6. DISCUSSION

Darjeeling-Kalimpong Himalaya including Sikkim and terai-Duars of sub-Himalayan topography forms a fundamental part of the Eastern Himalayan region that are the storehouse of rich and diversified biological resources, representing of a huge number of endemic, rare, endangered and economically important plants (Bhujel and Das 2002; Chowdhury 2009). Till now, a large number of botanists, naturalists and tourists from different parts of the world are paying attention to this region. Due to apposite environmental set-up, the region becomes one of the richest floral diversity in India. This region uniformly represents plant groups of various habits such as herbs, shrubs, small to large climbers and trees. Many wild species having therapeutic, religious and socio-cultural values are found to be of immense economic significance for the local ethnic people including food and ornamental potentiality (Sarkar 2011). On the other hand, a large number of trees belonging to the diverse families are known for their high quality timber, which are quite costly, durable and are much demanding in global market. However, many plant species of this region were found to be threatened and endangered (Das *et al.* 2010). North and South Bengal plain starts from the south of Terai region and continues up to the left bank of the Ganges. The region is about 50 to 100m above the sea level. The Western undulating highlands and plateau forms the eastern periphery of the Chota Nagpur and is made up of igneous rocks of the Archaean era as well as coal-bearing mudstone and quartzite rocks of Carboniferous period. Members of Polygonaceae are common both in the plains as well as in the mountainous ranges. Maximum members of this family are found in wild habitat throughout the state but few taxa are cultivated in gardens, sanctuaries and parks etc.

The members of the Polygonaceae are highly valued for their medicinal properties. The Genus *Polygonum* is growing as weed in different habitats and it has several economical and ecological importances. Some species of Polygonaceae were extensively used in traditional medicine system among the various ethnic groups in West Bengal as well as in India. Seeds and young leaves of *Fagopyrum dibotrys* (D. Don) Hara was used for treatment of colic, choleric diarrhea and abdominal blockage troubles in different parts of West Bengal. Various communities are used watery sap from roots of *Persicaria barbata* (Linnaeus) H. Hara as antiseptic. Local

people of Bengal plains are used Tender leaves, shoots and fruit of *Polygonum perfoliatum* Linnaeus as vegetable; whole plant are also used as depurative, diuretic, febrifuge and to stimulate blood circulation; leaves decoction is used in the treatment of dysentery, enteritis, boils and abscesses, poisonous snake bites, haematuria, cloudy urine and traumatic injuries. There are large numbers of ornamental plants in Polygonaceae. However, from West Bengal only four species are used as ornamentals namely *Antigonon leptopus*, *Coccoloba uvifera*, *Persicaria capitata*, *Persicaria orientalis*. Young leaves of *Fagopyrum dibotrys*, *Fagopyrum esculentum*, *Fagopyrum tartaricum*, *Rumex acetosella*, young shoot of *Rumex hastatus* and rhizome of *Bistorta amplexicaulis* have extensive local market value for their medicinal and commercial properties. Further study focused on cultural, medicinal and commercial aspects of Polygonaceae are required to unveil valuable bio resource.

Polygonaceae had been studied worldwide by various taxonomists in different laboratories to understand their evolution and phylogeny. As the members of this family are confined to Himalayan regions, so the West Bengal occupies the prominent position regarding their diversity. But, very little works was documented on the Polygonaceae from this region. Controversies about the phylogeny and affinity of some species of this region and their uncertain positioning of the genera and their relationship are still remains uncertain. Literature study revealed that no such detailed information were available on qualitative and quantitative morphology and anatomy on epidermal cells outline, stomata, trichomes, glands and palynology of the members of Polygonaceae used for understanding of their phylogeny from this region. So, the present study was focused on foliar macro-micromorphology (stipule, leaf architectures, trichomes, stomata, venations etc) in combination with other evidences such as pollen morphology and molecular data analysis of the available members of Polygonaceae from West Bengal in order to establish the authentic species level identification and more importantly to resolve the controversy of the systematic position of *Polygonum* and *Persicaria*.

The present work evidently exhibited that Polygonaceae is one of the well known families throughout West Bengal, represented by the recorded 9 genera and 35 species. According to earlier available literature (Maiti 1985; Prain 1906; Srivastava 2014) it was revealed that among the recorded 35 taxa, only 28 taxa of

Polygonaceae were reported earlier from the study area (Maiti and Sikdar 1985; Srivastava 2014). Among the recorded taxa, *Persicaria* Mill. was the largest genus with 13 species, followed by *Polygonum* L. with 8 species, *Rumex* L. with 5 species, *Fagopyrum* Mill. with 2 species, *Antigonon* Endl., *Bistorta* Adans., *Fallopia* Adans., *Homalocladium* (F. Muell.) L. H. Bailey and *Rheum* Hook. and Thompson with 1 species.

Different qualitative attributes such as habit, presence or absence of petiole, Ochreae, tepal number, shape, ovary and fruit shape could be used for the delimitation of different studied genus. Moreover, few significant quantitative characters *i.e.*, plant height, length/width of lamina and characteristic features of ochreae, tepal, filament and style also proved to be taxonomically important characters for the identification of different taxa below the rank of genus.

Among the recorded taxa *Antigonon leptopus* is the only climber member of the family. Another identifying feature of the species is the absence of ochreate stipule. *Homalocladium platycladum* segregated from the other recorded genera due to the presence of phylloclade.

Fagopyrum is an economically important genus of Polygonaceae (Campbell 1995) and known as the good source of Polyphenols (Holasova *et al.* 2002). The most distinguishable feature of this genus is the long sized nut and disc shaped glands alternating with stamens. The reported two species segregated from each other by their habitat like annual (*F. dibotrys*) and perennial (*F. esculentum*), anthers position basifixed (*F. dibotrys*) and dorsifixed (*F. esculentum*).

Fallopia is a prostrate or twining herb having 9 species worldwide, mostly found in northern temperate regions of Asia and Europe and among them only 1 species are reported from West Bengal. Plant habit, stem and pubescence leaf, tepal and nut shape are the characteristic features of the genus. Angular stem, articulated pedicel above the middle (Stewart 1972), narrowly keeled pubescent tepals and granular nut (Ronse Decraene and Akeroyd 1988) are key characteristic features of *F. convolvulus*.

