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ÖZNUR ERGEN AKÇİN

ALİ ENGİN

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# The Morphological, Anatomical and Ecological Properties of Endemic *Onosma bracteosum* Hausskn. & Bornm. (*Boraginaceae*) Species

Öznur ERGEN AKÇİN

Ondokuz Mayıs University, Faculty of Arts and Science, Department of Biology, Ordu - TURKEY

Ali ENGİN

Ondokuz Mayıs University, Faculty of Education, Department of Biology, Samsun - TURKEY

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**Abstract:** The endemic *Onosma bracteosum* Hausskn. & Bornm. (*Boraginaceae*) was investigated morphologically, anatomically and ecologically. It has setae with tuberculate bases. The stem is 15-35 cm tall and erect. The leaves are equifacial and amphistomatous. Stomata cells are anisocytic and anomocytic. The stomata index is 21.25 for the upper epidermis and 25 for the lower epidermis. This plant generally prefers sandy-loamy, sandy-clayey and loamy soils. In the soil samples, the N (2.3%), P (26%) and K (27%) concentrations were lower in the generative periods than in the vegetative periods.

According to the results of plant nutrient analysis, N% (1.140-3.274), P% (0.172-0.403) and K% (0.512-1.281) concentrations are higher in the above-ground parts during the vegetative growth period.

**Key Words:** *Boraginaceae*, *Onosma bracteosum*, morphology, anatomy, ecology.

## Endemik *Onosma bracteosum* Hausskn. & Bornm. (*Boraginaceae*) Türünün Morfolojik, Anatmik ve Ekolojik Özellikleri

**Özet:** Endemik *Onosma bracteosum* Hausskn. & Bornm. (*Boraginaceae*) türü morfolojik, anatmik ve ekolojik olarak incelenmiştir. Tabanları şişkin setalı tüylere sahip bir türdür. Gövde 15-35 cm uzunluğunda ve diktir. Yapraklar ekvifasiyal ve amfistomatiktir. Stoma hücreleri anizositik ve anomositiktir. Yaprakların üst yüzeyinde stoma indeksi 21.25, alt yüzeyinde 25 dir. Bitki genellikle kumlu tınlı, kumlu kireçli ve tınlı toprakları tercih etmektedir. Toprak örneklerinde N (% 23), P (% 26) ve K (% 27) konsantrasyonları generatif periyotta vejetatif periyoddan daha düşüktür. Bitkide yapılan analizlerin sonuçlarına göre vejetatif dönemde toprak üstü kısımlardaki % N (1.140-3.274), % P (0.172-0.403), % N (0.512-1.281) konsantrasyonlarının fazla olduğu bulunmuştur.

**Anahtar Sözcükler:** *Boraginaceae*, *Onosma bracteosum*, morfoloji, anatomi, ekoloji.

## Introduction

Some *Onosma* species are used as herbs, folk medicines and dyes. Dried flowers of *O. fruticosum* Sm. are used in folk medicine to treat respiratory ailments (Viney, 1994). *O. sericeum* Willd. and *O. armenum* DC. are used in the treatment of body swellings, and their flowers are eaten (Öztürk & Özçelik, 1991).

*Onosma* species are named Emzik otu (Eskişehir), Yalancı havacıva, Emzik (Kemah, Erzincan) and Emcek (Kemaliye, Erzincan) in Turkey. *O. bracteosum* Hausskn.

& Bornm. is an endemic plant and an asterotrichous species (Davis, 1978). It has been previously reported in the Lower Risk category (Ekim et al., 2000; IUCN, 2001).

Studies on the anatomy of this genus are limited. Metcalfe & Chalk (1979) and Watson & Dallwitz (1991) explained the characteristic properties of the family *Boraginaceae*. Akçin & Engin (2001) and Akçin (2004) studied the anatomical and ecological properties of some *Onosma* species. Binzet & Orcan (2003) investigated the

anatomical structure and palynological characteristics of *O. roussaei* DC. and *O. giganteum* Lam. Teppner (1981, 1988) reported the chromosome numbers of different species of *Onosma*. The anatomical and ecological properties of *O. bracteosum* have not been studied. Therefore, the purpose of this paper was to investigate the morphological, anatomical and ecological properties of *O. bracteosum*.

