along with the species have been indicate

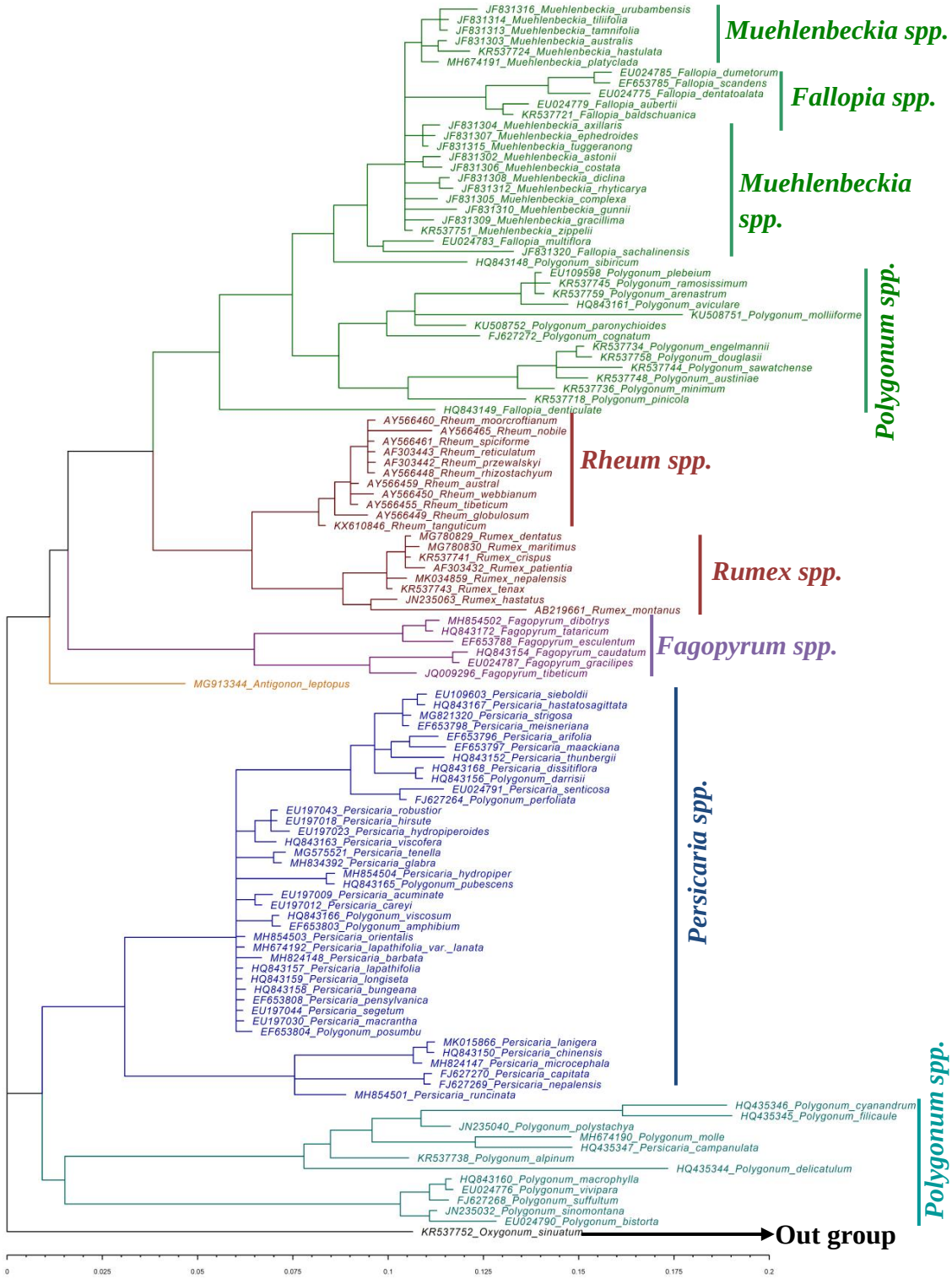


Fig. 44: Phylogenetic tree generated by Bayesian phylogenetic inference method consisting of *trnL-F* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. GenBank accession numbers along with the species have been indicated

