INFLUENCE OF TOPOGRAPHIC ASPECT ON THE DISTRIBUTION OF *NEPETA SEPTEMCRENATA* IN SAINT KATHERINE PROTECTORATE, SOUTH SINAI, EGYPT.

M.MANSOUR[1]; K. OMAR [2]

1 Botany Department,Faculty of Science (Boys branch),Al-Azhar University, Cairo, Egypt.

2 Saint Katherine Protectorate, the Nature Conservation Sector (NCS), Egyptian Environmental Affairs Agency(EEAA).

kariem_npe@yahoo.com

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 topographic aspect on plant distribution, morphological parameters and soil component. The results show that aspect influence on physical and chemical properties of soil. Water content showed great variation among different aspect directions. Plant traits also affected by these directions. Results found that 26.8% of *N.septemcrenata* populations' recorded at North aspect and no observation for *Nepeta* at South aspect. Soil physical properties showed significant variation among different aspect ranks. Results also showed positive correlation between soil total dissolved solids, electrical conductivity, sodium, potassium and chloride. This component show highest degree at east aspect. Soil pH and calcium carbonate showed the highest value at south west aspect, while calcium and magnesium show highest value at North east aspect.

Key words*: Nepeta septemcrenata*, Saint Katherine Protectorate; aspect; topography; spatial 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, 1999and 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 & 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 & Peet, 1990& Busing *et al.,* 1992).

Through its effects on net solar radiation and microclimate, aspect can have an important influence on the formation of soils (Jenny, 1941; Buol *et al.,* 1989; Carter and Ciolkosz, 1991) and plant community structure (Cantlon, 1951; Gilbert and Wolfe, 1959; Whittaker, 1975; Yeaton and Cody, 1979; Hicks and Frank, 1981). This influence occurs in areas as diverse as interior Alaska (Krause *et al.*, 1959). Alberta (Lieffers and Larkin, l987), Israel (Boyko, 1947), Spain (Dariage, 1987), Montana (Goldin and Ninlos, 1976), and the eastern United States (Franzmeier *et al*., 1969; Losche *et al.,* 1970, Hutchins *et al.,* 1976 and Boemer, 1984). Higher level of solar radiation on sun facing slopes result in higher soil temperatures than on slopes facing away from the sun (Franzmeier *et al.,* 1969; Hutchins *et al.,* 1976 and Macyk *et al.,* 1978), lower soil moisture levels (Gilbert and Wolfe, 1959; Stoeckler and Curtis, 1960), and decreased solum development (Cooper, 1969; Gilbert and Wolfe, 1959; Green, 1987 and Carter and Ciolkosz, 1991). Due to its effects on plant cover and soil depth, aspect influences runoff and soil erosion (Branson, *et al.*, 1981; Green, 1987; Agassi *et al.,* 1990 and Marques and Mora, 1992) and resulting levels of soil P (Klemmedson and Wienhold, 1992). Aspect also shows great influence on plant cover, (Branson *et al.,* 1981; Green, 1987; Agassi *et al.,* 1990 and Marques and Mora, 1992).