## Materials and Methods

Plant and soil samples of *O. bracteosum* were collected from different localities in the West and Central Black Sea regions in the A4-A6 squares. The locations are the following:

- 1- A4 Çankırı: Ilgaz, Çeltikbaşı village, 1300 m, Akçin 1028.
- 2- A5 Kastamonu: Tosya, Kös mountain, 1050 m, Akçin 1026.
- 3- A5 Amasya: Akdağ mountain, Akören village, 400 m, Akçin 1001.
- 4- A5 Amasya: Akdağ mountain, Kıranbaşalan village, 1150 m, Akçin 1005.
- 5- A5 Amasya: Kapaklı village, 450 m, Akçin 1003.
- 6- A5 Amasya: Erzincan road, 30 km, 450 m, Akçin 1002.
- 7- A5 Amasya: Ilica town, 410 m, Akçin 1011.
- 8- A5 Amasya: Borabay lake 600 m, Akçin 1006.
- 9- A5 Çorum: 12 km to İskilip, 680 m, Akçin 1018.
- 10- A5 Çorum: Kargı, Eğinönü plateau, 1000 m, Akçin 1020.
- 11- A5 Çorum: Around Kargı, 400 m, Akçin 1021.
- 12- A6 Samsun: Around Ladik, 950 m, Akçin 1016.

Morphological features were identified from fresh and herbarium material. Observed results were compared with the Flora of Turkey (Davis, 1978; Davis et al., 1988; Güner et al., 2000). The general appearances of plants and hairs were drawn according to Akçin 1003 and Akçin 1005. For anatomical analysis, cross-sections of root, stem and leaves were used. Photographs of them were taken with a Nikon FDX-35 microscope. The stomatal index and stomatal index rate were calculated as described by Meidner & Mansfield (1968).

Soil and plant samples were collected from 12 different localities during vegetative and generative growth periods. pH, texture, calcium carbonate, total soluble salts and organic matter content were determined (Öztürk et al., 1997). N%, K% and P% were determined by Kjeldahl's method, flame photometer and the ammonium molybdate-tin chloride method, respectively (Allen, 1976; Bayraklı, 1987).

The below-ground and above-ground parts of plant samples were dried at 70 °C in an oven for 48 h and milled. Nitrogen was determined according to Kjeldahl's method. Phosphorus was determined by spectrophotometer. Potassium analysis was conducted by flame photometer (Kaçar, 1984; Bayraklı, 1987).

## Results

### Morphological Properties (Figures 1, 2, 7)

Perennial. Stem, 15-35 cm tall, erect with few branches, glandular and eglandular hairy, patent-setose and with short dense hairs. Leaves glandular and eglandular hairy, tuberculate setae. Basal leaves 2-7 x 0.25-1 cm, lanceolate, lanceolate-spathulate with petiole. Cauline leaves 2.5-4.5 x 0.2-0.3 cm, sessile, oblong, oblong lanceolate, obtuse to acute. Bracts 1-2.1 x 0.15-0.6 cm, linear, linear-lanceolate and eglandular hairy. Inflorescence of 1-3 terminal cymes, scorpioid at first, becoming elongated and nearly straight. Pedicel 0.15-0.2 cm in flower, 0.3-0.35 cm in fruit. Calyx 0.8-1.5 cm in flower, 1.5-2.3 cm in fruit. Corolla cylindrical-campanulate to clavate-campanulate, 18-25 mm, cream-pale yellow, 5 lobed. Anthers 7-8 mm in length and filaments 9-15 mm. Nutlets obliquely ovoid, 2.5-2.9 x 1.8-2 mm. This plant generally prefers sandy-loamy, sandy-clayey and loamy soils.

### Anatomical Properties

#### Root (Figure 3)

Periderm is multilayered. Periderm cells are flat and wide. Cortex is 10-15 layered and parenchymatic. Parenchymatic cells are 8-20 x 10-55 µ. Cambium cells are 1-4 layered, flat and distinguishable. Xylem is composed of sclerenchymatic cells and trachea. Primary pith rays are 1-2 layered and secondary rays are 4-5 layered. In the pith, primary xylem tissue is present (Table 1).



Figure 1. *O. bracteosum*. General appearance, Akçin 1003 (Bar: 1 cm).

