Al-Azhar Bulletin of Science

Volume 23 | Issue 2 Article 12

12-1-2012

Section: Botany, Microbiology and Zoology

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How to Cite This Article

MANSOUR, M. and OMAR, K. (2012) "EFFECT OF ALTITUDINAL VARIATIONS ON THE DISTRIBUTION OF NEPETA SEPTEMCRENATA IN SAINT KATHERINE PROTECTORATE, SOUTH SINAI, EGYPT.," *Al-Azhar Bulletin of Science*: Vol. 23: Iss. 2, Article 12.
DOI: https://doi.org/10.21608/absb.2012.7214

EFFECT OF ALTITUDINAL VARIATIONS ON THE DISTRIBUTION OF *NEPETA SEPTEMCRENATA* IN SAINT KATHERINE PROTECTORATE, SOUTH SINAI, EGYPT.

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Abstract

A study was carried out on a wild herb *Nepeta septemcrenata* Benth. (Family : Lamiaceae) in Saint Katherine Protectorate, South Sinai, Egypt to assess the effect of altitude (1400 to 2200 m above mean sea level) on plant distribution, morphological parameters, soil component and grazing pressure. The results show that elevation influence on physical and chemical properties of soil. Water content show great variation among different elevation ranks. Plant traits also affected by elevation gradient. Results found that *N.septemcrenata* cover, Importance value, Number of individuals and internodes length increased positively with elevation while species richness decreases. Plant width, height and No. of branches also affected by elevation gradient and show highest values at elevation between 2000-2200 m.

Keywords: *Nepeta septemcrenata*; Saint Katherine Protectorate; altitudinal variation.

1. Introduction

The genus *Nepeta* (Lamiaceae) comprises approximately 250 species of annual or perennial herbs distributed in temperate Europe, Asia and Africa (Mabberley, 1997). They contain, depending on the species, up to 1% of essential oil as well as nepetalactone, iridoid, bitter principles, tannins and minerals. *Nepeta* essential oil is mainly composed of citral, citronellal, geraniol, carvacol, nepetol, thymol, pulegon, actinidine and monoterpene alkaloid (Nowiński, 1983; Mackú and Krejcá, 1989; Bown, 1999 Senderski, 2004). *Nepeta septemcrenata* is the only species of the genus *Nepeta* in Egypt (Täckholm, 1974). Near endemic found in Stony wadis. Sinai, northwest Saudi Arabia (Boulos, 2002).

The Saint Katherine Protectorate (SKP) is one of Egypt's largest protected areas and includes the country's highest mountains. This arid, mountainous ecosystem supports a surprising biodiversity and a high proportion of plant endemics and rare. The flora of the mountains differs from the other areas, due to its unique geology, morphology and climate aspects (Hatab, 2009).

The high mountains of southern Sinai support mainly Irano-Turanian steppe vegetation. Smooth faced rock outcrops supply sufficient run-off water to permit the survival of the unique flora. St. Katherine Protectorate is one of the most floristically diverse spots in the Middle East and with 44% of Egypt's endemic plant species. To date around 1261 species were recorded in Sinai. 472 plant species have been recorded as surviving and still occurring in SKP (Fayed and Shaltout, 2004) of these

19 species of the surviving flora are endemic and more than115 are with known by medicinal properties used in traditional therapy and remedies.

Topography is the principal controlling factor in vegetation growth and that the type of soils and the amount of rainfalls play secondary roles at the scale of hill slopes (O'Longhlin, 1981; Wood *et al.,* 1988; Dawes and Short, 1994). Elevation, aspect, and slope are the three main topographic factors that control the distribution and patterns of vegetation in mountain areas (Titshall *et al.* 2000). Among these three factors, elevation is most important (Day and Monk, 1974; Busing *et al.,* 1992). Elevation along with aspect and slope in many respects determines the microclimate and thus large-scale spatial distribution and patterns of vegetation (Geiger, 1966; Day and Monk, 1974; Johnson, 1981; Marks and Harcombe, 1981; Allen and Peet, 1990; Busing *et al.,* 1992).

