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A Study on The Relationships of Salinity and Endemism Ratios in The Surrounding of Salt Lake (Inner Anatolia, Turkey)

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Abstract

Three habitat types are seen in the surroundings of Salt Lake, salt steppes, marshes with and without freshwater sources. The ratios of endemic taxa belonging to those three vegetation types are compared to their soil saltinities. A strong parabolic relation was detected between the ions Mg, Na and SO_4 effective on soil salinity and the ratio of endemic taxa. The ratio of endemic taxa is 21.8% in the salt steppes with Mg: 18.3me/l, Na: 8.6 me/l, SO_4: 14.8 me/l ions levels, 29.1% in the marshes with freshwater sources where these ions have somewhat higher concentration (Mg: 24me/l, Na: 121.8 me/l, SO_4: 134me/l). Despite the fact that the ions reach their uppermost levels (Mg:31.4 me/l, Na: 375.8 me/l, SO_4: 362.9 me/l) in the marshes without freshwater sources, the ratio of endemic taxa decreases to 20.7 me/l.

Keywords: Salinity, endemism, Salt Lake, Inner Anatolia, Turkey

Tuz Gölü Çevresinde Tuzluluk Ve Endemizm Oranlarının İlişkileri Üzerine Bir Çalışma (İç Anadolu, Türkiye)

Özet:

Tuz Gölü çevresinde tuzlu stepler, tatlı su kaynakları bulunan bataklıklar ve tatlı su kaynakları bulunmayan tuzlu bataklıklar olmak üzere üç farklı habitat tipi yayılış gösterir. Bu vejetasyon tiplerine ait endemik takson oranları ile toprak tuzluluğu karşılaştırıldı. Toprak tuzluluğuna etki eden iyonlardan Mg, Na ve SO_4 miktarları ile endemik takson oranları arasında güçlü bir parabolik ilişki olduğu tespit edildi. Mg (18.3 me/l), Na (8.6 me/l) ve SO_4 (14.8 me/l) iyonlarının en düşük değerlerde bulunduğu tuzlu step vejetasyonunda endemik takson oranının 21.8%, bu iyon değerlerinin biraz daha arttığı (Mg: 24 me/l, Na: 121.8 me/l, SO_4: 134.1 me/l) tatlı su kaynaklarının bulunduğu tuzlu bataklıklarda endemik takson oranının 29.1% ve tatlı su kaynaklarının bulunmadığı tuzlu bataklıklarda ise bu iyon miktarlarının en yüksek değerde bulunmasına rağmen (Mg: 31.4 me/l, Na: 375.8 me/l, SO_4: 362.9 me/l) endemik takson oranının 20.7%'ye düştüğü tespit edilmiştir.

Anahtar Kelimeler: Tuzluluk, endemizm, Tuz Gölü, İç Anadolu, Türkiye

1. Introduction:

Edaphic properties are important factors that effect the distribution of plants in regions where climate and topography are more or less stable as in Salt Lake. In ecological point of view, physical and chemical properties of soils are especially effective on plant life and also distribution of plants. However as in Salt Lake environment where salt concentration of soil is high, chemical properties have more importance [1, 2].

Salt Lake is the result of tectonical subsidence of the land. Some of the under ground water feeded from mountains surrounding the Central Anatolia pan reach to the surface here. These waters dissolve mother rock and take some salts with them to the surface. This salty mixture looses its water as a result of rapid evaporation and leaves its salt in soil. This process has continued for years so there is an increasing salinity due to base water and excessive evaporation. Major ions effective on salinity are Ca, Mg, Na, K, HCO_3, Cl and SO_4.

