

# A REVISION OF THE GENUS *THALICTRUM* L. IN IRAN

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The genus *Thalictrum* L. is reviewed based on literature, available herbarium materials and new collected specimens. On the basis of 29 quantitative and qualitative characters a cluster analysis was performed by ward distance of phenetic method for arranging taxa in distinct species groups. An identification key to 6 accepted taxa is provided by using PCA and phenetic analyses. A checklist of accepted species and synonyms including selected studied specimens is given.

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**Key words:** *Thalictrum*; phenetics; cladistic; revision; Iran

مطالعه مروری جنس *Thalictrum* L. در ایران

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جنس *Thalictrum* L. بر اساس بررسی منابع و نمونه های هرباریومی و همچنین نمونه های جمع آوری شده توسط مؤلفین مورد بازبینی قرار گرفت. با استفاده از آنالیز تجزیه به عامل ها و تعیین متغیرترین صفات یک کلید شناسایی برای گونه های پذیرفته شده در ایران تهیه شد. علاوه بر آن بر اساس ۲۹ صفت کمی و کیفی ریخت شناسی، آنالیز خوشه ای با استفاده از روش وارد جهت تعیین جایگاه گونه ها در گروه های گونه ای انجام شد. علاوه بر آن فهرستی از گونه ها و مترادف های آنها به همراه منتخبی از نمونه های بررسی شده ارائه شده است.

## INTRODUCTION

The genus *Thalictrum* L. (Ranunculaceae) comprises about 190 known species distributed in temperate regions (Tamura 1995). These species are found in Irano-Turanian Region and Hyrcanian Province of Euro-Siberian Region. Members of the genus have commonly been known as "meadow rue" and actively being studied for medicinal value of their secondary metabolites (Lutskii & al. 2005; Khamidullina & al. 2006; Liscombe & al. 2009). In this study different available references (Ro & al. 1997; Rechinger & al. 1992; Davis 1965; Boissier 1867; Tamura 1995; Nikolic 1991 a & b; Pakravan & Assadi 2012) were consulted. The aim of this study is revising the taxonomy of the genus in Iran and presenting an identification key by checking diagnostic value of characters statistically.

## MATERIALS AND METHODS

Taxonomic studies are based on examining the herbarium specimens of different herbaria such as TARI, TUH, IRAN, HSBU, KAR, FARABI (Holmgren et al. 1990) and ALUH (Alzahra University Herbarium), (table 1).

### Phenetic and numerical analysis

In order to establish a phenetic analysis, at least 3 individuals from each population were studied for quantitative and qualitative morphological characters. For numerical analysis 11 qualitative and 18 quantitative characters were examined (see table. 2). All the statistical analyses were achieved using SPSS soft ware ver. 17. Cluster analysis based on Ward method, and ordination using Principal Component Analysis (PCA) and Factor Analysis (FA) were performed. Component matrix in morphological characters is given in table 2.

Table 1. List of the species studied in phenetic analyses.