The most important and controversial genus *Persicaria* shows the wide range of variation in morphological attributes and it also differ from other genera on the basis

of inflorescence type and stamens number. The systematic position of *Persicaria* and *Polygonum* are still very confusing (Steward 1930; Wilson 1990; Heywood *et al.* 2007). Hooker (1886) described 24 species under section *Persicaria* from undivided British India while Maiti and Sikdar (1985) listed 14 species from West Bengal based on the available herbarium specimens at CNH. Present study recorded a total of 13 species of *Persicaria* from the various altitudinal and topographical habitats of West Bengal.

In the present study three varieties of *P. chinensis* have been reported from the study area *i.e.*, *P. chinensis* var. *chinensis*, *P. chinensis* var. *ovalifolia* and *P. chinensis* var. *hispida*. Among the three varieties *Persicaria chinensis* var chinensis is quite common in wild in between 120m to 2800m of Himalaya whereas rest two varieties are quire uncommon in nature. The distribution of *Persicaria chinensis* var *hispida* was earlier known only from Myanmar, Thailand, China and North east India and is endemic to South-east Asia, present work first time recorded from the boundary of West Bengal at Durpin (Kalimpong) of Darjeeling Himalaya. The varieties are distinguished from each other by their base shape, length, width, surface of lamina and orchreae and presence and absence of gland in penduncle.

P. hydropiper is a very common and frequently occurring species and phyto-geographically distributed throughout the state near the water bodies. Its important morphological features are brown stem with reddish streaks, scabrous ochreae and 5 glandular tepals (Ronse Decraene and Akeryod 1988). Less common species of *P. posumbu* seems to be similar with more common *P. orientalis* but can be separated by presence of acuminate - caudate leaf apex and 7 stamens in *P. posumbu* while acute - acuminate leaf apex and 5 stamens in *P. orientalis*. Based on some quantitative characters such as leaf and ochreae length and tepal size, both species are also distinguished from each other.

P. nepalensis is another most frequently observed species of *Persicaria*, characterized by winged petiole, 4 tepals, 5 stamens, 2 styles and dark brown nut. Instead of a separate species, Hooker (1886) proposed it as the variety of *P. alata* Buchanon-Hamilton *ex* Spreng due to the presence of winged petiole in both.

Genus *Polygonum* is mainly distributed throughout the world such as NE India, Pakistan, Nepal, China, Japan, Bangladesh, Myanmar, Malaysia and Europe. Present

study reported 7 species of *Polygonum* from West Bengal. The habit range, stem type and color, lamina shape, apex, margin, inflorescence type, ochreae and tepal shape are the identifying character of the genus.

P. plebeium is an annual herb with prostrate, angular stem. Hooker (1886) proposed 9 varieties for *P. plebeium* based on the characters of stem, length of internodes and leaf shape. *P. plebeium* characterized by 3 – 4 flowers in a cluster, short pedicel and unequal tepals. *P. molle* is an annual shrub with retrorsely hirsute stem, dark brown, tubular, membranous ochreae. Among them, *P. perfoliatum* having unique characteristic feature *i.e.*, green herbaceous tubular ochreae with orbicular wing at apex and lamina are triangular-peltate, abaxially usually sparsely retrorsely prickly along veins.

Rumex is a perennial or annual herb, extremely variable genus having 200 species in the temperate regions of the world, of these 22 species are present in India (Srivastava 2014). In the present study, 5 species of *Rumex* L. were taxonomically studied from West Bengal. The major characteristic attribute of the genus is the presence of 6 tepals arranged in two whorls (outer three small and inner three enlarged forming valves). *R. dentatus* and R. *maritimus* are pretty similar each other, however quantitative characters such as leaf, ochreae and tepal length of these two species are the key points to differentiate them from each other. Economically important species of *R. acetosella* are quite available throughout the state. The species easily segregated from the other species of *Rumex* having unisexual flower.

Although morphological features are undeniably significant and simply studied attributes but in this case on the basis of morphological evidence species identification merely is not possible because the morphological variations are inadequate to be taxonomically informative with any degree of certainty in Polygonaceae. For that reason in the present study other parameters are also taken in consideration to resolve the confusion about the systematic position of different taxa of Polygonaceae.

Foliar macro and micro morphology more precisely leaf-architecture was frequently used as important parameter for solving numerous taxonomic disputes (Moore 2008). Hickey initially used this parameter *i.e.*, leaf shape, gland position, venation pattern and marginal configuration to represent the placement of plant species

(Hickey 1973). After that many authors categorize the plant groups and subgroups by using the leaf-architecture data. Beside these, morphology of stomata also provide taxonomically significant diagnostic characters, like stomatal index, stomata type and the occurrence of stomata on the leaf surface (Tripathi and Mondal 2012). Therefore, the leaf architecture study was undertaken in the present work to produce a comprehensive account of 34 taxa of Polygonaceae from West Bengal, India. The current study provides valuable information concerning micro-morphological features under light microscopy, which play significant role in the identification of Polygonaceae at genus and species levels. The study mainly paying attention to epidermal cells, stomatal complex, types of stomata, subsidiary cells and trichomes.

The foliar morphological exploration of *Fagopyrum* species from India was performed for the first time in this manuscript. It discovered numerous significant micro-morphological attributers which exhibited interesting inter-specific significance for identification. The shape of epidermal cells ranges from thick walled hexagonal, pentagonal and polygonal to irregular cells with undulating walls. *F. dibotrys* and *F. esculentum* was showing mesomorphic nature of plants. The stomata were distributed on both adaxial and abaxial lamina surfaces. Paracytic type of stomata was recorded in *F. esculentum* while in *F. dibotrys* it was anomocytic. Inamdar (1971) reported anomocytic, anisocytic and paracytic stomata in *F. dibotrys*. Quantitatively, stomatal length, breadth, stomatal frequency and stomal index were also showing variation in both species. Indumentums also bear significant importance for resolving the delimitation of angiosperms (Werker 2000). Metcalfe and Chalk (1950) provided modest information about indumentums in Polygonaceae. Non glandular, multiseriate unbranched trichomes were found in both the taxa of *Fagopyrum*. Venation pattern of the two species of *Fagopyrum* were more or less similar but variation was found in case of 3º and 4º vein categories which plays significant role in the identification for both the taxa.

The shape of the epidermal cells was irregular with smooth and undulate walls in both the surfaces of lamina *Fallopia convolvulus.* Here pericytic type of stomata was found on both leaf surfaces but more on abaxial surface. The presence of non glandular unicellular trichomes was reported by Lersten and Curtis (1992) but in the present study no such trichomes were recorded in *F. convolvulus*.