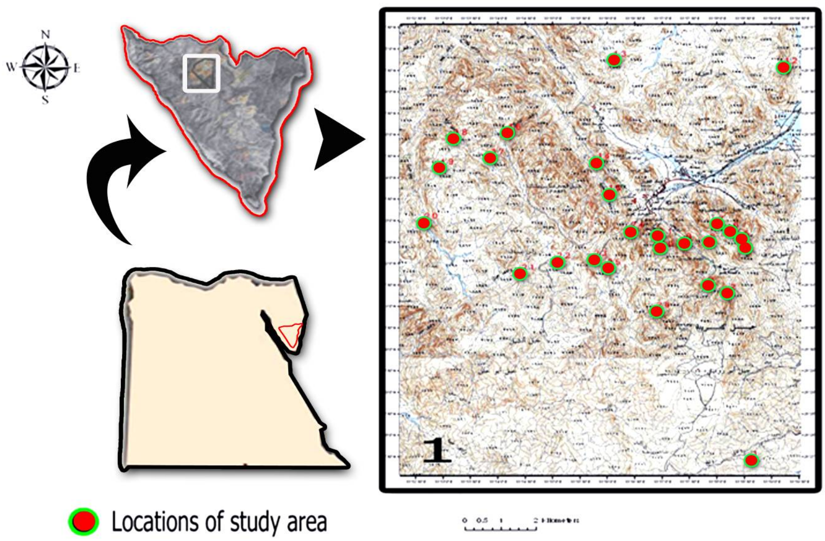
Marked aspect-related differences have been reported for a range of ecosystem properties: soil physical and chemical characteristics (Finney *et al.,* 1962; Franzmeier *et al.,* 1969; Macyk *et al.,* 1978 & Hicks and Frank, 1984): soil genesis (Green, 1987; Carter and Ciolkosz, l99l); stream water chemistry (Sallese *et al.,* 1982);plants species diversity (Boyko, 1947; Pook and Moore, 1966; Whitney, 1991 and Kudel, l992): and forest site properties (Trnnble and Weitzman, 1956; Hurtchins *et al.,* 1976; Hicks *et al.,* 1982; Verbyla and Fisher, 1989; Bale and Charley, 1993 and Mudrick *et al.,* 1994). While the reported magnitudes of the impacts of aspect vary considerably. and may be complicated by variations in other environmental factors, there is sufficient evidence to show that at some steep mid- latitude sites, aspect may exercise a primary control in maintaining ecosystem disjunctions (Bale and Charley 1993).

2. Material and Methods

2.1. Study area

The present study is carried out in 26 main localities of South Sinai, Map 1. represent the study locations from 1 to 26 as following:

Wadi Elrotk, Shak Elgragnia, Shak Mosa, Gabal Mosa, Farsh Ellia, Farsh Ellosa, Farsh Shoeibi, Wadi Elfaraa, Wadi Alarbein, Shak Abo Hamman, Kahf Elghola, Talet Elkalp, Elferee, Wadi Itlah, Wadi Eltalaa, Shak Itlah, Elmaein, Abo Tweita, Farsh Messila, Wadi Eltebk, Abo Waleie, Erheibt Nada, Elzawitin, Elmsirdi, Wadi Elshak and Elgabal Elahmar.



Map 1. Locations of study

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)). 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 %, $CaCO_3$ %m, Ca^{++} meq/L, Mg^{++} meq/L, Na^+ ppm, K^+ ppm, HCO_3^- meq/L, Cl-meq/L, SO_4^{--} meq/l).

Recorded GPS points for each location were imported into GIS software as excel sheet then we add it on TIN map then from 3d analyst tool we choose TIN surface and then chose TIN aspect, manual of topographic maps by Arc GIS are illustrated at ESRI, (2001). All data collected from the field will be classified according to its aspect in order to detect the effect of this factor.

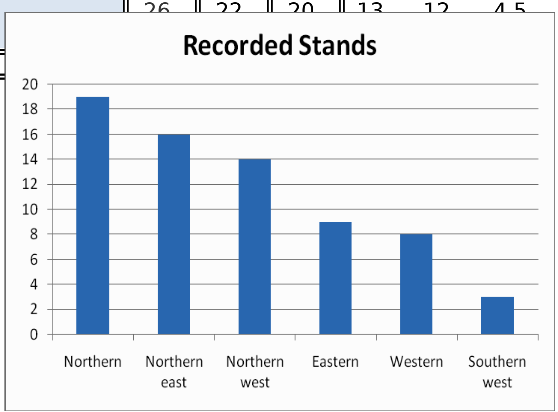
3- Results and discussion

Results showed that *N.septemcrenata* are located at North (26.8%), North East (22.3%), East (13.4%), West (11.9%), North West (20.89%) and South West (4.4%), there was no detection for the plant at the South aspect. This distribution pattern of the populated sites is not significantly different from the division of slope aspects among all survey sites. Table 1 and Figure 1 represent the No. of stands at each aspect categories.

