LEAF ANATOMICAL PROPERTIES OF SOME RARE AND ENDEMIC IRIS L. TAXA AND THEIR RELATIONS: SUBGENUS HERMODACTYLOIDES IN TURKEY

N. Kandemir

Received 2015. 10. 16; accepted for publication 2015. 12. 23

Kandemir, N. 2015. 12. 31: Leaf anatomical properties of some rare and endemic *Iris* L. taxa and their relations: subgenus *Hermodactyloides* in Turkey**.-** *Iran. J. Bot. 21 (2): 142-151***.**

Leaf anatomical characters of eight *Iris* L. taxa were compared and their relations were determined. *Iris danfordiae*, *Iris celikii, Iris histrioides*, *Iris pamphylica* and *Iris histrio* ssp. *aintabensis* are endemic to Turkey. *Iris bakeriana*, *I. celikii*, *I. histrioides*, *I. pamphylica*, *I. histrio* ssp. *aintabensis* and *Iris histrio* ssp. *histrio* have limited distribution in Turkey. The differences were seen especially in the mesophyl layer of the leaves. Mesophyll of *I. reticulata* and *I. histrioides* have an unifacial ensiform structure. Whereas mesophyll of the other investigated taxa have a bifacial ensiform structure. Leaf outline structure of all taxa are quadrangular structure (excluding *I. bakeriana*-terete structure). In mesophyll of leaves, hexagonal crystals (*I. histrioides*, *I. danfordiae, I. bakeriana, I. histrio* ssp. *histrio*, *I. histrio* ssp. *aintabensis* and *I. pamphylica*) and crystalline granules (*I. reticulata*, *I. bakeriana*, *I. celikii*, *I. danfordiae, I. histrio* ssp. *histrio*, *I. histrio* ssp. *aintabensis* and *I. pamphylica*) were found. The layer number of spongy and palisade parenchyma also vary among taxa. In the leaf anatomic characters of *I. histrio* ssp. *histrio*, *I. histrio* ssp. *aintabensis*, significant differences were not obseved. Based on the above leaves anatomical characters, we suggest that (1) *I. reticulata* and *I. histrioides* should be independent species with close relationships; (2) ssp. *histrio* and ssp. *aintabensis* should be homonym of *I. histrio*, rather than of its subspecies; (3) *I. danfordiae* and *I. celikii* should be independent species with close relationships; (4) *I. pamphylica* and *I. bakeriana* are different species of the subgenus.

Nezahat Kandemir (correspondence< nezahatkndmr@gmail.com*>),Department of Biology, Education Faculty, Amasya University, Amasya, 05189 TURKEY.*

Keywords: *Iris* taxa; rare endemics; leaf anatomy; Turkey.

مشخصات آناتومیکی برگ تعدادی از گونه های نادر و انحصاری جنس زنبق Iris از زیر جنس Hermodactyloides در ترکیه

نزهت کاندمیر، دانشیار، دپارتمان بیولوژی،دانشکده آموزش، دانشگاه آماسیه ، آماسیه، ترکیه

مشخصات آناتومیکی برگ هشت آرایه از جنس زنبق مقایسه و ارتباط بین آنها تعیین گردید. گونه های Iris danfordiae, Iris celikii, Iris histrioides, Iris pamphylica and Iris histrio ssp. aintabensis و Iris bakeriana, I. celikii, I. histrioides, I. pamphylica, I. histrio ssp. aintabensis and Iris histrio گونه های انحصاری ترکیه و ssp. Histrio دارای پراکندگی محدودی در ترکیه هستند. تفاوت هایی در صفات آناتومیکی گونه ها به خصوص در لایه مزوفیل برگ مشاهده گردید که بر اساس آنها Iris reticulata , Iris histrioides می بایستی به عنوان گونه های مستقل محسوب شوند. زیر گونه های histrio و aintabensis می بایستی به عنوان هم نام گونه I. histrio در نظر گرفته شوند. گونه های I. danfordiae و I. celikii گونه هایی مستقل باخویشاوندی نزدیک هستند و I. pamphylica و I. bakeriana گونه های متفاوت این زیر جنس هستند.

INTRODUCTION

Iris L. is an important genus of the Iridaceae family and is represented by a rich number of species in Turkey (40 species and 49 taxa) (Mathew 1984; 1988). As *Iris* species bloom earlier and grow faster than many other ornamental plants, they grow widely in parks, gardens and balconies for a long time as ornamental plants (Kandemir & Engin 2000). *I. histrio* and *I. reticulata* are widely preferred in rock gardens because of their different perigon colours and

wonderful fragrances. Some *Iris* species are also used for treating cancer, inflammation, bacterial and viral infections (Hanawa et al. 1991).

Species of the subgenus *Hermodactyloides* have great variations with regard to morphological characters (particularly *I. reticulata* and *I. histrio*). Güner & Peşmen (1980) and Mathew (1989) have reorganised the two taxa in the subgenus *Hermodactyloides* based on their morphological characters. According to this reorganisation, the samples of *I. reticulata* distributed in Mardin vicinity having eight evident lined leaves are distinguished as a separete species (*I. bakeriana*). Geographically, *I. bakeriana* is restricted in Turkey, while *I. reticulata* is widely distributed in Turkey. *I. histrioides* and *I. histrio* are similar taxa to each other in terms of their morphological characters. However, Mathew (1984), Güner & Peşmen (1980) reported that *I. histrio* and *I. histrioides* are two independent species based on the shape of their falls and chromosome numbers. Geographically, *I. histrioides* Fost. Ex Hayek is distributed only in the vicinity of Amasya, whereas *I. histrio* is distributed in Gaziantep, İçel and Hatay. Also, *I. histrio* is seperated into two subspecies as ssp. *histrio* and ssp. *aintabensis* G.P.Baker) B.Mathew by Mathew (1989), because of their variations in leaf, perigon tube and flowers segment measurements. But, the relationships between these two subspecies are still uncertain. Morphological characters (except the bract and outer perianth segments) of *I. danfordiae*(Baker) Boiss. and *I. celikii* Akpulat & K.I.Chr. are similar. But, based on differences in the falls and bract, Christensen & Akpulat (2004) reported that *I. danfordiae* and *I. celikii* may be considered as two independent species. *I. celikii* has limited distribution in Turkey (only in Hafik-Sivas). *I. danfordiae* is distributed in Niğde, Amasya and Ordu. *I. pamphylica* is an interesting species with a perigon tube of 2 cm in length and a flobby capsule. It is distributed only in Antalya and Mersin.

