Düzce University
Journal of Science & Technology

Research Article

A Morphological Study on Five *Polygonum* L. (Polygonaceae) Species from Turkey

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ABSTRACT

In this paper, five *Polygonum* L. (*P. lapathifolium* L., *P. persicaria* L., *P. arenastrum* Boreau, *P. bellardii* All., *P. arenarium*) species are examined morphologically for the systematic purposes by using trinocular microscope and Scanning Electron Microscope (SEM). With this study many morphological variations and properties were determined from studied samples and the results compared to the similar investigations done before and with Flora of Turkey. Moreover with this study new morphological properties for diagnostic purposes have determined and the description of studied *Polygonum* species have extended.

Keywords: *Polygonum*, Morphology, Systematic

Türkiye'den Beş *Polygonum* L. (Polygonaceae) Türü Üzerine Morfolojik Bir Çalışma

ÖZET

Bu çalışmada trinoküler ve taramalı elektron mikroskobu kullanılarak beş *Polygonum* L. türü (*P. lapathifolium* L., *P. persicaria* L., *P. arenastrum* Boreau, *P. bellardii* All., *P. arenarium*) sistematik amaçlı morfolojik olarak araştırıldı. Bu çalışma ile çalışılan örneklerden birçok özellik ve varyasyon tespit edilerek, elde edilen sonuçlar Türkiye florası ve konuyla ilgili daha önce yapılmış çalışmalarla karşılaştırıldı. Ayrıca bu çalışma ile bitkilerin teşhisinin kolaylığı açısından yeni morfolojik özellikler tespit edilerek çalışılan *Polygonum* türlerinin deskripsiyonu genişletildi.

Anahtar Kelimeler: *Polygonum, Morfoloji, Sistematik*

Received: 18/07/2014, Accepted: 22/07/2014

I. INTRODUCTION

THE Polygonaceae Juss. family is a cosmopolitan family, which has about 48 genera and 1200 taxa [1] and geographically distributed from the tropics to the arctic regions [2]. Polygonaceae include eight genera (*Atraphaxis* L., *Pteropyrum* Jaub. & Spach., *Calligonum* L., *Rheum* L., *Oxyria* Hill., *Polygonum* L., *Rumex* L. and *Emex* Campd.); herbs, shrubs or climbers; leaves generally alternate and simple; stipules usually united into a membraneous sheath (ochrea) around the stem (nodes are typically swollen); flowers in spikes, fascicles or panicles, hermaphrodite or unisexual, actinomorphic; pedicels with a marked articulation; petals absent; fruit a trigonous or lenticular nut, often enclosed in the persistent perianth in the Flora of Turkey. The genus *Polygonum* L. consist five sections: Aconogonon, Bistorta, Persicaria, Polygonum and Tiniaria and include thirty one taxa in Turkey [3-6]. *Polygonum* taxa are annual, perennial or suffrutescent herbs, perianth segments ± equal, free or united, petaloid above. Stamens usually 8, stigmas 2 or 3, fruit a trigonous or lenticular nut, always at least partially enclosed in the persistent perianth. *Polygonum* is a taxonomically difficult genus that classification of *Polygonum* taxa in Turkey is made more difficult by the apparent under-collecting of the weedy species. In the description of the taxa, colour of the perianth refers to the upper petaloid part only, the lower parts being usually greenish [3].

The taxonomic researches about *Polygonum* taxa is especially based on morphological features such as vegetative anatomy and trichome features [7], chromosome propeties [8] and pollen morphology [9]. Woodehouse (1931) was the first to publish a comprehensive study on pollen morphology of the Polygonaceae family [10]. In later years palynological characters were examined in relation to classification of this family [11]. The identification keys of *Polygonum* taxa are especially based on homo or heterophylly, flower colour, indumentum structure and ochrea shape and texture [12]. Due to the high hybridization rate [13], phenotypic variability [14], apparent under-collecting of the weedy species, correct identification is definitely very complicated in *Polygonum* species. Classifying of Polygonaceae taxa has remained a problem to be solved among the taxonomists [12]. The infrageneric classifications of *Polygonum* have long been studied by various taxonomists [15,16]. The traits of the seed and achene morphology have been detected as illuminating traits in the identification of *Polygonum* taxa [17]. With this study some morphological characters of five *Polygonum* species were determined for the systematic purposes and the description of studied *Polygonum* species have extended.

II. EXPERIMENTAL

Plant samples were dried according to standart herbarium techniques, and identified with second volume of Flora of Turkey [3] and stored in the Bingöl University Herbarium (BIN). Morphological characters of *Polygonum* species were determined by Trinocular Microscope (Leica) and scanning electron microscope (JEOL-JSM 6510) coated with gold, in Bingöl University central laboratory and with a Hitachi SU-1500 scanning electron microscope (SEM), coated with gold, in Wilfrid Laurier University (Canada) Herbarium (Biology). Studied samples collected below localities; *P. lapathifolium*: South of Yelesen village (Bingöl), steppe, 10.07.2013, 1600-1700 m., Kılıç 5514 (BIN-1275). *P. persicaria*: Entrance of Dikme village (Bingöl), roadside, 03.08.2013, 1600-1700m., Kılıç 5582 (BIN-1276). *P. arenastrum*: Vicinity of Taşkesen village (Elazığ), grasslands, 05.08.2009, 980-1000 m., Kılıç 1502 (BIN-1321). *P. bellardii*: Vicinity of Güneytepe village (Elazığ), sandy and moist areas, 20.06.2009, 1250-1270 m., Kılıç 1362 (BIN-1322). *P. arenarium*: West of Dikme upland, steppe, 10.07.2013, 1600-1700m. Kılıç 5534 (BIN-1320).

III. RESULTS & DISCUSSION

Genus *Polygonum* is characterized by the presence or absence of climbing stem, ochrea and eight stamens; morphologically, species of *Polygonum* could be distinguished from each other generally by some characters which were showed in Tables 1-5 and Figs. 1-10. Studied *Polygonum* species had variation degree of yellow glands on peduncles, perianth tube, flowers and perianth lenght [3]. To some extent quantitative characters such as plant climbing or not, leaf, ochrea, inflorescence, perianth, flower, peduncle and pedicel length also proved to be taxonomically important characters in *Polygonum* taxa (Tables 1-5).