Enormous range of variation was observed in the shape of epidermal cells of the studied taxa of *Persicaria* and found to be supportive as an additional taxonomic tool. The cells were smooth and thick walled, tubular or elongated, pentagonal, hexagonal, heptagonal, octahedral, polygonal or irregular and occasionally not arranged in definite pattern. The plants growing in humid conditions were characterized by undulating cell walls. Kapoor *et al.* (1971) recorded irregular epidermal cells only on abaxial surface of some taxa of *Persicaria* viz., *P. lapathifolia*, *P. glabra* and *P. nepalensis*. Ayodele and Olwokudejo (2006) investigated irregular cells on abaxial surface of *P. nepalensis*. In *P. orientalis* and *P. posumbu* irregular cells with undulating walls were recorded on adaxial surface. In *P. minor*, epidermal cells were pentagonal, hexagonal and octahedral on both surfaces while cells were pentagonal in *P. chinensis*. Typical benzene ring like cells was found in *P. barbata*. All taxa of the genus were visibly amphistomatic (Inamdar 1971) except *P. chinensis* which was hypostomatic (Kapoor *et al.* 1971). Diversity in stomatal morphology was recorded in the studied taxa. Most frequent type of stomata was paracytic. More than one type of stomata were also found in some taxa of *Persicaria* 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) were observed. The results were in accordance with previous worker such as Inamdar (1969, 1971) reported anomocytic, anisocytic and paracytic stomata in *P. glabra*. Trichomes are absent in four taxa such as *P. chinensis* var. *chinensis*, *P. chinensis* var. *ovalifolia*, *P. microcephala* and *P. nepalensis*. Majority of the taxa bears non glandular trichomes expect *P. minor*, *P. glabra* and *P. chinensis* var. *hispida* which served as their distinctive characteristic features. Elongated, slender and uniseriate trichomes were found in *P. chinensis* var. *hispida*, *P. lanigera*, *P. perfoliata* and *P. posumbu*. In the present study elongated, slender and multiseriate trichome with blunt end found in *P. barbata* whereas Inamdar (1971) used the terminology small shaggy trichomes for *P. barbata* but Payne (1978) did not provide any report for such structure of trichomes in his vocabulary of plant hair terminology. Lersten and Curtis (1992) observed long, multicellular, eglandular trichomes in *P. capitata*, during the present investigation the recorded result was similar. Haraldson (1978) assumed that *Persicaria* was an exceptionally developed genus on the basis of their trichome structure. Moreover,

the diversity was recorded in trichomes of the genus *viz*, one-celled, two-celled and four-celled peltate trichomes, stillate trichomes and spheroidal trichomes. The most common type is four-celled peltate trichome. Glandular trichomes were the typical capitate trichomes with short stalk were found only in *P. glabra* along with two-celled peltate trichomes. Capitate trichomes were common in Polygonaceae (Soleredor 1908; Kapoor *et al.* 1971; Haraldson 1978) but presently recorded only in *P. glabra*. Lersten and Curtis (1992) found spheroidal glands in 21 *Persicaria* species along with capitate trichomes. The investigation of detailed venation pattern of *Persicaria* species from India was performed for the first time in the present work. The 1º and 2 º venation patterns of all the taxa were more or less similar but they showed great variations in their higher degree venation pattern such as 3º and 4º vein category which plays important taxonomic tool for the identification of the studied taxa.

Shape of the leaf epidermal cells of *Polygonum* species varied from tetrahedral, pentagonal, hexagonal, heptagonal and polygonal benzene ring like structure to irregular with thick and undulating walls. In *P. molle*, epidermal cells were polygonal to irregularly shaped cells. Irregular cells with thick and undulating walls were found in *P. pubescens*, *P. plebeium* and *P. runcinatum*. Ayodele and Olwokudeji (2006) reported striated polygonal cells in *P. plebeium*. The variation in epidermal cell shape was helpful to some extent for the distinction of taxa. Leaves were primarily amphistomatic with different stomatal frequency and also more than one type of stomata was observed in single taxa. Stomatal distribution on adaxial and abaxial surface of lamina is not a reliable feature (Lersten and Curtis 1992). During the present study three stomatal types were recorded in this genus (Anisocytic, anomocytic and pericytic). Pericytic stomata along with anisocytic type were found in *P. plebeium*. Kapoor *et al.* (1971) also recognized three different types of stomata in *P. plebeium* viz., anomocytic, anisocytic and paracytic type whereas, Ayodele and Olwokudejo (2006) recorded only one type of stomata (anisocytic) while recently Ahmed *et al.* (2009) reported two different types *i.e.*, diacytic and amphianisocytic stomata for the same species. In the studied taxa of *Polygonum* two different types of 1º vein were found *viz*., pinnate (*P. plebeium*, *P. molle* and *P. viscosum*) and basal (*P. pubescens* and *P. runcinatum*). Variation also found in minor venation pattern *i.e.*, 3º and 4º vein category. In 4º vein three

different pattern were found viz., regular polygonal reticulate (*P. plebeium*), alternate percurrent (*P. pubescens* and *P. runcinatum*) and dichotomizing (*P. molle* and *P. viscosum*), regular (*P. posumbu* and *P. orientalis*). Indumentums are reliable attributes for species distinction of *Polygonum* (Schotsman 1950). In the genus *Polygonum*, non glandular trichomes were the most common type except in *P. plebeium* where glandular trichomes were present. The results were in accordance with the previous worker Ayodele and Olwokudejo (2006). The size of the trichome significantly showed variation in studied taxa of *Polygonum*.

