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## Fruit morphology of the genus *Rumex* L. (Polygonaceae) in Iran

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### Abstract

The genus *Rumex* with about 23 species is one of the most important species of the family Polygonaceae in Iran. In order to reveal the relationship of *Rumex* species we used fruit morphological characters including valve and achene features. Valves size and shape are variable among species. All taxa have trigonous achene but their size and color are different. *R. Acetosella* as only species of subgenus *Acetosella* shows uncertain placement in phenogram. *R. tuberosus* and *R. pictus* belong to subgenus *Acetosa* but they are located in cluster with species of subgenus *Rumex*. Our results show that the current classification of the genus *Rumex* into 3 subgenera is not correct.

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## Introduction

*Rumex* is a large genus of the family Polygonaceae with about 200 species (Stevens, 2001 onwards). This genus is distributed mainly in temperate regions of the northern hemisphere. *Rumex* consists of annual, biennial and perennial herbs. In Flora Iranica 26 species were listed for *Rumex* but 4 of these are not reported from Iran. In 1988 Mozaffarian reported *Rumex pictus* as a new species for Iran. So there are 23 species of *Rumex* reported for Iran until now. Three species are endemic for Iran including *R. ephedroides*, *R. kandavanicus* and *R. elbursensis* (Rechinger, 1968). *Rumex* occurs in North, Northwest, Northeast, West, South, Southwest, Southeast and Center of Iran. So it has a wide range of distribution in the country. These species are arranged in 3 subgenera including: *Acetosella*, *Acetosa* and *Rumex*.

*Rumex* is a very complex genus and there is not an agreement on subgenera treatment in different floras. In flora of Turkey, there are 23 species of *Rumex* which arranged in 3 subgenera: *Acetosella*, *Acetosa* and *Rumex* (Cullen, 1967). In flora of Pakistan, this genus has 15 species but the subgenera have not been defined (Rechinger, 2001). In flora Palaestina, there are 14 species in 3 subgenera: *Acetosa*, *Rumex* and *Platypodium* (Rechinger, 1981). In flora of the U.S.S.R. there are 49 species in 4 subgenera: *Acetosella*, *Acetosa*, *Hololapathum* and *Odontolapathum* (Lozinskaya, 1970). In Flora Europaea the genus has 50 species which arranged in 4 subgenera including: *Acetosella*, *Acetosa*, *Rumex* and *Platypodium* (Rechinger, 1964).

In *Rumex* flowers, there are 6 perianth segments that arranged in two whorls of three. Outer segments usually spreading but inner segments become enlarged and enclose achene. These segments are called valves. Valves may be membranous or leathery, dentate or entire, with or without swollen tubercle on midrib. Achenes are trigonous (Rechinger, 1968, 2001).

Fruit morphology of some genera of the family Polygonaceae including 2 species of *Rumex* has been studied using scanning electron microscopy in West Africa (Ayodele and Zhou, 2010). Some micro-morphological features including tepal epidermis, dorsal leaf epidermis, achene surface and pollen grains in Polygonaceae tribes also have been studied in Iran. In this study one species of *Rumex*, *R. Acetosa* as a representative of tribe *Rumiceae* has been studied (Mosaferi and Keshavarzi, 2011). Pollen morphology of seven species of *Rumex* from Pakistan examined by light microscope (LM) and scanning electron microscope (SEM) (Yasmin *et al.*, 2010). There is not any comprehensive research on *Rumex* morphological characters specially in Iran. The aim of this study is to reveal the relationships between *Rumex* species according to fruit morphological characters.

## Materials and methods

### Taxon sampling

Fruits were taken from the herbarium material deposited at the herbarium of the Research Institute of Forests and Rangelands (TARI). The list of the species and their localities are shown in Table 1.

### Morphological studies

Specimens were studied by dissecting microscope, Dino-Lite digital microscope and Scanning Electron Microscope (SEM) without any treatment. For SEM studies, dry mature fruits (valves with achene inside) were mounted on stubs and then coated with gold for 6-7 minutes using Physical Vapor Deposition (PVD) method. The specimens were examined and photographed with TESCAN VEGA II Scanning Electron Microscope. In order to determine different characters we used different floras (Cullen, 1967; Rechinger, 1964, 1968, 2001). Some characters including valve length, width and shape, tubercle length, width and shape, achene length, width and color.

