



Determination of wild plant species of *Brassicaceae* family in Turkish Thrace

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Abstract

The *Brassicaceae* (*Cruciferae*) is an important family of plants that include many economically important industrial oilseed, spice, vegetable and fodder crop species. The aim of this study was to identify the plant species with in the taxa of *Brassicaceae* family in the Thrace Region Flora of Turkey. In this research, wild species from *Brassicaceae* family were collected from 20 different locations during 6-7 May 2013. The aggregation days were clear and sunny weather, temperatures ranged between 17.2°C to 21.5°C. The altitude values of observed locations varied from 6 -518 m with variable soil features. Online I keys prepared by the AL-Shehbaz were used for identification of each taxa.

Key words: *Brassicaceae*, biologic variation, natural habitat, species, taxonomy

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Türkiye'deki Trakya Bölgesinin *Brassicaceae* familyasına ait yabancı türlerinin belirlenmesi

Özet

Brassicaceae (*Cruciferae*), ekonomik açıdan önemi olan, endüstriyel yağlı tohumlar, baharat bitkileri, sebzeler ve bazı yem bitkilerini bulunduran önemli bir familyadır. Bu çalışmanın amacı, Trakya Bölgesi doğal florasında bulunan, *Brassicaceae* familyasına ait yabancı türleri belirlemektir. Bu çalışmada, *Brassicaceae* familyasında yer alan yabancı türler, Trakya Bölgesi'nde bulunan 20 farklı lokasyondan, 6-7 Mayıs 2013 tarihlerinde, 17,2°C ile 21,5°C arasında değişen sıcaklıklarda toplanmıştır. Toprak özellikleri birbirlerinden farklı olan lokasyonların, deniz seviyesinden yükseklikleri 6 m ile 518 m arasında değişmiştir. AL-Shehbaz tarafından hazırlanan online anahtarları kullanılarak taksonlar belirlenmiştir.

Anahtar kelimeler: *Brassicaceae*, biyolojik çeşitlilik, doğal yaşam alanı, türler, taksonomi

1. Introduction

The *Brassicaceae* (*Cruciferae*) is an important dicotyledonous and angiospermic (true flowering) plant family with a global distribution. *Brassica* species are primarily adapted to temperate and sub-tropical climates depending on the species, and play an important role in global agriculture. It is the important family which includes many economically and important industrial oilseed, spice, vegetable and some fodder crop species. *Brassica napus*, *Brassica juncea*, *Sinapis alba*, *Sinapis nigra* (*Brassica nigra*), *Brassica oleracea*, *Brassica carinata*, *Camelina sativa*, *Crambe abyssinica*, *Eruca vesicaria* are some of the important species of *Brassicaceae* family (Warwick et al., 2006, 2007). Wild mustard (*Sinapis arvensis*) is the most famous weed plant of the family (Warwick et al., 2003, 2008). *Sinapis arvensis* is consumed as food in salads (Yücel et al., 2010).

The genus *Brassica* belongs to the *Brassicaceae* and the family takes the name because of this genus. The family contains 372 genus and 4060 species in the world. The family is being represented by 85 genus and 567 taxa in

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Turkey. This family contain *Alyssum*, *Cardamine*, *Erysimum*, *Draba*, *Lepidium*, *Sinapis* and *Brassica* as biggest generas. *Brassica rapa*, *Brassica oleracea*, *Brassica napus*, *Raphanus sativus*, *Arabidopsis thaliana* and many others are well-known species in *Brassicaceae* family in Turkey (Warwick and Sauder, 2005).

Turkey is strategically important country because of its location. The Balkan states of southeastern Europe and southwestern Asian countries are neighbors of Turkey. Thrace is divided among Turkey, Greece and Bulgaria, edged by the Aegean, Marmara and Black Seas (Papp and Sabovljević, 2003). The Thrace of Turkey covers an area of 23 500 km² and has 2500 vascular plant species (Ozhatay and Byfield, 2000).

