
Morphological and anatomical studies on some species of Polygonaceae in Egypt

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ABSTRACT

The taxonomic relationships among eight species of Polygonaceae; *Persicaria senegalensis* (Meisn.) Soják., *Rumex dentatus* L., *Rumex vesicarius* L., *Calligonum polygonoides* L., *Antigonon guatimalense* Meisn., *Antigonon leptopus* Hook. & Arn., *Ruprechtia laxiflora* Meisn. and *Ruprechtia salicifolia* (Cham. & Schldl.) C.A. Mey. have been concentrated on the basis of information derived from macro- and micro-morphological characters. These diagnostic characters appeared to be significant in differentiation among the studied species. The present work recorded important features in the blade outline, ochreae shape, perianth structure and fruit appendages. The stem outline ranged from terete, ovoid with wavy margin and pentagonal. Pericycle showed two types; parenchymatous and fibrous. Vascular structure of stem appeared either a continuous ring or isolated bundles. The outline of the petiole demonstrates that the studied species can be distinguished into four patterns (semi-terete with wavy margin, half circle with wavy margin, half circle with two projections and oval). Also the stomata revealed three main types; Anomocytic, anisocytic and paracytic. This work showed that the studied species recorded five types of non-glandular trichomes and three types of glandular trichomes. A dichotomous indented key to the species is constructed. The data recorded from the morphological and anatomical characters are used in numerical analysis. This analysis showed that species were grouped into two major clusters, the first one (I) consisted of one species; *Calligonum polygonoides* while the second cluster (II) included the remainders.

Keywords: Polygonaceae, macro-morphological characters, micro-morphological characters, numerical analysis

Introduction

Polygonaceae is a family of flowering plants known as the knotweed family. The name is based on the genus *Polygonum*, and was first used by Antoine Laurent de Jussieu in 1789 in his book, *Genera Plantarum*. The name of the family refers to the many swollen nodes on the stems of some species (Jussieu 1789).

Polygonaceae contained approximately 48 genera and 1,200 species. The largest genera are *Eriogonum* (240 species), *Rumex* (200 species), *Coccoloba* (120 species), *Persicaria* (100 species) and *Calligonum* (80 species) (Freeman & Reveal 2005 and Sanchez and Kron, 2008). The members of Polygonaceae are widely distributed and most of the species are concentrated in the northern temperate region (Heywood, 1978). They are groups of morphologically different herbs, shrubs, small trees or climbers characterized by simple leaves with covering ochreae stipules, unilocular ovary and endospermic seeds (Hutchinson and DaLziel, 1954 and Brummitt 1992).

Metcalfe and Chalk (1950 and 1979) gave a comprehensive report on foliar anatomy of the Polygonaceae. Lersten and Curtis (1992) examined foliar anatomy of genus *Polygonum* and described numerous anatomical features of the leaves (their variations and distribution patterns). Their studies were carried out on 153 species of *Polygonum* sensu lato representing all sections of the genus.

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Ayodele and Olowokudejo (2006) made comparative studies on the leaf epidermal features of five tribes including 19 species of family Polygonaceae in West Africa. Noor *et al.*, (2011) studied the foliar anatomical characters of *Polygonum minus* Huds to determine its taxonomic significance.

Jaretsky (1925) named two subfamilies: Eriogonoideae and Polygonoideae, including Coccoloboideae within the latter. The family was made up of more than two subfamilies, with various authors differing in their circumscriptions of the subfamilies (Bentham and Hooker, 1880; Buchinger, 1957 and Takhtajan, 1980). Roberty and Vautier (1964) divided the family again into three subfamilies, but this time the groups were Polygonoideae, Eriogonoideae, and Calligonoideae. The classification of Polygonaceae at and above the generic level has been unstable over the years. Haraldson, 1978 recognised two subfamilies; Polygonoideae based on *Polygonum* L. and Eriogonoideae based on *Eriogonum* Mich. Reveal (1989); Brandbyge (1992) and Freeman and Reveal (2005) used the two-subfamily division proposed earlier by Jaretsky (1925). The tribal treatment of *Polygonum sensu lato* has been varied since the time of Linnaeus (1753). Several authors placing the segregate taxa contained into different tribes and subfamilies (Ronse Decraene and Akeroyd, 1988).

The comprehensive revision of the family was published by Brandbyge in 1992 as a part of "The Families and Genera of Vascular Plants". Brandbyge (1992) followed earlier systems of plant classification in dividing Polygonaceae into two subfamilies, Eriogonoideae and Polygonoideae. The circumscriptions of these two subfamilies have been changed in light of phylogenetic studies of DNA sequences. Genera related to *Coccoloba* and *Triplaris* were moved from Polygonoideae to Eriogonoideae. The genus *Symmeria* does not belong to either of these subfamilies because it is sister to the rest of the family. Sanchez *et al.*, 2011 divided the subfamily Polygonoideae into five tribes, Calligoneae, Fagopyreae, Persicariae, Polygoneae and Rumiceae, leaving some genera unplaced. Schuster *et al.*, 2015 studied the molecular phylogenetic and added two new tribes namely Oxygoneae and Pteroxygoneae.

The main purpose of the present study is to use macro- and micro-morphological criteria to detect the morphological variability among the studied species of Polygonaceae growing in Egypt. This study has the following objectives:

- a) To evaluate the morphological criteria of the studied species and their sharing in the discrimination among them.
- b) To reveal the important role of numerical study in the analysis of the data derived from the variations among the species.

Materials and Methods

The present study is based on 8 species of Polygonaceae collected fresh from different localities in Egypt (Table I). In this work the studied materials were identified by means of comparison with specimens kept in the herbarium of Flora and Phytotaxonomy Researches department (CAIM). In addition to some references of cultivated plants and Flora of Egypt were used as; Bailey (1949), Lindley (1932), Hutchinson and Dalziel (1954), Täckholm (1974), Pandey (1997), and Boulos (1999). Voucher specimens of studied species were prepared and kept in the herbarium of Flora and Phytotaxonomy Researches department (CAIM) during September 2017 till September 2018.

Table 1: List of the collected species for the present study.