Species	Locality	Collector	Vocher	No.
<i>Th. foetidum</i> L.	Mazandaran: Pol-sefid	Assadi & Azadi	TARI	76027
<i>Th. foetidum</i> L.	Gilan: Rudbar, Pole- zanguleh	Mobayen	KAR	4892
<i>Th. foetidum</i> L.	Gilan: Rudbar, Pole- zang	Mobayen	KAR	4895
<i>Th. foetidum</i> L.	Azarbaijan, Gardaneh Almas, between Asalem & Khalkhal	Wendelbo & Assadi,	TARI	18499
<i>Th. foetidum</i> L.	Gilan: Rudbar, Pole-zanguleh	Mobayen	KAR	4894
<i>Th. isopyroides</i> C. A. Mey.	Markazi: Arak, Sefid khani Mt.	Akhani & Assadi	TARI	79030
<i>Th. isopyroides</i> C. A. Mey.	Golestan, Golestan National park, toward Bakadeh,	Wendelbow & et al.	TARI	11088
<i>Th. isopyroides</i> C. A. Mey.	Esfahan: Ghameshloo	Ghahreman & Aghustin	TUH	611
<i>Th. isopyroides</i> C. A. Mey.	Chahar- mahale Bakhtiari, Kuhe Gandoman	Zehzad	HSBU	86275
<i>Th. isopyroides</i> C. A. Mey.	Esfahan, Golestan kuh toward Khonsar	Wendelbow & Assadi	TARI	16401
<i>Th. isopyroides</i> C. A. Mey.	Markazi, Arak, road of Arak to Mahalat, Late-dar Mt.	Mozaffarian & Maasoumi	TARI	47926 1
<i>Th. isopyroides</i> C. A. Mey.	Fars, kuhe Bash, ESE Estehbanat,	Mousavi & Tehrani	IRAN	33653
<i>Th. isopyroides</i> C. A. Mey.	Markazi: Arak, Govar village, Shamsabad Mt.	Akhani	HSBU	645
<i>Th. isopyroides</i> C. A. Mey.	Markazi: Arak, Chal- Khatoon Mt.,	Akhani	HSBU	843
<i>Th. isopyroides</i> C. A. Mey.	Azarbaijan, 37 km. from Mianeh to Jolfa	Wendelbow & Assadi	TARI	19222
<i>Th. isopyroides</i> C. A. Mey.	Tehran: Karaj	Abbasi& Jahandoost	FARA BI	25762
<i>Th. isopyroides</i> C. A. Mey.	Mazandaran: Polsefid, forest above the village Sangdeh	Assadi	TARI	73432
<i>Th. minus</i> L. var. <i>majus</i> (Cranz) Hook. F. & Thomson	Tehran, Lar valley	Soleimani	ALUH I	77560
<i>Th. minus</i> L. var. <i>majus</i> (Cranz) Hook. F. & Thomson	Tehran, Lar valley	Sanei & Assadi	TARI	76089
<i>Th. minus</i> L. var. <i>majus</i> (Cranz) Hook. F. & Thomson	Tehran: Taleghan, Hasanjun	Ghazi	FARA BI	33212
<i>Th. minus</i> L. var. <i>majus</i> (Cranz) Hook. F. & Thomson	Gilan: Rudbar	Maleki	KAR	4881
<i>Th. minus</i> L. var. <i>majus</i> (Cranz) Hook. F. & Thomson	Tehran: Taleghan, near dam	Soleimani	ALUH	6452
<i>Th. minus</i> L. var. <i>minus</i>	Golestan: Moraveh Tappeh to Gonbad	Hewer	TARI	3936
<i>Th. minus</i> L. var. <i>minus</i>	Azarbaijan: Arasbaran	Jamzad & Zehzad	TARI	70718
<i>Th. minus</i> L. var. <i>minus</i>	Tehran: Taleghan	Soleimani	ALUH	6453
<i>Th. minus</i> L. var. <i>minus</i>	Tehran: Shahrestanak	Soleimani	ALUH	6454
<i>Th. minus</i> L. var. <i>minus</i>	Azarbaijan, Arasbaran	Pakravan	ALUH	6455
<i>Th. minus</i> L. var. <i>minus</i>	Tehran: Dizin	Soleimani	ALUH	6456
<i>Th. minus</i> L. var. <i>minus</i>	Golestan: Golestan National park, Tangeh-gol	Zehzad	HSBU	82103
<i>Th. minus</i> L. var. <i>minus</i>	Golestan: Golestan National park	Zehzad	HSBU	8227
<i>Th. minus</i> L. var. <i>minus</i>	Lorestan: 61 km on road from Aligodarz to Shoulabad, valley after the pass	Runemark & Lazari	TARI	26212

Table 1. Continued.

Species	Locality		Vocher	No.
<i>Th. minus</i> L. var. <i>minus</i>	Khorassan: Bezagh Mt.	Mobayen	KAR	4885
<i>Th. minus</i> L. var. <i>minus</i>	Tehran, Haraz road, Lar valley, Assal-Assal	Sanii & Assadi	TARI	14121
<i>Th. mazandaranicum</i> Pakravan & Assadi	Mazandaran, Lar valley	Assadi	TARI	13318
<i>Th. sultanabadense</i> Stapf	Tehran, Shahrestanak	Pakravan	ALUH	8901
<i>Th. sultanabadense</i> Stapf	Markazi: Arak, Sefid khani Mt.	Akhani & Assadi	TUH	79020
<i>Th. sultanabadense</i> Stapf	Azarbaijan, Ghasemloo valley	Zehzad	HSBU	73482
<i>Th. sultanabadense</i> Stapf	Yazd: Barfkhaneh Mt.	Wendelbow & Assadi	TARI	16466
<i>Th. sultanabadense</i> Stapf	Markazi: Arak, East of Shahzand,	Akhani	HSBU	847
<i>Th. sultanabadense</i> Stapf	Khorasan: 45 km north of Shirvan, Golool Sarani Protected area	Assadi & Maassoumi	TARI	50443
<i>Th. sultanabadense</i> Stapf	Qazvin: Razeghan	Mobayen	KAR	4874
<i>Th. tacabicum</i> Pakravan & Assadi	Azerbaijan: Shahindezh, Takab road	Siami & Zehzad	TARI	7374

Table 2. Characters and character states used in phenetic analyses.