The Thrace is climatically, topographically and biologically heterogeneous area (Davis, 1965). Thrace is one of the important Phytogeographic area by rich vegetation, large settlements and agricultural areas. In addition Güler, (2013) has determined 2573 taxa and 62 endemic plant species in the region. The climate of the Thrace is typical Mediterranean. The summers are dry and hot, wet winters are the main feature. Euro-Siberian, Irano-Turanian and Mediterranean are the important phytogeographical regions that the meet at this point in Turkey. The Euro-Siberian region coincides Turkish Thrace (Papp and Sabovljević, 2003).

The understanding of wild *Brassicaceae* species in natural habitats have provided information about useful genes for future breeding studies on the important cultural crops such *Brassica napus*, *Brassica oleracea*, *Camelina sativa* etc. and contribute to find new crops for agricultural production in addition to natural conservation. Although the determining of wild species in natural habitats and taxonomic studies have been reported by many researcher there are still numerous wild species yet to be identified.

The aim of this study was to determine the wild species of the *Brassicaceae* family found in the natural habitat of 20 different locations and elevations with highly variable climate in Thrace Region of Turkey.

2. Materials and methods

The locations were determined based on differences in geographical structures with variable ecological conditions (Figure 2.1.). Plant samples were taken from 20 different points from areas away from residential areas (two in İstanbul, six in Tekirdağ, four in Kırklareli, seven in Edirne and one in Çanakkale) on 6-7 May 2013. The collection days had clear and sunny weather, the temperatures ranged between 17.2°C to 21.5°C. The altitudes of sampling locations varied from 6 - 518 m (Table 2.1).



Figure 2.1. The map of locations in Thrace region of Turkey

Table 2.1. Plant sample gathering locations of Thrace part of Turkey and their altitudes, latitudes and longitudes

N	Provinces	Locations	Collection date	Altitude (m)	Latitude	Longitude
1	Istanbul	Silivri/Alı Paşa Köyü	06.05.2013	83	41°07'17.65"K	28°12'38.59"D
2	Istanbul	Çatalca/Çakıl Köyü	06.05.2013	154	41°07'29.67"K	28°25'49.09"D
3	Tekirdağ	Çerkezköy/Büyükyoncalı	06.05.2013	161	41°22'06.21"K	27°56'30.02"D
4	Tekirdağ	Marmara Ereğlisi/Merkez	06.05.2013	3	40°58'17.79"K	27°55'48.45"D
5	Tekirdağ	Şarköy/Eriklice	06.05.2013	16	40°38'30.98"K	27°11'17.42"D
6	Tekirdağ	Malkara/Kadıköy	07.05.2013	151	40°51'47.76"K	26°49'57.13"D
7	Tekirdağ	Hayrabolu/Çıkrıkçı Köyü	07.05.2013	76	41°14'04.80"K	27°06'11.76"D
8	Tekirdağ	Muratlı/Arzulu Köyü	07.05.2013	102	41°13'00.96"K	27°25'19.96"D
9	Kırklareli	Vize/Kıyıköy	06.05.2013	8	41°33'11.95"K	28°05'33.13"D
10	Kırklareli	Lüleburgaz/Evrensekiz	06.05.2013	93	41°23'03.99"K	27°29'02.41"D
11	Kırklareli	Pınarhisar/Kaynarca	06.05.2013	173	41°39'26.89"K	27°28'28.24"D
12	Kırklareli	Koçfaz/Elmacık Köyü	06.05.2013	518	41°54'24.03"K	27°10'42.10"D
13	Edirne	Süloğlu/Büyükgerdelli	06.05.2013	172	41°45'49.84"K	26°55'02.47"D
14	Edirne	Lalapaşa/Çömlekakpınar	06.05.2013	187	41°50'02.53"K	26°38'49.87"D
15	Edirne	Keşan/Yerli Su Köyü	07.05.2013	182	40°43'37.65"K	26°43'50.72"D
16	Edirne	Enez/Çavuşköy Köyü	07.05.2013	66	40°40'55.87"K	26°10'15.96"D
17	Edirne	Meriç/Küplü Köyü	07.05.2013	35	41°07'28.06"K	26°21'48.04"D
18	Edirne	Uzunköprü/Çiftlikköy	07.05.2013	48	41°14'49.09"K	26°36'55.07"D
19	Edirne	Havsa/Abalar Köyü	07.05.2013	87	41°34'19.71"K	26°44'51.73"D
20	Çanakkale	Gelibolu/Ocaklı Köyü	06.05.2013	168	40°29'25.98"K	26°38'02.78"D