Previously very little or no detailed foliar morphological description of the available taxa of *Rumex* from West Bengal was done. Therefore, current investigation can be considered as the first detailed qualitative and quantitative study of leaf epidermis of *Rumex* species. Shape of the epidermal cell ranges from pentagonal, hexagonal and polygonal to irregular cells. Irregular cells with undulating walls were confined to adaxial surfaces of *R. acetosella*, *R. dentatus* and *R. nepalensis* whereas polygonal cells were found on both lamina surfaces of *R. maritimus*. The characteristic feature of the genus *Polygonum i.e.*, thick and pitted walls were observed only in *R. nepalensis*. Amphistomatic leaves and more than one type of stomata were characteristic features of the genus *Rumex*. Pericytic and anisocytic type of stomata were observed together in *R. acetosella*, *R. dentatus* and *R. nepalensis* but in case of *R. maritimus* only pericytic stomata was found. Inamdar (1971) also found paracytic stomata in *R. dentatus* and *R. hastatus* which do not correspond to the present findings of pericytic stomata for the same taxa. Trichomes were absent in *R. nepalensis* and *R. acetosella*. Trichomes were only of non glandular type in the other two taxa of *Rumex*. Stellate hair which is divided into four parts was distinguishing feature of *R. dentatus*. Major venation pattern *i.e.*, 1º and 2º vein category were more or less similar in all the taxa of *Rumex*. In all the taxa the 1º vein was basal except in *R. nepalensis* where it was pinnate. Variation was found in minor venation pattern. Highest excurrent vein was 4º except in *Rumex acetosella* where it was 2º.

Though the detailed investigation of leaf architecture showed their importance as taxonomic tool but was not so much obliging in the delimitation of different taxa. Various quantitative features such as length and width of stomata and trichomes on adaxial and abaxial surface, stomatal frequency and stomatal index could be employed for the species delimitation. The characters have great taxonomic

significance when used in combination with other characters but delimitation of different taxa based on only leaf architecture especially in case of Polygonaceae is much difficult (Lersten and Curtis 1992).

Degree of significance among the various micro and macro morphological attributes were determined through ANOVA analysis and result showing highly significance among the attributes at $p<0.01$ level.

PCA has been used by various authors to evaluate the systematic importance of various quantitative attributes. In PCA all the studied macro and micro morphological attributes were distributed into two major group *viz*., A and B and the studied species were distributed in four groups. Group 1 represents all the taxa of *Persicaria*, group 2 represents species of *Polygonum*, species of *Rumex* were in group 3 while group 4 represents species of *Fagopyrum*. In group A, margin type, length of stipule, number of fimbriae, length of fimbriae, base angle, blade class, stomatal index, origin of indumentums, 3º and 4º vein category were grouped together which revealed that these attributes were positively correlated with each other. In group B, stomatal frequency, lamina length, lamina width, lamina area, base shape, apex shape, lamina shape were placed which reveal increased the value of one attributes increases the other while group A and B were inversely related with each other. Taxa of *Fagopyrum*, *Antigonon leptopus*, *Homalocladium platycladum* and *Fallopia convolvulus* were grouped on the positive side of PC1 based on their macro and micro morphological attributes. Twelve taxa of *Persicaria* (*Persicaria capitata*, *P. chinensis* var. *chinensis*, *P. chinensis* var. *hispida*, *P. chinensis* var. *ovalifolia*, *P. hydropiper*, *P. lanigera*, *P. minor*, *P. orientalis*, *P. perfoliata*, *P. posumbu*, *P. strigosa*) with similar type of margin, blade class, stomatal index, 3º and 4º venation pattern were grouped on the positive side of PC2. Rest of the taxa of *Persicaria* bearing contrasting attributes than the above mentioned twelve taxa were distributed on the negative side of PC2. All the five species of *Polygonum*, *Rheum nobile*, all the four species of *Rumex* having contrasting character with *Fagopyrum*, *Homalocladium platycladum*, *Fallopia convolvulus* and *Antigonon leptopus* and were grouped on the negative side of PC1. Calculated differences among all taxa were significant. Thus these characteristics should be useful for the identification of the studied taxa.

Correlation plays an imperative role in understanding the relationships between the differences and the similarities among different studied macro and micro-morphological attributes of all taxa. The present study revealed that, apex shape was positively and significantly correlated to the length and area of the lamina. Stomatal frequency was showing positive correlation with the length, width and area of the lamina which was quite obvious. Origin of indumentums and length of the indumentums were positively correlated with blade class. Stipule length and breadth were also showing positive correlation with lamina length and width. Significant negative correlation was found between number of fimbriae with lamina length and width. Stomatal frequency was also negatively correlated to the blade class.

Pearson similarity co-efficient dendrogram were established through numerical analysis of all the accumulated data from all the foliar macro and micro morphological attributes under study for all the studied taxa of Polygonaceae to understand the inter-relationship among them. The dendrogram showed that all the taxa of *Persicaria* forming four clusters. In one cluster all the varieties of *Persicaria chinensis* were grouped together as the morphological characteristic attributes among them were more or less similar. Another cluster consist of morphologically much similar taxa of *Persicaria i.e. P. posumbu* and *P. orientalis* as they both had ovate lamina with wide obtuse base angle, acuminate apex, erose margin, venation pattern were also similar in these two taxa. All the taxa of *Polygonum* also forming two clusters, one consists of *P. molle* and *P. runcinatum* indicating similarity in some morphological attribute among them *i.e.*, both the taxa bears lamina with saggitate base and acuminate apex, anisocytic stomata. Such promiximity may be due to their similar geographical distribution in high altitude of west Bengal. In other cluster remaining taxa of *Polygonum* (*P. pubescence, P.* viscosum and *P. plebeium*) were grouped together, this was probably due to their similar distributional pattern. *Homalocladium platyclada* separated from the other studied taxa due to the presence of phylloclade and it makes the separate cluster. *Antigonon leptopus* and *Fallopia convolvulus* shows very close proximity as both the taxa shared some common characters *viz*., both the taxa lack ochreate stipule. The entire dendrogram was quite significant and all taxa of same genera forming separate cluster and nearby cluster denotes the close proximity among taxa

Another important parameter which used in this study was palynology. The morphology of pollen grains could be acknowledged as a conserved character for systematic study and to establish the evolutionary lineage among the plants as it preserved in soil for a long period of time. Generally, the shape, size of pollen grains is quite specific to the family, genus as well as in species level. Therefore, palynology was frequently used as an important feature in resolving problems of systematic and inferring the phylogenetic relationships (Erdtman 1943; Walker and Doyle 1975; Punsalpaamuu 1999). The study had revolutionized with the discovery of electron microscope by which the surface structures of exine and intine can be studied which was never possible with light microscope (Cole and Behnke 1975).

It had been found that Polygonaceae is an example of one of the diverse eurypalynous family and its wide-ranging variations have enormous systematic potential at all levels, especially for generic delimitation (Nowicke and Skvarla 1977). Exine and its sculpturing also have great systematic significance in Polygonaceae (Hong and Hedgeberg 1990).