#### Stem (Figures 4, 7)

Epidermis is single layered. There are glandular and eglandular hairs on the epidermis. They are unicellular or multicellular. Collenchyma is 1-3 layered. Parenchyma cells are 10-15 x 4-6  $\mu$ . Endodermis is located above the phloem. Cambium is distinguishable. Diameter of trachea cells are 8-32  $\mu$ . The pith consists of large and cylindrical parenchymatic cells (Table 1).

#### Leaf (Figures 5-7)

There is a single layered epidermis on the upper and lower surface of the leaf. There are tuberculate setae, setose and glandular hairs on the epidermis. Tuberculate setae have cystoliths in the bases. Tuberculate setae hairs are more common on the upper epidermis. Stomata are anisocytic and anomocytic. Stomata index is 21.25 for the upper epidermis and 25 for the lower epidermis (Table 2). Leaf is equifacial. Palisade parenchyma cells are 2- (3) layered on the upper surface and single layered on the

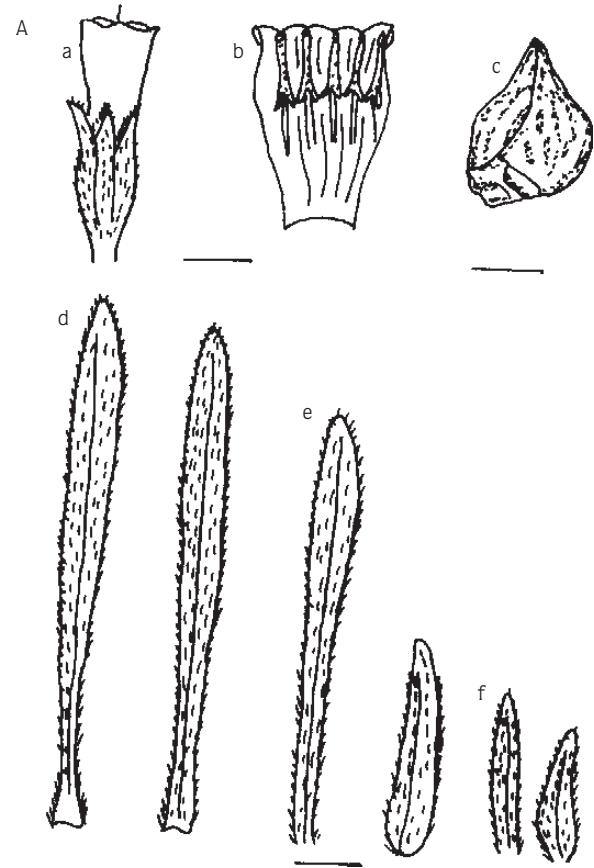


Figure 2. *O. bracteosum* A- a) flower, b) corolla and stamens, c) fruit, d) basal leaf, e) cauline leaf, f) bracts, (Bar: a, b: 0.5 cm; c: 1 mm; d, e, f: 1 cm).

lower surface. Spongy parenchyma cells are 4-6 layered. Vascular bundle is collateral. Vascular bundles are surrounded by a parenchymatic bundle sheath (Tables 1, 2).

#### Ecological Properties

##### Soil Analysis

This species generally prefers sandy-loamy, sandy-clayey and loamy soils. According to the results presented in Table 3, pH values were 7.20-7.80%. Calcium carbonate values were 0.52-40.20% and total salts were 0.01-0.05%.

The nitrogen concentration was 0.182-0.350 (0.261  $\pm$  0.014) in the vegetative period and 0.168-0.238 (0.202  $\pm$  0.008) in the generative period. The potassium, phosphorus and organic matter values were 0.35-0.78

Table 1. Anatomical measurements of *O. bracteosum*.

		Breadth ( $\mu$ )		Length ( $\mu$ )	
		Min	Max	Min	Max
ROOT	Periderm cells	15	65	10	40
	Parenchyma cells	10	55	8	20
	Diameter of trachea	10	100	-	-
STEM	Epidermis cells	6	17	8	14
	Collenchyma cells	8	28	8	20
	Parenchyma cells	10	50	4	16
	Diameter of trachea	8	32	-	-
	Diameter of pith cells	10	88	-	-
LEAF	Cuticle	4	5.5	-	-
	Upper epidermis cells	8	24	8	10
	Lower epidermis cells	8	22	4	8
	Palisade paren. cells	6.4	16	24	48
	Spongy paren. cells	10.5	28	8	24
FLOWER	Cuticle	4	12	-	-
	Upper epidermis cells	8	32	12	36
	Lower epidermis cells	8	24	12	34
	Parenchyma cells	9	32	5	24
	Diameter of trachea	1.6	4	-	-