### Statistical analysis

Quantitative and qualitative characters examined for

about four samples from each species. Finally, fourteen characters were evaluated. In order to reveal the species relationships, we conducted cluster analysis. So, the mean of quantitative characters were used and qualitative characters were coded as binary/multi-state characters. Hierarchical cluster

analysis was performed using SPSS version 18 software with Ward's method.

### Results

Fruit morphological characters used in this study are represented in Table 2 and 3. According to these characters we proposed a key to the *Rumex* species.

**Table 1.** List of *Rumex* species used for fruit morphological study and their localities.

Subgenus	Taxa	Localities (TARI)
<i>Acetosalla</i> (Meisn.) Rech. f.	<i>R. Acetosella</i> L.	Azarbajejan: Sabalan Mt, road to shabil, 2600 m, Jamzad, Zehzad, Taheri and Izadpanah 70631
	<i>R. ephedroides</i> Bornm.	Ilam: road of Ivan to Ilam, next to the road, 1100 m, Fattahi and Lashkar bolooki and Hamzehee 38
	<i>R. scutatus</i> L.	Tehran: near Damavand, S. slope on the road to Havir, 2000 m, Assadi and Mozaffarian 33303
	<i>R. Acetosa</i> L.	Azarbajejan: Arasbaran protected area, Doghrun, 2500 m, Assadi and Sardabi 23925
	<i>R. tuberosus</i> L.	Azarbajejan: Arasbaran protected area, Tolua-Ali, 650 m, Assadi and Vosughi 24936
<i>Acetosa</i> (Meisn.) Rech. f.	<i>R. cypris</i> Murb.	Fars: 34 km from Nurabad to Dogonbadan, 700 m, Assadi and Aboohamzeh 38449
	<i>R. vesicarius</i> L.	Hormozgan: Khalij-e-fars, Bushir to Bandar Lengeh, north of Taheri on road to Jam, 240 m, Bokhari and Wendelbo 203
	<i>R. pictus</i> Forssk.	Khuzestan: NE of Bostan around Kuh-e-Mish-Dagh, 50-200 m, Mozaffarian 53737
	<i>R. kandavanicus</i> (Rech.f.) Rech.f.	Mazandaran: Kelardasht, Kuhe Takhte Soleyman, 2700 m, Fotovat 10122
	<i>R. thjanschanicus</i> Los.	Khorasan: 14 km from Kashmar to Neyshabour, 1400-1500 m, Assadi and Mozaffarian 35603
<i>Rumex</i> (Syn: Subgenus <i>Lapathum</i> Rech. f.)	<i>R. patientia</i> L.	Azarbajejan: Rezaiyeh, Ghasemlu, 1600 m, Sabeti 7795
	<i>R. ponticus</i> E.H.L.Krause emend. Rech.f.	Chaharmahal-e-Bakhtiari: Shahr-e-Kurd, Chelgerd around Tunel Kuhrang, 2350-2500 m, Mozaffarian 57727
	<i>R. elbursensis</i> Boiss.	Mazandaran: S of Ramsar, E of Lapasar, 2950m, Runemark and Maassoumi 21686
	<i>R. crispus</i> L.	Tehran: Haraz road, Lar valley, Gosal darre, 2400m, Sanii and Assadi 14150
	<i>R. angustifolius</i> Campd.	Kurdestan: 20 km SE of Baneh, Gardaneh nahini, 1810 m, Fattahi and Tavakoly and Hatami 2405
	<i>R. conglomeratus</i> Murr.	Kerman: Khabr village, 2300 m, Assadi and Miller 25107
	<i>R. sanguineus</i> L.	Khorasan: In a gully 5 km N of Dozein, which is a village 55 km SE of Gonbad-e-Kabus, 950 m, Hower 3963
Continued <i>Rumex</i> (Syn: Subgenus <i>Lapathum</i> Rech. f.)	<i>R. obtusifolius</i> L.	Azarbajejan: Arasbaran protected area, Forests W of Makedi, 1700 m, Runemark and Assadi 22038
	<i>R. pulcher</i> L.	Azarbajejan: 28 km North East of Germi to Rord lar and Wan village, 600 m, Mozaffarian and Nowrozi 34852
	<i>R. alveolatus</i> Losinsk.	Tehran: Firuzkuh to Pole-Veresk, N. side of Pole-Gaduk, 1800 m, Wendelbo and Foroughi 13055
	<i>R. chalepensis</i> Mill.	Kerman: Mahan, 2000 m, Manuchehri Heravi 235
	<i>R. nepalensis</i> Spreng.	Mazandaran: 27 km to Haraz road from Kandavan, 1550 m, Assadi and Mozaffarian 33092
	<i>R. dentatus</i> L.	Sistan: Zabol – Bonjar, 500 m, Valizadeh and Maassoumi 1123

