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CARPOLOGICAL STUDY ON *HIPPOPHAE RHAMNOIDES* L.

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Abstract

Morphological traits of seeds and fruits belonging to *Hippophae rhamnoides* L. taxa (Sea buckthorn) collected from Kastamonu area in Black Sea region were investigated. Dimensions of fruit, seed and pedicel (length-width) are diagnostic characteristics for *H. rhamnoides* subsp. *caucasica* and those were measured and their shapes were observed. Observed that the measurement results of collected shapes and colors of samples were quite different.

Introduction

Fossil pollen records indicate that *Hippophae rhamnoides* L. (commonly known as Sea buckthorn) was widespread in late quaternary era in Anatolia (Bottema *et al.* 1995), suggesting that *Hippophae* L. is the native plant of Anatolia. As Rousi (1971), reported that only *Hippophae rhamnoides* L. subsp. *caucasica* is native to Turkey today, Rongsen (2005) discusses that subsp. *turkestanica* is native to Turkey as well, and Aras (1995a, 1995b, 1997), Aras *et al.* (2005, 2007) suggest that there might be different taxon or taxa. Rousi (1971) reported that some Turkish subsp. *caucasica* samples show great similarity to subsp. *turkestanica* and this resemblance probably results from adaptation to aridity. However, subsp. *caucasica* samples from the Bulgarian coast of the Black Sea represent a transition to subsp. *carpatica*.

Rousi (1971) pointed out that fruit dimension, especially its shape and pedicel length was characteristic features in taxonomy.

Trofimov (1961, 1967) classified *H. rhamnoides* under four groups according to seed characters, and concluded that seed characters could be used as one of the main criteria in its taxonomic division. Rousi (1965, 1971) stated that seed characteristics would successfully be useful in racial diversity of the taxon.

There is a limited number of articles on fruit, pedicel, flower and branch morphology of *Hippophae rhamnoides* and its fruit morphology studies were reported by name of the researchers (Pearson and Rogers 1962, Rousi 1971, Lian *et al.* 2000, Harrison and Beveridge 2002).

In the present carpological study, investigations were carried out on fruit, seed and pedicel characters in the taxonomic division of *H. rhamnoides* collected from Kastamonu area, Black Sea Region, (1) to contribute to carpological finding, (2) to test whether there is a significant association between the morphological characters measured in the *H. rhamnoides* and its environment, (3) to address whether there are taxonomical differences in *H. rhamnoides* collected from the area.

Materials and Methods

Mature and healthy carpological materials of *H. rhamnoides* L., all collected from natural populations from Kastamonu area were used.

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For the carpological study, 50 measurements for carpological dimensions (length and width) were performed by using digital imaging and analysis system.

Table 1. Some characteristics of the sampling sites.

Sampling sites	Latitude/ longitude	Altitude (m)	Annual precipitation (mm)	Annual temperature (°C)	Climate type
Kastamonu A4 Tosya, Taşköprü,Araç	41^0 02´N / 34^0 03´E	820	475.3	11.3	Humid
Çankırı A4 Ilgaz	40^0 36´N / 33^0 37´E	751	403.07	11.24	”
Çorum A5 Kargı	40^0 33´N / 34^0 57´E	776	422.3	10.7	”

Our results measurements were compared with others authors (Table 4). Collected samples were preserved in the herbarium of the Faculty of Science, the University of Istanbul (ISTF).

Table 2. Locations where *Hippophae* taxa were collected in Kastamonu province and its environment, collection dates and sampling sites.

Collection area	Sample no.	Collection dates
Kastamonu - Tosya - Taşköprü road	1-12	06.10.2006
Kastamonu - Tosya	28-30	27.10.2007
Kastamonu - Tosya - Deringöz Spring	20-27, 40	27.10.2007
Tosya - Kastamonu road	31-34	28.10.2007
Kastamonu Vehicle	37-39	28.10.2007
Çankırı Ilgaz - Tosya road	15,19,35,36	05.10.2006
Çorum Kargı Saraçlar village	16-18	15.11.2006

Thornthwaite method (Erinç 1962, Ardel *et al*. 1969) was used to find water balance and climate type of the sites and to interpret the statistical results in respect of ecological conditions.

Morphological distances between pairs of populations were calculated using average taxonomic distance.

Results and Discussion

As n = 50, the measurement results of fruit length-width, seed length-width, pedicel length-width of *H. rhamnoides* L. samples are given in Table 3; and the photographs are given in Fig. 1.

In Table 3 and Fig. 1, it can be seen that average fruit length of sample groups numbered 20, 24, 25 and 27 is over 11 mm, and the other groups is 7 - 10 mm.

As can be seen in Table 4, the fruit length is 10 mm or more in only subsp. *rhamnoides, H. tibetana,* and *H. goniocarpa* among subspecies of *H. rhamnoides.* The sample groups numbered 20, 24, 25, and 27 are close to subsp. *rhamnoides, H. tibetana* and *H. goniocarpa*.