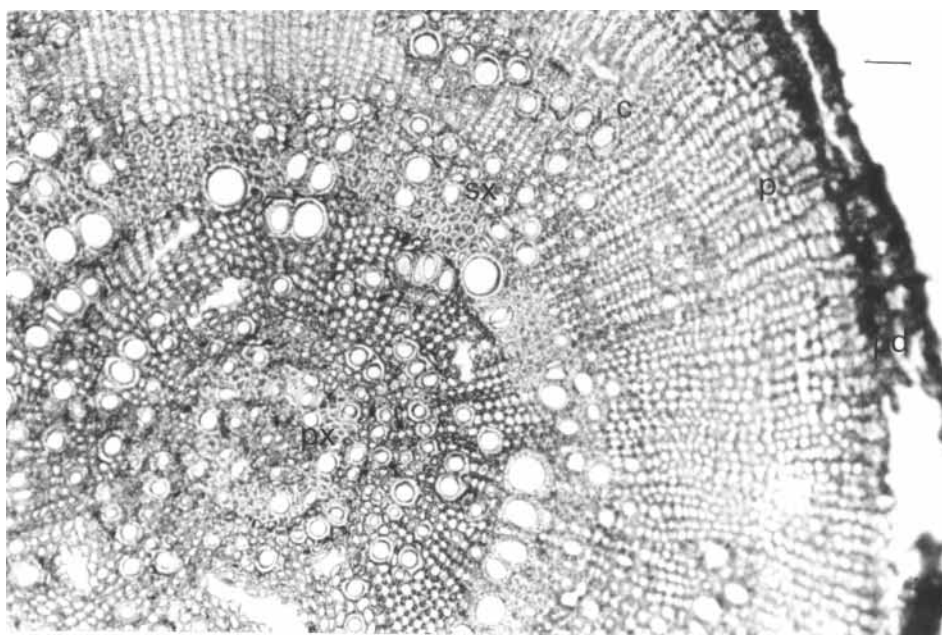


Figure 3. *O. bracteosum*. Cross-section of root. pd) peridermis, p) parenchyma, c) cambium, sx) secondary xylem, px) primary xylem (Bar: 100  $\mu$ ).

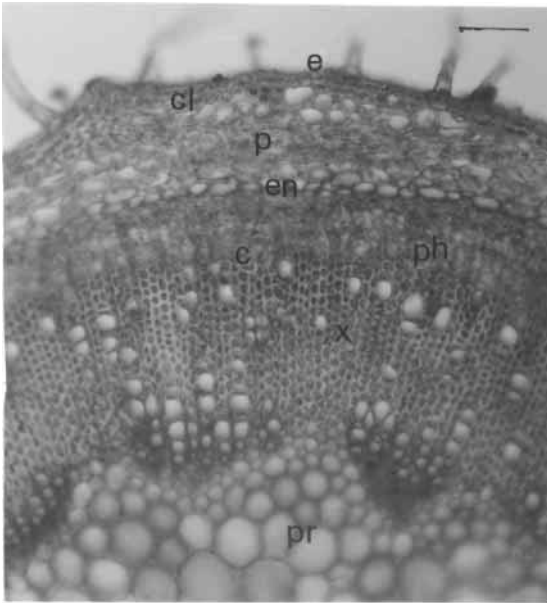


Figure 4. *O. bracteosum*. Cross-section of stem. e) epidermis, cl) collenchyma, p) parenchyma, en) endodermis, c) cambium, ph) phloem, x) xylem, pr) pith region (Bar: 80  $\mu$ ).