1. Materials and methods

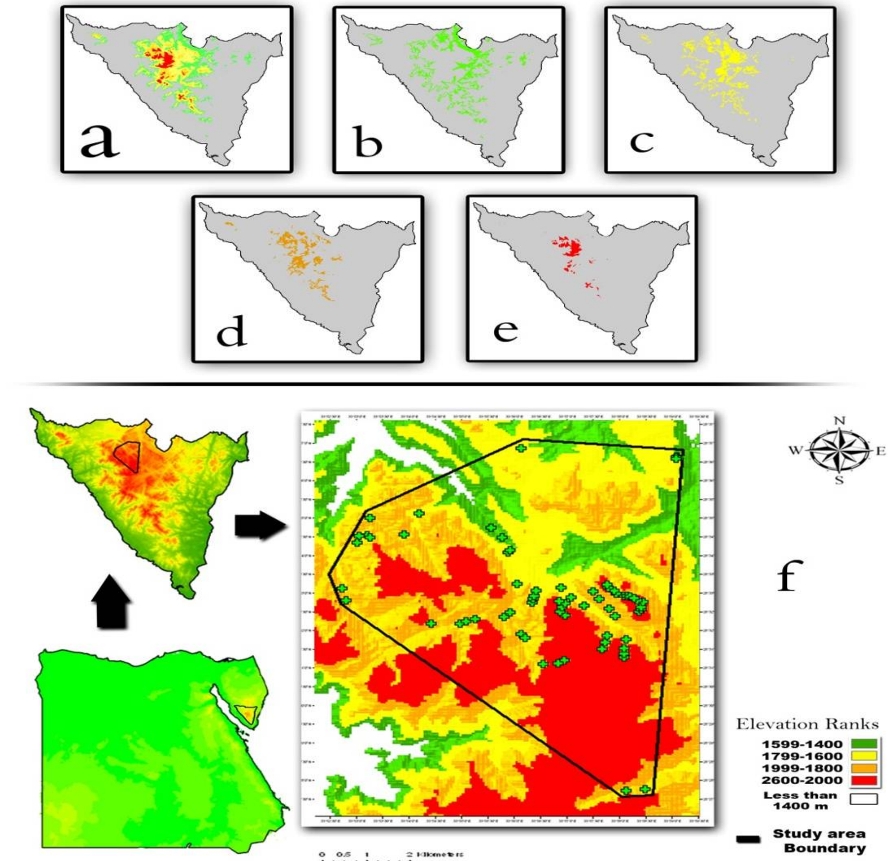
The present study was carried out in the period between March to August 2009, Quadrate Transect techniques were used to study vegetation within 26 locations inside Saint Kathreine Protectorae. 91 stands were studied within 26 locations. Morphological aspects were recorded for all *Nepeta septemcrenata Benth.* individuals by using morphological indices attributed on each parameter as fellow to evaluate the variations that exist among different locations under study (plant height (cm) , shape index of leaf, Number of branches per plant, internode length (cm), number of leaves per branch, Leaf area (cm^2), size index, Plant width (cm)). Mammal dung was surveyed by recording the species concerned (mainly camel, donkey, goat, ibex, and fox), the number of droppings, and the age category of the droppings are assessed according to (Alqumy, 2005). Soil samples have been collected during the work, from all the ninety one stands for the determination of their physical and chemical characteristics (Soil texture, Water content %, pH, T.D.S PPm, EC µs/ cm, Org.matter %, CaCO3 %m, Ca^{++} meq/L, Mg^{++} meq/L, Na^{+}

The elevation of a geographic location is its height above a fixed reference point, often the mean sea level. Elevation, or geometric height, is mainly used when referring to points on the Earth's surface, while altitude or geopotential height is used for points above the surface. A topographical map is the main type of map used to depict elevation, often through use of contour lines. In a Geographic Information System (GIS), digital elevation models (DEM) are commonly used to represent the surface (topography) of a place, through a raster (grid) dataset of elevations. Digital terrain models are another way to represent terrain in GIS (ESRI, 2001). Altitude was recorded for each site using GPS fix recorded in decimal degrees and datum WGS84 using Garmin 12 XL receiver. All data collected from the field will be classified according to elevation in order to detect the effect of elevation.

2. Results and discussion

The relationship was further confirmed when the distribution and altitude maps were superimposed. It was found that *N.septemcrenata* are have a wide range of distribution between 1435 and 2181 m, the average alt is 1850 m, it mean that the species' Alt niche length is occupied about 746 m upward, this niche representatives about 34.84% of the total available alt-niche in SKP (min-alt = 500 m and max alt =

2641 m). Stands within this study classified to 4 groups according to its altitude, it was shown that the highest presence for *N.septemcrenata* in elevation between 1800-2000m and the lowest presence detected at elevation between 1400-1600m.