1. *P. lapathifolium* L. (Syn: *P. nodosum* Pers.)

Table 1. *Comparisons of examined specimen (P. lapathifolium) with Flora of Turkey.*

	***P. lapathifolium* in Flora of Turkey**	***P. lapathifolium* in this study**
Plant	Tall annual	Annual herb, 33- 40 cm tall
Leaves	Lanceolate to very narrowly elliptic, cuneate at the base, usually glabrous, and always with pellucid, yellowish glands beneath	Lanceolate alternate, 4-7.5 x 0.5-1 cm petiolate, narrowly elliptic, cuneate at the base, upper surface glabrous sometimes edge and midrib pubescent, lower surface ± pubescent in midrib region
Stem	Ascending to erect, branched	Erect or ascending, greenish brown, hollow-round and ridged, upper part leafy-lower ± woody, internodes 2-6 cm long with sparse pillose hairs
Ochrea	Brownish, entire	Ochreae 2-5 mm, tubular, ovate, entire, brownish, glabrous
Peduncle and pedicel	With subsessile yellow glands	Peduncle 2-3.5 cm long, with subsessile yellow glands. Pedicel 1-1.2 mm long
Nut	Nut dark brown and glossy	Nut 1.5-2 × 0.5-1.5 mm, broadly ovate, biconvex, shining, blackish brown
Inflorescence	Inflorescence a dense, stout, oblong spike	Inflorescence axillary raceme or spike with variable number of flowers
Flower	Flowers usually pink	Flower 2-3 × 1-1.5 mm, bright pink
Perianth	c. 2 mm.	c. 2-2.5 mm., tepals 4, 1.5-2 × 0.5-1 mm, in two whorls, whitish, elliptic, 2 tepals with acute apex and 2 obtuse, entire
Pollen class, shape and surface	--	Tricolporate, subprolate, granulate

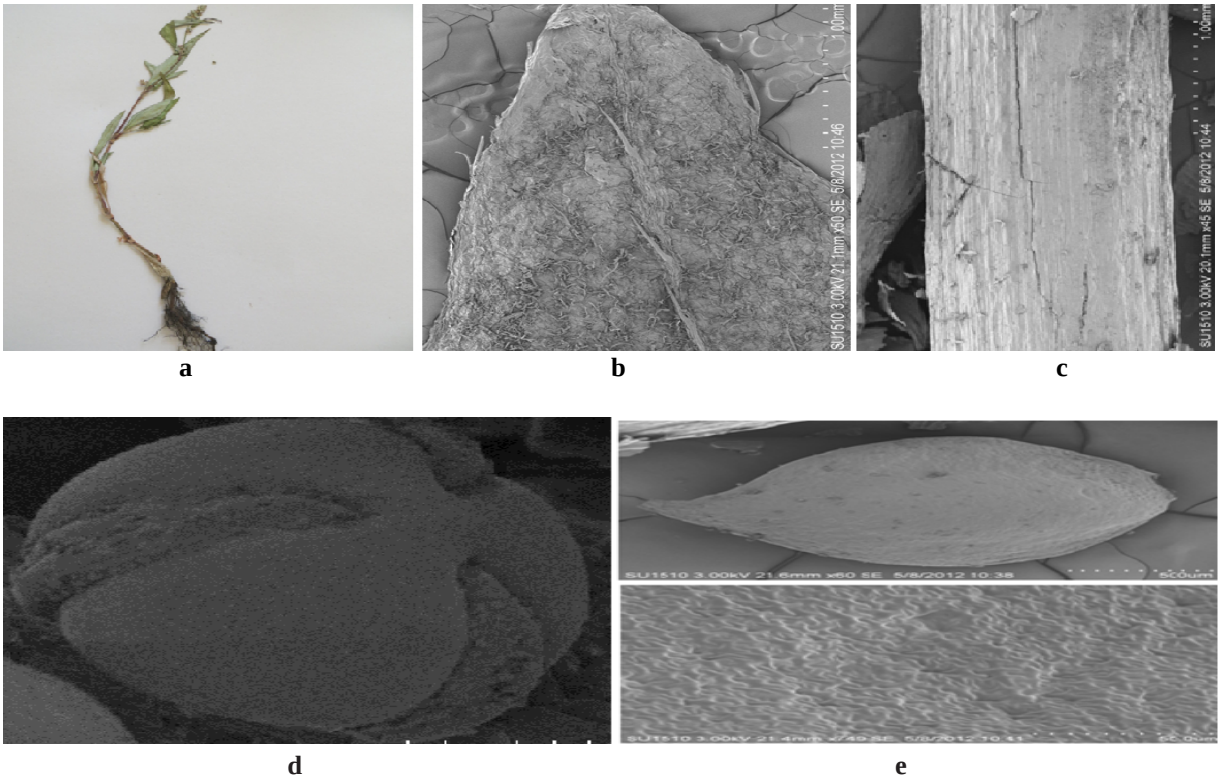


Figure 1. *(a) General view, (b) leaf surface, (c) stem, (d) pollen (e) seed and seed surface of P. lapathifolium.*