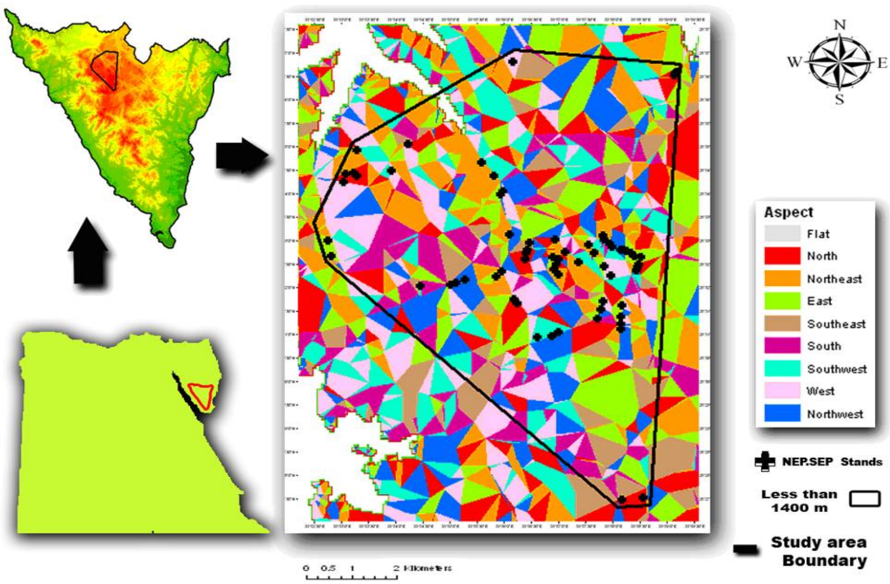
Soil physical properties showed significant variation among different aspect ranks, soil water content showed the highest value at west aspect and the lowest value at east aspect, this results come because the solar radiation is more concentrated in the eastern side that increase the evaporatation of soil water and these results confirmed the results recorded by Franzmeier *et al.* (1969); Hutchins *et al* (1976) and Macyk *et al*. (1978).

Table 1. Aspect categories for the *N.septemcrenata* habitats in SKP.

Aspect	N	NE	NW	E	W	SW
.Stand No	1	23	3	6	4	66
	2	24	8	9	5	86
	12	29	10	14	25	88
	13	31	11	15	26	0
	28	32	17	19	45	0
	30	35	18	20	55	0
	37	36	21	54	57	0
	40	39	22	64	61	0
	41	48	38	65	0	0
	42	50	56	0	0	0
	59	51	69	0	0	0
	60	58	70	0	0	0
	62	75	71	0	0	0
	76	80	87	0	0	0
	77	81	0	0	0	0
	78	14	0	0	0	0
	84	0	0	0	0	0
	85	0	0	0	0	0
	18	0	0	0	0	0
	19	16	14	9	8	3
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



Results also showed positive correlation between soil total dissolved solids, electrical conductivity, sodium, potassium and chloride. This component show highest degree at easte aspect. Soil pH and calcium carbonate showed the highest value at south west aspect, while calcium and magnesium show highest value at North east aspect. This variation in chemical and physical prosperities of the soil due to the differences in solar radiation ratios (Finney *et al*. 1962; Franzmeier *et al*. 1969; Macyk *et al* 1978 & Hicks and Frank 1981).



Map 2. Aspect ranks within study area.