Limiting effect of salinity on plant life and their distribution is mostly observed on ratio of endemic taxa. Because in a habitat when one of the environmental factors is dominant, cosmopolit plant species that can tolerate this factor or plant species that have physiological and morphological properties to live with this factor can survive. *Phragmites australis* (Cav.) Trin. ex Steudel is an example of species that has high tolerance. This is a widespread species spreading not only on salt marshes between Sultanhanı, Eskil and Gölyazı where the salinity is very high but also on wetlands that are formed from fresh waters. Although the endemic species comprise the most of the species that are selective to this environmental factor, a few of them are the cosmopolitans that can adapt and survive with this factor. For example *Dianthus aydogdui* Y. Menemen and E. Hamzaoğlu [3] is an endemic species living around Salt Lake where the salinity is high, however *Halocnemum strobilaceum* (Pall.) Bieb. is a cosmopolitan species spreading on whole Asia from south of Europe to Mongolia and north of Africa along sea sides and terrestrial salt marshes where the salinity is noticable in different ranges.

In this study, the relation between soil salinity and endemic taxa ratio is tried to determined.

2. Material And Methods

The material of this research is composed of plant species of three different vegetation types that are spreading around Salt Lake and soil analysis which are the results of the DPT 97 K 121060 and "floristic and synecological research of salt pans of Turkey" project.

Climatic data of the region were determined from "mean extreme temperature and precipitation values bulletin (daily-monthly)" published by DMI [4] and from Archives of Ankara Meteorological Directorship. In the determination of the climate type of the region Emberger temperature-precipitation related formula was used [5].

Informations about soil groups were provided from TSI "Konya closed pan soils" [6] and soil samples were analyzed at "Köy Hizmetleri Ankara Araştırma Laboratuarları".

For the identification of collected specimens "Flora of Turkey and the East Aegean Islands" was used [7]. In this research only the total species number and endemic taxa number of each vegetation types were used.

3. Definition of the region

Salt Lake is located between Ankara, Konya and Aksaray provincies at Central Anatolia. Phytogeographically the region is completely in Irano-Turanian region and very important for Turkey for endemic plants [8,9,10]. Altitude of the lake is 905 meters.

Aksaray, Şereflikoçhisar, Kulu and Cihanbeyli meteorological stations measurements were used to interpret the climate of the region. According to this, study-region is under the effect of semi-arid cold and very cold Mediterranean climate which is very common in Central Anatolia [5]. Annual mean precipitation changes between 308-365 mm. The most rainy months for Cihanbeyli are December, January and May, for Aksaray, Şereflikoçhisar and Kulu December, January, February, March, April and May. Mean annual temperatures are in the range of 10.8-12.9^{0}C. Maximum mean temperatures are recorded in July and August, minimum mean temperatures are recorded in December, January, February and March.

The climatic data of meteorological stations are given in Table 1. The arid period lasts for 4 or 5 months all of meteorological stations (Fig. 1-4).

One of the most common soil groups at Salt Lake environ is salty hydromorphic alluvial soils. This type of soil is common in closed domain where drenage is bad and irrigation is insufficient. Also koluviyal soils, vertisols and organic soils are present in a less ratio in this region compared to neighbouring the alluvial soils. Brown soils are one of the big soil groups especially around Ereğli, Karapınar, Konya and Aksaray. Not only hydromorphic alluvial soils but also brown soils contain different salt ratios.

Regions between brown soils spreading on a large areas that contain less salt ratio are used for grain agriculture and other parts are covered by salty steppe formation and used as pasture.

Table 1: Bioclimatical synthesis

Stations	h	P	M	m	PE	S	Q_2	Precipitation Regime	Bioclimate
Şereflikoçhisar	975	363.0	29.6	-0.5	32.5	1.0	41.9	W.S.F.Su	Semi-arid, cold, Medit. Climate
Aksaray	980	347.4	29.9	-3.4	36.7	1.2	36.4	W.S.F.Su	Semi arid, very cold, Medit. Climate
Cihanbeyli	969	308.0	29.1	-3.8	33.1	1.1	32.7	S.W.F.Su	Arid, very cold, Medit. Climate
Kulu	1000	365.0	29.0	-5.0	40.6	1.4	37.7	W.S.F.Su	Semi arid, very cold, Medit. Climate

h: Altitude

P: Annual Mean Precipitation (mm)