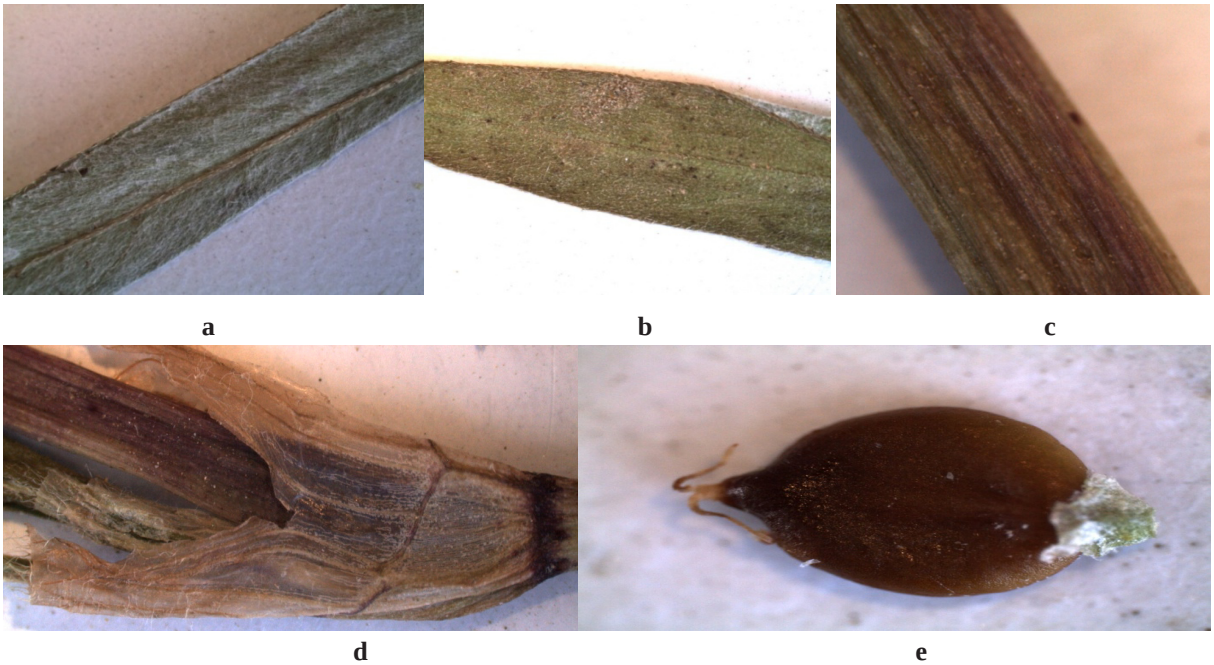


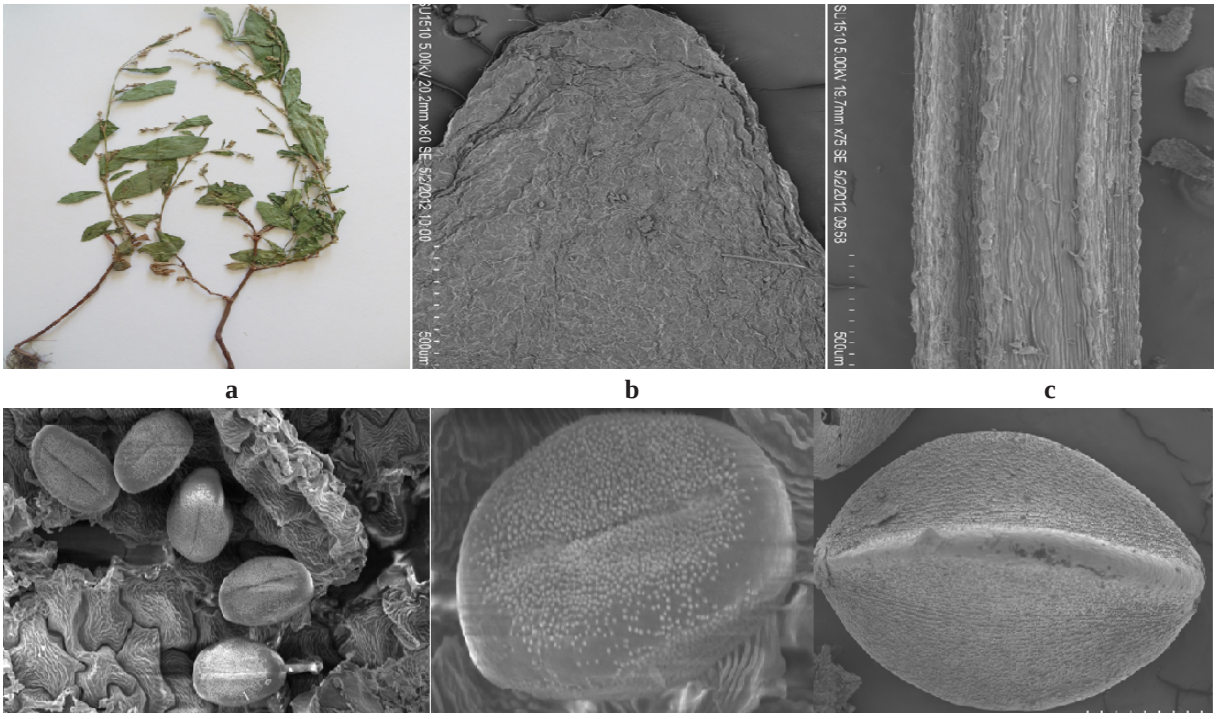
Figure 2. *(a) Lower surface of leaf, (b) upper surface of leaf, (c) stem, (d) ochrea, (e) seed of P. lapathifolium.*

The ochrea, peduncle, pedicel, nut, inflorescence, flower, perianth and pollen properties of *P. lapathifolium* has showed some differences from Flora of Turkey. These characters can be seen in Table 1. *P. lapathifolium* very similar to *P. persicaria*, but in terms of some features sperated from *P. persicaria* (Tables 1,2). So with this study new morphological properties for diagnostic purposes have detected and the description of *P. lapathifolium* have extended.

2. *P. persicaria* L.