Species	Locality and date
<i>Persicaria senegalensis</i> (Meisn.) Soják.	El- Qaluobea . Marc, 2018
<i>Rumex dentatus</i> L.	El- Qaluobea . Marc, 2018
<i>Rumex vesicarius</i> L.	El- Qaluobea . Marc, 2018
<i>Calligonum polygonoides</i> L.	Alexandria. June 2018
<i>Antigonon guatimalense</i> Meisn.	Mazhar Garden, 20/ 5/ 2018.
<i>Antigonon leptopus</i> Hook. & Arn.	Mazhar Garden, 20/ 5/ 2018.
<i>Ruprechtia laxiflora</i> Meisn.	Mazhar Garden, 20/ 5/ 2018.
<i>Ruprechtia salicifolia</i> (Cham. & Schltdl.) C.A. Mey..	Mazhar Garden, 20/ 5/ 2018.

Table 2: The taxonomic treatment of the studied species in the system of A. Engler according to Melchior (1964).

Subfamily	Tribe	Species
Polygonaceae	Persicarieae	<i>Persicaria senegalensis</i>
	Rumiceae	<i>Rumex dentatus</i> <i>Rumex vesicarius</i>
	Atraphaxidinae	<i>Calligonum polygonoides</i>
Coccoloboideae	Coccolobeae	<i>Antigonon guatimalense</i> <i>Antigonon leptopus</i>
	Triplariaceae	<i>Ruprechtia laxiflora</i> <i>Ruprechtia salicifolia</i>

The herbarium specimens were examined, photographed and kept in the herbarium of the Flora and Phytotaxonomy Researches Department (CAIM). The morphological characters of collected specimens of studied taxa were studied. For anatomical investigation each specimen was fixed according to Nassar and El Sahhar, (1998) in F.A.A. (formalin - glacial acetic acid - 70% ethyl alcohol) with the ratio of 5: 5: 90 by volume. Stems and leaves (petiole & blade) were hand sectioned at 20-30 μ . The sections were stained according to Dilcher (1974) in safranin (1% solution in 50% ethanol) and light green (1% solution in 96% ethanol) and photographs. The relationship among the studied taxa has been analyzed using Average Linkage (Between Groups) of SPSS program version 22.

Results and Discussion

I- Morphological Aspects

a- Macro- morphological Aspects

The different macro- morphological features of studied species were extensively investigated to indicate the importance of these characters. Variation in these aspects among the species is listed in Table 3 and illustrated in Plates 1& 2. The results were used to build a dichotomous indented key to the investigated species.

- A- Leafless plant, fruit spiny..... *Calligonum polygonoides*
- AA- Leafy plant, fruit not spiny
 - B- Climber plant with tendrils
 - C- The outer sepals are cordate, leaves 3-3.5 cm wide... *Antigonon leptopus*
 - CC- The outer sepals are ovate, leaves 4.5- 5 cm wide*Antigonon guatimalense*
 - BB- Erect plant without tendrils
 - D- Fruit winged
 - E- Leaf is ovate-deltoid, nutlet is ovoid..... *Rumex vesicarius*
 - EE- Leaf is oblong-lanceolate, nutlet is trigonous *Rumex dentatus*
 - DD- Fruit not winged
 - G- Herb *Persicaria senegalensis*
 - GG- Shrub
 - H- Leaf lanceolate *Ruprechtia salicifolia*
 - HH- Leaf elliptic..... *Ruprechtia laxiflora*

Table 3: Summary table and Data coding of macro- morphological characters of the studied species

Characters	Species							
	<i>Persicaria senegalensis</i>	<i>Rumex dentatus</i>	<i>Rumex vesicarius</i>	<i>Calligonum polygonoides</i>	<i>Antigonon guatimalense</i>	<i>Antigonon leptopus</i>	<i>Ruprechtia laxiflora</i>	<i>Ruprechtia salicifolia</i>
1- Habit: Herb [1], shrub [2].	1	1	1	2	2	2	2	2
2- Stem: Erect [1] / climber [2].	1	1	1	1	2	2	1	1
3- Stem branching: Branched from the base [1]/ branched above [2].	2	1	1	2	2	2	2	2
4- Leaf margin: Entire [1]/ erenulate [2]/ undulate [3].	1	1	1	0	2	3	1	3
5- Leaf appearance: Smooth [1]/ chartaceous [2]/ rugose [3].	1	1	1	0	2	3	1	1
6 - Blade outline: Lanceolate [1]/ Obovate-deltoid [2]/ cordate [3]/ oblong [4].	1	4	2	0	3	3	4	1
7- Blade apex: Acute [1]/ obtuse [2]/ Acuminate [3] / Truncate [4].	3	2	2	0	3	1	1	1
8- Blade base: Symmetric [1]/ A symmetric [2].	2	2	1	0	1	1	1	1
9- Blade length: Short (2-5 cm) [1]/ long (10-20 cm) [2].	2	2	1	0	1	1	1	1
10- Ocreae: Two lobed membranous [1]/ not fringed [2], scaly [3].	2	3	3	1	1	1	2	2
11- Petiole: Very short (3- 4 mm) [1]/ long (3- 5 cm) [2]/ very long (7- 9 cm) [3].	1	3	3	0	2	2	1	1
12- Inflorescence: Racemes [1]/ cymes [2].	1	1	1	2	1	1	2	2
13- Flower: Unisexual [1]/ bisexual [2].	2	2	2	2	2	2	1	1
14- Perianth: 6- segments [1]/ 5- segments [2].	1	1	1	2	2	2	1	1
15- Perianth color: Pink [1]/ green [2].	1	1	1	1	1	1	2	2
16- Stamens: 6 [1]/ 8 [2]/ 16 [3].	2	3	1	1	2	2	2	2
17- Style: 3 [1]/ 4 [2].	2	1	1	1	1	1	2	2
18- Fruit appendages: With spines [1]/ with wing [2]/ without appendages [3].	3	2	2	1	3	3	3	3
19- Nutlet shape: Trigonus [1]/ flattened [2]/ ovoid [3]	2	3	3	3	1	1	1	1
20- Nutlet length: Short (2-3 mm) [1]/ long (6-12 mm) [2].	1	1	1	2	2	2	1	1
21- Nutlet color: Brown [1]/ white [2].	1	1	1	2	1	1	1	1

The morphological characters were found diagnostic to the investigated species. The studied species were herbs in *Persicaria senegalensis* , *Rumex dentatus* and *Rumex vesicarius* while were trees in the others. The stem was climber in *Antigonon guatimalense* and *Antigonon leptopus* and erect in the rest. *Calligonum polygonoides* was leafless but the other species were leafy. Leaf appearance was chartaceous in *Antigonon guatimalense*, rugose in *Antigonon leptopus* and smooth in the remainders. Blade outline ranged from lanceolate in *Persicaria senegalensis* and *Ruprechtia salicifolia*. obovate-deltoid in *Rumex vesicarius* only, cordate in *Antigonon guatimalense* and *Antigonon leptopus* and oblong in the rest. Fruit with spines in *Calligonum polygonoides* only, winged in *Rumex dentatus* and *Rumex vesicarius* while without appendages in the remainders. Nutlet shape was flattened in *Persicaria senegalensis* , ovoid in *Rumex vesicarius*, *Rumex dentatus* and *Calligonum polygonoides* while trigonous in the remainders.