The purpose of this study is to determine the degree of relationships between investigated taxa regarding to their leaf anatomical characters and to designate taxonomic significance of leaf anatomical characters.

MATERIAL AND METHODS

Plant samples were collected from different locations in Turkey between 2010 and 2012. The sampling locations were shown in table 1. Taxonomic descriptions of the taxa were made according to Mathew (1984; 1989), Güner & Peşmen (1980), Christensen & Akpulat (2004). Fresh plant samples were fixed in 70 % alcohol solution and anatomical investigations were carried out on fresh and alcohol solution of the samples. Surface -sections from the upper and lower surfaces of leaves were taken. The epidermis and stoma cells numbers in 1 mm^2 of surface section were determined. The mean and standard devition values of these cells were calculated according to Seçer (2013) and stomata index was evaluated (Mesdner and Mansfield 1968).

Table 1. The localities where *Iris* taxa were collected in Turkey. "E" indicates endemic.

Taxon	Localities
I.bakeriana	Gaziantep: Yeşilce Village-Sof Mountain, *Quercus* forest, 1200 m., 10 March. 2010, Kandemir 434..
	Mardin: Savur-Pınardere Village, Menzeli place *Quercus* shrub calcareous areas, 900 m., 20 March 2010, Kandemir 435.
I. reticulata	Gaziantep: Yeşilce village-Sof Mountain, *Quercus* forest, 1000 m., 10 March. 2010, Kandemir 436.
	Maraş: Göksun-Acalmak Cennet Stream, *Abies* forest, 1800 m., 2 April 2010, Kandemir 439.
I.histrioides (E)	Amasya: Ziyaret-Altıpelit Plateau, bushy areas, 1000 m., 10 March 2010, Kandemir 439.
	Samsun: Ladik-Derebaşalan village, bushy areas, 1500 m., 17 March 2010, Kandemir 440.
I.celikii (E)	Sivas: Hafik-Celalli Village, road side, 1350 m., 17 April 2011, Kandemir 336.
I. danfordiae (E)	Amasya: Boğa Village, Kaşka mezrası, near culture areas, 750 m., 22 February 2011, Kandemir 427.
	Ordu: Mesudiye to Gölköy, Muzamana village vicinity *Quercus* shrub, rocky places, 1100 m., 6 Mach 2011, Kandemir 428.
I. histrio ssp. *aintabensis* ((E)	Gaziantep: Yeşilce Village-Sof Mountain, *Quercus* forest, 1200 m., 12 March 2011, Kandemir 430.
	Gaziantep: Bahçearası, Acarobası Village, Kesmeliburun place, scrub and calcareous rocky, 1100 m., 10 March 2012, Kandemir 431.
I. histrio ssp. *histrio*	Gaziantep: Islahiye-Fevzipaşa, Nur Mountain, 600-800 m., 10 March 2012, Kandemir 432.
	Mersin: Silifke-Uzuncaburç, Delikılıç place, scrub and vineyard, calcareous rocky, 1150 m., 12 March 2012, Kandemir 433.
I. pamphylica (E)	Antalya: Beşkonak-Düzağaç Village, Kızılca district, rocky places, 850-900 m., 14 March 2012, Kandemir 440.
	Mersin: Fındık Pınar Plataeu- Akarca Güzlesi village, roadside and open forest, 900-1100 m., 9 May 2012, Kandemir 441.

The plant samples were collected from two different localities. These localities have different altitudes. For each taxa, 10 plant samples were taken from two different localities. The paraffin method was used for preparing cross-sections of the leaf parts (Algan 1981). The cross-sections of leaves were taken with a microtome and the anatomical measurements were made with a micrometric ocular. The binocular microscope with drawing tube was used for drawing cross and surface-sections.

For the stasistical analysis, 12 characters of the leaves were used. While the characters were coded as A, B, C, D, E, F, G, H, J, I, K and L, the taxa were coded as 1, 2, 3, 4, 5, 6, 7 and 8 (Table 2). The significance of the difference between the leaf anatomic measurements of taxa collected from different altitudes were evaluated by using t-test (Seçer 2013). The results of analysis were given in tables 2-4.

RESULTS AND DISCUSSION

This study gives information about interspesific relationships of eight *Iris* taxa from Turkey based on leaf anatomical characters. Rudall (1994) gave a general description of leaf anatomy in *Iridaceae* family and reported the importance of leaf anatomical characters for the systematic of the family. Generally, *Iridaceae* family have ensiform leaves, with a bifacial equitant sheathing base and unifacial blade. In cross-section outline structure of leaves of family found terete leaves, quadrangular leaves and bifacial leaves.

We found that having terete, quadrangular, unifacial and bifacial leaves structure of these taxa. The leaves of *I. reticulata* and *I. histrioides* were unifacial ensiform type. But, the leaves of *I. bakeriana, I. celikii*, *I. danfordiae*, *I. pamphylica*, *I. histrio* ssp. *histrio* and *I. histrio* ssp. *aintabensis* were bifacial ensiform type. While *I. reticulata*, *I. histrioides, I. histrio* ssp. *histrio*, *I. histrio* ssp. *aintabensis*, *I. danfordiae*, *I. celikii* and *I. pamphylica* have quadrangular leaves (figs. 1a, c-g), *I. bakeriana* has terete leaves (fig. 1b). Epidermal cells were square shaped and large celled in *I. reticulata*, *I. histrioides*, *I. histrio* ssp. *aintabensis* and *I. bakeriana*; rectangular shaped and large celled in *I. celikii*; rectangular shaped and small celled in *I. danfordiae, I. histrio* ssp. *histrio* and *I. pamphylica*. The cuticle layer was thick in all taxa. Epidermal cells and cuticle layer were with konic papillae and micropapillae, respectively. Micropapillae on the cuticle layer were extremely conspicuous (*I. histrioides*, *I. bakeriana* and *I. pamphylica*) and slightly conspicuous (*I. reticulata*, *I. celikii*, *I. danfordiae*, *I. histrio* ssp. *histrio* and *I. histrio* ssp. *aintabensis*). Rudall & Mathew (1990) and Kandemir (2011) suggested that micropapillae on the cuticle layer and papillae in epidermis cells have some taxonomic significance.