Characters	Character states	abbreviation	No.
Leaf outline	0-triangular/1-ovate/2- oblong	TLS	1
Lower Leaflet Shape	0-fusifiform/1-triangular with three shallow divisions/2-triangular-reniform/3-triangular with three medium divisions/4- lanceolate	LLS	2
Upper Leaflet Shape	0- fusiform/ 1- triangular with three shallow divisions/ 2-triangular-reniform/ 3-triangular with three medium divisions/ 4-lanceolate	ULS	3
Lower Leaflet Size	0.5-2 cm	LLSi	4
Upper Leaflet Size	1-2 cm	ULSi	5
Lower Leaf blade Shape	0-acute/1-acuminate/2-aristate/3-attenuate/4-lanceolate	LLbS	6
Upper Leaf blade Shape	0-acute/1-acuminate/2-aristate/3-attenuate/4-lanceolate	ULbS	7
Lower Leaflet Margin	0- plane/1-revolute/2-involute/3-revolute to plane	LLM	8
Upper Leaflet Margin	0- plane/1-revolute/2-involute/3-revolute to plane	ULM	9
Leaf Indumentum	0-glabrous/1-lanate/2-unicellular	LI	10
Leaf Indumentum position	0- glabrous/ 1-lower epidermis/2-both surfaces	LIP	11
Length of petiole	0-4cm	LoP	12
Stipule	0-absent/1-present	S	13
Stem Indumentum	0-glabrous/1-lanate/2-unicellular	SI	14
Peduncle Length	0-3 cm	PLe	15
Inflorescence Shape	0-racem/2-panicle	IS	16
Flower Color	0-white/1-pale cream/2-cream/3-yellow/4-pale yellow	FC	17
Filament Length	1-6 mm	FL	18
Stamen Length to Petal Length	0- $SLtPL \leq 0.7$ 1- $0.7 \leq SLtPL \leq 2$ 2- $SLtPL \geq 2$	SLtPL	19
Flower diameter	4-8 mm	FD	20
Number of fruitlets	0- $NoF \leq 6$ 1- $NoF \geq 6$	NoF	21
Fruitlets size	0.5-1 cm	FS	22
Fruitlets color	0-brown/1-pale green/2-green	Frc	23
Fruitlets beak length	0.5 -2 mm	FBL	24
Fruitlets beak shape	0-curved/1-falcate	FBS	25
Fruitlets trichome	0-glabrous/1-hairy	FT	26
Grooves of fruitlets	-	GoF	27
Plant length	25-100 cm	PL	28
Ramification	0-basally /1-from middle	RAMI	29

## RESULTS

### Phenetic and numerical analysis

In order to determine the most variable morphological characters, a factor analysis based on Principal Component Analysis (PCA) was performed. The analysis showed that the first six factors comprised over 99% of the total variation (tables 3 & 4).

In the first factor with about 32% of the total variation, characters such as stem height, petiole length, existence of stipule, the number of ribs on the fruit, and shape of lower leaflets had the highest correlation ( $\geq 0.7$ ). In the second factor with about 22% of the total variation, 2 characters i.e., indumentum of the stem and leaves showed the highest correlations ( $\geq 0.7$ ). In the third factor with about 18% of the total variation, 2 characters viz., size of the upper leaflets and shape of the fruit beak had the highest correlation ( $\geq 0.6$ ). The fourth, fifth and sixth factors revealed almost 13%, 9%, and 6% of the total variation respectively.

An identification key was presented using these characters. As it is evident from PCA graph, *Thalictrum minus* var. *minus*, *Th. minus* var. *major*, *Th. tacabicum* and *Th. mazandaranicum* were separated from the remaining taxa along the first factor and the two species namely, *Th. foetidum* and *Th. isopyroides* were separated from *Th. sultanabadense* along the second factor (fig. 1).

A cluster analysis using Ward method revealed that total populations of each species are located at the same cluster (fig. 2). Moreover, similar species namely, *Th. minus*, *Th. tacabicum* and *Th. mazandaranicum* were clustered with each other and *Th. foetidum*, *Th. isopyroides* and *Th. sultanabadense* positioned in a separate cluster.