Persicaria senegalensis



Rumex vesicarius



Rumex dentatus



Calligonum polygonoides



Antigonon guatimalense



Antigonon leptopus



Ruprechtia laxiflora



Ruprechtia salicifolia

Plate 1: Herbarium specimens of the studied species



Persicaria senegalensis



Rumex vesicarius



Rumex dentatus



Antigonon guatimalense



Antigonon leptopus



Ruprechtia laxiflora



Ruprechtia salicifolia

Plate 2: Leaf of the studied species

b- Micro- morphological Aspect

Micro-morphological investigation included the anatomical aspects of stem and leaf (petiole and blade). Also stomata and trichomes are included as shown in Table (4) and Plates (3, 4, 5, 6, 7 and 8).

Table 4: Summary table and Data coding of micro- morphological characters of the studied species

Characters	Species	<i>Persicaria senegalensis</i>	<i>Rumex dentatus</i>	<i>Rumex vesicarius</i>	<i>Calligonum polygonoides</i>	<i>Antigonon guatemalense</i>	<i>Antigonon leptopus</i>	<i>Ruprechtia laxiflora</i>	<i>Ruprechtia salicifolia</i>
Stem	1- Outline: Terete [1]/ ovoid with wavy margin [2]/ / pentagonal [3].	2	2	2	1	3	3	1	1
	2- Cuticle: Thick [1]/ very thick [2].	1	1	1	2	1	1	2	2
	3- Cuticle: Smooth [1]/ warty [2].	1	1	1	2	1	1	1	1
	4 Epidermal: Radial [1]/ tangentially [2].	1	2	2	1	1	2	2	2
	5- Hypodermis: Present [1]/ absent [2].	2	2	2	1	1	1	1	1
	6- Cortex: Wide [1]/ narrow [2].	2	2	2	1	2	2	2	2
	7-Cortex: One type of tissue [1]/ two types [2]/ three types [3].	2	1	1	3	2	2	2	2
	8-Druses in cortex: Present [1]/ absent [2].	2	2	2	1	1	1	1	1
	9- Pericycle: Parenchyma [1]/ fibers [2].	2	1	1	2	2	2	2	2
	10- Vascular bundle: Continuous ring [1]/ isolated bundles [2].	2	2	2	1	2	2	1	1
	11- Phloem: Will defined [1]/ ill-defined [2].	1	2	2	1	1	1	1	1
	12- Phloem: Patches [1]/ ring [2].	1	1	1	2	1	1	2	2
	13- Pith: Homogenous [1]/ heterogeneous [2].	1	1	1	2	2	2	1	1
	14- Pith: Solid [1]/ hollow [2].	2	1	1	1	1	1	1	1
	15- Druses in pith: Present [1]/ absent [2].	2	1	1	1	2	1	1	1
Petiole	16- Petiole outline: Semi-terete with wavy margin [1]/ half-circular with wavy margin [2]/ half-circular with two projections[3]/ oval [4].	2	1	1	0	3	3	4	4
	17- Cuticle: Thick [1]/ very thick [2].	1	2	1	0	2	2	2	2
	18- Cuticle: Smooth [1]/ warty [2].	1	1	2	0	1	1	2	2
	19- Epidermis: Radial [1]/ mixed [2].	1	2	2	0	1	1	1	1
	20- Main vascular bundles: One [1]/ more than one [2].	2	1	1	0	1	1	1	1
	21- Splitting of vascular bundles: Present [1]/ absent [2].	1	1	1	0	2	2	1	1
	22- Arrangement of vascular bundles: In a circle [1]/ irregularly scattered [2].	1	2	2	0	2	2	1	1
	23- Bundle sheath: Wide parenchyma [1]/ narrow parenchyma [2].	1	1	1	0	2	2	2	2
	24- Tissue associated: Collenchyma [1]/ fibers [2].	1	1	1	0	2	2	2	2
	25- Druses: Present [1]/ absent [2].	2	2	2	0	2	2	2	2
Blade	26- Cuticle: Thick [1]/ very thick [2].	2	2	2	0	1	1	1	1
	27- Cuticle: Smooth [1]/ warty [2].	1	2	2	0	1	1	1	1
	28- Epidermis: Radial [1]/ mixed [2].	1	2	2	0	1	1	1	1
	29- Mesophyll: Dorsiventral [1]/ isobilateral [2].	1	1	1	0	2	2	1	1
	30- Vascular bundles sheath: Collenchyma [1]/	1	1	1	0	2	2	2	2

	sclerenchyma [2].							
	31- Main vascular bundles: One [1]/ more than one [2].	1	1	1	0	2	2	2
	32- Subsidiary vascular bundles: 3 [1]/ more than 3 [2].	2	1	1	0	1	1	2
	33- Schizogenous canals: Present [1]/ absent [2].	1	1	1	0	1	1	2
	34- Druses: Present [1]/ absent [2].	1	1	1	0	1	1	1
	35- Stomata: Anomocytic [1]/ anisocytic [2]/ paracytic [3].	3	1	1	0	2	2	1
	36- Unicellular papillose: Present [1]/ absent [2].	1	1	1	0	2	2	2
	37- Simple with long broad, blunt & smooth apical cell: Present [1]/ absent [2].	2	1	1	0	1	1	2
	38- Simple with long broad, acute & smooth apical cell: Present [1]/ absent [2].	2	1	1	0	1	1	1
Trichomes	39- Uniseriate: Present [1]/ absent [2].	2	2	2	0	1	1	1
	40- Bristle: Present [1]/ absent [2].	1	2	2	0	2	2	2
	41- Unicellular stalk and bicellular head: Present [1]/ absent [2].	2	2	2	0	1	1	2
	42- Short unicellular stalk and multicellular head: Present [1]/ absent [2].	2	2	2	0	1	1	1
	43- Sessile glands: Present [1]/ absent [2].	1	1	1	0	2	2	2

I- Stem anatomy

The stem outline ranged from terete in *Calligonum polygonoides*, *Ruprechtia salicifolia* and *Ruprechtia laxiflora*, ovoid with wavy margin in *Persicaria senegalensis*, *Rumex dentatus* and *Rumex vesicarius* and pentagonal in the rest. Hypodermis was absent in *Persicaria senegalensis*, *Rumex dentatus* and *Rumex vesicarius* and present in the remainders. Pericycle showed two types; parenchymatous in *Rumex dentatus* and *Rumex vesicarius* and fibrous in the rest. Vascular structure of stem was a continuous ring in *Calligonum polygonoides*, *Ruprechtia salicifolia* and *Ruprechtia laxiflora* while isolated bundles were found in the remainders.