The mesophyll consisted of palisade-like parenchyma cells in *I. reticulata* and *I. histrioides* (figs. 2a, c). This parenchyma was 2-(3) layered in *I. reticulata* M.Bieb. and 3-4 layered in *I. histrioides*. In the mesophyll of *I. reticulata* and *I. histrioides*, the spongy parenchyma was not observed. The parenchyma cells were large and dense with chloroplast. In *I. bakeriana, I. histrio* ssp. *histrio*, *I. histrio* ssp. *aintabensis, I. danfordiae*, *I. celikii* and *I. pamphylica* Hedge , mesophyll was of the bifacial type (figs. 2b, d-g). The palisade parenchyma was 1-(2) layered in *I. celikii* and *I. histrio* ssp. *histrio*, 2 layered in *I. danfordiae* and *I. pamphylica*, 1 layered in *I. histrio* ssp. *aintabensis* and *I. bakeriana*. The spongy parenchyma was 1-(2) layered in *I. celikii* and *I. histrio* ssp. *histrio*, 2 layered in *I. danfordiae*, *I. bakeriana* and *I. histrio* ssp. *aintabensis*, 1 layered in *I. pamphylica*. In all taxa, mesophyll cells at the center were large, oval shaped and without chloroplast. These cells were broken into pieces.

Vascular bundles were typically one row on each side of the leaf. Small bundles were between large bundles in mesophyll. In *I. bakeriana* is absent small bundles. Vascular bundles consisted of one layer of bundle sheath, thin walled and cells without chloroplast (except *I. celikii*). The bundle sheath cells were small in *I. histrioides* and *I. pamphylica*. While the vascular bundles in mesophyll of *I. reticulata* and *I. histrioides* followed one row paraenchyma below the epidermis (figs. 2a, c), the vascular bundles of *I. bakeriana*, *I. histrio* ssp. *histrio*, *I. histrio* ssp. *aintabensis*, *I. celikii* and *I. danfordiae* followed two row parenchyma below the epidermis (figs. 2b, d-f). In *I. pamphylica*, vascular bundles were below the epidermis (fig. 2g). There were sclerenchyma cells only in phloem pole of large and small vascular bundles (except *I. bakeriana*) and at the corners of the leaves.

In all taxa, stomata were large, dense and the anomocytic type. Stomata were below rather than the epidermis cells. They have two epidermis cells. The mean number of epidermis and stoma cells in 1 mm^2 in upper surfaces of the leaves were found to be: 132 and 89, 143 and 76, 151 and 114, 143 and 92, 77 and 132, 85 and 50, 145 and 102, 140 and 106 in *I. reticulata, I. histrioides, I. celikii, I. danfordiae*, *I. pamphylica*, *I. bakeriana*, *I. histrio* ssp. *histrio, I. histrio* ssp. *aintabensis,* respectively. The mean number of epidermal and stoma cells in 1 mm^2 in lower surfaces of the leaves were found to be: 126 and 107, 122 and 87, 142 and 130, 129 and 112, 79 and 136, 80 and 65, 138 and 105, 132 and 110 in *I. reticulata, I. histrioides, I. celikii, I. danfordiae*, *I. pamphylica*, *I. bakerniana, I. histrio* ssp. *histrio* and *I. histrio* ssp. *aintabensis*,