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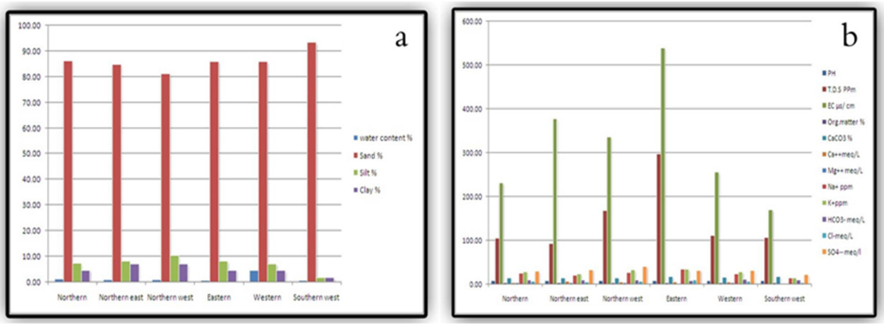
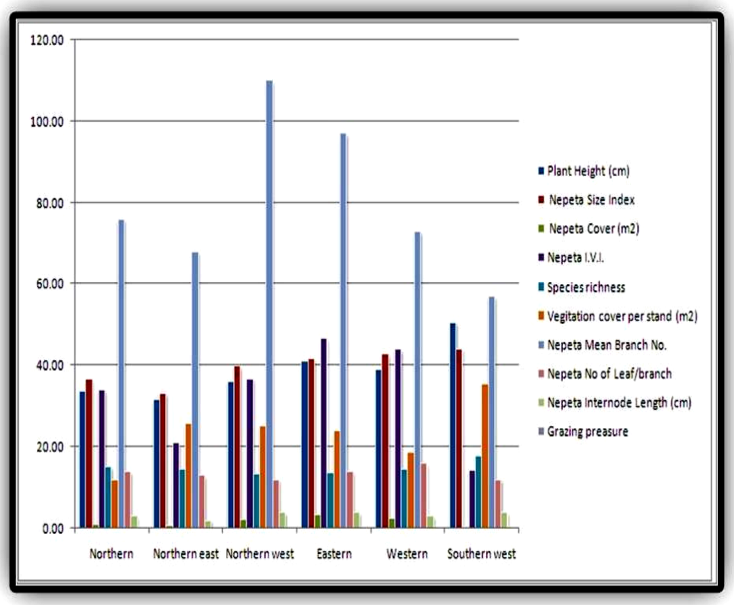


Figure 2. Variation in soil component among different aspect, (a) physical properties, (b) chemical prosperities.

Results recorded great variation in soil components, and plant traits due to the variation in aspect (Table 2).

Table 2. Variation in Soil prosperities and morphological characters of *N.septemcrenata* among different habitat aspects

Aspect	North	Northeast	North west	East	West	Southwest
Soil physical prosperities						
% water content	1.17	1.04	0.84	0.56	4.54	0.74
% Sand	86.32	84.79	81.30	85.96	85.92	93.33
% Silt	7.40	8.20	10.50	8.10	7.10	1.80
% Clay	4.70	7.00	7.10	4.70	4.50	1.80
Soil chemical properties						
pH	8.48	8.46	8.05	8.34	8.48	8.57
T.D.S PPm	105.17	93.00	168.07	297.00	111.25	106.33
EC µs/ cm	231.44	378.00	336.36	539.22	255.88	170.33
% Org.matter	4.25	3.83	3.69	3.54	3.31	3.24
% CaCO3	15.03	15.20	15.00	16.89	15.69	17.83
Ca++meq/L	3.53	6.00	5.64	5.33	5.69	2.33
Mg++ meq/L	2.92	3.33	3.46	2.78	3.44	0.67
Na+ ppm	25.82	20.43	26.75	33.75	23.26	14.52
K+ppm	29.05	23.76	32.29	34.70	28.25	15.07
HCO3- meq/L	9.94	9.13	10.14	8.78	10.81	9.33
Cl-meq/L	6.49	4.95	6.62	10.53	7.44	4.42
SO4-- meq/l	29.19	33.63	40.32	32.00	31.00	21.67
Plant morphological characters						
Plant Width (cm)	39.24	34.85	43.45	42.26	46.60	37.53
Plant Height (cm)	33.87	31.55	36.22	41.24	38.94	50.67
Nepeta Size Index	36.56	33.20	39.84	41.75	42.77	44.10
Nepeta Cover (m2)	0.89	0.79	2.21	3.43	2.46	0.44
.Nepeta I.V.I	34.03	20.96	36.80	46.71	43.97	14.38
Species richness	15	15	14	14	15	18
Vegitation cover per stand (m2)	11.93	25.66	25.22	24.01	18.65	35.41
.Nepeta Mean Branch No	76	68	110	97	73	57
Nepeta No of Leaf/branch	14	13	12	14	16	12
Nepeta Internode Length (cm)	3	2	4	4	3	4