Map 1. Altitude map show different elevation ranks detected within study, (a) elevation more than 1400 m, (b) 1400-1600m, (c) 1600-1800m, (d) 1800-2000m, (e) 2000-2200 m, (f) species distribution within different elevation.

The results show that elevation influence on physical and chemical properties of soil as shown in Table 2. Water content show great variation among different elevation ranks and this agrees with results recorded by (El-Ghareeb and Shabana, 1990; Moustafa and Zaghloul, 1993; Moustafa and Zayed, 1996; Whittaker, 1975; Peet, 1988), low elevation wadies show the highest values while high elevation wadies show the lowest values.

Table 2. Physical properties of soil among different elevation ranks

Elevation ranks	Statistic	Alt	water content%	%Sand	%Silt	%Clay
1400-1600	Minimum	1435	0.38	85.89	1.67	1.20
	Maximum	1578	32.00	96.72	10.59	5.17
	Mean	1505.125	4.68	91.92	5.64	2.44
	Range	143	31.62	10.84	8.93	3.97
1600-1800	Minimum	1607	0.42	40.00	4.18	0.78
	Maximum	1791	4.80	93.38	23.60	36.40
	Mean	1709	1.25	83.44	9.76	6.80
	Range	184	4.38	53.38	19.42	35.62
1800-2000	Minimum	1800	0.08	67.05	1.69	0.61
	Maximum	1998	1.74	97.70	19.32	13.64
	Mean	1895.233	0.85	85.99	7.45	5.06
	Range	198	1.66	30.65	17.62	13.03
2000-2200	Minimum	2000	0.38	40.09	3.97	1.72
	Maximum	2181	1.43	93.66	41.53	18.38
	Mean	2053.563	0.80	81.56	9.62	7.13
	Range	181	1.05	53.57	37.56	16.66
Total	Minimum	1435	0.08	40.00	1.67	0.61
	Maximum	2181	32.00	97.70	41.53	36.40
	Mean	1850.328	1.37	85.15	8.20	5.58
	Range	746	31.92	57.70	39.87	35.79

Chemical prosperities of soil show great variation among different elevation ranks, results found that ph values decrease with elevation and T.D.S, EC, Ca, K, Cl and So4 show the highest values between 1800-2000m.

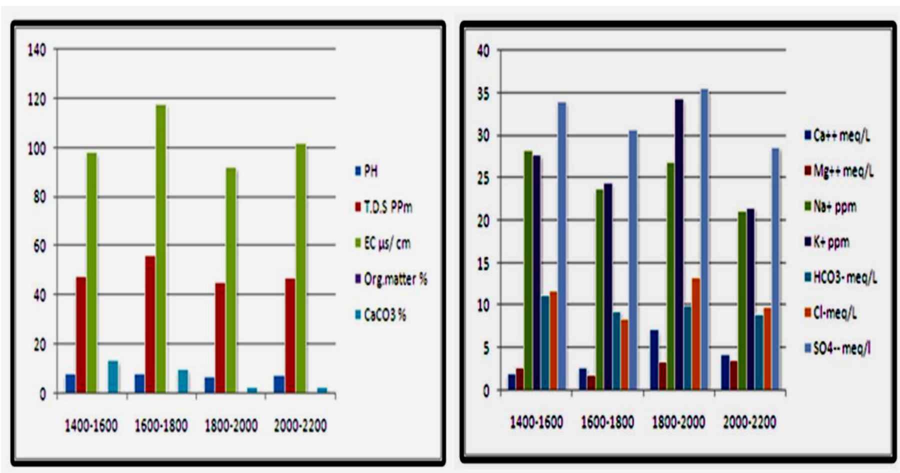


Figure 1. Chemical properties of soil among different elevation ranks.