Table 2. *Comparisons of examined specimen (P. persicaria) with Flora of Turkey.*

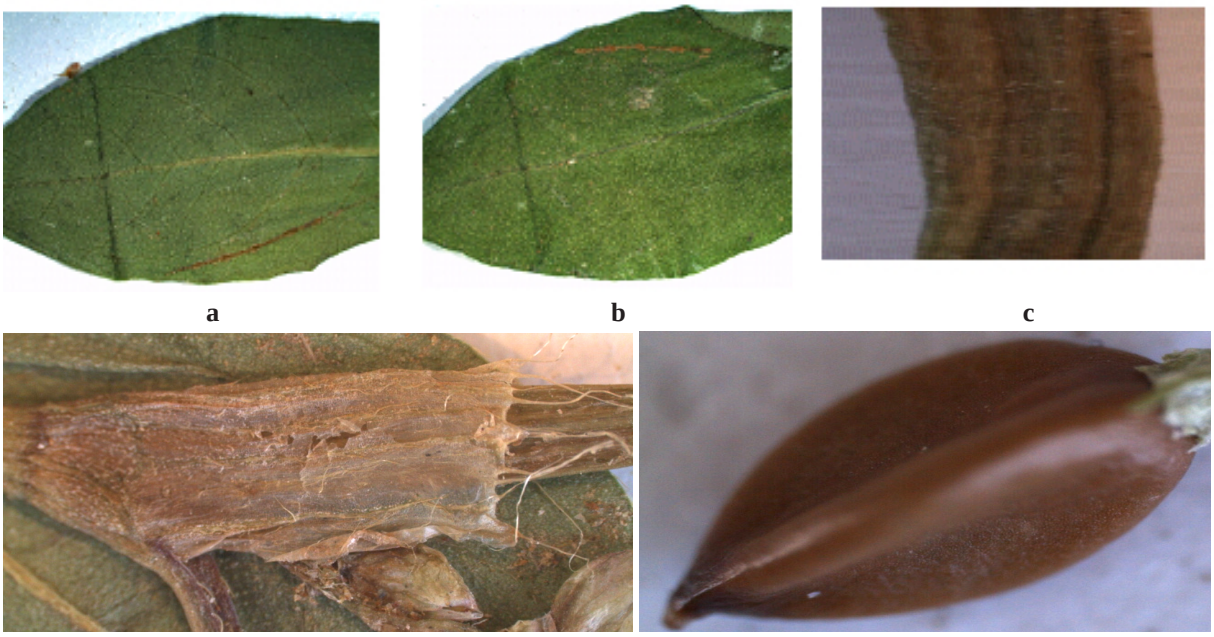
	***P. persicaria* in Flora of Turkey**	***P. persicaria* in this study**
Plant	--	Annual herb, 28-35 cm tall
Leaves	Eglandular	Scarcely brownish blotched, narrowly elliptic, enlarged to apex alternate, apex obtus, 2-7.5 x 0.5-2 cm, petiolate, cuneate at the base, glabrous, scarcely pubescent in edge
Stem	--	Erect, ascending or decumbent, brownish but upward greenish, branched or not, hollow, internodes 1.5-5 cm, glabrous
Ochrea	Ciliate	Ochreae 1-1.5 mm, narrowly tubular, entire, pellucid light brow, ciliate at apex and with brown veins.
Peduncle and pedicel	Eglandular	Peduncle 1.5-3. cm long, glabrous or rarely with a few glands, pedicel 0.7-1 mm, long
Nut	--	Nut 2-3 × 1-1.5 mm, broadly ovate, trigonous or compressed, equal or longer than perianth, blackish brown
Flower	Bright pink	Flower 2-3.5 × 1.5-2 mm, bright pink
Perianth	--	c. 2-2.5 mm., tepals 4 obtuse, 1-2 × 0.5-1 mm, pinkish or rarely whitish, elliptic, entire
Pollen class, shape and surface	--	Tricolporate, subprolate, granulate



a **b** **c**

d **e** **f**

Figure 3. *General view (a), leaf surface (b), stem (c), pollen (d), pollen surface (e) and seed (f) of P. persicaria.*



a **b** **c**

d **e**

Figure 4. *(a) Lower surface of leaf, (b) upper surface of leaf, (c) stem, (d) ochrea, (e) seed of P. persicaria.*

In Flora of Turkey general properties, stem, nut, perianth and polen features of *P. persicaria* is unspecified; with this study these characters have determined and the descritions of the *P. persicaria* have extented.

3. *P. arenastrum* Bor., (Syn: *P. aequale* Lindm.)

Table 3. *Comparisons of examined specimen (P. arenastrum) with Flora of Turkey.*

	***P. arenastrum* in Flora of Turkey**	***P. arenastrum* in this study**
Plant	Annual herb	Annual herb, abundantly branched and rosette forming, 25 - 48 cm high
Leaves	Elliptic	Alternate, 0.5-1.5 × 0.2-0.7 cm, petiole 1-1.5 mm long, lamina elliptic - oblong, entire, revolute, pinnat, both surfaces glabrous.
Stem	Usually procumbent or prostrate, mat-forming	Stem prostrate, ascending or procumbent, glabrous, ± round, ridged, green to brownish with scarcely brownish punctate
Ochrea	Ochrea much smaller than the internodes, brownish-based, with faint nerves	Ochreae much smaller than the internodes, 5-10 mm, silvery, brownish-based, ovate, hyaline, lacerate, clearly nerved
Nut	Nut dull, 1.5-2 mm, not or scarcely exerted from the perianth	Nut 2-2.5 × 1-1.2 mm, ovoid, trigonous, blackish and smooth, not or scarcely exerted from the perianth
Inflorescence	--	Inflorescence is solitary, in fascicles, usually in the axil ofupper leaves
Flower	Borne in fascicles in the axils of the upper leaves	Flower 2-3 × 1-1.5 mm, pedicel 1-1.5 mm, articulated at the end, tepals 5 parted, 1.5-4 × 0.5-1 mm, entire, elliptic - oblong
Perianth	Less than 3mm, pinkish or white	2-2.5 mm, greenish and pinkish at apex
Pollen class, shape and surface	--	Tricolporate, spherodial, circular, granulate