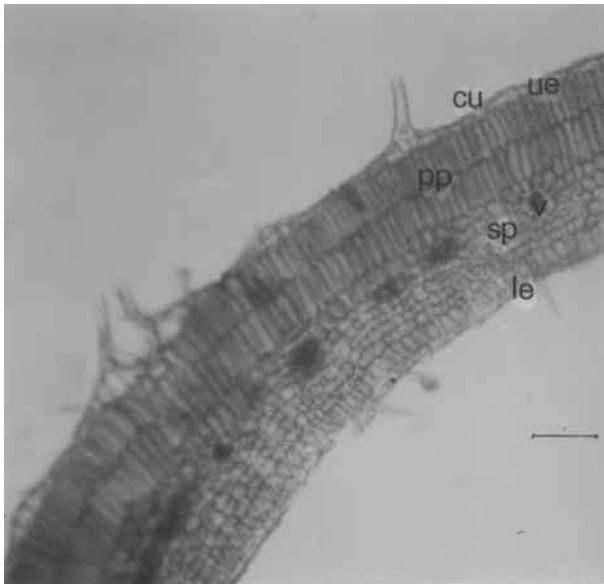


Figure 5. *O. bracteosum*. Cross-section of leaf. cu) cuticle, ue) upper epidermis, pp) palisade parenchyma, sp) spongy parenchyma, v) vascular bundle, le) lower epidermis (Bar: 50  $\mu$ ).

(0.539  $\pm$  0.040), 0.005-0.030 (0.019  $\pm$  0.002) and 0.70-4.64 (2.429  $\pm$  0.325) in the vegetative period and 0.11-0.71 (0.391  $\pm$  0.046), 0.004-0.024 (0.014  $\pm$  0.002) and 0.64-4.30 (1.238  $\pm$  0.288) in the generative period, respectively (Table 4).

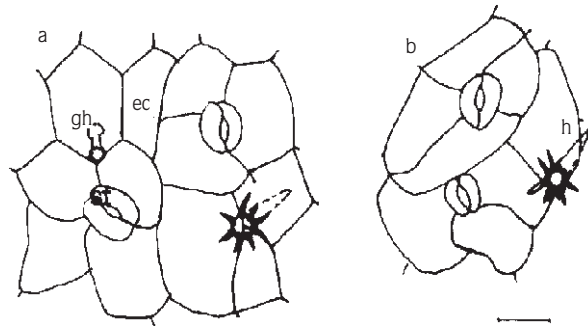


Figure 6. Surface-section of leaf. a) upper epidermis, b) lower epidermis, st) stoma, ec) epidermis cell, h) hair, gh) glandular hair.

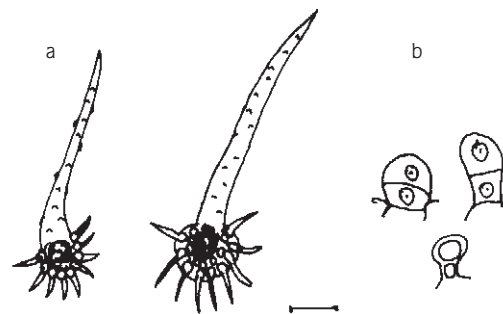


Figure 7. Hair types of the plant. a) Eglandular hairs b) glandular hairs (Bar: 0.5 mm).

Table 2. Stoma features on the upper and lower epidermis of *O. bracteosum*.

	Upper surface of leaf	Lower surface of leaf
Number of stomata (1 mm <sup>2</sup> )	14 $\pm$ 1	42 $\pm$ 1
Number of epidermis cells (1 mm <sup>2</sup> )	90 $\pm$ 2	132 $\pm$ 2
Stomata length	20-25 $\mu$	20-25 $\mu$
Stomata width	15-20 $\mu$	12-15 $\mu$
Stomata index	13.46	24.13
Stomata index rate	0.5578	

### Plant Analysis

The N%, P%, and K% values of the below-ground parts of *O. bracteosum* are given in Table 5. The nitrogen concentration was 0.734-1.295 (0.984  $\pm$  0.050) in the vegetative period and 1.015-1.575 (1.234  $\pm$  0.044) in the generative period. The P% values were 0.042-0.224 (0.142  $\pm$  0.016) in the vegetative period and 0.112-

Table 3. Physical analysis results of the soil samples.