#### Valve characters

Valve size is very different. Valve length range between 1.1 to 15.2 mm (Table 2). In most species

valve length is less than 10mm. only 4 species including *R. cyprius*, *R. vesicarius*, *R. ponticus* and *R. elbursensis* has large valves with more than 10mm

length.

Valves may be membranous or leathery. So valve thickness differs in species. Almost all species belonging to subgenus *Acetosa* have membranous valves. Moreover 4 species of subgenus *Rumex* (*R. conglomeratus*, *R. sanguineus*, *R. obtusifolius*, and *R. nepalensis*) have membranous valves. Remaining taxa have leathery valves.

Valve margin may be entire or dentate. Most species have valves with entire margin. In *R. cyprius* the valve margin has small spines or teeth. *R. obtusifolius* and *R. dentatus* have up to 4 teeth. *R. chalepensis*, *R. pulcher* and *R. nepalensis* have 4 to 8 teeth and *R. alveolatus* has about 8 to 14 teeth on valve margin (Fig. 1, 2 and 3).

**Table 2.** Comparison of fruit morphological data in *Rumex* species (quantitative characters). Abbreviations: VL: Valve Length, VW: Valve Width, TL: Tubercle Length, TW: Tubercle Width, AL: Achene Length, AW: Achene Width, NVT: Number of Valves with Tubercle(s).

Characters Taxa	VL (mm)	VW (mm)	TL (mm)	TW (mm)	AL (mm)	AW (mm)	NVT
<i>R. Acetosella</i>	1.145	0.517	0	0	1.288	0.831	0
<i>R. ephedroides</i>	3.463	5.262	0	0	2.421	0.994	0
<i>R. scutatus</i>	5.652	5.899	0	0	2.929	1.363	0
<i>R. Acetosa</i>	2	1.5	0	0	2	0.5	0
<i>R. tuberosus</i>	3.817	5.123	0.76	0.629	2.125	1.12	3
<i>R. cyprius</i>	15.241	17.038	0	0	4.457	1.931	0
<i>R. vesicarius</i>	12.216	8.592	0	0	3.222	1.449	0
<i>R. pictus</i>	5.106	9.256	3.25	1.472	2.5	1	3
<i>R. kandavanicus</i>	4.004	4.444	0	0	2.727	1.541	0
<i>R. patientia</i>	7.339	7.295	3.538	2.002	3.317	1.809	3
<i>R. ponticus</i>	13.63	13.372	5.072	2.438	5.007	2.789	1
<i>R. elbursensis</i>	12.08	12.548	5.285	3.474	5.764	3.211	1
<i>R. crispus</i>	3.938	3.122	1.832	1.084	2.522	1.572	3
<i>R. angustifolius</i>	9.545	8.551	4.685	1.924	5.542	2.841	3
<i>R. conglomeratus</i>	2.428	0.925	1.141	0.509	1.661	1.076	3
<i>R. sanguineus</i>	2.186	0.616	0.977	0.763	1.559	0.955	1
<i>R. obtusifolius</i>	3.515	1.681	1.273	0.759	2.017	1.172	1
<i>R. alveolatus</i>	6.107	4.595	2.871	1.496	3.245	2.067	3
<i>R. chalepensis</i>	4.981	3.523	2.96	0.93	3.09	1.765	3
<i>R. thjanschanicus</i>	6.587	6.715	2.5	1	3	1.5	1
<i>R. dentatus</i>	3.5	1	1.5	0.5	1.5	0.5	3
<i>R. pulcher</i>	4	3	3	1	2.5	1.5	3
<i>R. nepalensis</i>	5	4	2	1	3	2	1

Valve shape is a variable character among *Rumex* species. Valves may be ovoid, suborbicular, orbicular-cordate, ovate-triangular, cordate, lingulate, triangular or reniform (Table 3, Fig. 1, 2 and 3).