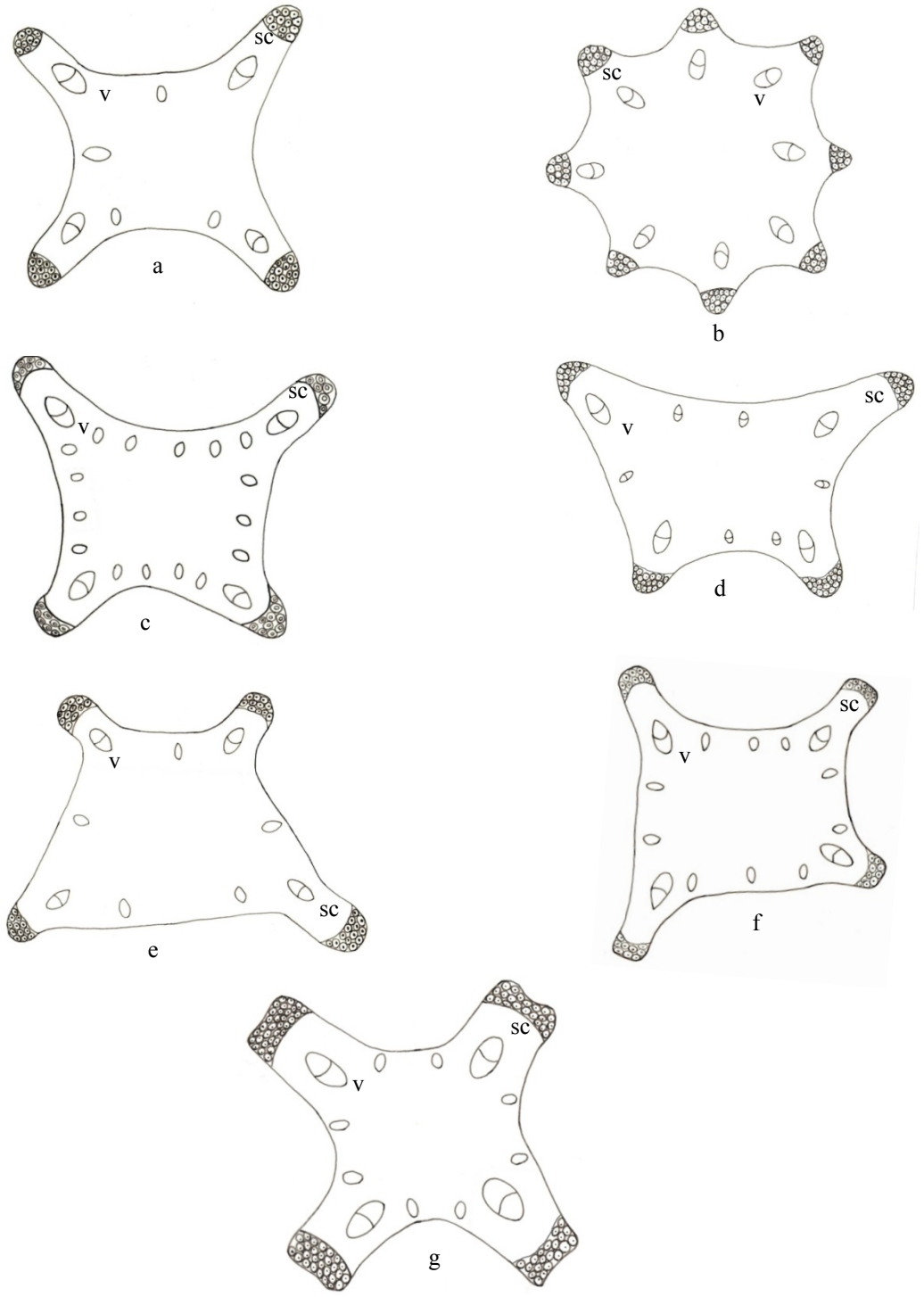

Fig. 1. The general leaf drawings of the *Iris* taxa. a, *I. reticulata*; b, *I. bakeriana*; c, *I. histrioides;* d, *I. histrio* ssp. *aintabensis*; e, *I. danfordiae*; f, *I. celikii*; g, *I. pamphylica*; v, vascular bundles; sc, sclerenchyma (Scale bars=100 µm).

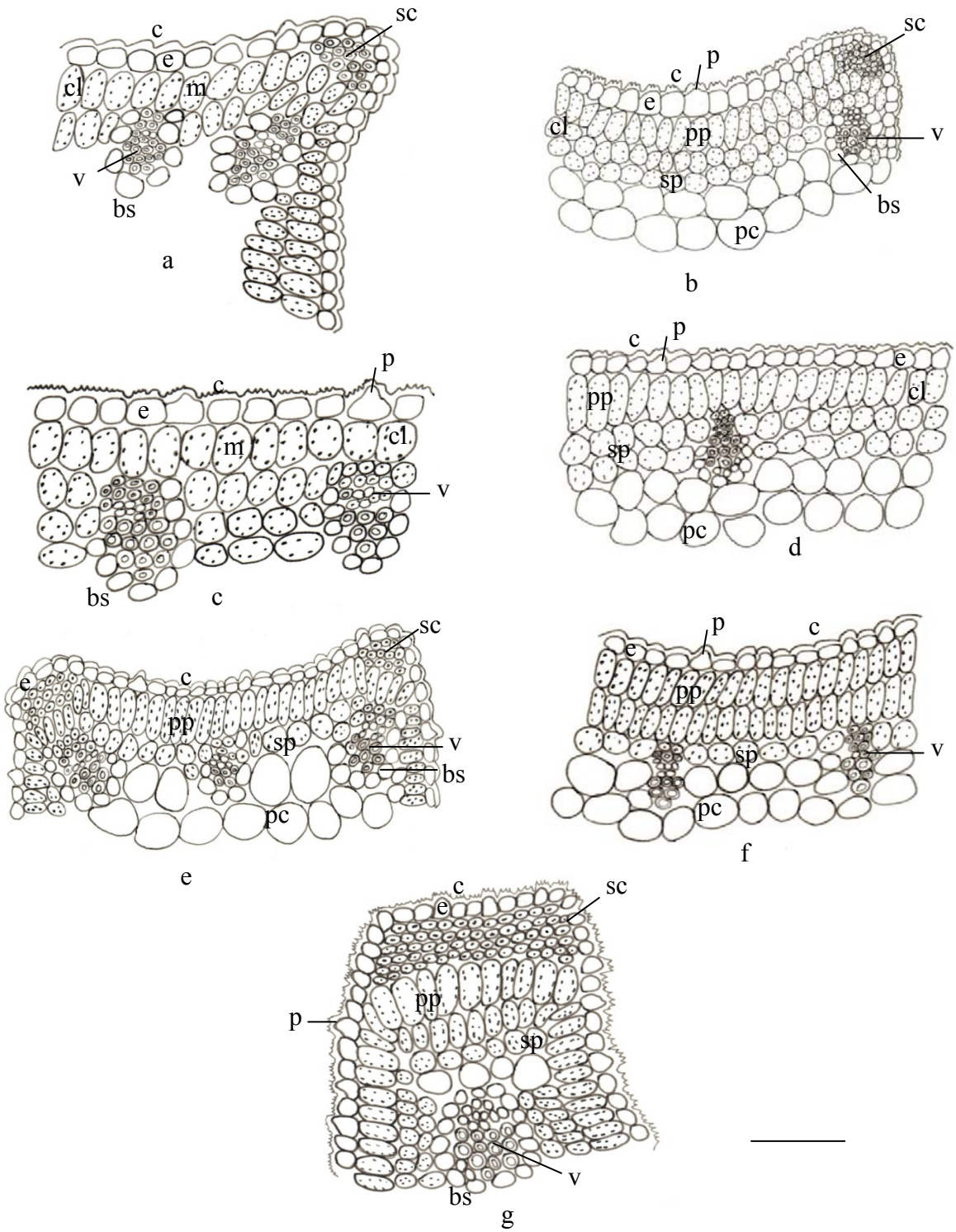

Fig. 2. The leaf cross-sections of the *Iris* taxa. a, *I. reticulata*; b, *I. bakeriana*; c, *I. histrioides*; d, *I. histrio* ssp. *aintabensis*; e, *I. danfordiae*; f, *I. celikii*; g, *I. pamphylica;* c, cuticle; e, epidermis; m, mesophyll; pp, palisade parenchyma; sp, spongy parenchyma; cl, chloroplast; v,vascular bundles; bs, bundle sheath.; sc, sclerenchyma; pc, parenchyma cell; p, papillae (Scale bars=100 µm).

respectively (table 3). The least number of stomata was determined in *I. bakeriana* whereas the most one was in ssp. *aintabensis* and *I. pamphylica*. When the stomata index of these taxa investigated, it is seen that the highest stomata index value is in *I. pamphylica* and the lowest one in *I. histrioides* both in lower and upper epidermis. According to the results, it is found out that the stomata number does not change in *I. histroides* but some changes are seen in other taxa. The biggest stomata is determined in *I. histrio* ssp. *aintabensis* and the smallest ones in *I. celikii* (figs. 3 a-g).