Locality	Clay (%)	Silt (%)	Sand (%)	Texture	pH	Total Salts (%)	CaCO <sub>3</sub>
1- Ilgaz Çeltikbaşı Village	21.12	30.37	48.21	Loamy	7.20	0.04	0.52
2- Kastamonu Kös Mountain	24.51	30.20	45.29	Loamy	7.60	0.03	4.58
3- Akdağ, Akören Village	16.91	19.81	63.28	Sandy-loam	7.35	0.01	32.56
4- Akdağ, Kıranbaşalan Village	6.28	11.49	82.23	Sandy-loam	7.30	0.01	40.20
5- Akdağ, Kapaklı Village	16.94	22.30	60.76	Sandy-loam	7.40	0.02	12.26
6- Amasya-Erzincan Road 30 km	8.94	20.50	70.56	Sandy-loam	7.45	0.04	4.09
7- Amasya-İlica Town	21.51	22.84	55.65	Sandy-clayey-loam	7.60	0.03	4.90
8- Borabay Lake	15.17	20.62	64.21	Sandy-loam	7.55	0.04	22.89
9- Çorum-around İskilip	21.79	27.99	50.22	Sandy-clayey-loam	7.80	0.05	6.26
10- Kargı-EğİNönü Plateau	23.53	20.72	55.75	Sandy-clayey-loam	7.50	0.03	1.63
11- Around Kargı	16.94	22.30	60.76	Sandy-loam	7.40	0.02	12.26
12- Around Ladik	15.79	22.41	61.80	Sandy-loam	7.40	0.04	9.62
				Mean ±SE	7.463 ± 0.046	0.030 ± 0.004	12.64 ± 3.670

Table 4. Chemical analysis results of the soil samples.

Locality	N (%)		P (%)		K (%)		Organic matter	
	VP	GP	VP	GP	VP	GP	VP	GP
1	0.278	0.238	0.028	0.021	0.78	0.71	4.64	4.30
2	0.265	0.210	0.023	0.012	0.50	0.35	2.20	0.97
3	0.182	0.168	0.019	0.016	0.39	0.24	1.88	0.69
4	0.350	0.182	0.021	0.015	0.35	0.11	1.10	0.86
5	0.224	0.198	0.030	0.02	0.44	0.36	2.97	1.29
6	0.350	0.262	0.018	0.012	0.60	0.44	1.88	1.50
7	0.266	0.195	0.019	0.013	0.72	0.52	3.12	0.91
8	0.21	0.178	0.005	0.004	0.65	0.52	4.00	0.64
9	0.252	0.190	0.010	0.008	0.56	0.43	0.70	0.64
10	0.250	0.206	0.012	0.007	0.38	0.23	1.88	1.13
11	0.265	0.210	0.023	0.012	0.50	0.44	2.20	0.97
12	0.245	0.194	0.025	0.024	0.60	0.194	2.58	1.50
Mean ±	0.261±	0.202±	0.019±	0.014±	0.539±	0.391±	2.429±	1.283±
SE	0.014	0.008	0.002	0.002	0.040	0.046	0.325	0.288

VP Vegetative Period

GP Generative Period

0.441 (0.310 ± 0.035) in the generative period. The K% concentration was 0.240-0.561 (0.379 ± 0.031) in the vegetative period and 0.263-0.710 (0.446 ± 0.046) in the generative period.

The N%, P%, and K % values of the above-ground parts of the plant are given in Table 6. N%, P%, K%

values were 1.140-3.274 (1.950 ± 0.205), 0.172-0.403 (0.284 ± 0.020) and 0.512-1.281 (0.798 ± 0.062) in the vegetative period and 0.910-1.697 (1.358 ± 0.093), 0.093-0.321 (0.284 ± 0.020) and 0.188-1.065 (0.641 ± 0.069) in the generative period, respectively.

Table 5. Concentrations of N, P, K in below-ground parts of plant samples.

Locality	N (%)		P (%)		K (%)	
	VP	GP	VP	GP	VP	GP
1	0.912	1.162	0.224	0.441	0.557	0.710
2	0.945	1.325	0.189	0.312	0.315	0.424
3	0.920	1.015	0.150	0.384	0.259	0.278
4	0.735	1.155	0.156	0.363	0.240	0.263
5	1.190	1.260	0.181	0.420	0.318	0.388
6	0.982	1.312	0.126	0.240	0.434	0.484
7	1.295	1.333	0.152	0.286	0.561	0.600
8	1.207	1.575	0.073	0.112	0.417	0.561
9	0.734	1.335	0.110	0.192	0.400	0.464
10	0.980	1.108	0.096	0.168	0.249	0.271
11	0.962	1.119	0.042	0.288	0.378	0.480
12	0.945	1.112	0.200	0.512	0.428	0.440
Mean ± SE	0.984 ± 0.050	1.234 ± 0.044	0.142 ± 0.016	0.310 ± 0.035	0.379 ± 0.031	0.446 ± 0.046

VP Vegetative Period                      GP Generative Period

Table 6. Concentrations of N, P, K in above-ground parts of plant samples.