*Tubercle characters*

Some of species may have a swollen tubercle on midrib. Tubercle shape and size is different (Table 2, 3). In *R. sanguineus* tubercle is globular and about

0.9×0.7mm. In *R. elbursensis*, *R. sanguineus*, *R. chalepensis* and *R. nepalensis* is fusiform. In *R. tuberosus*, *R. conglomeratus*, *R. obtusifolius* and *R. alveolatus* is oval and in *R. patientia*, *R. ponticus*, *R. crispus*, *R. pictus*, *R. thjanschanicus*, *R. dentatus* and *R. pulcher* is ovoid (Fig. 1, 2,3).

*Achene characters*

Achenes are trigonous in all species (Fig. 4). Achene length is less than 5 mm in most species. Only in *R. ponticus*, *R. elbursensis* and *R. angustifolius* the length of achene is more than 5 mm. Achene color is usually brown. In *R. Acetosella* and *R. ephedroides* is light brown. In *R. scutatus* is yellowish grey. In *R. cyprius* and *R. vesicarius* is brownish. In *R. pictus* is yellowish-brown (Table 2, 3).

**Table 3.** Comparison of fruit morphological data in *Rumex* species (qualitative characters). Abbreviations: VT: Valve Thickness, VS: Valve Shape, VM: Valve Margin, NTVM: Number of Teeth on Valve Margin, TE: Tubercle Existence, TS: Tubercle Shape, AC: Achene Color.

Characters Taxa	VT	VS	VM	NTVM	TE	TS	AC
<i>R. Acetosella</i>	membranous	ovoid	entire	0	absent	absent	light brown
<i>R. ephedroides</i>	membranous	suborbicular	entire	0	absent	absent	light brown
<i>R. scutatus</i>	membranous	orbicular	entire	0	absent	absent	yellowish-grey
<i>R. Acetosa</i>	membranous	suborbicular	entire	0	absent	absent	dark brown
<i>R. tuberosus</i>	membranous	reniform	entire	0	present	rounded-oval	dark brown
<i>R. cyprius</i>	membranous	suborbicular	spinescent	0	absent	absent	brownish-white
<i>R. vesicarius</i>	membranous	suborbicular	entire	0	absent	absent	brownish
<i>R. pictus</i>	membranous	reniform-ovate	entire	0	present	ovate-oblong	yellowish-brown
<i>R. kandavanicus</i>	leathery	ovate-triangular	entire	0	absent	absent	dark brown
<i>R. patientia</i>	leathery	orbicular-cordate	entire	0	present	ovate to ellipsoid	brown
<i>R. ponticus</i>	leathery	orbicular-cordate	entire	0	present	ovoid	brown
<i>R. elbursensis</i>	leathery	orbicular-cordate	entire	0	present	fusiform	brown
<i>R. crispus</i>	leathery	orbicular-cordate	entire	0	present	ovate	brown
<i>R. angustifolius</i>	leathery	cordate	entire	0	present	fusiform	brown
<i>R. conglomeratus</i>	membranous	lingulate	entire	0	present	oval	brown
<i>R. sanguineus</i>	membranous	lingulate	entire	0	present	globular	dark brown
<i>R. obtusifolius</i>	membranous	triangular	dentate	3-4	present	oval	brown
<i>R. alveolatus</i>	leathery	ovate	dentate	8-14	present	oval	dark brown
<i>R. chalepensis</i>	leathery	triangular	dentate	4-9	present	fusiform	brown
<i>R. thjanschanicus</i>	leathery	orbicular-cordate	entire	0	present	ovoid	brown
<i>R. dentatus</i>	leathery	triangular	dentate	2-4	present	ovate	dark brown
<i>R. pulcher</i>	leathery	ovate	dentate	4-8	present	suborbicular-ovate	brown
<i>R. nepalensis</i>	membranous	ovate-triangular	dentate	6-8	present	fusiform	dark brown

*Key to the Rumex species according to fruit morphology*

- 1a. Valves membranous .....2
- 1b. Valves leathery.....13
- 2a. Valves without tubercle .....3
- 2b. Valve(s) with tubercle .....8
- 3a. Valves length less than 10 mm.....4
- 3b. Valves length more than 10 mm.....7
- 4a. Valves ovoid, valves length usually less than