N: Line number of locations

Soil samples were taken from each location the 500-750 g soil samples taken at a depth of 30-60 cm during collection of plant materials. The minerals and organic matter content of soil samples were determined by analyzing for pH, EC, S, Soil organic matter, P, Ca, K and Mg. The results are given in Table 2.2.

Table 2.2. Soil samples features belonging to locations

Name of location	pH (Sat.)	EC ($\mu\text{S}\cdot\text{cm}^{-1}$)	S (%)	OS (%)	L (%)	P (kg/da)	Ca (mg/kg)	K (mg/kg)	Mg (mg/kg)
Silivri/Alı Paşa Village	7.32	1306	61	0.44	11.91	6.43	6158	305.6	218.7
Çatalca/Çakıl Village	7.09	967	49	1.74	1.43	5.59	4480	172.7	181.3
Çerkezköy/Büyükyoncalı	7.38	702	41	1.43	7.77	10.83	6166	117.1	246.6
Marmara Ereğlisi/Center	9.40	707	33	0.76	5.28	13.69	6039	215.8	560.9
Şarköy/Eriklice	7.31	1326	52	1.43	15.98	7.26	5835	727.9	777.9
Malkara/Kadıköy	6.83	1303	63	4.68	6.86	655.19	5329	123.6	866.7
Hayrabolu/Çıkrıkçı Village	6.61	997	48	3.00	0.98	33.32	3315	692.1	490.2
Muratlı/Arzulu Village	6.88	751	62	2.84	10.33	50.29	6022	824.4	366.3
Vize/Kıyıköy	7.36	495	43	1.96	4.90	13.06	5153	820.6	203.1
Lüleburgaz/Evrensekiz	7.34	706	48	1.48	6.94	33.81	6072	273.6	207.4
Pınarhisar/Kaynarca	6.89	914	54	2.94	10.33	50.29	6022	824.4	366.3
Koçfaz/Elmacık Village	7.08	721	48	1.43	4.22	6.51	5810	212.2	204.2
Süloğlu/Büyükgerdelli	7.15	884	67	5.53	2.49	663.58	4245	200.0	518.4
Lalapaşa/Çömlekakpınar	7.15	433	37	1.64	1.58	22.35	2963	147.1	195.4
Keşan/Yerli Su Village	7.24	607	44	2.19	10.93	4.89	5855	897.9	165.5
Enez/Çavuşköy Village	6.72	1248	60	2.54	1.96	19.49	6089	653.9	286.8
Meriç/Küplü Village	6.72	529	36	1.36	1.43	32.13	3691	251.7	242.3
Uzunköprü/Çiftlikköy	7.60	788	57	0.50	17.49	3.84	5969	210.9	182.7
Havsa/Abalar Village	7.39	495	34	1.19	3.77	11.38	5031	160.0	164.7
Gelibolu/Ocaklı Village	7.58	1590	76	0.51	11.76	2.72	5401	210.7	184.8

pH:soil acidity. EC:electrical conductivity. OS:organic substances. L: lime. P: phosphorus (P_2O_5). Ca: calcium. K:potassium. Mg:magnesium S:the ratio of saturation

As seen in the table, the pH value of Hayrabolu/Çıkrıkçı Village, Malkara/Kadıköy, Muratlı/Arzulu Village, Pınarhisar/Kaynarca, Enez/Çavuşköy Village and Meriç/Küplü Village, were acidic and the pH value of Silivri/Alı Paşa Village, Çatalca/Çakıl Village, Çerkezköy/Büyükyoncalı, Marmara Ereğlisi/Center, Şarköy/Eriklice, Vize/Kıyıköy, Lüleburgaz/Evrensekiz, Koçfaz/Elmacık Village, Süloğlu/Büyükgerdelli, Lalapaşa/Çömlekakpınar, Keşan/Yerli Su Village, Uzunköprü/Çiftlikköy, Havsa/Abalar Village and Gelibolu/Ocaklı Village were alkaline.