Detail study on pollen grains of all the collected taxa of Polygonaceae revealed interesting features on various attributes *viz*., unit, polarity, outline, shape, size, colpi number and length, exine sculpturing and thickness that were quite significantly supportive to reduce the taxonomic errors in species level identification.

Pollen grains of all examined species had monad, isopolar and radiosymmetric grains with variable shapes ranges from spheroidal to prolate spheroidal and prolate to sub prolate type. The most dominant type was spheroidal grains found in 14 taxa followed by prolate spheroidal in 12 taxa, while sub prolate in 4 taxa and prolate in 3 taxa were least common type and the result are quite similar with some past reports (Wang and Feng 1994; Zhang and Zhou 1998; Hong *et al.* 2005; Yasmin *et al.* 2010).

Wodehouse (1931) observed the size of *Persicaria* pollen grains varied from 51µm to 70µm. Wang and Feng (1994) noted great variations in the pollen grains size of some Chinese species of *Persicaria* such as *P. lapathifolia* (35.8 µm), *P. longiseta* (38.4 µm), *P. hydropiper* (43.5 µm). Zhang and Zhou (1998) comprehensively studied the pollen grains morphology of *P. amphibia*, *P. barbata*, *P. glabra*, *P. hydropiper*, *P. lapathifolia*, *P. longiseta*, *P. orientalis* and *P. maculosa* from China

and reported average pollen grains diameter varied from 42.1 µm to 64.5 µm. In the present study medium sized pollen grains (24.14µm – 43.16µm) were dominant and observed in 27 taxa while in 6 taxa the pollen grains were small (15.85µm – 23.15µm). Largest pollen grains observed in *Fagopyrum esculentum* (45.70 x 40.38µm) and *Polygonum pubescens* (15.85µm) with smallest pollen grains.

All the taxa of *Persicaria* bears pantoporate pollen grain but *Persicaria tenella*, *P. capitata* and *P. campanulata* had tricolpate pollen grain and the results matched with various previous works (Wang and Feng 1994; Zhang and Zhou 1998). Both pantoporate and tricolopate types of pollen grain were observed among the taxa of *Persicaria* and *Polygonum* but distinct variation lies among their exine ornamention, exine thickness and in the arrangement of lumina and muri. Pollen grains of *Polygonum* are of smaller in dimension than that of *Persicaria* and lumina of *Polygonum* mostly bear baculae having slit and longitudinal fold, muri regularly shaped where as in *Persicaria* lumina are large and granulose. All these distinct pollen grain features strongly support *Persicaria* and *Polygonum* as an individual or as separate genera. In four species of *Rumex*, two species of *Fagopyrum* and *Fallopia convolvulus* the pollen grains were of tricolporate type (Den Nijs *et al.* 1980; Van Leeuwen *et al.* 1988; Nokwicke and Skvarla 1979; Wang and Feng 1994; Zhang and Zhou 1998; Zhou *et al.* 2002). In studied *Polygonum* species both pantoporate (*Polygonum pubescens*, *Polygonum runcinatum* and *Polygonum viscosum*) and tricolpate (*Polygonum molle* and *Polygonum plebeium*) pollen grains were observed. Length of the colpi among the studied species ranges from 9.17 – 33.84µm.

Exine ornamentation was a very important characteristic features of pollen grain and was quite species specific (Moore and Webb 1978). Based on exine thickness the pollen grains were grouped into 4 class starting from 1.04 –1.80µm for 10 taxa, 2.04 – 2.93µm for 13 taxa, 3.30 – 3.99µm for 7 taxa and more than 4µm for 3 taxa. The results of the present studies are in accordance with earlier authors (Zang and Zhou 1998; Yasmin *et al.* 2010). The gathered morphological data were quite close for similar species growing in various ranges of Himalayas in China, Pakistan and India except minute differences in their sizes, colpi length and exine thickness.

Degree of significance among the various pollen attributes were determined through ANOVA analysis and result showing highly significance at $p<0.01$ level.

To draw the significant relationship among the various attributes of pollen grains and also within the studied taxa, entire accumulated data were further analyzed through PCA and Correlation matrix analysis. PCA has been used by various authors to evaluate the systematic importance of pollen grains data (de Abreu *et al.* 2015; Mezzonato-Pires *et al.* 2015). Based on PC analysis *Rumex* and *Fagopyrum* were grouped on the positive side of PC1 with tricolporate aperture, long colpi and relatively large polar axis. Eight taxa of *Persicaria* (*P. capitata*, *P. chinensis* var. *chinensis*, *P. chinensis* var. *hispida*, *P. chinensis* var. *ovalifolia*, *P. hydropiper*, *P. orientalis*, *P. strigosa* and *P. tenella*) with spheroidal shape, thick exine and large equatorial diameter were grouped on the positive side of PC2. Rest of the taxa of *Persicaria* having thin exine, relatively small equatorial diameter than the above mentioned eigth taxa were distributed on the negative side of PC2. *Antigonon leptopus*, *Fallopia convolvulus*, *Homalocladium platycladum*, *Polygonum molle*, *P. plebeium*, *P. pubescens*, *P. runcinatum*, *P. viscosum* and *Rheum nobile* with contrasting attributes of *Rumex* and *Fagopyrum* were grouped on the negative side of PC1. The calculated differences among all taxa were significant and these characteristic features might be useful for the identification of the studied taxa.

Correlations play an important role in understanding the relationships between the differences and the similarities among different studied attributes of pollen grains of all taxa. The present study revealed that, polar axis of the pollen grains were positively and significantly correlated to the shape, colpi length, aperture, ratio of polar axis and equatorial diameter (P/E). Equatorial diameters of the pollen grains were positively correlated to the exine thickness and aperture of the pollen grains. Shape of the pollen grain was showing positive correlation to the colpi length and P/E ratio. Positive correlations were also found between the exine thickness and the aperture type of pollen grains. Colpi length of the grain was also positively correlated with aperture and P/E ratio. Significant negative correlation was found between aperture and P/E ratio of the pollen grains, polar axis and thickness of exine. Exine thickness of the pollen grain was also negatively correlated to the colpi length and P/E ratio.