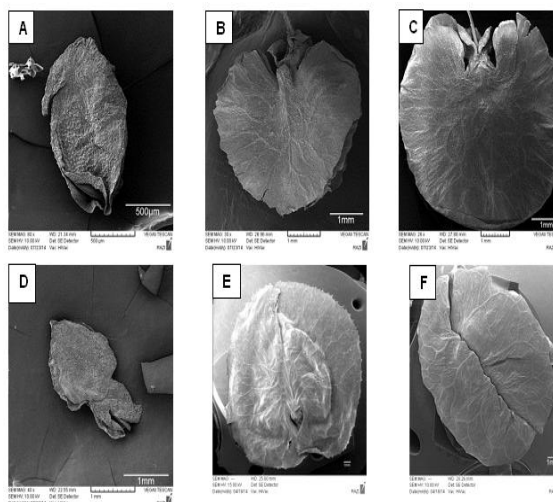
- achene length ..... *R. Acetosella*
- 4b. Valves suborbicular .....5
- 5a. Achene dark brown ..... *R. Acetosa*
- 5b. Achene light brown .....6
- 6a. Valves length 5.6 ..... *R. scutatus*
- 6b. Valves length 3.4 mm..... *R. ephedroides*
- 7a. Valves margin entire..... *R. vesicarius*
- 7b. Valves margin spinescent ..... *R. cyprius*
- 8a. Valves lingulat.....9

- 8b. Valves reniform, triangular or ovate-triangular.....10
- 9a. All valves tuberculate, tubercles oval ..... *R. conglomeratus*
- 9b. Only one valve tuberculate, tubercle globular ..... *R. sanguineus*
- 10a. Valves reniform .....11
- 10b. Valves triangular or ovate-triangular .....12
- 11a. Valves with rounded – oval tubercles.....*R. tuberosus*
- 11b. Valves with ovate-oblong tubercles ..... *R. pictus*
- 12a. Valves triangular, with oval tubercles ..... *R. obtusifolius*
- 12b. Valves ovate-triangular, with fusiform tubercles .....*R. nepalensis*
- 13a. Valves without tubercle..... *R. kandavanicus*
- 13b. Valve(s) with tubercle ..... 14
- 14a. Valve length more than 10 mm .....15
- 14b. Valve length less than 10 mm .....16
- 15a. Valve with ovoid tubercle ..... *R. ponticus*
- 15b. Valve with fusiform tubercle ..... *R. elbursensis*
- 16a. Valves cordate or orbicular – cordate .....17
- 16b. Valves triangular or ovoid .....20
- 17a. Valves cordate ..... *R. angustifolius*
- 17b. Valves orbicular – cordate .....18
- 18a. Valve length less than 5 mm ..... *R. crispus*
- 18b. Valve length more than 5 mm .....19
- 19a. All valves tuberculate ..... *R. patientia*
- 19b. Only one valve tuberculate ..... *R. thjanschanicus*
- 20a. Valves triangular .....21
- 20b. Valves ovoid .....22
- 21a. Valves with fusiform tubercles, valves margin with 4-9 teeth ..... *R. chalepenis*
- 21b. Valves with ovate tubercles, valves margin with 4 teeth .....*R. dentatus*
- 22a. Valves with ovate tubercles, valve margin with 8 14 teeth ..... *R. alveolatus*
- 22b. Valves with suborbicular-ovate tubercles, valves margin with 4-8 teeth .....*R. pulcher*

**Discussion**

In *Rumex* inner segments of flowers become enlarged and enclose fruit. These segments are called valves. In this study we used fruit morphological characters

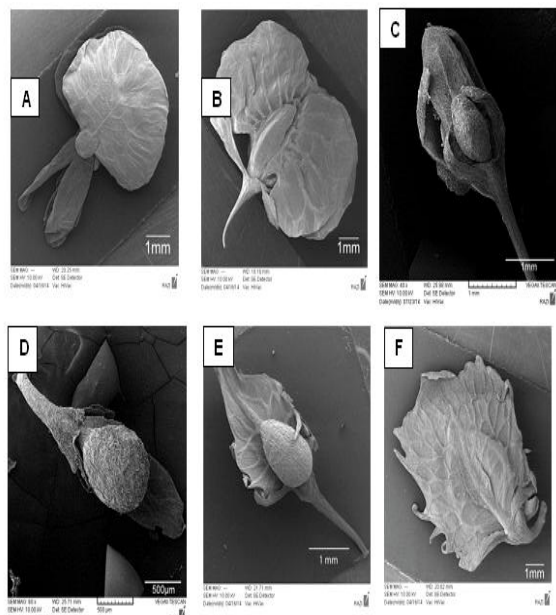
including valve and achene features to reveal the relationship of species. Scanning electron microscopy of achenes provides some characters that are useful for delimitation of tribes and genera but rarely at the specific level in Polygonaceae (Ronse Decraene *et al.*, 2000; Ayodele and Zhou, 2010; Mosaferei and Keshavarzi, 2011). So we only used Achene size and color to compare species in this study. Valves size, shape and thickness are variable among taxa.