The lowest soil electrical conductivity value and lowest calcium degree were measured in Lalapaşa/Çömlekakpınar location. Whereas, the highest electrical conductivity values and the lowest phosphorus degree were measured in Gelibolu/Ocaklı Village location. The lowest organic matter value was determined in Silivri/Alı Paşa Village, while the highest value was detected in Süloğlu/Büyükgerdelli location. The lowest lime degree was found in

Hayrabolu/Çıkrıkçı and the highest degree was seen in Şarköy/Eriklice. The highest calcium degree and the lowest potassium degree were determined in Çerkezköy/Büyükyoncalı.

Climatic data with average annual relative humidity of the average wind speed, mean temperature and average rainfall (2012 and 2013) are shown in Table 2.3. Climate data of the locations was obtained from the Turkish State Meteorological Service-Ankara.

Table 2.3. Climate data of the 2012 and 2013 years for the locations

Climatic data	İstanbul		Tekirdağ		Edirne		Kırklareli		Çanakkale	
Years	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
ARH (%)	87.04	85.73	83.30	77.68	68.8	70.47	67.55	67.82	68.47	71.54
AWS (m/sn.)	7.22	6.76	2.74	2.70	2.00	1.93	1.82	1.76	3.26	4.11
AT (°C)	12.50	12.63	15.35	15.41	14.77	15.06	14.27	14.27	17.18	15.67
AR (mm)	72.06	38.93	42.67	37.20	42.85	51.43	60.28	48.16	37.55	49.20

ARH: The average annual relative humidity. AWS: The average annual wind speed. AT: The average annual temperature. AR: The average annual rainfall

As seen in the table, the highest average annual temperature degree was observed at Çanakkale and the lowest temperature was seen at İstanbul. The highest average annual relative humidity, wind speed and annual rainfall were observed at İstanbul. Kırklareli was a location where the average annual relative humidity and annual wind speed was the least. The sampling process was made during flowering period. All plants species were collected without disturbing their natural habitats. From each location twenty plant samples were taken. Roots, stems, leaves and flower parts of the plant materials were sampled to be carried out for maintaining plant integrity during identification. Plant samples were labeled and taken to the laboratory in appropriate bags. Once pressed and dried the plants were ready for identification. Taxa of species belonging to *Brassicaceae* family in Flora of Thrace region of Turkey (Davis, 1965) were identified using the online keys prepared by the AL-Shehbaz (1988). The species name and Latin names of plant samples was determined using identification keys.

3. Results

In this study, 6 different genus were observed. *Sisymbrium*, *Descurainia*, *Rapistrum*, *Brassica*, *Sinapis*, *Barbarea* that were identified by taxonomic classification on plant samples. *Rapistrum rugosum*, *Sisymbrium orientale*, *Descurainia sophia*, *Brassica nigra*, *Sinapis arvensis*, *Barbarea vulgaris* were determined plant species from *Brassicaceae* family growing wild in Thrace natural habitat. The species identified taxonomically according to locations are shown in Table 3.1.

Table 3.1. Identified *Brassicaceae* Species belonging to locations in Thrace Region of Turkey