.Figure 3. *N.septemcrenata* morphological characters among different habitat aspects

Nepeta septemcrenata height, size index, species richness and vegetation cover per stand showed the highest values at south west aspect.

Nepeta septemcrenata cover, I.V.I and No. of branches showed the highest values at east aspect while plant width, No. of leaves per branch and internodes length showed the highest values at west aspect and this is due to the light density.

Aspect also showed great influence on *N.septemcrenata* cover, the highest value was recorded at east side and the lowest value was recorded at south west this effect was recorded also by Branson *et al.* (1981); Green (1987); Agassi *et al*. (1990) & Marques and Mora (1992).

Conclusion

From this study we can detect the great effect of topographic aspect on the vegetation structure and soil composition resulting from variation in solar exposure among different aspect ranks, this variation lead to change in the species demography and morphological characters due to the change in soil temperature and water evaporation.

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References

1. Agassi, M.; Shainberg, I. and Morin, J. (1990): Slope, aspect, and phosphogypsun effects on runoff and erosion. Soil Science Society of America Journal 5, 1: 1102-1106.
2. Allen, R.B. and Peet, R.K., (1990): Gradient analysis of forests of the Sangre de Cristo Range, Colorado. Canadian Journal of Botany, 68, 193-201.
3. Bale, C.L. and J.L. Charley. (1993): The impact of aspect on forest floor characteristics in some Eastern Australian Sires. Forest Ecology Management 67: 305-317.
4. Boemer, R.E.J . (1984): Nutrient fluxes in littler fall and decomposition in four forests along a gradient of soil fertility in southern Ohio. Canadian Journal of Forest Research14:794-802.
5. Boulos, L. (2002): Flora of Egypt, Vol. 3. Al hadara publishing, Cairo, Egypt, 373pp.
6. Bown D., (1999): Wielka encyklopedia ziół. Warszawa:165-317.
7. Boyko, H. (1947): On the role of plants as quantitative indicators and the geoecological law of distributions. Journal of Ecology 35: 138-157.
8. Branson, F.A.; G.F. Gifford; K.G. Renard, and R.F. Hadley. (1981): Rangeland hydrology. Society for Range Management, Range Science Series 1. Dubuque, IA, USA Kendall/Hunt Publishing Co. 645 pp.
9. Buol, S.W.; F. D. Hole, and R.J. Mccracken. (1989): Soil Genesis and Classification. Iowa state Univ. Press, Ames. 446 pp.
10. Busing, R. T.; White, P. S., and MacKende, M. D. (1992): Gradient analysis of old spruce-fir forest of the Great Smokey Mountains circa 1935. Canadian Journal of Botany, 71: 951-958.
11. Cantlon, B.E. (1951): Vegetation and microclimate on north and south slopes on Cashetunk Mountain, New Jersey. Ecological Monographs 23: 211 -270.
12. Carter, B.J. and E.J. Ciolkosz. (1991): Slope gradient and aspect effects on soils developed from sandstone in Pennsylvania. Geoderma. l9:1 99-213.
13. Cooper, A.W. (1960): An example of the role of microclimate in soil genesis. Soil Science 90: 109-l20.
14. Dariage, T.C.D. (1987): An ordination analysis of vegetation patterns on topoclimate gradients in south east Spain. Journal of Biogcography 14: 197-211.
15. Dawes, W. R., and Short, D. (1994): The significance of topology for modelling the Surface hydrology of fluvial landscapes. Water Resources Research, 30, 1045- 1055.
16. Day, F. P., and Monk, C. D. (1974): Vegetation patterns on a Southern Appalachian watershed. Ecology, 55: 1064-1074.
17. ESRI. (2001): ArcGIS Spatial Analyst: Advanced GIS Spatial Analysis Using Raster and Vector Data. White Paper. Available online at: www.esri.com.
18. Fayed, A. and Shaltout, K. (2004): Conservation and sustainable use of Medicinal plants in arid and semi-arid eco-systems project, Egypt (GEF, UNDP) (project no: 12347/12348), Flora of Saint Catherine protectorate, final report. And Floristic Survey of