**Fig. 1.** Scanning Electron Micrographs of valves of *Rumex* species: A) *R. Acetosella*, B) *R. ephedroides*, C) *R. scutatus*, D) *R. Acetosa*, E) *R. cyprius*, F) *R. vesicarius*. Scale bars: Fig. A= 500 µm; Figs. B – F= 1 mm.

According to our results, we can suggest 4 types of valves in *Rumex* species: Type I: Valves membranous, without tubercle. This type includes 6 species (*R. Acetosella*, *R. ephedroides*, *R. scutatus*, *R. Acetosa*, *R. cyprius* and *R. vesicarius*). In *R. Acetosella* valve size is 1.145×0.517. This species has the smallest valve among *Rumex* species. The inner perianth segments do not enlarging in fruit and they are not longer than the achene. So we can separate it from other species according to its size. In Flora Iranica this species is the only member of subgenus *Acetosella*. The remaining 5 species belong to subgenus *Acetosa* (Rechinger, 1968). Here we have 2 subgroups: first, species with small valves (valves length less than 10 mm) including *R. ephedroides*, *R. scutatus* and *R. Acetosa*. The second, species with large valves (valves length more than 10 mm)

including *R. cyprius* and *R. vesicarius*.



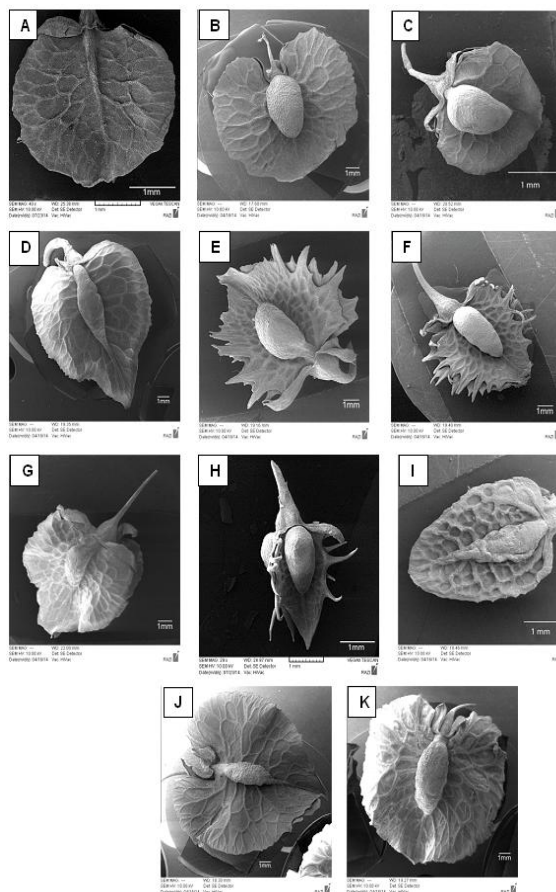
**Fig. 2.** Scanning Electron Micrographs of valves of *Rumex* species: A) *R. tuberosus*, B) *R. pictus*, C) *R. conglomeratus*, D) *R. sanguineus*, E) *R. obtusifolius*, F) *R. nepalensis*. Scale bars: Figs. A, B, C, E, F = 1 mm; Fig. D = 500 μm.

Type II: Valves membranous, all valves or at least one of them tuberculate. This type includes 6 species (*R. tuberosus*, *R. pictus*, *R. conglomeratus*, *R. sanguineus*, *R. obtusifolius* and *R. nepalensis*). *R. tuberosus* and *R. pictus* belong to subgenus *Acetosa* but the other 4 species are members of subgenus *Rumex* (Rechinger, 1968).

Type III: Valves leathery, without tubercle. This type includes only one species (*R. kandavanicus*). This species does not have a distinct tubercle but the midrib is somewhat thickened.