M: Maximum mean temperature of the hottest month (°C)

m: Minimum mean temperature of the coldest month (°C)

PE: Summer recipitation (mm)

S: Aridity index S=PE/M

Q_2: Emberger's pluviometric quotient $Q_2=2000xP/M^2-m^2$

	a	b	c	d	e	f
Şereflikoçhisar		975	363	12.9	-0.5	29.6

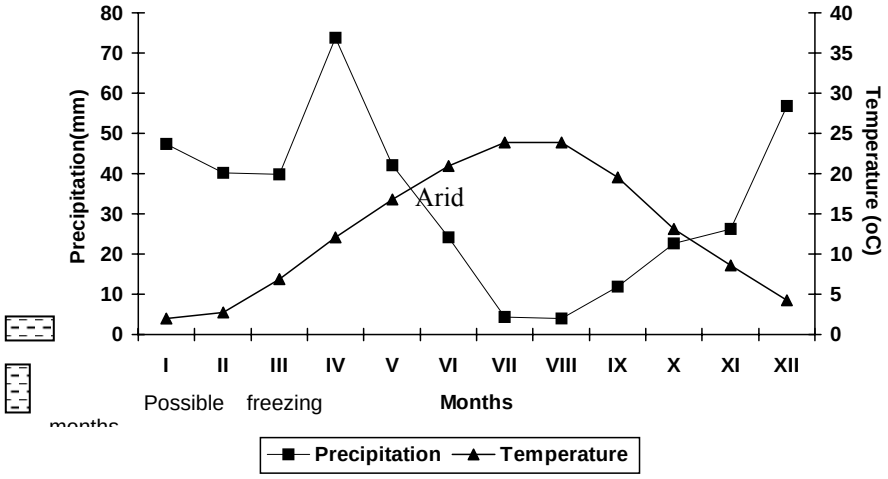

Figure 1: Ombrothermic diagram of Şereflikoçhisar

	a	b	c	d	e	f
Aksaray		980	347.4	11.8	-3.4	29.9

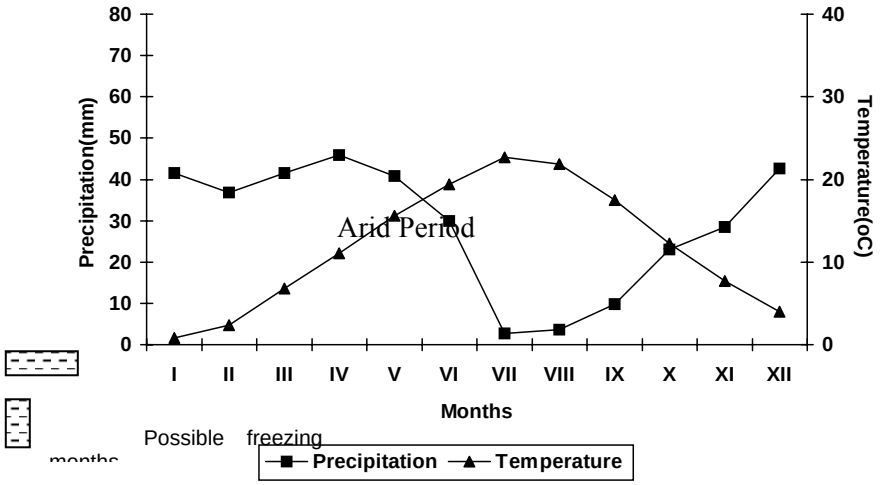

Figure 2: Ombrothermic diagram of Aksaray station

a	b	c	d	e	f
Cihanbeyli	969	308	11.1	-3.8	29.1

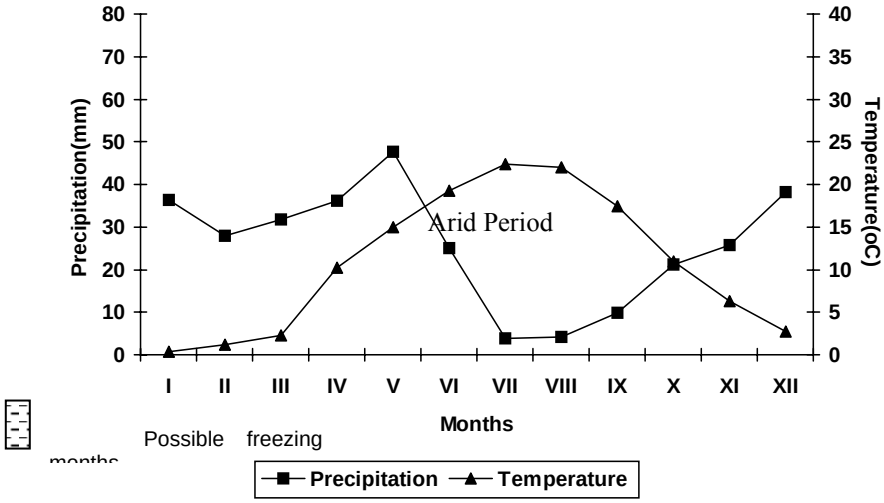

Figure 3: Ombrothermic diagram of Cihanbeyli station

a	b	c	d	e	f
Kulu	1000	365	10.8	-5	29

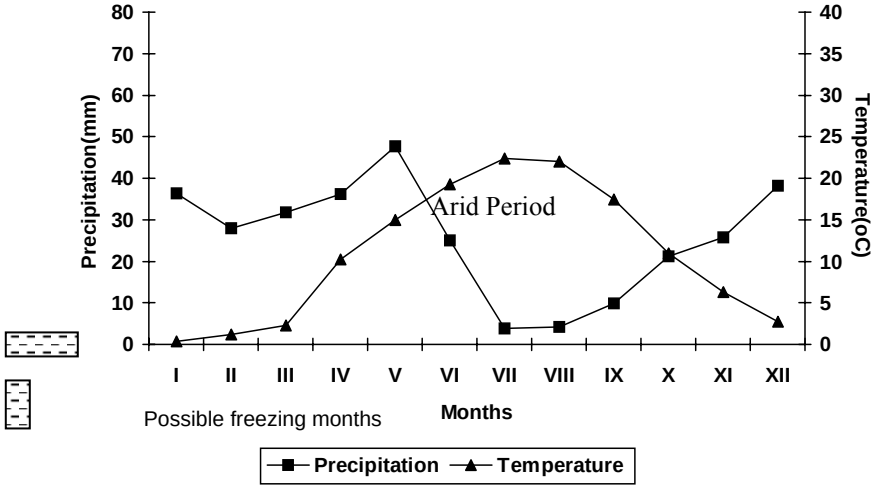

Figure 4: Ombrothermic diagram of Kulu station

4. Results

1. Salty Steppes:

This is a type of vegetation growing on brown soils where the base water never reaches to the surface throughout the year and altitude is higher than the salt marshes. This vegetation type surrounds the salt marshes and widespreads. *Artemisia santonicum* L. is dominant on the landscape (11).

Mean values of analysis of four soil samples belong to this vegetation type and endemism conditions are given in Table 2.

Table 2. Endemism conditions and mean values of soil analysis results of salty steppe vegetation.

Total species and sub taxa number	Number of endemic taxa	Endemism ratio (%)	Cations (me/l)				Anions (me/l)		
			Ca	Mg	Na	K	HCO_3	Cl	SO_4
78	17	21.8	13.3	18.3	8.6	1.3	8.2	12.3	14.8

2. Salt Marshes with Freshwater Sources

This vegetation type is spreading at the salt marshes between Sultanhanı, Eskil and Gölyazı where fresh water sources are common [12]. Because of these fresh water sources, soil

surface always humid except for the most arid period between August and October. Salinity degree of salty hydromorphic alluvial soil at this region is lower that the marshes that do not have fresh water sources. These sources flows to the lake with forming narrow canals and changing the direction according to weak slope. However as a result of excessive evaporation they dry before reaching the lake. The species of *Poaceae, Cyperaceae* and *Juncaceae* families dominate the landscape of this vegetation type .