II- Leaf anatomy

The petiole outline demonstrates that the studied species can be distinguished into four patterns; semi-terete with wavy margin in *Rumex dentatus* and *Rumex vesicarius*, half circle with wavy margin in *Persicaria senegalensis*, half circle with 2 projections in *Antigonon guatimalense* and *Antigonon leptopus* and oval in the rest. Epidermis was mixed radially and tangentially in *Rumex dentatus* and *Rumex vesicarius* and radially only in the remainders. Main vascular bundles were only one in *Persicaria senegalensis* and more than one in the rest. Arrangement of vascular bundles showed two types; in a circle in *Persicaria senegalensis*, *Ruprechtia salicifolia* and *Ruprechtia laxiflora* and irregularly scattered in the remainders.

Blade was isobilateral in *Antigonon guatimalense* and *Antigonon leptopus* and dorsiventral in the remainders. Epidermis was mixed in *Rumex dentatus* and *Rumex vesicarius* and radially only in the remainders. Vascular bundle sheath composed of collenchyma cells in *Persicaria senegalensis*, *Rumex dentatus* and *Rumex vesicarius* while composed of sclerenchyma cells in the rest. Main vascular bundles is one in *Persicaria senegalensis*, *Rumex dentatus* and *Rumex vesicarius* and more than one in the remainders.

III- Stomata

The stomata revealed three main types; Anomocytic, anisocytic and paracytic.

1- Anomocytic: present in *Rumex dentatus*, *Rumex vesicarius*, *Ruprechtia salicifolia* and *Ruprechtia laxiflora* and absent in the remainders.

2- Anisocytic: present in *Antigonon guatimalense* and *Antigonon leptopus* and absent in the remainders.

3- Paracytic: present in *Persicaria senegalensis*

IV- trichomes

This work showed that the studied species recorded five types of non-glandular trichomes and three types of glandular trichomes.

Non-glandular trichomes

- 1- Unicellular papillose: present in *Persicaria senegalensis*, *Rumex dentatus* and *Rumex vesicarius* and absent in the remainders.
- 2- Simple with long broad, blunt & smooth apical cell: present in *Rumex dentatus*, *Rumex vesicarius*, *Antigonon guatimalense* and *Antigonon leptopus* and absent in the remainders.
- 3- Simple with long broad, acute & smooth apical cell: Present in all species but absent in *Persicaria senegalensis* only.
- 4- Uniseriate: Present in *Persicaria senegalensis*, *Rumex dentatus* and *Rumex vesicarius* and absent in the remainders.
- 5- Bristle: Present in *Persicaria senegalensis* only and absent in the rest.

Glandular trichomes

- 1- Unicellular stalk and bicellular head: Present in *Antigonon guatimalense* and *Antigonon leptopus* and absent in the remainders.
- 2- Short unicellular stalk and multicellular head: Present in *Antigonon guatimalense*, *Antigonon leptopus*, *Ruprechtia salicifolia* and *Ruprechtia laxiflora* and absent in the remainders.
- 3- Sessile glands: Present in *Persicaria senegalensis*, *Rumex dentatus* and *Rumex vesicarius* and absent in the remainders.