Accumulated data from all the morphological characteristics of the pollen grains under study were analyzed numerically to establish the Pearson similarity co-efficient dendrogram for all the studied taxa of Polygonaceae to understand the interrelationship among them. The dendrogram showed that the *Rumex nepalensis, R. dentatus, R. maritimus, R. acetosella, Rheum nobile, Fagopyrum esculentum* and *F. dibotrys* were clustered together as they all bears tricolporate type of pollen grains. All the taxa of *Polygonum* (*P. plebeium, P. molle, P. runcinatum, P. pubescens, P. viscosum*) were forming one cluster. In this cluster P. plebeium and P. molle shows close proximity than the others as they both bears tricolpate grains while the other bears pantoporate type of grains but all of them have other similar pollen morphological attributes therefore they were clustered together. The third sister cluster 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. In this big cluster, three varieties of *P. chinensis* shows very close proximity as they bears similar pollen grains morphology with minute differences in their size and lumina shapes. *Persicaria capitata, P. tenella* and *P. campanulata* showed close proximity as they bears tricolpate type of pollen grains. Two variety of *Persicaria lapathifolia* were cluster together as they shared similar pollen morphotype with mute differences in the size of the pollen grains. The entire dendrogram was quite significant and all taxa of same genera forming separate cluster and nearby cluster denotes the close proximity among genera.

For obtaining more consistent results all the macro, micro and pollen morphological data were taken into consideration and were analyzed numerically to establish the Pearson similarity co-efficient dendrogram to understand the inter-relationship among all the studied taxa of Polygonaceae. From the dendrogram it was easily observed that *Homalocladium, Antigonon* and *Polygonum* were exhibit sister relationship among them while *Persicaria, Rumex, Rheum* and *Fagopyrum* showed very close proximity. More or less similar type of clustering was found when the

macro and micro morphological data and pollen morphological data were analyzed separately.

For further confirmation about the systematic position of Polygonaceae, molecular documentation was also taken in consideration for the present study. The debate regarding the distinctness of *Persicaria* and *Polygonum* was a century - old one and had also affected recent phylogenetic studies of the group. In this communication, high resolution phylogeny of Polygonaceae based on three chloroplast DNA region *viz*., *rbcL*, *matK* and *trnL-F* were made and moreover, phylogenetic analysis of many less known members of Himalayan Polygonaceae, including *Persicaria strigosa*, *P. glabra*, *P. tenella*, *P. lanigera* and *P. lapathifolia* var *lanata* had been first ever attempted here. The present study focused on new findings based on extended taxon sampling and Maximum Likelihood (ML) and Bayesian phylogenetic inference (BI) analyses of three chloroplast markers, which can be useful for the systematic positioning of different genera of Polygonaceae. Maximum likelihood was considered to evaluate alternative trees. Conversely it considers the likelihood of each tree elucidating the given data based on a model of evolution. In this method, it compares how different trees predict the observed data (Swofford *et al.* 1993). ML analyses had an advantage over maximum parsimony (MP) as the probability of nucleotide substitutions and rates of these substitutions were taken into consideration, explaining the phylogenetic relationships of taxa in a more practical way. Another important deliberation of this method is the branch length, which parsimony ignores, with changes being more expected to happen along long branches than short ones. ML is computationally intensive and it is the best approach to inferring phylogenies from a theoretical point of view as it is impossible to explore all trees as there are too many. Metropolis (1953) revolutionized Bayesian Inference and it became a widely used method amongst phylogeneticists. Some advantages of BI over maximum parsimony (MP) and maximum likelihood (ML) methods are the likelihood of account for the phylogenetic ambiguity, use of prior information and amalgamation of complex models of evolution that inadequate computational analyses for traditional methods. Although overcoming complex analytical operations the posterior probability still involves a summation over all trees and, for each tree, integration over all possible combinations of substitution model parameter values and branch lengths. Molecular differences were detected

among the species although these were not differentiated at the morphological level. The current study shows that uniting *Persicaria* with *Polygonum sensu stricto* is unnatural and indeed, cuts across the unique affinities of both the taxa. Their apparent resemblance can only be linked by their more distant affinities within the subfamily Polygonoideae. From the phylogenetic study it was also observed that most of the members of the family are monophyletic in origin.

During the present study on phylogeny of Polygonaceae based on *rbcL* gene the eight genera were subdivided into two groups where five genera (*Persicaria, Rumex, Fagopyrum, Rheum* and *Antigonon*) represented one group and *Polygonum*, *Fallopia* and *Muehlenbeckia* formed another group. The phylogenetic study based on *matK* and *trnL-F* genes of these eight genera also showed that *Fallopia* and *Muehlenbeckia* were closely associated with *Polygonum*. Nevertheless, during the present phylogenetic study the two genera *Polygonum* and *Persicaria* were found to be distantly related forming different clusters. However in the present study first tribal division proposed by Haraldson (1978) proved to be nearly in line with the present data based on their molecular data, but a new delimitation of genera is proposed. Present study denotes a division of *Polygonurn* L. *sensu lalo* and its related taxa into two tribes: Polygoneae (containing *Polygonum* L. *sensu stricto*, *Fallopia* Adans. and *Muehlenbeckia* Mesin.) and *Persicarieae* (containing *Persicaria* Mill., *Fagopyrurn* Mill., *Antigonon* Endl., *Rheum* L and *Rumex* L). Similar division was also supported by morphological study to a certain extent. Decraene and Akeroyd (1988) and Decraene *et al.* (2000) also reported similar tribes for the family Polygonaceae, placing *Persicaria, Fagopyrum, Aconogonon, Bistorta, Koenigia* under the tribe Persicarieae and *Polygonum, Muehlenbeckia, Fallopia, Rheum, Rumex* under the tribe Polygoneae. The stated tribe division by the above workers matches with the current study, while the genera placed under the tribes did not completely matched.

Sanchez and Kron (2008) also showed similar type of grouping through phylogenetic analysis, where they made comprehensive studies on phylogenetics of Polygonaceae with particular interest on Eriogonoideae. Three choloroplast region (*rbcL*, *matK* and *ndhF*) analyses by Sanchez and Kron (2008) showed that subfamily Polygonoideae is polyphyletic. They grouped the subfamily Polygonoideae in 3 tribes (Persicarieae, Polygoneae and Rumiceae) consisting of 11 genera (*Polygonum*

L, *Atraphaxis* L., *Emex* Campd., *Fagopyrum* Mill., *Fallopia* Adans., *Koenigia* L., *Muehlenbeckia* Meisn., *Oxyria* Hill., *Persicaria* (L.) Mill., *Rheum* L. and *Rumex* L.). However, during the present phylogenetic analysis based on these three chloroplast DNA region *viz., rbcL, matK* and *trnL-F*, it was also observed that these eight genera can be subdivided into two tribes- Persicarieae and Polygoneae as proposed by Haraldson (1978); Decraene and Akeroyd (1988) and Decraene *et al.* (2000).