Mean values of analysis of two soil samples belong to this vegetation type and endemism conditions are given in Table 3.

Table 3. Endemism conditions and mean values of soil analysis results of salt marshes with freshwater sources.

Total species and sub taxa number	Number of endemic taxa	Endemism ratio (%)	Cations (me/l)				Anions (me/l)		
			Ca	Mg	Na	K	HCO_3	Cl	SO_4
55	16	29.18	5.8	24	121.8	9.1	3.2	8.8	134.1

3. Salt Marshes without Fresh Water Sources

This is the most widespread vegetation type that is spreading on salty hydromorphic alluvial soils. Salinity of this region which is spreading from lake shore, except for the region with fresh water sources, to the beginning of salty steppes is very high with respect to the other vegetation types. Soil surface is dry from June to November because of excessive evaporation. This region has a white appearence as a result of the excessive accumulation of minerals that cause salinity. Members of *Chenepodiaceae, Plumbaginaceae* and *Poaceae* dominate on the landscape [12].

Mean values of analysis of six soil samples belong to this vegetation type and endemism conditions are given in Table 4.

Table 4. Endemism conditions and mean values of soil analysis results of Salt marshes without freshwater sources.

Total species and sub taxa number	Number of endemic taxa	Endemism ratio (%)	Cations (me/l)				Anions (me/l)		
			Ca	Mg	Na	K	HCO_3	Cl	SO_4
82	17	20.7	10.6	31.4	375.8	8.7	5.1	18.8	362.9

There are 20 endemic plant species known from only Salt Lake or Salt Lake and locally in its environ and distribution of them at three different vegetation types are given in Table 5.

5. Discussion And Conclusion

Salt Lake environ is one of the endemism centers of Turkey [10]. Soil samples analysis results and endemic taxa ratios of three different vegetation types of the area were given in Figures 2 and 3 respectively.

According to this it is found that there is a strong parabolic relation between endemic taxa and Mg, Na and SO_4 ions that are effective on salinity.

Mg (18.3 me/l), Na (8.6 me/l) and SO_4 (14.8 me/l) are in their lowest values in salty steppe vegetation and endemic taxa ratio of this vegetation type is 21.8%.

Salt marshes at Sultanhanı, Eskil and Gölyazı where fresh water sources are present, the values of these ions a bit higher (Mg:24 me/l, Na:121.8 me/l, SO_4:134.1 me/l) and endemic taxa ratio is 29.1%. This endemism ratio is the higgest for the vegetation types determined at this region. Up to this point it can be tought that there is a proportionality between Mg, Na, SO_4 ions and endemic taxa ratio.

The endemic taxa ratio does not increase, on the contrary, it decreases to 20.7% at salt marshes without fresh water sources where the amount of these ions increase to very high level (Mg: 31.4 me/l, Na: 375.8 me/l, SO_4: 362.9 me/l).

There are 20 endemic plant species at Salt Lake and its environ. Three of them are found only at salty steppes, 6 of them at only salt marshes with fresh water sources and nine of them at salt marshes without fresh water sources. While *Limonium tamaricoides* is found at both of the vegetation types *Verbascum helianthemioides* is found at only salt marshes with fresh water sources and salt marshes without fresh water sources.

This situation shows that, the presence of Mg, Na and SO_4 ions in the soil at certain values is formideal balance between plants survival and adaptation capacity, and so it causes to think that endemic taxa ratio is high. It is hard to estimate the amounts of the ions forming this ideal balance. But it can be said that the avarage values are as follows; Mg: 21-28 me/l, Na: 65-250 me/l, SO_4: 75-250 me/l.