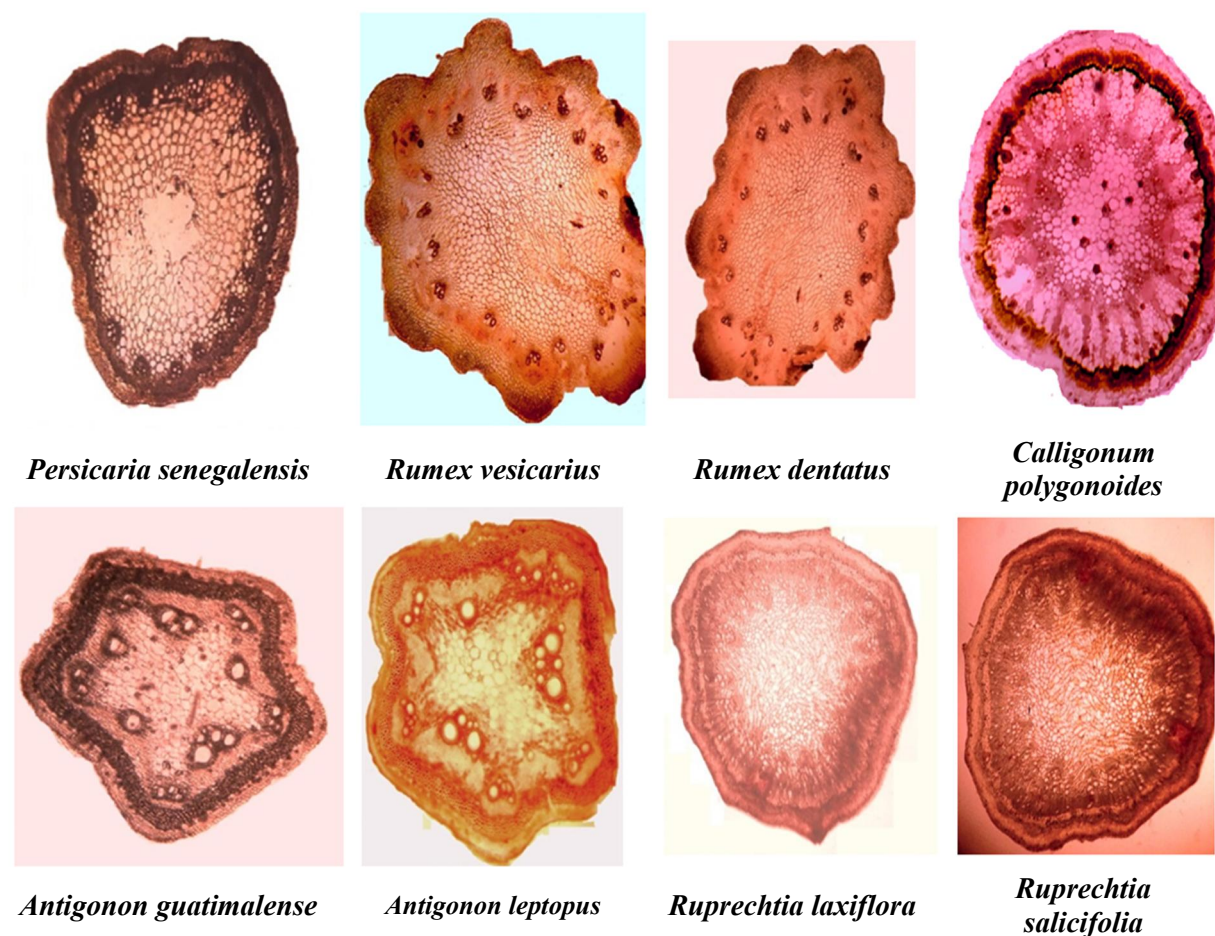
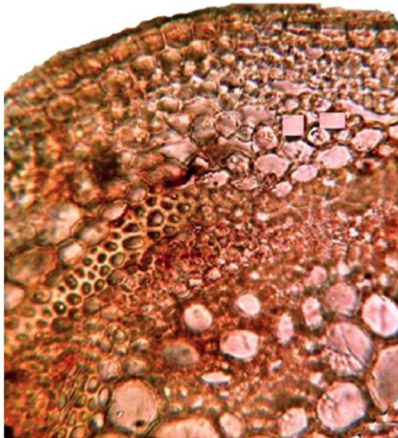
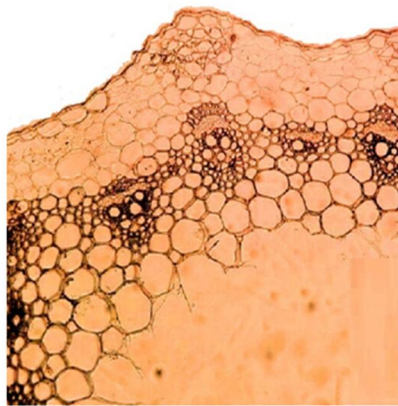


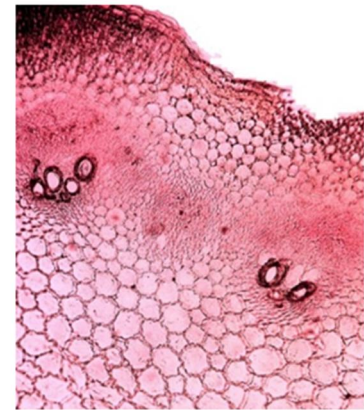
Plate 3: T. S. in Stem outlines of the studied species



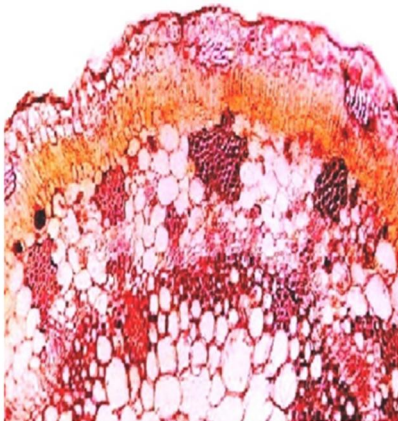
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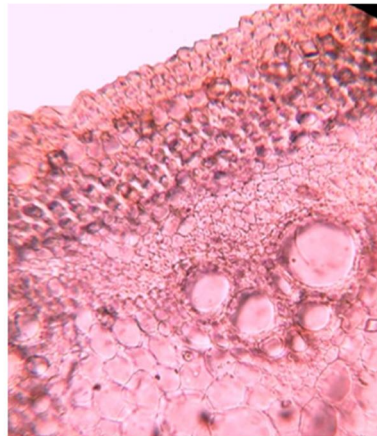
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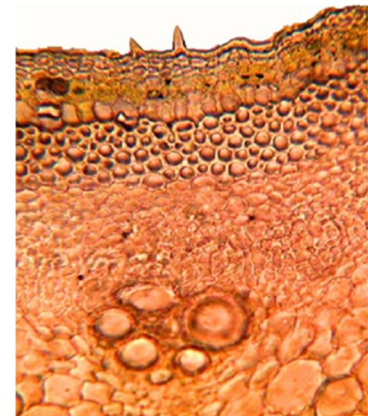
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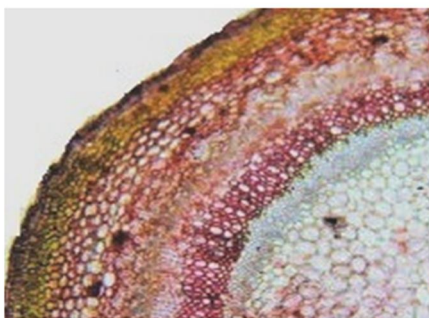
Calligonum polygonoides



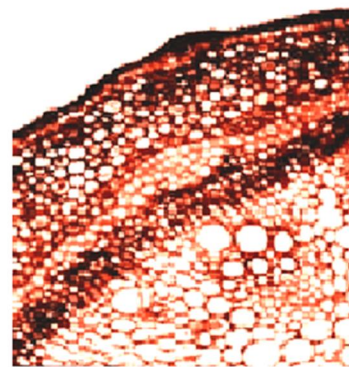
Antigonon guatimalense



Antigonon leptopus

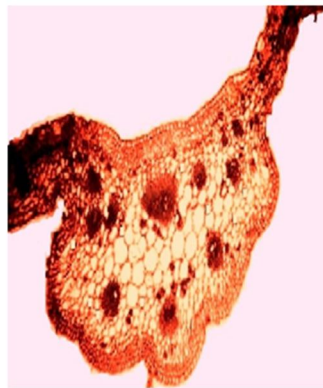


Ruprechtia laxiflora

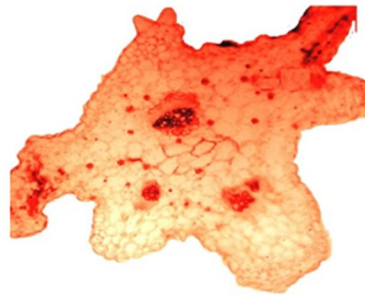


Ruprechtia salicifolia

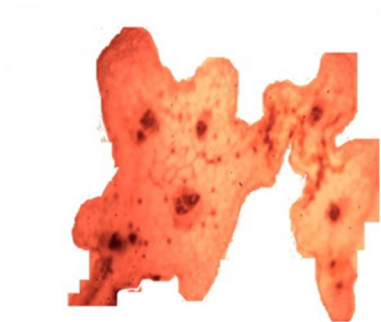
Plate 4: T. S. in Stem sectors of the studied species