Locations	Species Names
Silivri/Ali Paşa Village	<i>Rapistrum rugosum</i> (L.) All.
Çatalca/Çakıl Village	<i>Rapistrum rugosum</i> (L.) All.
	<i>Sinapis arvensis</i> L.
Çerkezköy/Büyükyoncalı	<i>Rapistrum rugosum</i> (L.) All.
Marmara Ereğlisi/Center	<i>Sinapis arvensis</i> L.
Şarköy/Eriklice	<i>Brassica nigra</i> (L.) W.D.J.Koch
	<i>Sinapis arvensis</i> L.
Malkara/Kadıköy	<i>Rapistrum rugosum</i> (L.) All.
	<i>Sinapis arvensis</i> L. var. <i>orientalis</i> (L.) W.D.J.Koch & Ziz
Hayrabolu/Çıkrıkçı Village	<i>Rapistrum rugosum</i> (L.) All.
Muratlı/Arzulu Village	<i>Sinapis arvensis</i> L.
Vize/Kıyıköy	<i>Rapistrum rugosum</i> (L.) All.
	<i>Brassica nigra</i> (L.) W.D.J.Koch
Lüleburgaz/Evrensekiz	<i>Rapistrum rugosum</i> (L.) All.
Pınarhisar/Kaynarca	<i>Rapistrum rugosum</i> (L.) All.
Koçaz/Elmacık Village	<i>Barbarea vulgaris</i> R.Br.
Süloğlu/Büyükgerdelli	<i>Sisymbrium orientale</i> L.
Lalapasa/Çömlekakpınar	<i>Rapistrum rugosum</i> (L.) All.
	<i>Descurainia sophia</i> L.
Keşan/Yerli Su Village	<i>Rapistrum rugosum</i> (L.) All.
Enez/Çavuşköy Village	<i>Rapistrum rugosum</i> (L.) All.
Meriç/Küplü Village	<i>Rapistrum rugosum</i> (L.) All.
Uzunköprü/Çiftlikköy	<i>Rapistrum rugosum</i> (L.) All.
Havsa/Abalar Village	<i>Rapistrum rugosum</i> (L.) All.
Gelibolu/Ocaklı Village	<i>Rapistrum rugosum</i> (L.) All.
	<i>Sinapis arvensis</i> var. <i>orientalis</i> (L.) W.D.J.Koch & Ziz

In this study, 7 taxa were found in 20 different locations of Thrace. *Rapistrum rugosum* L., *Barbarea vulgaris* L., *Descurainia sophia* L., *Sisymbrium orientale* L., *Sinapis arvensis* L., *Sinapis arvensis* var. *orientalis* (L.) were the taxa that determined in Thrace. *Rapistrum rugosum* L. was the most common species and it was found at 15 locations (Figure 3.1.). Minimum common species, *Sisymbrium orientale* L., *Barbarea vulgaris* and *Descurainia sophia* L. were also observed in the natural flora of the Thrace region.

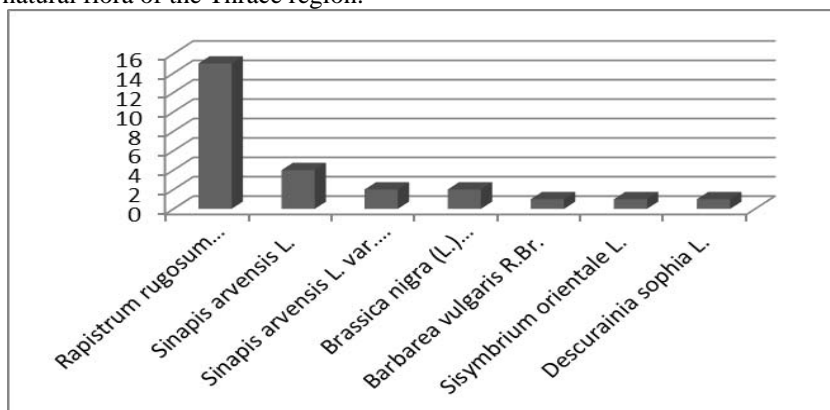


Figure 3.1. The number of locations where taxa found

Barbarea vulgaris, also called bittercress, herb barbara, rocketcress, yellow rocketcress, winter rocket, and wound rocket, is a biennial herb of the genus *Barbarea*, belonging to the mustard family. Some *Barbarea vulgaris* genotypes are naturally resistant to some insect species. In this study *Barbarea vulgaris* plants only were observed in Elmacak/Kırklareli location in 518 m altitude, 7.8 pH, 1.43 organic substances and 14.27°C average two annual temperature conditions.

Baskin et al. (2004) identified that seeds of *D. sophia* germinated at about 15°C. Species of *Descurainia sophia* L. was found at 187 m altitude, 7.15 pH, 1.64 organic substances and 14.91°C average biannual temperature conditions in Lalapaşa/Çömlekakpınar/Edirne location. The seasonal temperature changes of Edirne were suitable to germination and growing of *D. sophia*.