According to Figures 5 and 6, endemic taxa ratio and Ca and Cl ions' amounts are inversely proportional. However this relation is not strong as in Mg, Na and SO_4. Also no relation could be established between K and HCO_3 ions amounts and endemic taxa ratio.

As a result, in order to understand whether or not there is a relation between the salinity and endemic taxa ratio, there should be detailed researches especially in ecology, molecular genetics, evolution, biostatistics, physiology and systematics.

Table 5. Endemic plant species of Salt Lake and their distribution in three vegetation types.

Grid Square	Endemic Plant Species	Explanations	Salty Steppes	Salt Marshes with Freshwater Sources	Salt Marshes without Fresh Water Sources
B4, C3	*Acantholimon halophilum*	Known only from Salt Lake.	+		
B4	*Asparagus Iycaonicus*	Known only from Salt Lake.			+
B4, B5	*Astragalus ovalis*	Presence in Salt Lake is determined with this study.	+	+	
B4	*Dianthus aydogduii*	Known only from Salt Lake.		+	
B4, B5	*Elymus elongatus subsp. salsus*	_			+
B4, B5	*Erysimum torulosum*	-	+		
B4	*Ferula halophila*	Known only from Salt Lake.	+		
B4, C4, C5	*Gladiolus halophilus*	Known only from Salt Lake.			+
B4	*Hypericum salsugineum*	Known only from Salt Lake.			+
B4	*Limonium tamaricoides*	Known only from Salt Lake.	+	+	+
B4, B5, C4	*Microcnemum coralloides* subsp *anatolicum*	Subspecies of this species in Anatolia known as endemic.		+	
B4, C4	*Onosma halophila*	-			±
B4, B5	*Salsola stenoptera*	-		+	
B4, C4	*Salvia halophila*	-			+
B4	*Silene salsuginea*	Known only from Salt Lake.			+
B4, B5	*Sphaerophysa kotschyana*	A ditypical genus known only from Turkey and Iran.		+	
B4, C4	*Suaeda prostrata subsp anatolica*	Known only from Salt Lake.		+	
A3, B4	*Tarayacum mirabile*	-			±
B4, B5	*Verbascum helianthemioides*	-	±	±	
B4, B5, C4	*Verbascum pyroliforme*	-			+