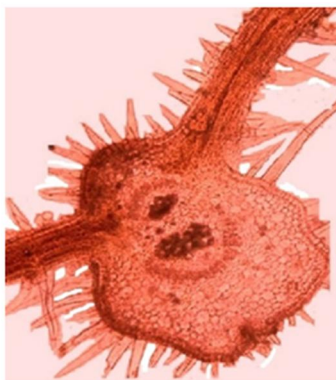
Persicaria senegalensis



Rumex vesicarius



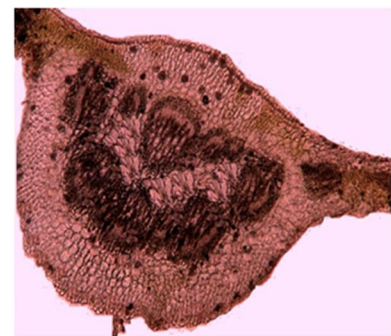
Rumex dentatus



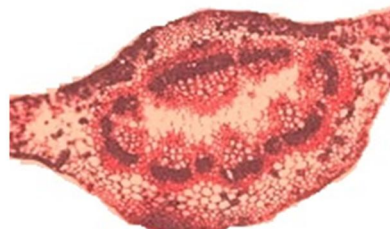
Antigonon guatimalense



Antigonon guatimalense

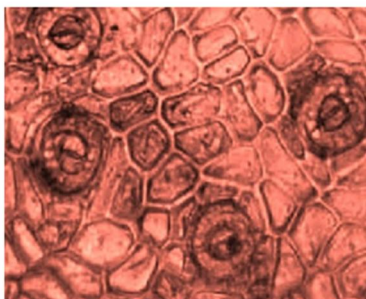


Ruprechtia laxiflora

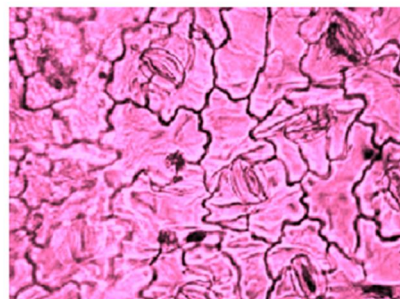


Ruprechtia salicifolia

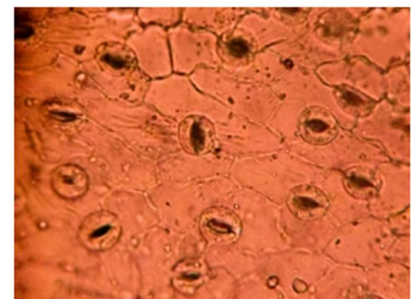
Plate 5: T. S. in Leaf blades of the studied species



Persicaria senegalensis



Rumex vesicarius



Antigonon guatimalense

Plate 6: The main types of stomata in the studied species

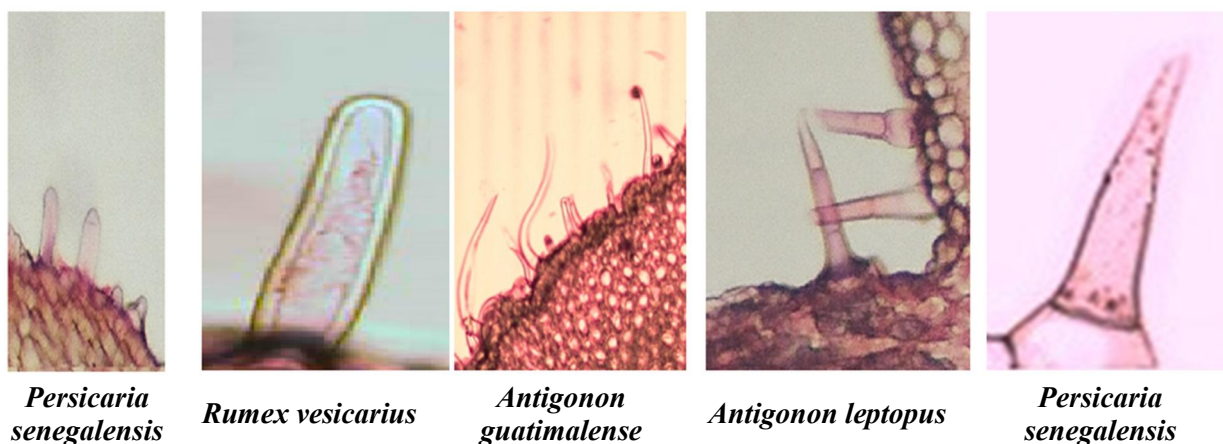


Plate 7: The main types of non-glandular trichomes in the studied species

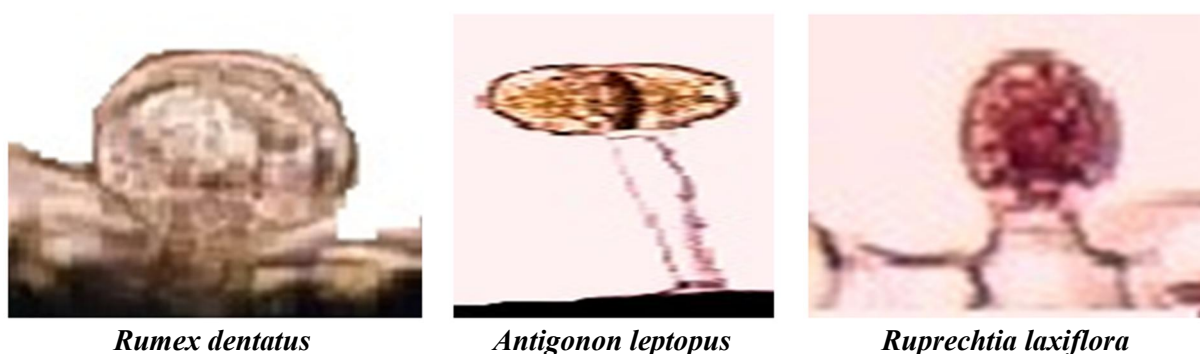


Plate 8: The main types of glandular trichomes in the studied species

c- Numerical Analysis

The characters from macro and micro-morphological investigations for 8 species of Polygonaceae were used for numerical analysis by using the method of clustering as a tool in the identification of the studied species and in distinguishing the taxonomic relationships among the studied species. The results of clustering analyzed by the agglomeration of Schedule measure distance and similarity using average linkage between groups by SPSS program.