## DISCUSSION

The occurrence of the *Th. minus* varieties in a separate cluster showed very close relationship of them. Different shape of fruit, leaflet and different color of the upper and lower surfaces of the leaflets distinguish them from each other. On the contrary to the occurrence of the phenotypic plasticity of some characters in *Th. minus* complex, the mentioned characters have not changed under the environmental variability as Nikolic (1991) has resulted on this complex. Our results are also in agreement with Hook and Thomson (1855) in which 2 varieties are distinguished from each other. Data analyses of six *Thalictrum* species using UPGMA clustering method showed that *Th. minus* plus *Th. mazandaranicum* and *Th. tacabicum* are separated in a distinct cluster as well. These taxa have similar morphological characters such

as leaflet shape, inflorescence and indumentums. The occurrence of *Th. sultanabadense* in a separate cluster from *Th. mazandaranicum* and *Th. tacabicum* is as a result of specific characteristics such as short stem, raceme inflorescence and curved fruit that are restricted to this species. Phenetic analysis has showed the grouping of taxa.

### Key to the accepted species of *Thalictrum* in Iran

1. Plant with white dense hairs 3. *Thalictrum foetidum*  
- Plant without white dense hairs 2
2. Stem less than 30 cm high. Inflorescence a raceme.  
Fruit curved 2. *Thalictrum sultanabadense*  
- Stem more than 30 cm high. Inflorescence a panicle.  
Fruit straight 3
3. Pedicels length more than 4 cm, leaflets length 3-4 mm, entire 1. *Thalictrum isopyroides*  
- Pedicels length not more than 4 cm. Leaflets length more than 4 mm with different division 4
4. Inflorescence shape oblong, not pyramid 5. *Thalictrum mazandaranicum*  
- Inflorescence a dense pyramid panicle 5
5. Leaflets with deep division, lobes oblong and acute 6. *Thalictrum tacabicum*  
- Leaflets cordate, dentate in margin 4. *Thalictrum minus*

### Taxonomic treatment

1- *Th. isopyroides* C. A. Mey. In Ledeb., Fl. Alt. 2: 364 (1830).

Typus: Kazakhstan, C. A. Mey. (LE)

*Typical characters:* Stem up to 50 cm height, erect, simple or branched, glabrous. Leaves stipulate, shortly petiolate or sessile. Leaves 3-4 times pinnately divided. Leaflets size 3×1 mm, three parted. Inflorescence a loose panicle. Pedicle up to 60 mm long. Flowers yellow. Stamens pendent, anthers 8 mm long, acuminate. Achene erect with 8 indistinct ribs.

Selected studied specimens: Golestan, Golestan National Park, toward Bakadeh, 1450 m, 2 May 1974, Wendelbow & et al., 11088 (TARI); Azarbaijan, 37 km. from Mianeh to Jolfa, 1400-1450 m, 22 April 1976, Wendelbow & Assadi 19222 (TARI); Esfahan, Golestan Kuh toward Khonsar, 2600 m, 28 May 1982, Wendelbow & Assadi 16401 (TARI); Chahar- mahale Bakhtiari, kuhe Gandoman, 3 May 1975, Zehzad 86275 (HSBU); Markazi, Arak, road of Arak to Mahalat, Late-dar Mt., 2100-2500 m, 14 June 1984, Mozaffarian & Maassoumi 47926 (TARI); Fars, kuhe Bash, ESE Estehbanat, 12 May 1976, Mussavi & Tehrani 33653 (IRAN); Tehran, Karaj, Kondor, 2250 m, 16 June 1972, Amini 7966 (TARI).

Table 3. PCA analysis of quantitative morphological characters in *Thalictrum* species.