Persicarieae: The taxonomic delimitation of *Persicaria, Fagopyrurn, Antigonon, Rheum* and *Rumex* were remarkably convoluted even by Polygonaceae standards. The position of *Rumex* in Persicarieae group and as sister to Polygoneae having weak support in molecular studies (Sanchez *et al.* 2009, 2011; Schuster *et al.* 2011) and the branching order of genera were also hardly ever resolved. Present findings give good support for the sister relationship of Polygoneae and Rumiceae. In case of *Rumex*, results are similar to the findings by Navajas-Pérez *et al.* (2005) showing that the genus is monophyletic in origin. Present study was showing that *Fagopyrum* exhibit the sister relationship with *Persicaria*. This placement was in accordance with the finding by Kim and Donoghue 2008.

Polygoneae: The current analyses do not deviate from the well-established relationships of Polygoneae being composed of the three genera (*Polygonum, Muehlenbeckia* and *Fallopia*). The analyses clearly showing that *Polygonum* is polyphyletic in origin and the sister relationship among these three genera were supported by both ML and BI analysis of three chloroplast marker (*rbcL, matK* and *trnL*-F).

The segregation of these two tribe also supported by the other evidences such as anatomy (Perdrigeat 1900; Laubengayer 1937; Vautier 1949; Haraldson 1978), pollen morphology (Gross 1913; Wodehouse 1931; Hedgeberg 1946; Nowicke and Skvarla 1977), chromosome numbers (Jaretzky 1928; Love and Love 1956) and chemical substances (Jaretzky 1925) which has provided a considerable data to split the tribe. The treatment of the Polygonaceae by Haraldson (1978) and Decraene and Akeroyd (1988) have suggested that the taxa, in the broad sense, segregated into two separate tribes: Polygoneae and Persicarieae. The Persicarieae have prominent nectar-secreting emergences, which may be free or fused, while in Polygoneae nectarial zones are not well developed externally (Ronse Decraene and Smets 1991).

Tribe Polygoneae emend. Haraldson (1978) are shrubs with outer tepals often winged, smaller or larger than inner, while tribe Persicarieae Dumortier (1827) are generally herbs with outer tepals not winged, keeled or angular, often smaller than inner or absent. In Polygoneae the stamens are dilated at the base, outer stamens are reduced in size, whereas in Persicareae the stamens are not dilated at the base, inner stamens are reduced in size. Taxa with a trifid venation pattern of tepals are placed in Persicareae this probably represents the primitive type, while taxa with a dendricular venation pattern found in Polygoneae. The tepal epidermis is strongly papillose, never smooth and has irregular to elongated cells in case of Polygoneae, while in case of Persicareae, the tepal epidermis consists of rectangular to elongated cells with a smooth or usually longitudinally striate cuticle.

Decraene and Akeroyd 1988 also maintained *Persicaria* as a distinct genus and they separated it from *Polygonum s.s.* on the basis of the floral characters *i.e.,* the outer tepals were never keeled or angular in *Persicaria* and differ from the inner tepals only in size (Graham and Wood 1965) whereas in *Polygonum*, outer tepals were often differentiated from the inner by smaller and pointed or slightly angular around the single main vein; trifid venation was observed on tepal which was different from the dendricular venation of *Polygonum*; the species of *Persicaria* have inter-staminal, free or fused nectarines while in *Polygonum*, filaments are never flattened and strongly subulate, but are often cylindrical and filiform (Trail 1896) and no nectaries are visible. Though *Polygonum* can be separated from *Persicaria* by comparison with their morphological character states but their boundaries are not clear due to the high level of variability within the genus (Decraene and Akeroyd 1988).

During the entire phylogenetic study it was also observed that within the cluster of *Persicaria* species, several *Polygonum* species were amalgamated, indicating a need of taxonomical repositioning of some of the studied taxa. Based on the study of *rbcL*, *matK* and *trnL-F* gene sequences of Polygonaceae some name changes had also been proposed, *i.e., Polygonum viscosum* Buch.-Ham. *ex* D. Don, Prodr., Fl. Nepal. 71. 1825 ≡ *Persicaria viscosa* (Buch.-Ham. *ex* D. Don) H. Gross *ex* Nakai, Rep. Veg. Quelp. 42. 1914; *Polygonum amphibium* L., Sp. Pl. 1: 361. 1753 ≡ *Persicaria amphibia* (L.) Delarbre, Fl. Auvergne ed. 2: 519. 1800; *Polygonum filicaule* Wall. *ex* Meisn, Pl. Asiat. Rar. 3: 59. 1832 ≡ *Persicaria minuta* (Hayata)

Nakai, Fl. Jap. Suppl. 173. 1936; *Polygonum pulchrum* Blume, Bijdr. Fl. Ned. Ind. 11: 530. 1826 ≡ *Persicaria pulchra* (Blume) Soják, Preslia 46: 154. 1974; *Polygonum pubescens* Blume, Bijdr. Fl. Ned. Ind. 2: 532. 1825 ≡ *Persicaria pubescens* (Blume) H. Hara , J. Jap. Bot. 17(6): 335. 1941; *Polygonum setosulum* A. Rich., Tent. Fl. Abyss. 2: 227. 1850 ≡ *Persicaria setosula* (A. Rich.) K. L. Wilson, Kew Bull. 45: 632. 1990; *Polygonum posumbu* Buch.-Ham. *ex* D. Don, Prodr. Fl. Nepal. 71. 1825 ≡ *Persicaria posumbu* (Buch.-Ham. *ex* D. Don) H. Gross, Bot. Jahrb. Syst. 49(2): 313. 1913; *Persicaria angustifolia* (Pall.) Ronse Decr., Bot. J. Linn. Soc. 98: 367. 1988 ≡ *Polygonum angustifolium* Pall. Reise Russ. Reich. 3: 230. 1776; *Persicaria campanulata* (Hook. *f*.) Ronse Decr., Bot. J. Linn. Soc. 98: 367. 1988 ≡ *Polygonum campanulatum* Hook. *f.* Fl. Brit. Ind. 5: 51. 1886; *Persicaria maculosa* Gray, Nat. Arr. Brit. Pl. 2: 269. 1821 ≡ *Polygonum fusiforme* Greene, Erythea 1(12): 259–260 1893; *Polygonum viscosum* Buch.-Ham. *ex* D. Don, Prodr., Fl. Nepal. 71 1825 ≡ *Persicaria viscosa* (Buch.-Ham. *ex* D. Don) H. Gross *ex* Nakai, Rep. Veg. Quelp. 42. 1914. The other taxonomical evidences viz. gross morphology, foliar macro and micro morphology and palynology did not support all the name changes. But, combining all the studied parameter it was observed that taxonomical repositioning of two of the studied taxa was needed. Thus amalgamated study of all taxonomic marker *viz*., foliar macro and micro morphology, palynology and phylogenetic study through *rbcL*, *matK* and *trnL-F* genes of Polygonaceae, it can be said that the taxa *Polygonum microcephalum* and *Polygonum perfoliatum* were probably misplaced under the genus *Polygonum*, their actual taxonomic position appears to be within the genus *Persicaria* as the studied attributes of these two taxa were more analogous with *Persicaria* than *Polygonum*.