Locality	N (%)		P (%)		K (%)	
	VP	GP	VP	GP	VP	GP
1	3.250	1.121	0.403	0.245	1.281	1.065
2	1.855	1.505	0.340	0.173	0.729	0.577
3	2.252	1.697	0.270	0.213	0.640	0.404
4	1.930	1.337	0.278	0.201	0.583	0.188
5	1.572	1.417	0.324	0.233	0.637	0.606
6	2.270	2.120	0.226	0.133	0.769	0.755
7	1.189	1.170	0.273	0.158	1.080	0.876
8	1.140	0.910	0.231	0.201	0.834	0.842
9	1.712	1.470	0.201	0.106	0.794	0.724
10	3.274	1.112	0.172	0.093	0.512	0.376
11	1.505	1.125	0.331	0.163	0.865	0.589
12	1.450	1.310	0.360	0.321	0.857	0.686
Mean ± SE	1.950 ± 0.205	1.358 ± 0.093	0.284 ± 0.020	0.187 0.018	0.798 ± 0.062	0.641 ± 0.069

VP Vegetative Period                      GP Generative Period

## Discussion

*Onosma* species are used as herbs, folk medicines and dyes. *O. bracteosum* is an endemic taxon and an Irano-Turanian element (Davis, 1978).

The morphological properties determined in our study are generally similar to those in the Flora of Turkey (Davis, 1978). In our study, basal leaves were 2-7 x 0.25-1 cm, cauline leaves were 2.5-4.5 x 0.2-0.3 cm,



bracts were 1-2.1 x 0.15-0.6 cm, the calyx was 0.8-1.5 cm in the flower and 1.5-2.3 cm in the fruit, the corolla was 18-25 mm, and nutlets were 2.5-2.9 x 1.8-2 mm.

Metcalf & Chalk (1979) and Watson & Dallwitz (1991) explained the characteristic properties of the family *Boraginaceae*. *O. bracteosum* had a secondary root structure. The periderm was multilayered. The cortex was 10-15 layered and parenchymatic. The xylem was composed of sclerenchymatic cells and trachea. There was a single-layered epidermis on the stem. The collenchyma was 1-3 layered. The same results were seen in *O. roussaei* and *O. giganteum* (Binzet & Orcan, 2003). There are tuberculate setae and glandular hairs on the epidermis of the stem and leaf. Setae have 6-10 tuberculate hairs and cystoliths. These tuberculates number 5-6 in *O. isauricum* Boiss. & Heldr., 8-12 in *O. stenolobum* Hausskn. ex H. Riedl and 7 (6) in *O. bornmuelleri* Hausskn. (Akçin & Engin 2001; Akçin, 2004). Pignatti (1982) used setae as taxonomic characters to determine *Onosma* species in Italy. The leaf was equifacial. The stomata were anisocytic and anomocytic. Metcalfe & Chalk (1979) pointed out that there were both anomocytic and anisocytic stomata in this family. The same results were seen in some other *Onosma* species (Akçin and Engin, 2001; Akçin, 2004). The stomata index was 21.25 for the upper epidermis and 25 for the lower epidermis. The stomata index rate was 0.5578.

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- O. bracteosum* prefers sandy-loamy, sandy-clayey and loamy soils. The pH of the soils was 7.20-7.80; 25% of the soils were neutral and 75% were slightly alkaline. The salt concentration was very low. N% was within rich levels. P% was within optimum levels except for samples from locality 8 in the vegetative and generative periods. K concentration was within optimum levels in the vegetative period but samples from localities 3, 4, 10 and 12 had low levels in the generative period. The N (23%), P (26%) and K (27%) concentrations were lower in the generative period than in the vegetative period.
- According to chemical analysis of the below-ground parts, N, P and K rates were higher in the generative period. However, N, P and K concentrations of the above-ground parts were higher in the vegetative period because physiological activities are very intensive in the above-ground parts in the vegetative period. Similar results have been observed for *Asphodelus aestivus* Brot., *Vitex agnus-castus* L. and *O. stenolobum* (Pirdal, 1989; Doğan & Mert, 1998; Engin & Akçin, 2000).

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