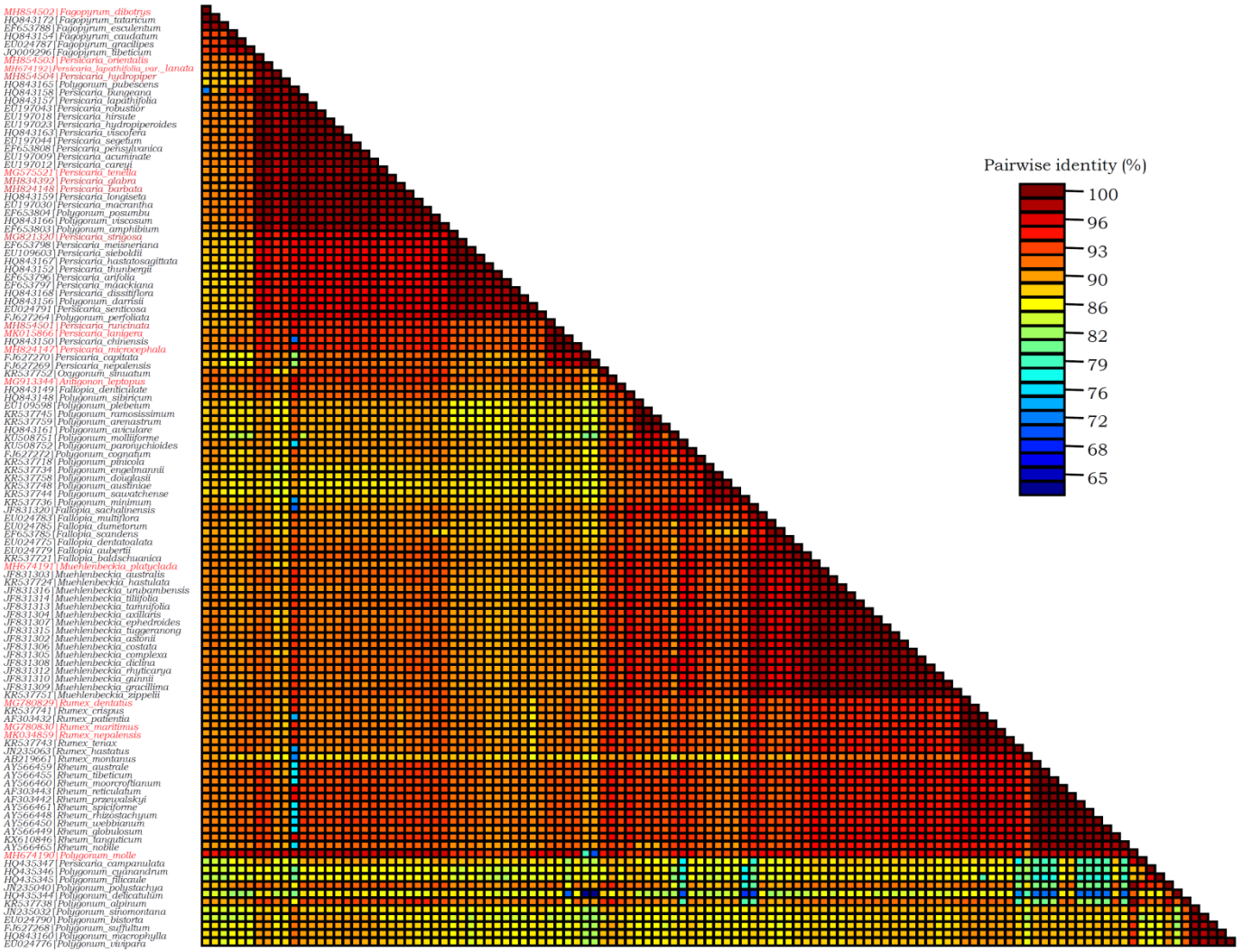


Fig. 45: Nucleotide sequence identity matrix of *trnL-F* gene of the members of Polygonaceae of the present study and that of other members of Polygonaceae reported worldwide. Identity percentages are indicated on the right side corner of the matrix