the Mountainous Southern Sinai: Saint Katherine Protectorate, final report.

19. Finney, H .R; Holowalchuk, N. and M.R. Heddleson. (1962): The influence of microclimate on the morphology of certain soils of the Allegheny Plateau of Ohio. Soil Science Society of America Proceedings 26:287-292.

20. Franzmeier, D.P.; E.J. Pedcrson; T.L. Longwell; J.G. Byme and C.K. Losche. (1969): Properties of some soils in the Cumberland Plateau as related to slope, aspect and position. Soil Society of America proceedings 33:755- 761.

21. Geiger, R., (1966): The climate near the ground. Harvard University Press, Cambridge, Mass. genomic DNA from various wild-type and transgenic plants. BMC

22. Gilbert, C.E. and J.N. Wolfc. (1959): Soil moisture investigations at Neotoma, a forest bioclimatic laboratory in central Ohio. Ohio Journal of Science 59: 38-46.

23. Goldin, A. and T.J. Ninlos. (1976): Vegetative patterns on limestone and acid parent materials in the Garnet Mountains of western Montana. Northwest Science 51: 149-160.

24. Green, J.A. (1987): Soil depth and development as related to affect in the Nebraska Pine Ridge. Soil Survey Horizons 28: l6-19.

25. Hatab, E.E. (2009): Ecological studies on the *Acacia* Species and Ecosystem Restoration in the Saint Katherine Protectorate, South Sinai, Egypt. *Ph.D.*, *Thesis,* Fac. Sci., Al-Azhar Univ 227pp.

26. Hicks, R.R.; Frank, Jr., PS.; Wiant, Jr., H.V. and Carvell, K.L. (1982): Biomass productivity related to soil-site factors on a small watershed. West Virginia Forest Notes, West Virginia Agricultural Experiment Station Circular l2l (9): 9- 12.

27. Hicks, R.R.; Jr. and PS. Frank. Jr. (1981): Relationship of aspect to soil nutrients, species importance, and biomass in a forested watershed in West Virginia. Forest Ecology Management 8: 281-291.

28. Hurtehins, R.B.; R.L, Blevins; J.D. Hill and E.B.White. (1976): Influence of soils and microclimate on vegetation of forested slopes in eastern Kentucky. Soil Science l2l: 234-241.

29. Hurtehins, R.B.; R.L, Blevins; J.D. Hill and E.B.White. (1976): Influence of soils and microclimate on vegetation of forested slopes in eastern Kentucky. Soil Science l2l: 234-241.

30. Jenny, H. (l94l): Factors of Soil Formation. McGraw-Hill. New York.

31. Johnson, E. A., (1981): Vegetation organization and dynamics of lichen woodland communities in the Northwest Temtories. Canada Ecology, 62, 200-215.

32. Klemmedson, J.O. and B.J. Wienhold. (1992): Aspect and species influences on nitrogen and phosphorus accumulation in Arizona chaparral soil plant systems. Arid Soil Research and Rehabilitation 6: 105-116.

33. Krausc, H.H.; S. Rieger and S.A. Wilde. (1959): Soils and forest growth in the Tanana Watershed of interior Alaska. Ecology 40: 492-495.