Table 3. Chemical properities of soil among different Elevation ranks

Elevation ranks	Statistic	PH	T.D.S PPm	EC μs/ cm	Org.matter %	CaCO3 %	Ca++ meq/L	Mg++ meq/L	Na+ ppm	K+ ppm	HCO3- meq/L	Cl- meq/L	SO4-- meq/l
1400-1600	Minimum	8.20	48.00	98.00	0.34	13.50	1.00	0.50	19.22	16.81	5.00	17.25	26.00
	Maximum	8.80	156.00	386.00	3.28	23.00	3.50	6.00	57.45	55.70	20.00	6.25	45.00
	Mean	8.51	80.38	183.38	1.36	17.50	2.00	2.75	28.21	27.79	11.19	11.75	34.00
	Range	0.60	108.00	288.00	2.94	9.50	2.50	5.50	38.23	38.89	15.00	11.00	19.00
1600-1800	Minimum	7.88	56.00	118.00	0.23	10.00	1.00	0.50	7.77	7.77	5.50	11	5.00
	Maximum	8.90	316.00	586.00	5.77	23.50	6.50	6.50	48.42	50.30	15.00	6	47.50
	Mean	8.50	103.31	213.92	2.28	17.88	2.73	1.85	23.72	24.42	9.27	8.50	30.62
	Range	1.02	260.00	468.00	5.54	13.50	5.50	6.00	40.65	42.53	9.50	5.00	42.50
1800-2000	Minimum	7.10	45.00	92.00	0.23	2.50	1.00	0.30	9.20	9.11	5.00	18.5	16.00
	Maximum	8.80	1,730.00	3,390.00	17.08	21.50	53.00	14.50	65.00	75.30	20.00	8	133.00
	Mean	8.26	188.33	447.73	3.49	15.37	7.15	3.45	26.91	34.35	9.98	13.25	35.58
	Range	1.70	1,685.00	3,298.00	16.85	19.00	52.00	14.50	55.80	66.19	15.00	10.50	117.00
2000-2200	Minimum	7.60	47.00	102.00	0.45	2.50	1.00	1.00	10.40	10.40	4.50	12.5	3.00
	Maximum	8.70	598.00	1,086.00	19.34	16.50	26.50	11.50	53.64	53.64	20.00	7.25	108.00
	Mean	8.39	117.94	267.25	6.78	12.88	4.19	3.50	21.10	21.54	8.88	9.88	28.63
	Range	1.10	551.00	984.00	18.89	14.00	25.50	10.50	43.24	43.24	15.50	5.25	105.00
Total	Minimum	7.10	45.00	92.00	0.23	2.50	1.00	0.30	7.77	7.77	4.50	11	3.00
	Maximum	8.90	1,730.00	3,390.00	19.34	23.50	53.00	14.50	65.00	75.30	20.00	8	133.00
	Mean	8.37	142.13	327.70	3.79	15.51	4.97	3.07	25.06	28.58	9.72	9.50	32.77
	Range	1.80	1,685.00	3,298.00	19.11	21.00	52.00	14.50	57.23	67.53	15.50	3.00	130.00

Plant traits were also affected by elevation gradient as shown in Figure 2 and Table 4. Results revealed that *N.septemcrenata* cover, I.V.I, number of individuals and internodes length increased positively with elevation, while species richness was decrease. Plant width, height and no. of branches were also affected by elevation gradient and showed the highest values at elevation between 2000-2200m, thus confirming the results recorded by Dierig, *et al*. (2006).