a- Macro-morphological characters

The numerical analysis of 21 macro- morphological characters showed that the studied species were grouped into two major clusters as shown in Fig. (1). The first cluster (I) consisted of one species *Calligonum polygonoides* represented the tribe Atraphaxidinae. The second cluster (II) comprises the remainders.

The second cluster divided into two sub clusters. The first sub cluster represented the subfamily Polygonoideae and divided into two groups. The first group contained *Persicaria senegalensis* represented the tribe Persicarieae. The second group included *Rumex dentatus* and *Rumex vesicarius* represented the tribe Rumiceae. The second sub cluster represented the subfamily Coccoloboideae and divided into two groups. The first group contained *Antigonon guatimalense* and *Antigonon leptopus* which represented the tribe Coccolobeae. The second group contained *Ruprechtia salicifolia* and *Ruprechtia laxiflora* represented the tribe Triplaridae.

- Degree of similarity among the studied species:

The data presented in (Table 5) showed that *Rumex dentatus* and *Rumex vesicarius* gave the highest degree of similarity ratio 73.4% followed by 72.6% between *Antigonon guatimalense* and *Antigonon leptopus* and 42.8% between *Ruprechtia salicifolia* and *Ruprechtia laxiflora*. The highest degree of similarity ratio for *Persicaria senegalensis* was 32.4% with *Rumex vesicarius* and 30.2%

with *Rumex dentatus*. The highest degree of similarity ratio for *Calligonum polygonoides* was 26.7% with *Antigonon guatimalense* and 25.4% with *Rumex dentatus*.

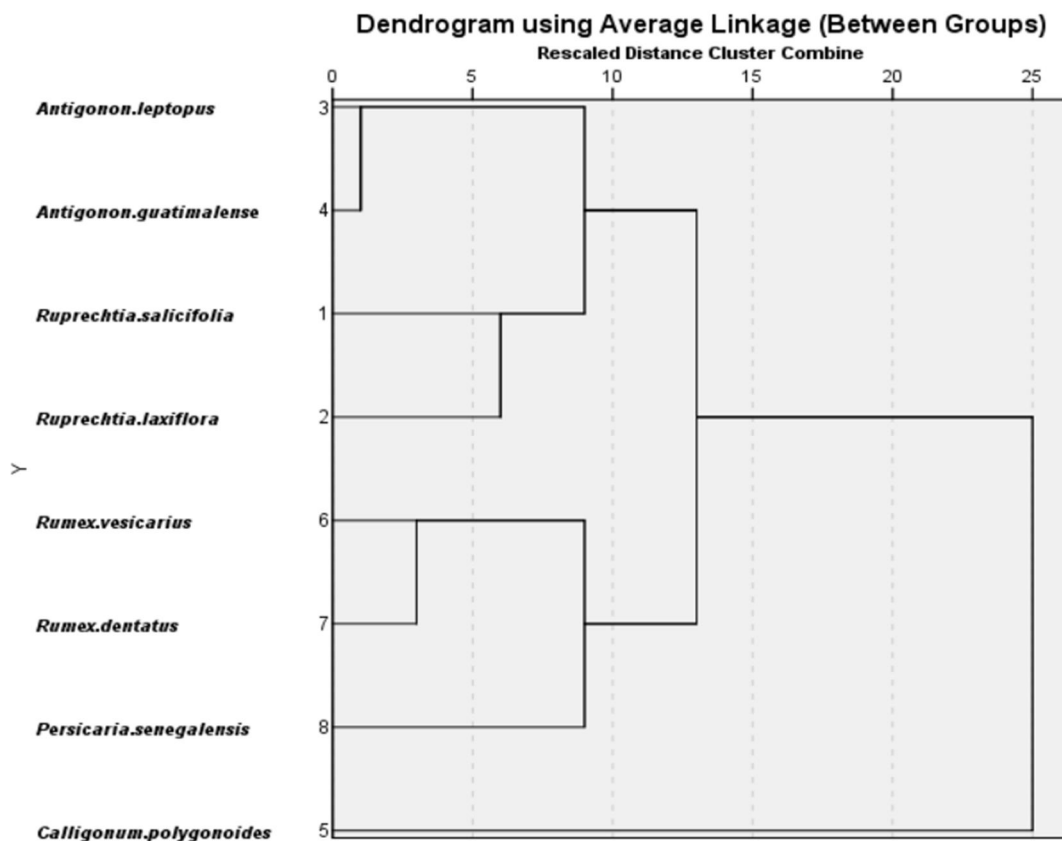


Fig. 1: Dendrogram showed similarity value of the studied species based on macro-morphological characters

Table 5: Proximity matrix showed similarity value of the studied species based on macro-morphological characters

	<i>Persicaria senegalensis</i>	<i>Rumex dentatus</i>	<i>Rumex vesicarius</i>	<i>Calligonum polygonoides</i>	<i>Antigonon guatimalense</i>	<i>Antigonon leptopus</i>	<i>Ruprechtia laxiflora</i>	<i>Ruprechtia salicifolia</i>
<i>Persicaria senegalensis</i>	1.00	0.302	0.324	0.090	0.196	0.206	0.104	0.187
<i>Rumex dentatus</i>	0.302	1.00	0.734	0.254	0.213	0.056	0.183	0.186
<i>Rumex vesicarius</i>	0.324	0.734	1.00	0.003	0.132	0.054	0.106	0.122
<i>Calligonum polygonoides</i>	0.090	0.254	0.003	1.00	0.267	0.243	0.075	0.004
<i>Antigonon guatimalense</i>	0.196	0.213	0.132	0.267	1.00	0.726	0.340	0.265
<i>Antigonon leptopus</i>	0.206	0.056	0.054	0.243	0.726	1.00	0.310	0.251
<i>Ruprechtia laxiflora</i>	0.104	0.183	0.106	0.075	0.340	0.310	1.00	0.423
<i>Ruprechtia salicifolia</i>	0.187	0.186	0.122	0.004	0.265	0.251	0.428	1.00

b- Micro-morphological characters

The numerical analysis of 43 micro- morphological characters for 8 species of Polygonaceae showed the same results of Cluster analysis in macro-morphological characters but differ in degree of similarity among the studied species as shown in Fig. (2).