Sisymbrium orientale is a species in the mustard family known by the common names Indian hedgemustard and eastern rocket. *S. orientale* was preferred over a pH range of 4 to 10 (Chauhan et al., 2006). *Sisymbrium orientale* L. was located in Süloğlu/Büyükgerdelli/Edirne location at 172 m altitude, 14.91°C average biannual temperature, 7.15 pH and 5.53 organic substances conditions.

On the other hand, *Rapistrum rugosum* L. was determined at different conditions as 8 m to 187 m altitude, 6.61 pH - 7.60 pH, 12.50°C-17.18°C average annual temperature. Cousens Et al. (2006) identified that the optimal temperature range for germination was between 10°C and 25°C. Results showed that this species can live under very different ecological conditions. But *Rapistrum rugosum* only was observed in areas with acidic pH values (Altay et. al, 2012). *Brassica nigra*, was found Şarköy/Eriklice/Tekirdağ and Vize/Kıyıköy/Kırklareli locations. *B. nigra* was determined in 16 m and 8 m altitude, pH of 7.31 and 7.36, 15.35°C and 14.27°C average annual temperature in this study. *Brassica nigra*, adapted to a wide range of climatic conditions. Suited to many types of soils except very heavy clays, it prefers temperature of 6°C to 27°C and pH of 4.9 to 8.2 (Duke, 1978, 1979).

Sinapis arvensis (*Brassica kabera* (DC.) Wheeler) is an annual or winter annual plant of the genus *Sinapis* in the family *Brassicaceae*. It is commonly known as charlock mustard, field mustard, wild mustard or charlock (Mulligan 1992). In the Çatalca/Çakıl/İstanbul, Marmara Ereğlisi/Tekirdağ, Şarköy/Eriklice/Tekirdağ, Malkara/Kadıköy/Tekirdağ, Muratlı/Arzulu/Tekirdağ and Gelibolu/Ocaklı/Çanakkale location of the study area *Sinapis arvensis* was found. It was identified between 3m and 168 m altitude, pH of 6.83 to 9.40 and 12.60°C to 16.42°C average two annual temperature. *Sinapis arvensis* was preferred different organic substances rate from 4.68 to 0.51.

Barbarea vulgaris was determined as the species of *Brassicaceae* family of Kırklareli in a previous research by Güler (2013). In addition, in this study, *Rapistrum rugosum*, *Brassica nigra*, *Barbarea vulgaris*, were found in Kırklareli. Kireç and Yarcı (1999), identified that *Rapistrum rugosum* was the species of the *Brassicaceae* in Enez /Edirne. According to the results by Yarcı (1999); *Sinapis arvensis* L. was determined species, found in Thrace. In our study we found *Barbarea vulgaris* in Kofçaz location and *Rapistrum rugosum* in Pınarhisar location as differently previous studies by Güler (2013) and Yarcı (1999).

Barbarea vulgaris, *Rapistrum rugosum* and *Brassica nigra* were found taxa in Kırklareli city of Thrace in this research. *Rapistrum rugosum* was determined a taxa in Enez location. *Rapistrum rugosum* and *Sinapis arvensis* were determined taxa in İstanbul.

4. Conclusions and discussion

The results of this research showed that Thrace part of Turkey was got rich for many genus and species of *Brassicaceae* family. On the other hand, Thrace region has different soil structures according to locations to contribute growing a very different kind of species. Other results for this study indicated that *Rapistrum rugosum* is the most abundant taxa in Thrace region. The less distributed species in Thrace region were identified as *Barbarea vulgaris*, *Sisymbrium orientale* and *Descurainia sophia*.

In this study, it was also determined that natural hybridization among *Brassicaceae* species contributed in creating differences among them irrespective of their original morphological and physiological properties. In addition widespread distribution of pesticides and other chemical applications have decreased the diversity of these taxa. Thus, the natural environment should be protected to increase taxa diversity in flora of Thrace region.

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