According to Wu & Cutler (1985), diversity of shape and size of styloid crystals are taxonomically important characteristics in *Iris* taxa. Franceschi & Nakata (2005) repoted that crystal shape and distribution are used as a taxonomic character. While dense crystalline granules were seen on leaves of *I. reticulata*, *I. bakeriana*, *I. celikii*, *I. danfordiae, I. histrio* ssp. *histrio*, *I. histrio* ssp. *aintabensis* and *I. pamphylica*, rare hexagonal crystals were seen on leaves of *I. histrioides*, *I. danfordiae, I. bakeriana, I. histrio* ssp. *histrio*, *I. histrio* ssp. *aintabensis* and *I. pamphylica*. Kandemir et al. (2012) reported that different styloids and small crystalline granules contained on the leaves and corm tunics of some *Crocus* L. taxa. Also, these characters informed can be important in distinguising of *Crocus* taxa.

According to statistical analysis, the leaf anatomic measurements of *I. bakeriana*, *I. reticulata*, *I. histrioides* and *I. danfordiae* do not have any significant differences at different altitudes (P>0.05) (Table 2). However, some variations in the leaf anatomic measurements of *I. pamphylica*, *I. histrio* ssp. *aintabensis* and *I. histrio* ssp. *histrio* are seen with regard to altitude (P<0.05) (Table 2). Also, it is determined that palisade and spongy parenchyma length-breadth, stomata number, trachea diameter and cuticle thickness are the best characteristics that represent the anatomic variations between these taxa relative to altitude (Table 2). According to table 4, there are important similarities among the leaf anatomic characters of some taxa such as, 2-3, 6-7, 4-5, 5-6, 4-6, 3-6 and 3-7. But there are no similarities among the leaf anatomic characters of taxa such as, 1-2, 1-3, 5-7, 6-8, 7-8, 5-8, 4-7, 2-6 and 2-7. There are important correlations among *I. histrio* ssp. *aintabensis, I. danfordiae*, *I. celikii* and *I. histrioides, I. reticulata* at the level of P>0.05 (Table 4). But, there are not correlations among *I. histrio* ssp. *histrio*, *I. danfordiae, I. celikii, I. bakeriana and I. pamphylica* (P<0.05).

Kandemir et al. (2011) reported neither positive nor negative correlations are seen between soil analysis results (p>0.05) of *I. reticulata* and *I. bakeriana*. Thus, Kandemir et al. (2011) proposed that *I. reticulata* and *I. bakeriana* are independent species relating to ecologic characteristics. According to the leaf anatomical characters, we also think that *I. bakeriana* and *I. reticulata* may be different species. The same state is seen in other *Iris* taxa in China by Yu et al. (2009), in *Crocus* taxa in Turkey by Kandemir (2011), in leaf anatomy of Iridaceae family in Australasian by Rudall (1986) and in leaf anatomy of the bulbous *Iris* taxa by Rudall & Mathew (1993). The *I. histrio*, *I. histrioides* and *I. reticulata, I. histrioides* and *I. danfordiae*, *I. celikii* were similar taxa to each other morphologically. However, *I. histrioides* was different from *I. histrio* and *I. reticulata* in chromosome number, structure and the shape of falls, *I. celikii* was different from *I. danfordiae* in bract colours and spotted perigon segments (Güner & Peşmen 1980; Christensen & Akpulat 2004). We see that *I. reticulata* and *I. histroides, I. danfordiae* and *I celikii* are closer species to each other in terms of leaf anatomic characters. However, *I. histrioides* are similar not only *I. histrio* ssp. *aintabensis* but also *I. histrio* ssp. *histrio* according to their leaf anatomic structure**.** Moreover, these similarities and diffences between these species and subspecies are supported by statistical results in this study (Table 4, p>0.05). Because of variations in perigon tube, falls and standarts measurements, *I. histrio* was seperated into two subspecies as ssp. *histrio* and ssp. *aintabensis* by Mathew (1989). According to the many similarities in the leaf anatomic characters of this study, we think that these two subspecies might be homonym of *I. histrio*, rather than of its subspecies**.** It is neccesary to make some researches on these taxa to claryify their taxanomic status.

It is seen that *I. pamphylica* and *I. bakeriana* are different species of subgenus *Hermodactyloides* in terms of leaf anatomic characters. This phenomenon has also been seen in the statistical analysis results of the two taxa (Table 4, p<0.05). Based on the pollen, morphological and anatomical characters of *I. pamphylica* is a different species of subgenus *Hermodactyloides* (Mathew 1989; Rudall 1994). These researchers reported that pollen and morphological characters of *I. pamphyllica* and *I. masia* are similar to each other. Not only pollen morphology of *I. pamphylica* show similarities to *I. masia* but also it shows similarities to other taxa of subgenus *Limniris* (except *I. lazica and I. unguicularis*). To determine the similarities in anatomical characters of these two taxa, anatomical investigations on *I. masia* should be made. Since *I. pamphylica* provided connection between subgenera *Hermodactyloides* and *Limniris* relating to polen and morphological characters, subgenus