Component	Total Variance Explained					
	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.392	32.387	32.387	9.392	32.387	32.387
2	6.387	22.025	54.412	6.387	22.025	54.412
3	5.154	17.774	72.186	5.154	17.774	72.186
4	3.810	13.136	85.322	3.810	13.136	85.322
5	2.652	9.146	94.469	2.652	9.146	94.469
6	1.604	5.531	100.000	1.604	5.531	100.000
7	6.652E-16	2.294E-15	100.000			
8	5.041E-16	1.738E-15	100.000			
9	4.720E-16	1.628E-15	100.000			
10	3.845E-16	1.326E-15	100.000			
11	3.471E-16	1.197E-15	100.000			
12	2.825E-16	9.740E-16	100.000			
13	2.496E-16	8.608E-16	100.000			
14	2.142E-16	7.386E-16	100.000			
15	1.522E-16	5.248E-16	100.000			
16	1.257E-16	4.333E-16	100.000			
17	5.002E-17	1.725E-16	100.000			
18	4.455E-17	1.536E-16	100.000			
19	3.818E-33	1.317E-32	100.000			
20	-9.299E-18	-3.206E-17	100.000			
21	-7.517E-17	-2.592E-16	100.000			
22	-1.065E-16	-3.672E-16	100.000			
23	-2.022E-16	-6.973E-16	100.000			
24	-2.399E-16	-8.271E-16	100.000			
25	-2.635E-16	-9.088E-16	100.000			
26	-2.983E-16	-1.029E-15	100.000			
27	-3.891E-16	-1.342E-15	100.000			
28	-5.089E-16	-1.755E-15	100.000			
29	-7.604E-16	-2.622E-15	100.000			

Extraction Method: Principal Component Analysis.

Table 4. Component matrix of PCA in morphological characters.

	Component Matrix <sup>a</sup>					
	Component					
	1	2	3	4	5	6
Total leaves shape	.254	.392	.422	-.721	-.028	.288
Lower leaflet shape	.718	-.575	.061	.313	.140	-.182
Upper leaflet shape	.273	-.858	.147	.402	-.061	.054
Lower leaflet size	-.077	.589	.343	-.479	.548	-.025
Upper leaflet size	.383	-.297	.704	-.084	-.456	-.234
Lower leaf blade shape	.502	-.611	.158	-.054	.584	.080
Upper leaf blade shape	.527	-.608	.002	.017	.557	.208
Lower leaflet margin	-.950	-.212	-.019	-.219	-.002	-.058
Upper leaflet margin	-.950	-.212	-.019	-.219	-.002	-.058
Leave indumentum	.535	.460	-.269	.396	-.463	.243
Leave indumentum position	.066	.710	-.119	.689	.034	.045
Length of petiole	.876	.320	.284	.108	-.043	-.190
Stipule	.778	.416	.048	.434	.177	-.003
Stem Indumentum	.057	.764	.491	.030	-.146	.388
Peduncle length	-.453	.278	-.713	-.149	.402	.161

Table 4. Continued.

	Component Matrix <sup>a</sup>					
	Component					
	1	2	3	4	5	6
Inflorescence shape	.539	.646	-.381	-.185	.314	-.118
Flower color	.484	.065	.324	-.809	-.034	-.014
Filament length	-.810	-.436	-.117	.245	.009	.284
Stamen length to petal length	-.122	-.093	-.832	-.349	.148	.376
Flower diameter	.096	-.117	.527	.424	.374	.616
Number of fruitlets	-.528	.597	-.093	.583	.122	-.025
Fruitlets size	-.716	-.082	.356	.585	.108	-.028
Fruitlets color	-.453	.503	.464	.180	.227	-.493
Fruit beak length	-.728	.037	.614	.122	.278	.022
Fruit beak shape	.252	.512	.657	.048	.488	.056
Fruitlets trichome	.223	.094	-.660	.053	.536	-.464
Grooves of Fruits	.755	-.376	-.470	.229	.122	-.019
Plant length	.982	-.002	-.011	-.007	-.159	.106
Ramification	-.040	-.765	.589	-.049	.234	-.101

Extraction Method: Principal Component Analysis.  
a. 6 components extracted.