34. Kudel, P. (1992): Slope aspect effect on soil and vegetation in a Mediterranean ecosystem

Israel Journal of Botany 41: 243-250.

35. Lieffers, VJ. and P.A. Larkin-Lieffers. (1987): Slope, aspect and slope position as factors controlling grassland communities in the coulees of the Oldman River. Alberta.Canadian Journal of Botany 65: 1371-1378.

36. Losche, C.K.; R.J McCracken and C.B. Daley. (1970): Soils of steeply sloping landscapes in the southern Appalachian Mountains. Soil Science Society of America Proceeding 34: 473-478.

37. Mabberley, D.J. (1997): The Plant Book: A Portable Dictionary of the Vascular Plants. Cambridge University Press. Cambridge. 874 pp

38. Mackú, J, and Krejcá, J., (1989): Atlas roślin leczniczych. Wrocław: 276 pp.

39. Macyk, T.M.; Pawluk S. and Lindsay, J.D. (1978): Relief and microclimate as related to soil properties. Canadian Journal of Soil Science 58: 421-438.

40. Marks, P. L. and Harcombe, P. A., (1981): Forest vegetation of the Big Thicket, southeast Texas. Ecological Monographs, 51: 287-305.

41. Marques, M.A. and Mora, E. (1992): The influence of aspect on runoff and soil loss in a Mediterranean burnt forest (Spain). Catena l9: 333-344.

42. Mudrick, D.A.; Hoosein, M.; Hicks, R.R. and E.C. Townsend. (1994): Decomposition of leaf littler in an Appalachian forest: effects of leaf species, aspect, slope position and time. Forest Ecology Management 68: 231-250.

43. Nowiński, M., (1983): Dzieje upraw i roślin leczniczych. Warszawa: 150 pp.

44. O’Longhlin, E. M., (1981): Saturation regions in catchments and their relations to soil and topographic properties. Journal of Hydrology, 53: 229-246.

45. Pook, E.W and C.WE. Moore. (1966): The influence of aspect on the composition and structure of dry schlerophyll forest on Black Mountain, Canberra, A.C.T. Australian Journal of Botany 14: 223-242.

46. Sallese, PA.; Coates, J.A. and Hicks, R.R. (1982): Nutrient relationships in two small West Virginia Watersheds 322-343.

47. Stoelker, J.H. and W.R. Curtis. (1960): Soil moisture in southwestern Wisconsin as affected by aspect and forest type. Journal of Forestry 58: 892-896.

48. Täckholm, V. (1974): Students' Flora of Egypt. Publ. Cairo Unvi. Printing by cooperative printing company Beirut, 888 pp.

49. Titshall, L.W.; O’Connor, T.G., and Morris, C.D., (2000): Effect of long-term exclusion of fire and herbivory on the soils and vegetation of sour grassland. African Journal of Range and Forage Science, 17: 70–80.

50. Trnnble, G.R.; Jr. and S. Weilrlman. (1956): Site index studies of upland oaks in the northern, Appalachians Forest Science 1: 162-173.

51. Verbyla, D.L. and R.F. Fisher. (1989): Effect of aspect on ponderosa pine height and diameter growth. Forest Ecology Management 27: 93-98.

52. Whitney, G.G. (1991): Relation of plant species to substrate. landscape position, and aspect in north central Massachusetts. Canadian Journal of Forest Research 2l: 1245-1252.

53. Whittaker, R.H. (1975): Communities and ecosystems. Second edition, Macmillan, New York 387 pp.

54. Wood, E. F.; Sinpalan, M.; Beven K., and Band L., (1988): Effects of spatial variability and scale with implications to hydrological modelling. Journal of Hydrology, 102: 29-47.

55. Yeaton R.L and M.L. Cody. (1979): The distribution of cacti along environmental gradients in the Sonoran and Mohave deserts. Journal of Ecology 67: 529-541