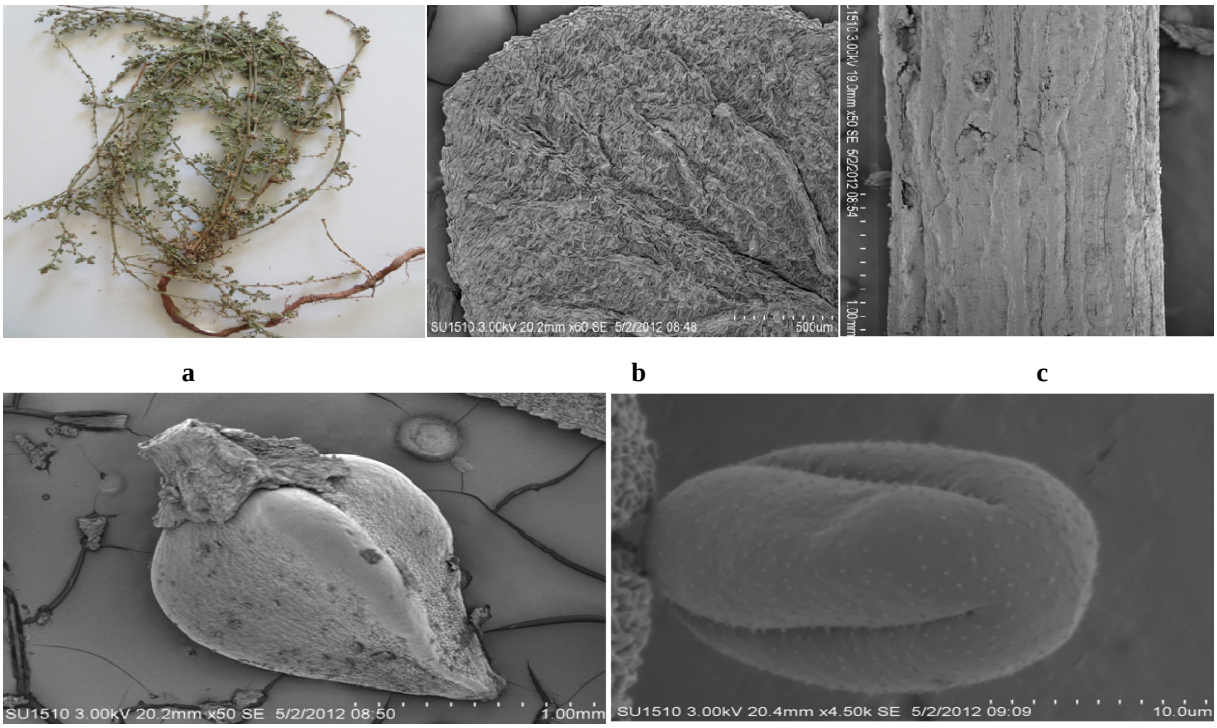


Figure 5. *General view (a), leaf surface (b), stem (c), seed (d) and pollen (e) of P. arenastrum.*