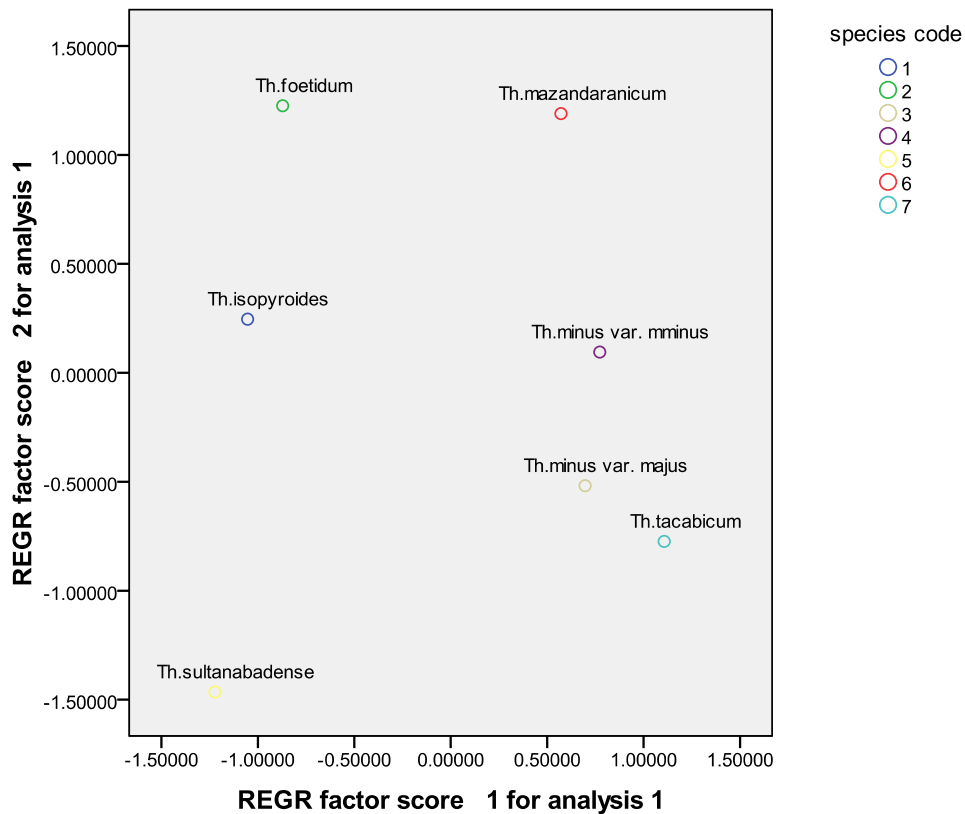


Fig. 1. PCA graph of *Thalictrum* species in Iran.