The data presented in (Table 6), showed that *Ruprechtia salicifolia* and *Ruprechtia laxiflora* gave the highest degree of similarity ratio 98.6% followed by 93.2 % between *Antigonon guatimalense* and

Antigonon leptopus, *Rumex dentatus* and *Rumex vesicarius* showed high degree of similarity ratio 90.3%. The highest degree of similarity ratio for *Persicaria senegalensis* was 14.8% with *Rumex vesicarius* and *Rumex dentatus*. Moreover the highest degree of similarity ratio for *Calligonum polygonoides* was 16.3% with *Rumex vesicarius* and *Rumex dentatus*.

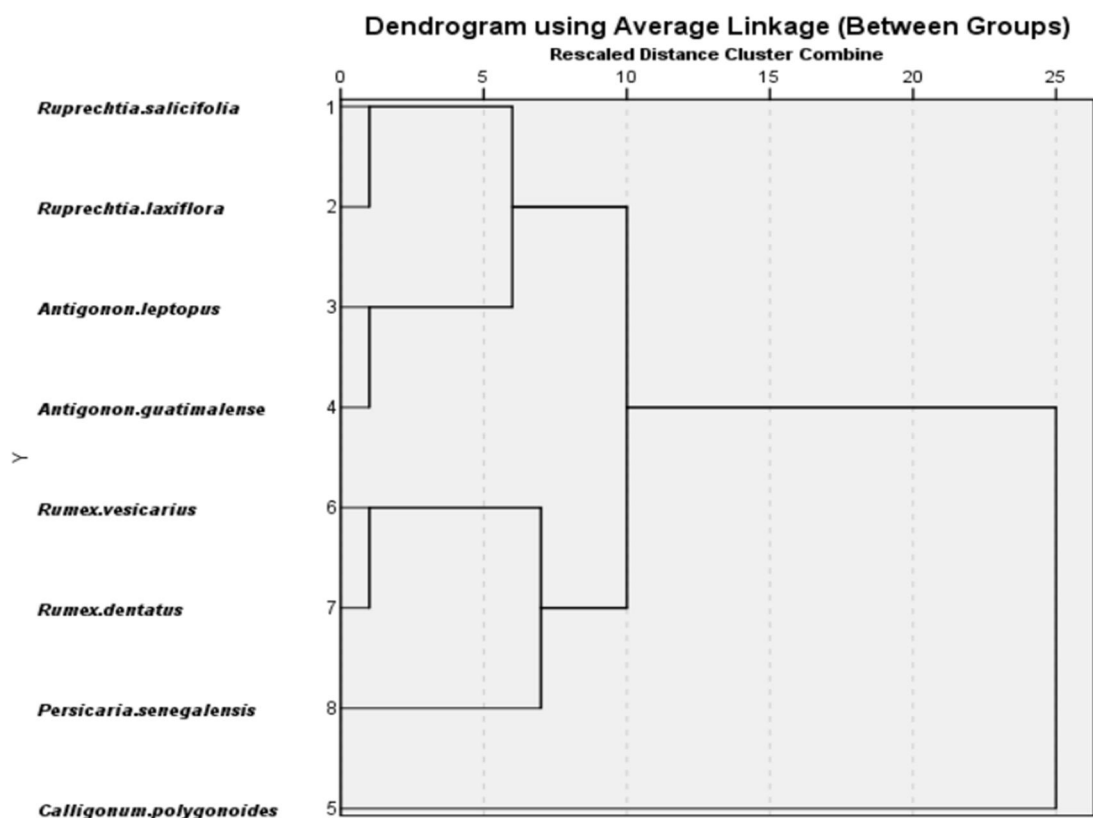


Fig. 2: Dendrogram showed similarity value of the studied species based on micro-morphological characters

Table 6: Proximity matrix showed similarity value of the studied species based on micro-morphological characters

	<i>Persicaria senegalensis</i>	<i>Rumex dentatus</i>	<i>Rumex vesicarius</i>	<i>Calligonum polygonoides</i>	<i>Antigonon guatimalense</i>	<i>Antigonon leptopus</i>	<i>Ruprechtia laxiflora</i>	<i>Ruprechtia salicifolia</i>
<i>Persicaria senegalensis</i>	1.00	0.148	0.148	0.068	0.056	0.017	0.084	0.084
<i>Rumex dentatus</i>	0.148	1.00	0.903	0.163	0.089	0.008	0.236	0.236
<i>Rumex vesicarius</i>	0.148	0.903	1.00	0.163	0.170	0.089	0.236	0.236
<i>Calligonum polygonoides</i>	0.068	0.163	0.163	1.00	0.012	0.012	0.036	0.036
<i>Antigonon guatimalense</i>	0.056	0.089	0.170	0.012	1.00	0.932	0.364	0.364
<i>Antigonon leptopus</i>	0.017	0.008	0.089	0.012	0.932	1.00	0.428	0.428
<i>Ruprechtia laxiflora</i>	0.084	0.236	0.236	0.036	0.364	0.428	1.00	0.986
<i>Ruprechtia salicifolia</i>	0.084	0.236	0.236	0.036	0.364	0.428	0.986	1.00

Conclusion

The results of macro- and micro- morphological characters considered Polygonoideae and Coccoleboideae as two separate subfamilies. This study supported the systems of Melchior (1964), Sanchez *et al.*, (2011) and Schuster *et al.*, (2015) while was not agreed with the systems of Jaretsky (1925) Reveal (1989) Brandbyge (1992) and Freeman and Reveal (2005) in including Coccoleboideae

within Polygonoideae. On the other hand the results agreed with Roberty and Vautier (1964) in separating Calligonoideae as a distinct subfamily.

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