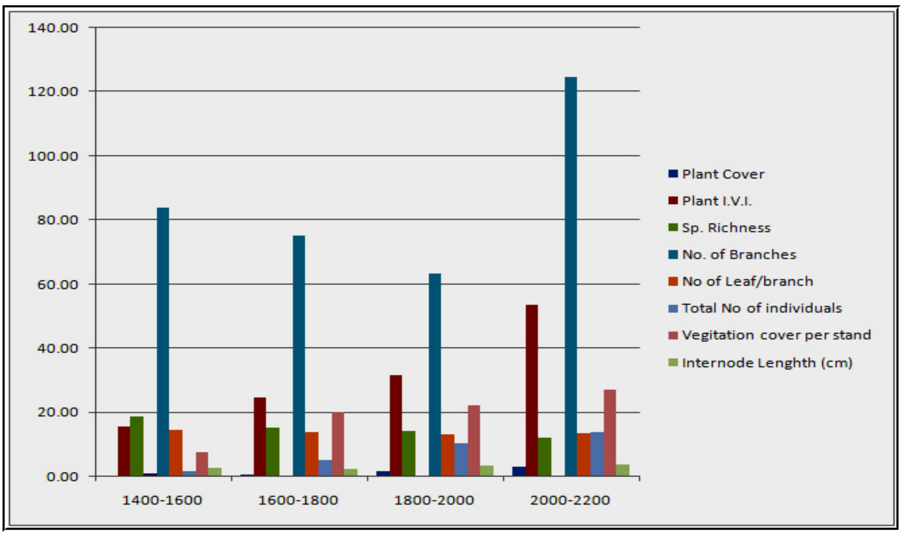


Figure 2. Morphological characters among different elevation ranks

.Table 4. Morphological characters among different elevation ranks

Elevation ranks	Statistic	Plant Height	Size Index	Plant Cover	Plant I.V.I.	Sp. Richness	No. of Branches	No of Leaf/branch	Total No of individuals	Vegitation cover per stand	Internode Lenghth (cm)
1400-1600	Minimum	12.00	18.00	0.03	7.57	18.00	8.00	8.00	1.00	4.80	2.00
	Maximum	47.50	50.00	0.69	41.05	21.00	350.00	26.00	4.00	12.97	4.00
	Mean	33.69	37.92	0.26	15.70	18.88	83.88	14.50	1.88	7.60	2.83
	Range	35.50	32.00	0.67	33.47	3.00	342.00	18.00	3.00	8.17	2.00
1600-1800	Minimum	20.00	21.50	0.04	6.42	10.00	12.00	8.00	1.00	3.57	0.10
	Maximum	52.00	57.17	3.65	80.23	26.00	350.00	22.00	23.00	124.63	5.00
	Mean	36.29	36.05	0.67	24.85	15.38	75.08	14.00	5.08	20.21	2.53
	Range	32.00	35.67	3.61	73.81	16.00	338.00	14.00	22.00	121.07	4.90
1800-2000	Minimum	5.00	11.00	0.02	5.72	8.00	14.00	10.00	1.00	1.98	2.00
	Maximum	72.00	65.00	11.96	88.38	21.00	400.00	20.00	53.00	56.38	5.53
	Mean	35.89	37.90	1.67	31.71	14.33	63.33	13.20	10.53	22.19	3.32
	Range	67.00	54.00	11.94	82.66	13.00	386.00	10.00	52.00	54.40	3.53
2000-2200	Minimum	15.00	10.50	0.02	5.18	6.00	8.00	8.00	1.00	1.10	2.00
	Maximum	65.00	73.50	10.79	97.58	18.00	500.00	20.00	42.00	75.15	7.00
	Mean	37.92	40.93	3.10	53.58	12.06	124.75	13.60	14.06	27.10	3.66

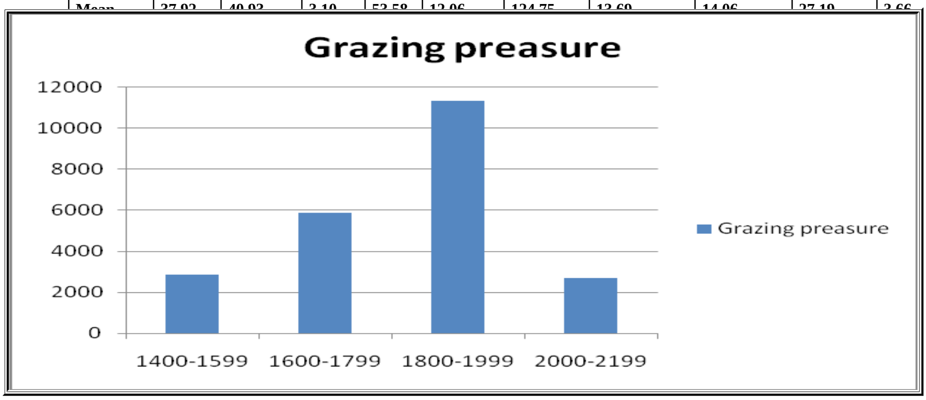


Figure 3. Grazing pressure among different elevation ranks.

Elevation gradient showed great influence on grazing pressure. It was found that about 49% of grazing was concentrate between 1800-2000m and about 25% between 1600-1800m and this agrees with results recorded by **Rashad *et al.*, (2002).** This can be resulting because the high plant covers within this rank and the presence of tourism pathways.

Conclusion

From this study we can detect the great effect of altitude on the vegetation structure and soil composition which lead to change in the species demography and morphological characters due to the change in climatic factors.

Acknowledgement
I would like to express deepest grateful to **Mr. Mohammed kotb,** General Manger of Saint Katherine protectorate for his support during research steps.

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