**Dendrogram**

\*\*\*\*\* H I E R A R C H I C A L C L U S T E R A N A L Y S I S \*\*\*\*\*

Dendrogram using Ward Method

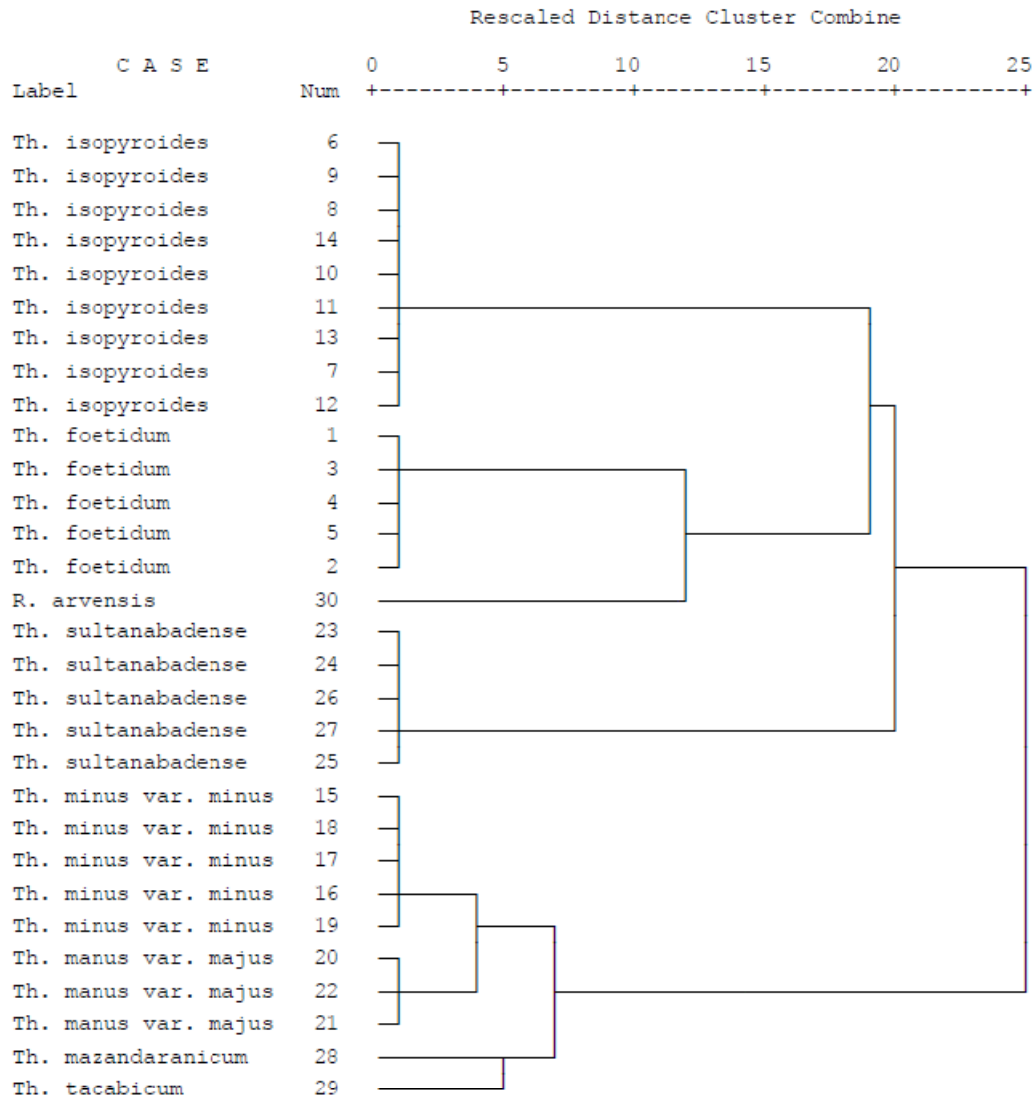


Fig. 2. Cluster analysis with Ward method of populations in *Thalicttrum* species.

2-*Th. sultanabadense* Stapf, Verh. Zool. - Bot. Ges. Wien, 38: 550 (1888).

Typus: Persia, Sultanabad, Pichler, comm. J.E. Polak. (WU)

*Typical characters:* Stem 8-30 cm high, erect, almost simple and glabrous. Exstipulate. Petiole 1-2 cm long. Leaves divided; leaflets fan-shape, with acuminate teeth. Raceme spread. Flowers white; stamens pendant, anther 9 mm long, acute. Achene falcate with 8 ribs.

Selected studied specimens: Azarbaijan, Ghasemloo valley, 3 May 1974, Zehzad 73482 (HSBU); Khorasan, 45 km north of Shirvan, Golool Sarani protected area, 2300-3000 m, 24 April 1984, Assadi & Maassoumi 50443 (TARI); Markazi, Arak, East of Shahzand, 2 June 1986, Akhaneh 847 (HSBU); Yazd Barfkhaneh Mt., 2300-3800 m, 4 April 1975, Wendelbow & Assadi 16466 (TARI); Qazvin, Razeghan, 30 April 1973, Mobayen 4874 (KAR); Tehran, Shahrestanak, 25 June

2010, Pakravan 8901; 12 May 2011, Soleimani 6451 (ALUH).

3- *Th. foetidum* L. Sp. Pl. 545 (1753).

Typus: Hortus Cliffortianus, BM.

*Typical characters:* Stem up to 60 cm height, branching from the middle of stem, with glandular hairs. Leaves exstipulate, 2-3 times pinnately divided. Leaflet size 4-7×6-9 mm, ovate-orbicular, dentate, with dense glandular hairs. Inflorescence spread panicle. Flowers white. Stamens pendent, anthers acute. Achene erect with 10 prominent ribs, covered with glandular hairs.

Selected studied specimens: Azarbaijan, Gardaneh Almas, between Asalem & Khalkhal, 2600m, 16 July 1975, Wendelbo & Assadi, 18499 (TARI); Mazandaran, Polsefid, forest above the village Sangdeh, 1500-2500m, 19 June 1995, Assadi 73432, (TARI); Semnan, 50 km N of Semnan, between Sheli and Hikuh village, 2400 m, 28 June 1982, Assadi & Mozaffarian 40560 (TARI).

4- *Th. minus* L., Sp. Pl. 546(1753).

Typus: Europa, Herb. Linn 713/12 (lectotypus).

*Typical characters:* Rhizome ± thick. Stem up to 150 cm height, branching from the middle to upper part, glabrous. Leaves stipulate, petiolate or sessile; blade 3-4 times pinnately divided. Leaflets size 10-35×5-30 mm, oval to circular, with shallow lobes or toothed, with simple hairs. Inflorescence a dense or a loose spread or pyramidal panicle. Flowers pendant; perianth green to yellow. Stamens ± pendent, filaments longer than the anthers; anthers acuminate. Achenes fusiform with 9-12 ribs.