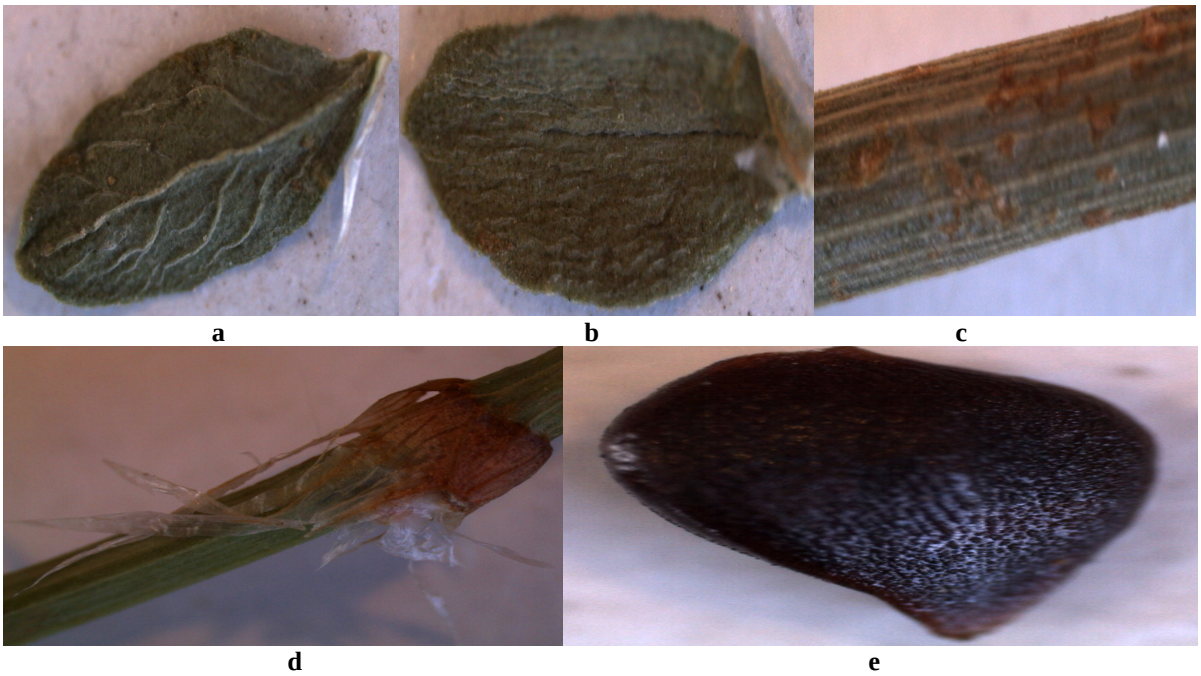


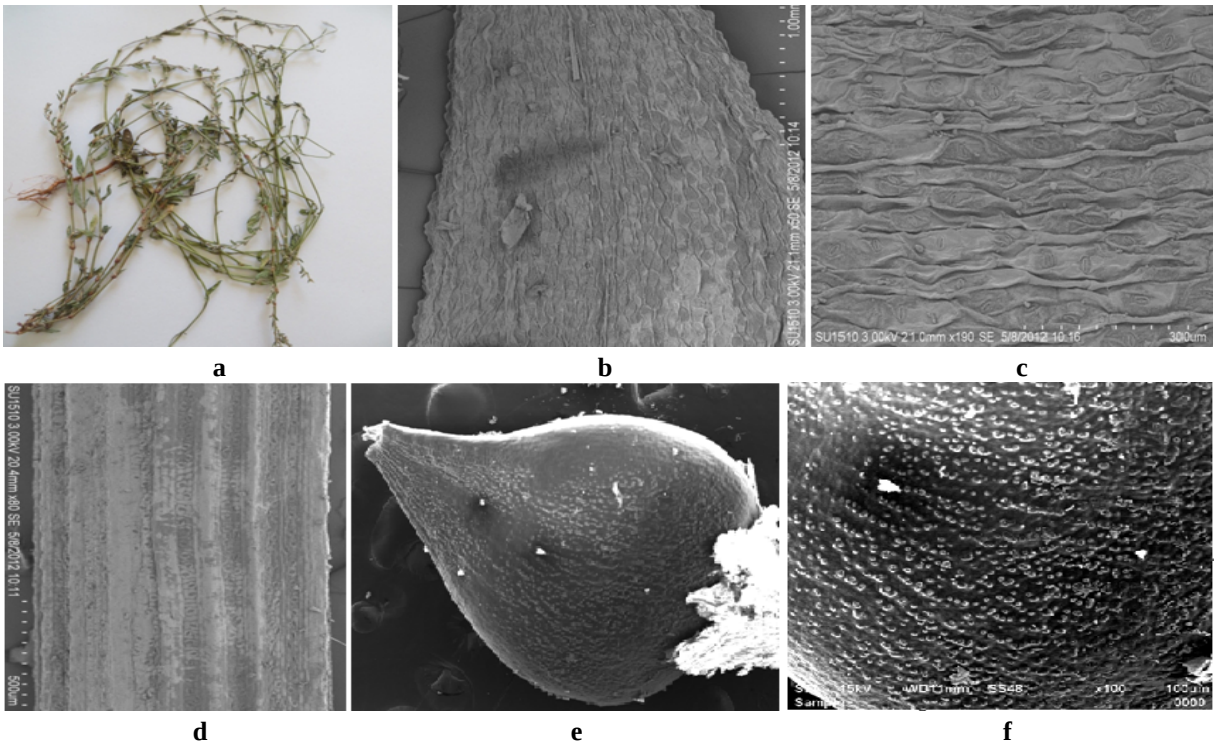
Figure 6. *(a) Lower surface of leaf, (b) upper surface of leaf, (c) stem, (d) ochrea, (e) seed of P. arenastrum.*

P. arenastrum and *P. arenarium* were found to be closely related to each other but the presence of prostrate stem, clearly nerved ochreae, structure of perianth tube and blackish-smooth nut in *P. arenastrum* best distinguished it from *P. arenarium.* Moreover extensive descriptions of the morphological characteristics of *P. arenastrum* have been given in this study (Table 3).

4. *P. arenarium* Waldst. & Kit.

Table 4. *Comparisons of examined specimen (P. arenarium) with Flora of Turkey.*

	***P. arenarium* in Flora of Turkey**	***P. arenarium* in this study**
Plant	Prostrate or weakly ascending annual herbs	Prostrate or ascending, glabrous annual herb, 30-50 cm.
Leaves	Ellipitic, c. 15 x 4 mm, longer than bracts.	The leaf is simple, sessile or subsessile, elliptic to linear oblong, subrevolute, weakly undulate margin, obtuse apex and pinnate venation, colour dark or light green, about 1-2.5 cm long and 0.3 - 0.7 cm wide, glabrous.
Stem	Slender, not more than 3 mm thick, smooth or a little striate.	Slender, with whitish striate, cylindrical and glabrous, not more than 3 mm thick, branched from the base and with several branches. The nodes are swollen and the internodes are 2-5 cm length.
Ochrea	--	Ochreae much smaller than the internodes, 5-8 mm, brownish-based, ovat to lanceolate, hyaline, lacerate, clearly brown midrib nerve.
Nut	Nuts slightly exserted from the perianth, glossy.	Nuts slightly exserted from the perianth, 2-3 × 1-1.3 mm, ovoid and trigonous, broad at base, apiculate apex, smooth, brownish, granulate.
Inflorescence	Often on short, condensed, lateral branches, or on short, ± dense flowered, terminal spikes.	Inflorescence is solitary, in fascicles, usually in the axil of upper leaves, ± dense flowered, terminal spikes.
Flower	--	Flower 2-2.5×1-1.5 mm, pedicel 0.5-1 mm, axillary and solitary or subsolitary.
Perianth	About 2 mm	Green pinkish at magrin and apex, persisting and enclosing the nuts, 1.5-2 mm.
Pollen class, shape and surface	--	Tricolporate, spherodial, prolate, granulate.



a **b** **c**

d **e** **f**

Figure 7. *General view (a), leaf surface (b), stem (c), pollen (d), pollen surface (e) and seed (f) of P. arenarium.*