Fig. 1. Fruit, pedicel and seed photographs of samples of *Hippophae* taxa collected around Kastamonu.

In Table 3 and Fig. 1, it is seen that average fruit width of the samples numbered 31 and 34 are more than 7 mm, the samples numbered 3, 4, 13, 37 - 39 are less than 5 mm and the other ones are between 5 and 7 mm.

Fruit widths of subsp. *caucasica* are reported by Rousi (1971) as 3 - 6 mm; McKean (1982) as 3 - 7 mm; Aras *et al*. (2007) as 4.16 - 7.86 mm (Table 4). Hyvonen (2003) reported that the fruit width of four subsp. *caucasica*, *fluviatilis*, *sinensis* and *turkestanica* is less than 5 mm, and fruit width of 6 - 6.5 mm belongs to other four subsp. *carpatica*, *mongolica*, *rhamnoides* and *yunnanensis*; and the ones with fruit width of 7 mm and more belong to *H. tibetana*.

The majority of fruit colors of studied samples is seen to be Opriment, Persimmom, Tangerine, cadmium orange; and saffron yellow, Indian yellow, Mojalica yellow and yellow ochre in limited number of samples in accordance with Wilson (1941) color scale.

Rousi (1971) reported that subsp. *caucasica* was saffron yellow; Korovina and Fefelov (2003) reported that the fruit color in Caucasian types can be yellow, light-yellow and lemon yellow, and

rarely red. He attributed the wide variety of color in the taxon *H. rhamnoides* to climate change. Korovina (1988) indicated that this taxon had variations in fruit, seed dimensions and color in Russia and this originated from four different climate types. Considering the climate type in the

Table 3. The fruit, seed and pedicel dimensions of *Hippophae* taxa and their comparison with others.

Taxa	Fruit length (mm)	Fruit width (mm)	Seed length (mm)	Seed width (mm)	Pedicel length (mm)
H. rhamnoides	4 -9[1]	4 -8[1]	2,6-5,4[1]	1,5-3,5[1]	
	4 -9(-10)[6]	3-8[6]	4 -7[6]	1,5-2[6]	1-7[6]
H. rhamnoides subsp. *rhamnoides*	9-12[1]	8-11[1]	3,8-5,1[1]	1,9-3,3[1]	1-3(-4)[1]
	8-11[3]	5-7[3]			
subsp. *fluviatilis*	5-6[1]	4 -6[1]	2,8-4,4[1]	1,9-2,5[1]	1-5[1]
subsp. *carpatica*	6-8[1, 3]	5-7[1, 3]	3,3-5,3[1]	2-2,6[1]	1-3[1]
subsp. *caucasica*	6-9[1, 2]	3-6[1]	3,5-5,3[1]	1,7-3[1]	1-3[1]
	5,5-9,87[5]	3-7[2]	2,86-6,77[5]	1,13-3,54[5]	
		4,16-7,86[5]			
subsp. *turkestanica*	5-7(-9)[1, 6]	3-5[1, 6]	2,7-4,2[1]	1,5-2,5[1]	3-4(7)[1,3,4,6]
			2,8-4,2[6]		
subsp. *mongolica*	6-9[1, 6]	5-8[1, 6]	3,8-5,1 [1, 6]	2,1-3 [1]	1-4 [1,3,4,6]
subsp. *sinensis*	4-6 [1, 6]	4 -6 [1, 6]	2,8-4,1 [1]	1,9-2,6 [1]	1,2 [1, 6]
			2,8-4 [6]		1-2,5[3, 4]
subsp. *yunnanensis*	5-7 [1, 6]	5-7 [1, 6]	3-3,9 [1, 6]	2,1-2,5 [1]	1-2 [1, 6]
					1-2,5[3, 4]
subsp. *gyantsensis*	5-7 [1]	3-5 [1]	4,5-4,6 [1]	2,4-2,5[1]	2[1]
subsp. *wolongensis*	4 -5,5(6) [4]	(4,5)5-6(7) [4]	3-4 [4, 6]	1,5 [4, 6]	3-5 [4, 6]
	4 -6[6]	4,5-6(-7) [6]			
H. salicifolia	5-7[1, 6]	5-7[1, 6]	3,8-5 [1]	2-3[1]	1-4 [1, 6]
			2,8-5,2[6]		
H. tibetana	8-11 [1, 6]	6-9 [1, 6]	4,1-5,2 [1]	2-2,7 [1]	1-2 [1, 6]
			4 -5,6 [6]	1,9-2,8 [6]	
H. gyantsensis	5-7 [6]	3-5 [6]	4,5 [6]		2 [6]
H. litangensis	6-8 [6]				
H. ganiocarpa	(5,5)6-10 [3]	(3,5)4-5,9 [3]			
	6-10[6]				
H. ganiocarpa subsp. *litangensis*	6-7,6 [3]	4,5-5,3 [3]			
H. neurocarpa	7-8,4 [3]	2,8-3,3 [3]	4-6 [6]		
	5,5-8(-9) [6]	3-4 [6]			
H. neurocarpa subsp. *neurocarpa*	6-8(-9) [6]				
H. neurocarpa subsp. *stellatopilosa*	5,6-6,5 [3]	2,5-3,3 [3]			
	5,5-6,5 [6]				