Very variable plants in size and leaflet shape. It is divided into two varieties as follow:

- Achene oblong with 12 ribs, leaflet oblong, upper part green, lower paler var. *majus*
- Achene oval with 11 ribs, leaflet cordate, with involutes margin var. *minus*

- var. *majus* (Cranz) Hook. F. & Thomson. Fl. Ind. 17. 1855.

Typus: Pakistan

Selected studied specimens: Gilan, Rudbar, 24 May 1986, Maleki 4881 (KAR); Golestan, In desert wooded valley on mountain about 8 km S of Chenaran on road from Moraveh Tappeh to Gonbad, 950 m, 12 June 1977, Hewer 3936 (TARI); Tehran, Lar valley, 16 May 2011, Soleimani 6470 (ALUH) and 2400 m, 12 June 1974, Sanei & Assadi 14121 (TARI); Taleghan: near the lake, 19 May 2011, Soleimani 6452 (ALUH); Taleghan: Hasanjun, 2 June 2009, Ghazi 33212 (FARABI).

- var. *minus*

Selected studied specimens: Azarbaijan, Kaleibar, Arasbaran protected region, 9 May 2011 Pakravan

6455 (ALUH), same location, 11 May 1991, Jamzad & Zehzad 70718(TARI); Golestan, Golestan National Park, 2 May 1974, Zehzad 8227 (HSBU); Lorestan, 61 km on road from Aligodarz to Shoulabad, valley after the pass, 2400 m, 26 May 1977, Runemark & Lazari 26212 (TARI); Tehran, Dizin, 15 May 2011, Soleimani 6456 (ALUH); Tehran, Haraz road, Lar valley, Assal-Assal, 2200 m, 12 July 1974, Sanei & Assadi 14121 (TARI).

5- *Th. mazandaranicum* Pakravan & Assadi, Fedd. Repert. 123: 3. 2012.

Typus: Persia, Mazandaran, Lar valley, 2420 m, 2 May 1974, Assadi 13318 (holotypus: TARI, Paratypus: the same address, Cronquist 10714).

*Typical characters:* Perennial. Stem simple, erect, 60–100 cm high, glabrous. Stipules large, 5–8 × 5 mm, triangular, sheathed around the stem. Leaves more or less appressed to the stem; petiole 1–10 mm long; leaf blade oblong, bipinnate; leaflets 1–4 × 1.5–3.5 cm, oblong in outline, with 3 obtuse to acute lobes, with convolute margin; upper surface glabrous, darker, the lower surface glaucescent-green with sparse glandular hairs. Inflorescence narrowly oblong panicle. Perianth segments pale yellow, erect; filament slender; anther with sharp point. Achene oval.

The main differences between the species and all subspecies of *Th. simplex* is the presence of long stipules (exstipulate in subspecies of *Th. simplex*). Ridel (1991) has recorded this specimen as *Th. simplex* for the flora of Iran but Pakravan & Assadi (2012) have noticed the differences with *Th. simplex* as mentioned above.

Studied specimen: Persia: Mazandaran: Lar valley, 2420 m, 2 May 1974, Wendelbo & Assadi 13318 (TARI).

6- *Th. tacabicum* Pakravan & Assadi Fedd. Repert. 123: 3. 2012.

Typus: Azerbaijan: Shahindezh, Takab road, Mahmudabad, 20 May 1976, Siami & Zehzad, No. 7374 (holotype: TARI, isotype: Herbarium of Urmieh University).

*Typical characters:* Stem 50–100 cm high, erect. Stipules 2–3 mm long, lanceolate, scarious. Leaves 2–3 pinnate, sessile; leaflets with petiole 4–20 mm long; leaflets of basal leaves oblong-ovate, oblong-lanceolate in the upper leaves, trilobate or tridentate, with convolute margins, 20–35 × 5–25 mm, the upper surface glaucescent-green, glabrous. Inflorescence dense, pyramidal panicle, many flowered, perianth segments pale yellow, longer than stamens. Pedicels in fruiting stage up to 11 mm long. Stamens with filaments not dilated, linear with acuminate appendage. Fruitlets small, sessile, ovoid-oblong, convex laterally, with 12 ribs and scattered hairs.



Azerbaijan: Shahindezh, Takab road, Mahmudabad, 20 May 1976, Siami & Zehzad 7374 (TARI).

This species is close to *Th. angustifolium* JACQ. var. *laserpittifolium* KOCH. (Although this taxon is doubtfully invalid) but is different in having stipules (*Th. angustifolium* has no stipule), longer peduncle, broader leaflets, smaller perianth segments and larger fruit.

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