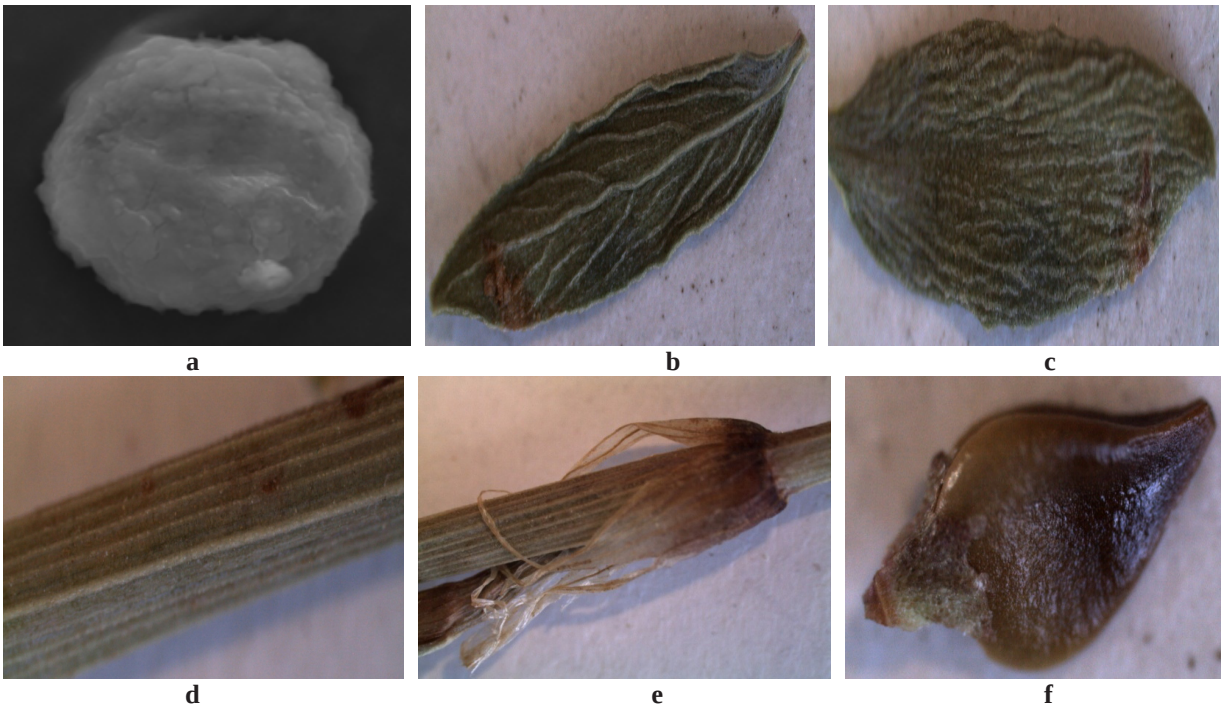


Figure 8. *(a) Pollen (b) lower surface of leaf, (c) upper surface of leaf, (d) stem, (e) ochrea, (f) seed of P. arenarium*

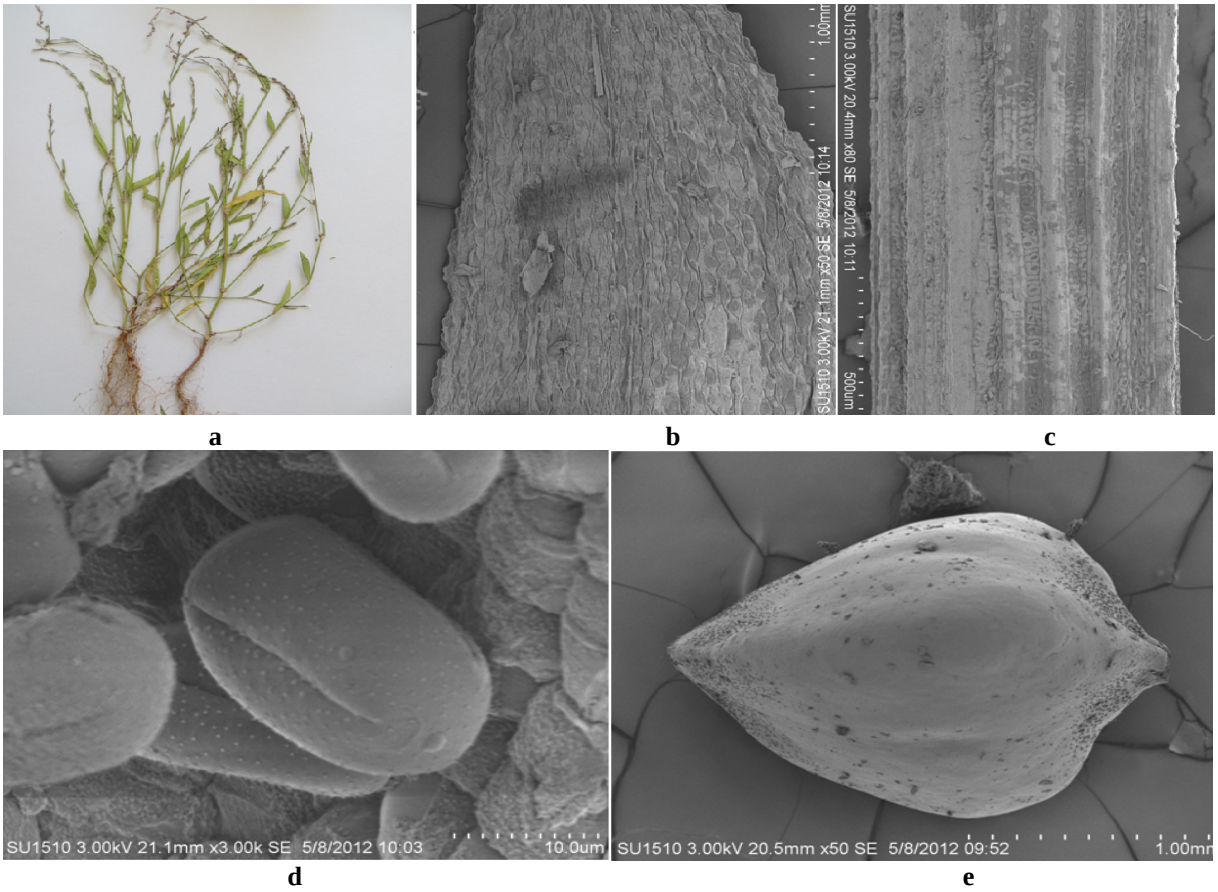
The results obtained from morphological studies of *P. arenarium* were generally consistent with the description given in Flora of Turkey; but in respect to some morphological characters the results of *P. arenarium* differ from Flora of Turkey; with this study flower and ochrea features of *P. arenarium* were detected which were unspecified in Flora of Turkey (Table 4).

5. *P. bellardii* All., (Syn: *P. patulum* Bieb.)

Table 5. Comparisons of examined specimen (*P. bellardii*) with Flora of Turkey.

	***P. bellardii* in Floraof Turkey**	***P. bellardii* in this study**
Plant	Glabrous annual, erect or ascending, 20-60 cm.	Glabrous annual herb, 20-30 cm, erect.
Leaves	Ellipitic, narrowly ellipitic or linear oblong, 12-45 x 2-12 mm, caducous.	The leaf is simple, alternate, sessile - subsessile, elliptic to linear oblong with an entire margin, subacute to obtuse apex and pinnate reticulate venation. The colour of upper surface of leaves is dark green, the lower being paler, with hairs on both surfaces. The leaf is about 1.5-4.5 cm long and 0.3-0.5 cm wide, glabrous.
Stem	Slender, with whitish striate, 3 mm thick at most.	The stem is slender, with whitish striate, herbaceous, erect, cylindrical and glabrous. It measures about 20-40 cm in length and up to 2-3 mm thick. It is dichotomously or axially branched with several branches. The nodes are slightly swollen and the internodes are 2-6 cm in length.
Ochrea	--	A membranous ochrea is present at the internodes as a sheath around the stem and measures about 3.5 - 6.5 mm long, tubular and brownish below, upper portion lacerate and silvery, lanceolate with acute apex.