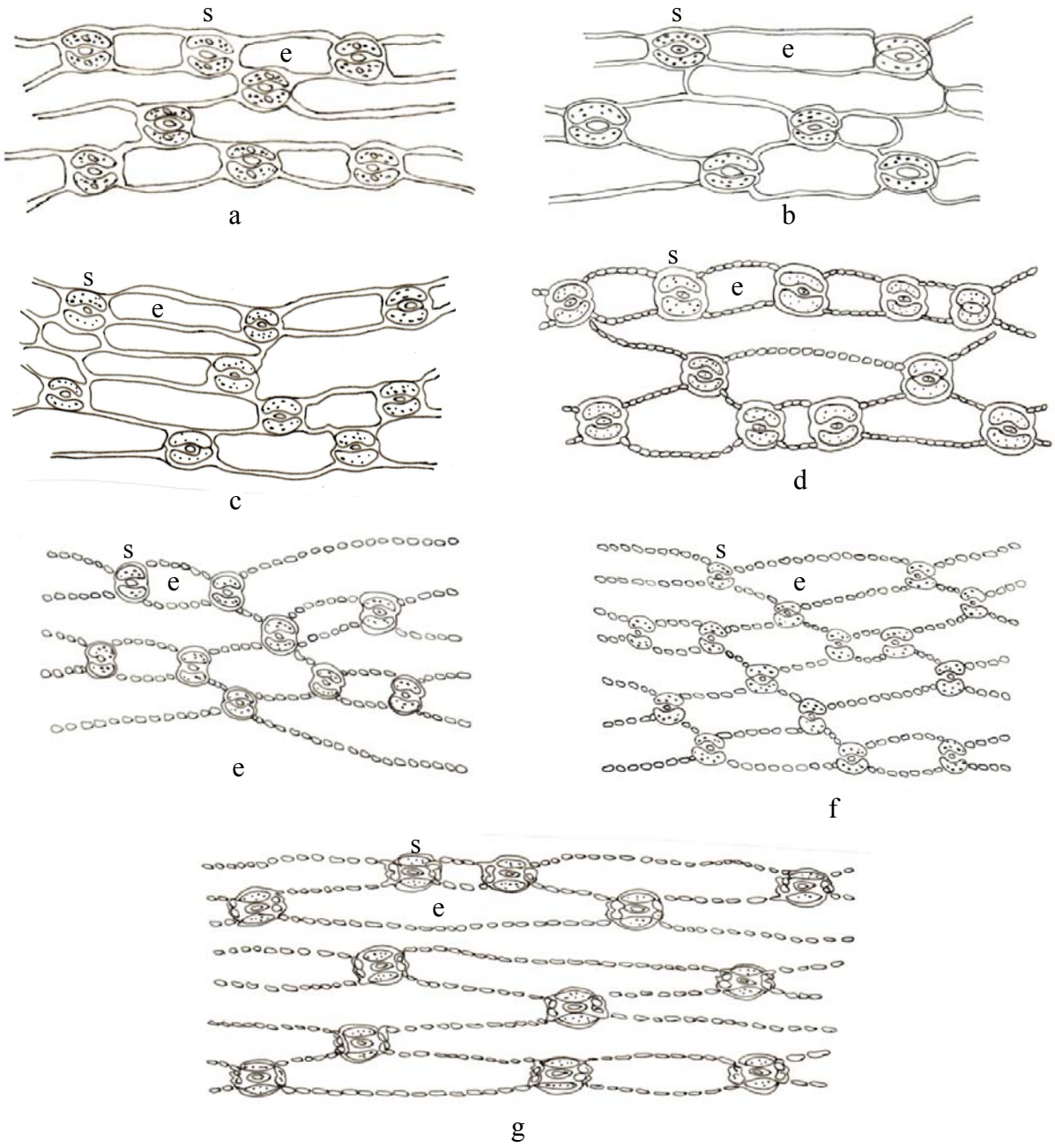

Fig. 3. The leaf surface-sections of *Iris* taxa (lower surface). a, *I. reticulata*; b, *I. bakeriana*; c, *I. histrioides*; d, *I. histrio* ssp. *aintabensis*; e, *I. danfordiae*; f, *I. celikii*, g, *I. pamphylica;* e, epidermis; s, stoma (Scale bars=100 µm).

Table 2. T-test values based on 12 leaf anatomical characters of the investigated *Iris* taxa. *: mean ± standard deviation values in first altitudes, **: mean ± standard deviation values in second altitudes