7. CONCLUSION

Polygonaceae has the status of being one of the trickiest families of angiosperms to identify due to its ambiguity in morphological attributes. Any taxa are difficult to identify on the basis of morphological character like Polygonaceae where floral parts are seasonal, they can be easily identify and classify using different taxonomical parameter. As in the present study, taxa can be recognized from any parts of the plant therefore these methods appear much easier than morphology especially when flowers and fruits are not properly available. This is one of the most extensive studies of the family Polygonaceae from West Bengal that includes thirty six taxa belonging to nine genera. Some taxa of this family were widely used in traditional medicine system among the various ethnic groups in West Bengal. From the field survey it was observed that the members of the family were widely distributed throughout the state mostly confined to marshy places and the hilly slopes of Darjeeling - Kalimpong Himalaya. It was observed that members of Polygonaceae (wild and cultivated) are the important component of floral diversity and ecosystem of various water bodies, marshy lands and wet habitat in different altitudinal ranges and climates of West Bengal. The work is evocative in nature that highlights the utility of different taxonomic parameters *viz*., morphological, palynological and molecular markers.

Both qualitative and quantitative morphological attributes related to plant habit, stem, leaves, ochreae, tepals, stamen, style, ovary and nut have been used for the delimitation of the taxa. As this study was based on extensive survey during different season from all over the West Bengal for four consecutive years, therefore the geographic range of the taxa were very large and great covenant of morphological variations were discovered. Even though morphological markers have taxonomic importance but in case of the family Polygonaceae these characters are not enough to distinguish different taxa. However, it is important to emphasize that the revision of neglected morphological characters and combined them with modern imminent and newest techniques will be very useful in further authentication, identification and classification of taxa of Polygonaceae.

Leaf architecture of thirty five taxa were critically examined with the use of light microscopy to evaluate both adaxial and abaxial leaf surface features such as shape of epidermal cells, stomata and trichome types and their distribution frequency. Such a comprehensive micro-morphological studies of some taxa of Polygonaceae has been conducted first time in this work. Epidermal cell shapes are variable but generally polygonal. Six different stomatal patterns have been reported for seven genera i-e, anomocytic, anisocytic, paracytic, pericytic, staurocytic and cyclocytic type, infrequently two or three stomata types on the same leaf surface. Glandular trichomes included peltate trichomes, capitate trichomes and stellate trichomes. It has been proved during this study that most of characters are tremendously unique and stable. These characters could not be solely used as the base for the taxonomic classification of the family Polygonaceae. There are some differences at specific level that permit the delimitation of the taxa and can serve as good taxonomic tools and on this basis identification keys have been provided.

Based on comprehensive studies on pollen morphology, significant diversity in the pollen characters including shape and size of pollen grains, colpi length, exine intine thickness and sculpturing of exine is noted in the family and found to be taxonomically useful. Maximum variation related to aperture number is examined in *Persicaria* species where pollen are tricolpate and pantoporate while related to sculpturing two main pollen types, each divided into several subtypes have been observed in the genus. Present pollen study proved that the family Polygonaceae is eurypalynous family. Also, pollen morphological characters are generally distinct at generic level and in most cases pollen types varied from one species to another.

In order to investigate inter and intra specific relationships more precisely the phylogeny and variability polygonaceous species, phylogenetic analysis based on three chroloplast genome (*rbcL*, *matK* and *trnL-F*) were made. These results have been compared with previous morphological and molecular investigations so that to evaluate the worth of this technique. From the entire study few interference could be drawn that *Persicaria chinensis* can be segregated into three varieties viz., *P. chinensis* var. *chinenis*, *P. chinensis* var. *ovalifolia* and *P. chinensis* var. *hispida*; uniting *Persicaria* with *Polygonum* sensu stricto is unnatural and indeed, cuts across the unique affinities of both the taxa; most of the members of the family are

monophyletic in origin except *Polygonum*; sister relationship was observed in between Polygoneae and Rumiceae; studied genera can be subdivided into two tribes- Persicarieae and Polygoneae.

All these studies help to make corrections in the previous published work and also strengthen the treatment of complex family Polygonaceae. Morphological markers are still the most significant and relatively easily studied features of great importance to the taxonomist but pollen morphological characters are taxonomically potential traits and play significant role in generic identification and classification in the family Polygonaceae.

All the accumulated data from different studied parameters (macro and micro morphology, pollen morphology and molecular phylogeny) of 35 selected Indian taxa may definitely be serving as important and useful tools in comparative studies as well as understanding or reconsidering the systematics and evolutionary phylogeny of the family Polygonaceae. Pollen morphology is important for delimiting the taxa but it will gives more better result if it should be used in combination with other taxonomic evidences viz., morphology, anatomy, cytology and ecology. The examined remarkable pollen features (with three major pollen types and twelve subtypes examined from only nine genera of the family) were found quite significant and recommend that there is much scope for further research on pollen morphology of the family Polygonaceae from different part of India in order to establish phylogenetic lines. If molecular phylogeny analysis is extended to other members of the Polygonaceae from different parts of World, there would be probability of getting a comprehensive account of their genetic relationship in future and so the studies should be continued for more reliable data and to establish the authentic species level identification and more importantly understanding the genuine phylogenetic lineage to understand the evolution of Polygonaceae.