Nut	Usually glossy and punctate.	Nut 1.3-1.4 × 0.7-1.1 mm, ovoid, broad at base, usually gloossy, apiculate apex, smooth and brownish black.
Inflorescence	Inflorescence lax, terminal, with 1-2 flowers at each node.	Inflorescence in axillary clusters with 1-2 flowers in each cluster or node.
Flower	Flowers 3 - 4 cm	Flower 3-3.5 × 2-2.3 mm, pedicel 0.5-1 mm.
Perianth	Perianth persisting and enclosing the nuts, trigonous-ovoid.	The perianth is green with reddish magrin, persisting and enclosing the nuts.
Pollen class, shape and surface	--	Tricolporate, suboblate-circular-lobate, granulate.



a **b** **c**

d **e**

Figure 9. *General view (a), leaf (b), stem (c), pollen (d) and seed (e) of P. bellardii.*

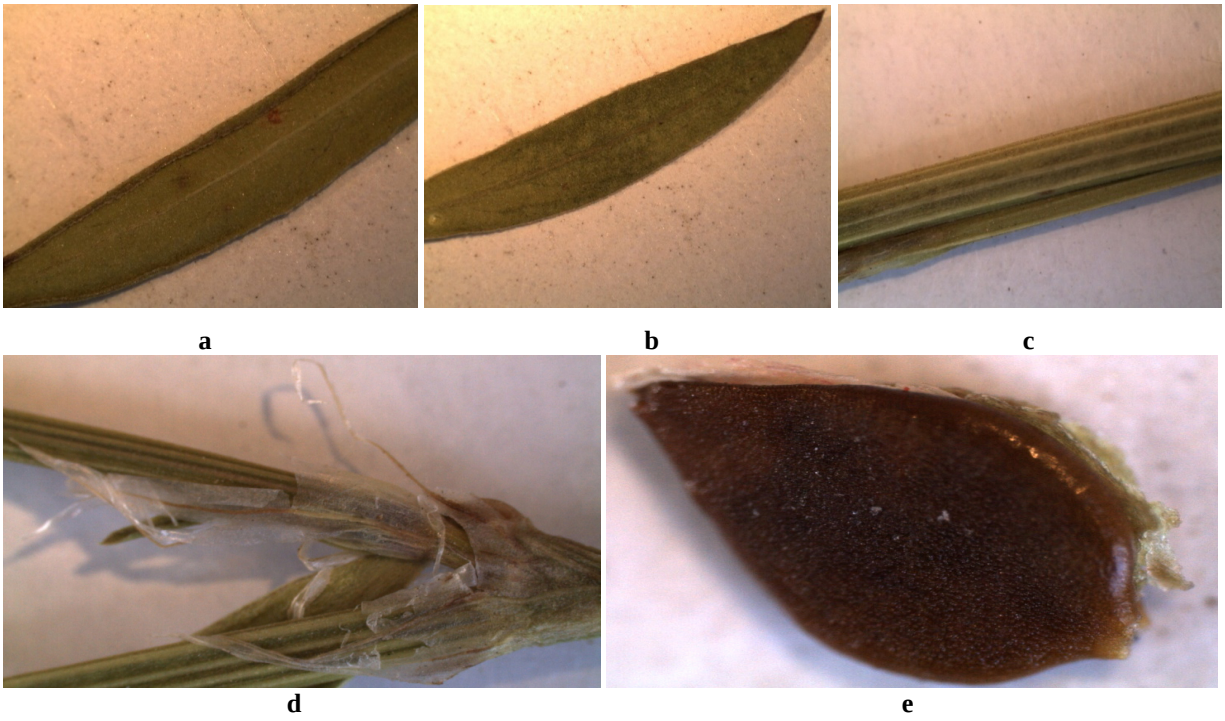


Figure 10. *(a) Lower surface of leaf, (b) upper surface of leaf, (c) stem, (d) ochrea, (e) seed of P. bellardii.*

As seen in Table 5, some properties of studied sample has showed some differences from Flora of Turkey, so with this study ochrea and pollen features of *P. bellardii* have determined and new morphological characters have detected and the description of *P. bellardii* have extended.

IV. CONCLUSION

Among the 5 species examined, two basic morphological nut shapes were determined: trigonous, ovate or broady ovate, compressed and ovoid which are completely shiny or dull, brown or dark brown, and both show three range of nut surface; smooth-undulate, granulate and reticulate-papillae. Nutlets vary considerably in size, with the length ranging between 1.3 - 2.5 mm and the width from 0.5 - 1.5 mm, generally enclosed by the persistent perianth. (Figs. 1-5; Tables 1-5). Morphological and anatomical researchs with plants are still the most important and relatively easily studied characters of great significant among the plant taxonomist, but micromorphological characters of pollen are taxonomically potential features and play significant role in generic identification and classification in the Polygonaceae family [18]. In addition general plant morphology, pollen characters have been used for the identification of taxa [19], for number of phylogenetic studies [20] and proved to be valuable tool in solving taxonomic problems and supporting taxonomic suggestion [21]. In this study, using scanning electron microscopy the palynological study of 5 species belonging to *Polygonum* genus were investigated. This study bring to light the benefit of both qualitative and quantitative characters in taxonomic studies about *Polygonum* taxa.

In conclusion, qualitative and quantitative morphological features related to stem, leaves, ochrea, flower, inflorescence, perianth, nut and polen have been used for the delimitation of the studied taxa. As this study was based on both herbarium and personal collection, a great deal of morphological variations were discovered. This study help to make corrections in the previous published work and

with this study new morphological properties for diagnostic purposes have determined, the description of studied species have extended and also provide additional information for valid identification of *Polygonum* taxa.

ACKNOWLEDGEMENTS: This work is supported by Bingöl University Scientific Project (Project no: 2013.203.129).

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