Type IV: Valves leathery, all valves or at least one of them tuberculate. This type includes 10 species (*R. patientia*, *R. crispus*, *R. angustifolius*, *R. alveolatus*, *R. chalapensis*, *R. thjanschanicus*, *R. dentatus*, *R. pulcher*, *R. elbursensis* and *R. ponticus*). All species of types III and IV belong to subgenus *Rumex* (Rechinger, 1968). This grouping is somewhat congruent with classification of taxa in Flora Iranica.

Since, species of subgenus *Acetosa* constitute one group (type I) and the remaining taxa in other groups belong to subgenus *Rumex* (type II, III and IV). Only 3 exceptions are seen (*R. Acetosella*, *R. tuberosus* and *R. pictus*). So valve thickness and presence or absence of tubercle are useful characters for determining species relationships.



**Fig. 3.** Scanning Electron Micrographs of valves of *Rumex* species: A) *R. kandavanicus*, B) *R. patientia*, C) *R. crispus*, D) *R. angustifolius*, E) *R. alveolatus*, F) *R. chalapensis*, G) *R. thjanschanicus*, H) *R. dentatus*, I) *R. pulcher*, J) *R. elbursensis*, K) *R. ponticus*. Scale bars = 1 mm.

Valve shape is variable among taxa. In general we can suggest 4 groups according to valve shape. Group I: valves ovate, ovate-triangular and triangular. Group II: valves suborbicular, orbicular-cordate and cordate. Group III: valves lingulate. Group IV: valves reniform. This classification is not congruent with Flora Iranica. For example group I has 8 members

that one of them belongs to subgenus *Acetosella* and other 7 species belong to subgenus *Rumex*. In group II there are 11 species which belong to subgenera *Acetosa* and *Rumex*. So this classification is not very useful for determining species.



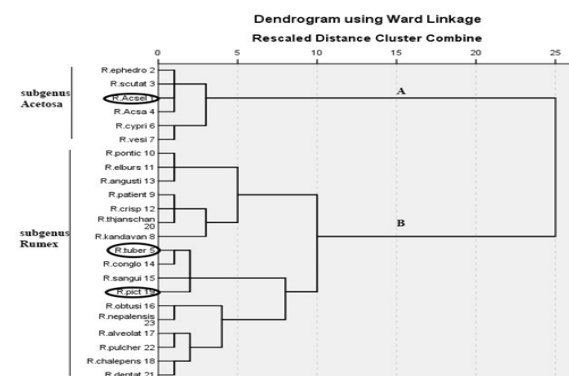
**Fig. 4.** Scanning Electron Micrograph of *R. alveolatus* achene. Scale bar = 300 µm.

Tubercle shape (if present) also is variable among taxa. In general, there are 4 types of tubercles: oval, ovate, fusiform and globular. Since in some species tubercle is absent, so this character also does not help for grouping species.

In Flora Iranica the genus *Rumex* is divided into 3 subgenera including: *Acetosa*, *Acetosella* and *Rumex*. Results of this study do not support this classification. A phenogram by the Ward's method revealed two main clusters (Fig. 5). The first cluster (A) consists of 5 species belonging to subgenus *Acetosa* and *R. Acetosella*. The latter belongs to subgenus *Acetosella* but it is nested among species of subgenus *Acetosa*. Species of subgenus *Acetosa* all have membranous valves without tubercle but their size and shape are different. *R. Acetosella* has ovoid, membranous valves without tubercle, with entire margin. Valves are small. So this species has common characters with species of subgenus *Acetosa*.

The second cluster (B) consists of 15 species belonging to the subgenus *Rumex*. In this cluster there are two species (*R. tuberosus* and *R. pictus*) which belong to the subgenus *Acetosa*. These two species both have reniform, membranous valves with

entire margin. All valves have tubercles. Most of species of subgenus *Rumex* has leathery valves. *R. tuberosus* and *R. pictus* are more similar to species of subgenus *Acetosa* but in phenogram they show close relationship to species of subgenus *Rumex*. Maybe the existence of tubercle is a common character that relates these species.



**Fig. 5.** Phenogram using Ward's Method based on fruit morphological characters.

This analysis shows that the current classification of subgenera is not very clear. More research including anatomical, palynological and molecular studies are needed to show the exact differentiation of subgenera.

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