Taxa	Cuticle thickness (µm) (A)	Epiderma length (µm) (B)	Epiderma breadth (µm) (C)	Palisade length (µm) (D)	Palisade breadth (µm) (E)	Trachea diameter (µm) (F)	Phloem diameter (µm) (G)	Scleremchy diameter (µm) (H)	Sheathcell diameter (µm) (I)	Stoma number (1 mm^2) (J)	Spongy length (µm) (K)	Spongy breadth (µm) (L)	t and p values
1.*I. bakeriana*	*11.3 ±1.25 **13.7 ±1.15	23 ± 2.05 28.7 ± 2.35	22.1 ± 1.79 28.5 ± 2.75	34.4 ± 3.56 41 ± 5.16	19.8 ± 1.98 24.6 ± 3.40	12.6 ± 1.83 13.8 ± 1.31	8.3 ± 0.94 8.7 ± 0.94	6.9 ± 0.87 8.3 ± 0.67	22.4 ± 2.36 25.5 ± 2.27	50 ± 1.44 65 ± 1.37	28 ± 3.86 30.2 ± 2.36	29.7 ± 3.20 31.6 ± 2.93	t=-3.52, p>0.05
2.*I. reticulata*	12.1 ± 1.85 14.8 ± 0.78	26.7 ± 3.12 27.7 ± 2.05	27.5 ± 2.06 27.7 ± 2.05	43.5 ± 5.79 47.4 ± 3.23	26.5 ± 3.37 26.8 ± 2.52	17.7 ± 2.05 20.4 ± 1.57	10.2 ± 1.47 10.4 ± 1.57	8.0 ± 0.81 7.8 ± 0.78	24.9 ± 3.21 27.2 ± 2.20	87 ± 1.17 108 ± 1.15	_ _	_ _	t=-1.77, p>0.05
3.*I. histrio*ides	18 ± 3.71 21.3 ± 2.54	29.5 ± 3.68 29.5 ± 3.68	30 ± 4.08 30.2 ± 4.26	33.5 ± 5.29 42 ± 4.21	32.5 ± 5.40 32.4 ± 2.36	14.5 ± 2.54 18.2 ± 2.14	10.8 ± 1.13 10.6 ± 1.26	9.0 ± 1.05 9.3 ± 0.82	28.1 ± 2.28 28.1 ± 2.28	76 ± 1.05 87 ± 1.41	_ _	_ _	t=-2.07, p>0.05
4.*I. celikii*	12.9 ± 1.85	22 ± 2.58	24 ± 3.94	53 ± 4.21	33.5 ± 4.11	14.8 ± 2.04	6.6 ± 1.17	9.9 ± 1.47	_	132 ± 2.22	36 ± 3.94	35 ± 4.08	
5.*I. danfordiae*	16.2 ± 1.93 19 ± 1.63	17 ± 2.30 17.6 ± 2.36	22 ± 5.37 20.9 ± 3.72	55.5 ± 4.37 58.2 ± 5.49	30.5 ± 5.50 34 ± 3.94	20.5 ± 3.68 22.1 ± 2.18	14 ± 3.94 14 ± 2.90	13.3 ± 3.30 13.4 ± 2.95	17.8 ± 2.14 18.6 ± 2.06	92 ± 1.52 112 ± 1.17	32 ± 6.32 29 ± 3.16	31.5 ± 7.09 29 ± 4.59	t=-1.22, p>0.05
6.*I. histrio* ssp. *aintabensis*	10 ± 1.63 12.5 ±1.64	21.6 ± 2.01 28.4 ± 2.22	22.6 ± 1.77 28.4 ± 1.64	39.8 ± 1.39 42.5 ± 5.40	21.5 ± 1.77 29.2 ± 2.20	17.6 ± 1.71 19.6 ± 1.17	9.8 ±1.39 11 ± 1.24	7.5 ± 1.26 8.8 ± 1.03	14.4 ± 1.42 21.7 ± 2.45	104 ± 1.22 106 ±1.15	33.4 ± 4.08 27.9 ± 2.18	29.4 ± 3.47 25.2 ± 3.29	t=-1.98, p<0.05
7.*I. histrio* ssp. *histrio*	8.4 ± 0.81 10.3 ±1.76	13.8 ± 0.99 17.3 ± 1.33	18.1 ± 1.58 26.3 ± 2.45	38.9 ± 2.36 46 ± 3.94	18.2 ± 1.39 29.1 ± 1.52	13.1 ± 1.98 17.4 ± 1.89	6.3 ± 1.22 10 ± 1.56	7.8 ± 1.08 8.3 ± 1.15	18.1 ± 1.49 22.5 ± 2.32	94.1 ± 1.17 106 ± 1.07	34.3 ± 3.68 29.8 ±1.47	33.1 ± 2.33 28 ± 1.69	t=-2.53, p<0.05
8.*I. pamphylica*	9.0 ± 0.81 10.3 ± 1.33	14.5 ± 2.87 21.6 ± 3.06	18.1. ± 2.07 22.9 ± 2.33	35 ± 4.71 49 ± 4.59	23.5 ± 4.74 29.5 ± 5.98	16.7 ± 3.09 18.8 ± 1.31	9.8 ± 0.91 10.1 ± 1.52	10.3 ± 1.33 12.4 ± 2.01	29 ± 3.94 34.5 ± 3.68	132 ± 2.36 137 ± 1.17	27.6 ± 2.06 23 ± 1.69	24.8 ± 1.75 21.2 ± 1.39	t=-2.28, p<0.05

Table 3. Stomata properties on the upper and lower epiderma of leaves in investigated *Iris* taxa (mean ± standard deviation)

	I. bakeriana	*I. reiculata*	*I. histrioides*	*I. celikii*	*I. danfordiae*	*I. histrio* ssp. *aintabensis*	*I.histrio* ssp. *histrio*	*I. pamphylica*
Number of stomata in upper surface (1mm^2)	50 ± 1.10	89 ± 1.17	76 ± 0.97	114 ± 1.96	92 ± 1.10	106 ± 1.27	102 ± 1.72	132 ± 2.05
Number of epidermis cells in upper surface	85 ± 1.17	132 ± 1.17	143 ± 2.04	151 ± 1.35	143 ± 1.77	140 ± 1.15	145 ± 1.55	77 ± 1.33
Stomata index	37.03	40.27	35.18	43.01	39.14	43.08	41.29	63.15
Number of stomata in lower surface	65 ± 1.40	107 ± 1.15	87 ±1.39	130 ± 1.43	112 ± 1.28	110 ± .60	105 ± 1.28	136 ± 1.26
Number of epidermis cells in lower surface	80 ± 1.25	126 ± 1.47	122 ± 1.70	142 ± 2.07	129 ± 1.13	132 ± 1.82	138 ± 1.89	79 ± 1.03
Stomata index	44.82	45.92	41.62	47.79	46.47	45.45	43.20	63.25
Stomata lenght (µm)	35-40	45-48	40-45	30-34	30-38	45-52	45-50	40-50
Stomata breadth (µm)	22-28	25-30	28-35	20-28	25-30	30-40	30-38	30-35

Table 4. Correlations based on t- test between investigated *Iris* taxa.

Taxon	Mean differences	t values	p values	Signi-ficance		Taxon	Mean differences	t values	p values	Signi-ficance
1 – 2	7.48	2.11	0.034 p < 0.05	*		5 – 8	6.95	2.22	0.026 p < 0.05	*
2 – 3	0.41	0.202	0.845 p > 0.05	NS		4 – 7	-8.52	-2.53	0.030 p < 0.05	*
1 – 3	-7.55	-2.96	0.016 p <0.05	*		4 – 6	-5.65	-2.08	0.064 p > 0.05	NS
6 – 7	-2.32	-1.87	0.088 p > 0.05	NS		3 – 7	4.45	1.35	0.209 p > 0.05	NS
4 – 5	-3.25	-0.82	0.430 p >0.05	NS		3 – 6	1.20	0.307	0.766 p >0.05	NS
5 – 7	-4.80	-2.79	0.017 p < 0.05	*		2 – 7	4.86	3.02	0.014 p < 0.01	*
5 – 6	-2.48	-1.20	0.252 p >0.05	NS		2 – 6	-5.61	-2.73	0.045 P< 0.05	*
6 – 8	-6.52	3.52	0.030 p < 0.05	*		7 – 8	-3.85	-3.10	0.029 p < 0.05	*

NS, non significant; * significant at the level of 0.05

Hermodactyloides might be accepted as intermediate subgenus in the genus *Iris.* Moreover, Mathew (1989) and Mathew & Atay (1998) informed that seperation of subgenus *Hermodactyloides* were unneccesary because of this connection. The anatomical and statistical findings in this study support the idea that the subgenus *Hermodactyloides* should not be seperated from the *Iris* genus.