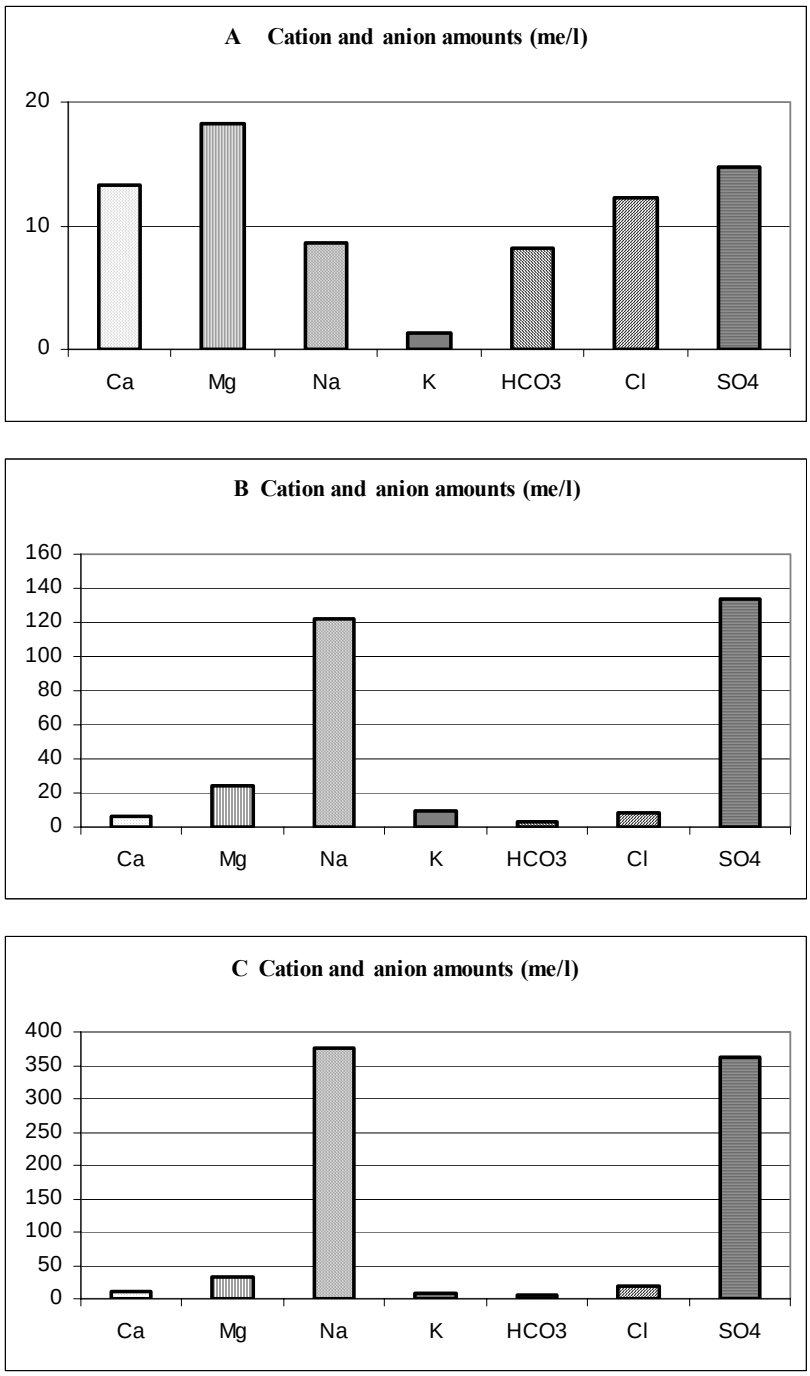

Figure 5. Soil samples analysis results of three different vegetation types; A) Salty steppes, B) Salt marshes with fresh water sources, C) Salt marshes without fresh water sources.

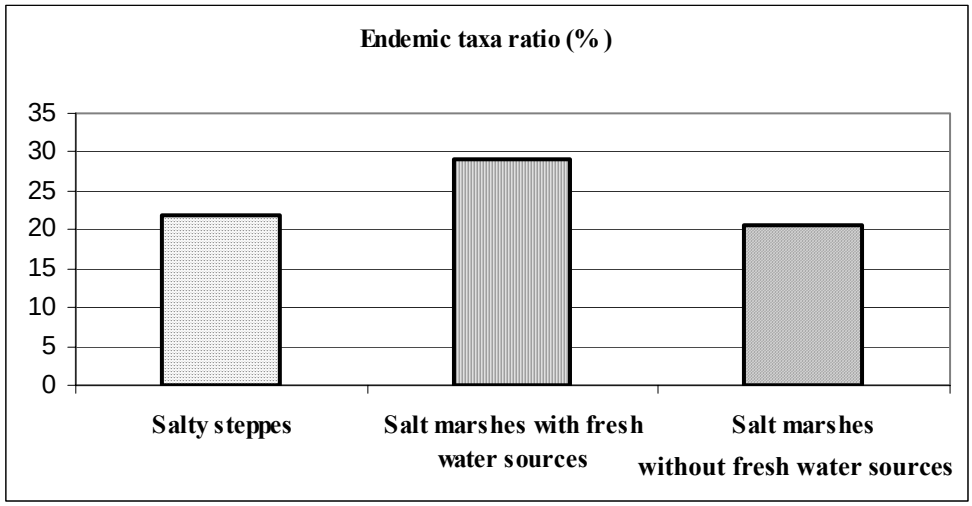

Figure 6. Endemic taxa ratio of three different vegetation types.

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