Rousi (1971)[1], McKean (1982)[2], Lian (1998)[3], Lian *et al*. (2003)[4], Aras *et al*. (2007)[5] and Shu (2007)[6].

sites where research material were collected and the climatic diagrams, the present authors have the opinion that fruit color change and morphological characteristics do not arise from climate. Climate types of these sites (Cankırı, Çorum, Kastamonu, Tosya) are all humid, microthermal, with moderate lack of water in summer and continental climate close to ocean climate.

Table 4. Pearson correlation analysis between pairs of morphological characters of the *Hippophae* populations studied.

	Fruit length	Fruit width	Seed length	Seed width	Pedicel length	Pedicel width
Fruit length	1					
Fruit width	0.660858	1				
Seed length	0.894346	0.618628	1			
Seed width	0.332103	0.629917	0.371557	1		
Pedicel length	–0.12333	–0.0842	–0.08573	–0.56213	1	
Pedicel width	–0.05348	0.366002	0.056621	0.327677	0.188434	1

The average seed length in the present research materials is 5 mm and more in sample groups numbered 16 - 18, 20, 24, 25, 27 and 31; less than 4 mm in sample groups numbered 3, 4, 11, 28, 29, 32 and 36, and between 4 and 5 mm in the other sample groups (Table 3 and Fig. 1).

The average seed width is less than 1.5 mm in two samples numbered 37 and 39; more than 2 mm. in the 26 samples. Seed width of the other sample groups is between 2 mm. and 1.5 mm. One sample has seed width of 2.48 mm.

Rousi (1971) stated that the seeds of *H. rhamnoides uav. caucasica* were generally long and narrow; their lengths were between 3.5 and 5.3 mm., widths were between 1.7 and 3 mm.; Aras *et al*. (2007) remarked that their lengths were between 2.86 and 6.77 mm, widths were between 1.13 and 3.54 mm. Hyvoven (2003) emphasized that the ones shorter than 3.7 mm in terms of seed length appear in four subsp. *fluviatilis*, *sinensis*, *turkestanica* and *yunnanensis;* the ones longer than 3.9 mm in the other four subsp. *carpatica*, *caucasica*, *mongolica* and *rhamnoides*, the ones wider than 2.1 mm in terms of seed width appeared in subsp. *fluviatilis*, *sinensis*, *yunnanensis, carpatica*, *caucasica*, *mongolica* and *rhamnoides*, the ones narrower than 2.1 mm appear in subsp. *turkestanica.*

Pedicel length of the samples varies between 0.77 and 3.07. Research materials are gathered under 3 groups with respect to average pedicel length. The average pedicel length is more than 2.5 mm in the samples numbered 20, 24, 25, 27; less than 1 mm in the samples numbered 8, 15, 29, 36; between 1 and 2.5 mm in the other sample groups. Rousi (1971) reported that the pedicel length of subsp. *caucasica* was between 1 and 3 mm (Table 4).

When showing the average pedicel widths are analyzed, it is possible to gather the sample groups under three main groups. The sample groups with pedicel width of more than 0.8 mm are 31, 33-35; between 0.7 mm and 0.8 mm are 4, 12, 15-18, 21-23, 26, 29, 30, 32, 36 and 40, and of less than 0.7 mm are 1-3, 5-11, 13, 14, 19, 20, 24, 25, 27, 28 and 37-39 (Table 4 and Fig. 1).

When Pearson's correlation is analyzed (Table 5), it is seen that there is positive correlation between seed and fruit length; high negative correlation between pedicel width and fruit length. While the correlation between seed width and fruit and seed length is low, it is seen that the correlations between seed and fruit widths are high. While the correlation coefficient is r = 0.37, it is remarkable that the correlation coefficient between seed width and pedicel width is r = 0.33.

There is a negative correlation between pedicel length and fruit and seed dimensions. However, pedicel width has a negative correlation only with fruit length.

The present research results reveal that the variations in fruit, seed, pedicel dimensions and fruit color which are accepted as diagnostic characters do not originate due to climate. Differences in diagnostic characters despite the similarity of climate conditions can be explained in such a way that *H. rhamnoides* was widespread on late quaternary in Anatolia, and the grouping and differences existed among the studied population in terms of the morphological characters may explain that there were different origins or varieties forming the *Hippophae* stands.

The authors are of opinion that molecular and chemotaxonomical studies along with revision studies on this economically valuable taxon is necessary because of its all-purpose usage areas, especially its medicinal and nutritional properties and enlightenment of its taxonomy.

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