In investigated taxa, xeoromorphic leaves properties were seen such as; stomata were below the epiderma cells, mesophyll was in isolateral and unifacial structure, there was a parenchyma on the mesophyll that kept water, dense sclerenchyma cells in the vascular bundles and on the edge of the leaf, extending to the epiderma of the sclerenchyma as girders. These characters were found in the other plant (Rudall & Mathew 1990; Rotondi et al. 2003).

In leaf anatomical characters of investigated taxa, some differences such as; the layer number and structure of mesophyll, the shape of the epidermis cells, whether they have papilae in epiderma, position micropapillae on the cuticle layer, leaf outline structure, the position of the vascular bundles in mesophyll, stomata number, crystal types of leaf were found**.** We think that these characters are used as distinguished taxonomic character in the classification of these taxa. In addition to the different properties, some similar properties such as; stomata are similar type, there is sclerenchyma in the vascular bundles and at the corner of the leaf, there is sheath bundle around the vascular bundles, (except *I. celikii*), the cells in the center of mesophyll are similar in structure and there is the vascular bundles in the mesophyll were determined in the leaf anatomical of investigated taxa

Apart from some exceptions such as; structure of mesophyll, leaf outline structure, whether they have papilae and micropapillae in epiderma and cuticle in this study, it is determined that there is a close relation between the taxanomic state and leaf anatomic properties of investigated *Iris* taxa.

REFERENCES

Algan, G. 1981: The microtechnic for plant tissues. – Fırat University Press, Turkey.

Christensen, K.I. & Akpulat, H.A. 2004: *Iris celikii* (Iridaceae) a new species from north-eastern Turkey. –Nordic Journal of Botany 24: 207-210.

Franceschi, V.R. & Nakata, P.A. 2005: Calcium oxalate in plants: formation and function. –Annual Review Plant Biological 56: 41-71.

Güner, A. & Peşmen, H. 1980: Taxonomical studies on some *Iris* L. species. –Natural Journal Function Sciences. 4: 25-37.

Hanawa, F., Thara, S. & Mizutani, J. 1991: Isoflavonoids produced by *I. pseudacorus* leaves treated with cupric chloride. –Phytochemistry 30: 157-163.

Kandemir, N. & Engin A. 2000: An autecological study on *Iris histrioides* Foster (Iridaceae) distributed in the Central Black Sea Region. –Turkish Journal of Botany 24: 347-354.

Kandemir, N. 2011 a: Comparative leaf anatomy of some endemic *Crocus* L. taxa fromTurkey. – Bangladesh Journal of Botany 40: 155-162.

Çelik, A. & Sürücü, A. 2011b: Ecological response of some *Iris* L. taxa (Iridaceae) in Turkey. –Bangladesh Journal of Botany 40: 177-184.

Kandemir, N., Çelik, A. & Yayla, F. 2012: Comparative anatomic and ecologic investigations on some endemic *Crocus* taxa (Iridaceae) in Turkey. –Pakistan J ournal of Botany 44: 1065-1074.

Mesdner, H. & Mansfield, T.A. 1968: Physiolgy of stomata. –London, McGraw-Hill.

Mathew, B. 1984: *Iris* L. In: Davis P.H. (ed.), Flora of Turkey and the East Aegean Islands 8: 382-410. –Edinburg University press Edinburg.

Mathew, B. 1988: *Iris* L. In: Davis P.H., Mill, R.R. & Tan, K. (eds.), Flora of Turkey and the East Aegean Islands 10: 227-228. –Edinburg University press, Edinburg.

Mathew. B. 1989: A taxonomic revision of *Iris* subgenus *Hermodactyloides* (Iridaceae). In: Tan, K. (ed.), Plant taxonomy, phytogeography and related subjects. 81-109. –Edinburg University press. Edinburg.

Mathew, B. & Atay S. 1998: Some interesting observations on *I. pamphylica*. –The Karaca Arboretum Magazine 4: 167-172.

Rotondi, A., Rossi, F., Asunis, C. & Cesaraccio C. 2003: Leaf xeromorphic adaptations of some plants of acoastal Mediterranean macchia Ecosystem. –Journal Mediterranean Ecology 4: 25-35.

Rudall, P. 1986: Taxonomic significance of leaf anatomy in Australasian Iridaceae. –Nordic Journal of Botany 6: 277-289.

Rudall, P. & Mathew, B. 1990: Leaf anatomy in *Crocus* (Iridaceae). –Kew Bullettin 45: 535-544.

Rudall, P. & Mathew, B. 1993: Leaf anatomy of the bulbous Irises. –Botanishe Jahrbücher für systematische 115:63-76.

Rudall, P. 1994: Anatomy and systematics of Iridaceae. – Botanical Journal of the Linnean Society 114: 1-21.

Seçer, I. 2013: Pratical data analysis using SPSS and LISREL. –Anı pubication, Turkey.

Wu, Q.G. & Cutler, D.F. 1985: Taxonomic, evolutionary and ecological implications of the leaf anatomy of rhizomatous *Iris* species. –Botanical Linnean Society 90: 25\3-303.

Yu, F.X., Zhang, H.Q., Yuan, M. & Zhou, Y.H. 2009: Karyotype studies on ten *Iris* species (Iridaceae) from Sichuan, China. –Caryologia 62: 253-260.