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ECOLOGY OF AN UPLAND FOREST NEAR NOWSHERA, NWFP, PAKISTAN

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Abstract

The lower valley slopes were dominated by arboreal vegetation, the middle by tall shrub and the top exposed slopes by grasses. The vegetation comprises of *Olea ferruginea, Monotheca buxifolia, Acacia modesta, Dodonaea viscosa* and *Cymbopogon jwarancusa*, the first 3 species constituting the tree layer and the last 2 the field layer. *O. ferruginea* and *M. buxifolia* occupied the deep soil, *A. modesta* inhabited the hot eroded sites, *D. viscosa* was rather uniformly distributed except the top slopes but was more adapted to exposed and warm habitats and *C. jwarancusa* dominated the top exposed slopes. *O. ferruginea* and *A. modesta* are expected to form a climax with *D. viscosa* as a dominant from field layer.

Introduction

This report is based on the study of an upland forest vegetation around the shrine of Bahadur Baba, a Muslim saint of 16th century. The research area is located at a distance of about 16 km south of Nowshera Cantonment, district Peshawar (72°0' east longitude and 33°52' north latitude). It spreads over 2 square km and comprises a bowl-shaped valley and the hills with rim of the bowl, about 1050 m high. The spurs laterally arising from these hills generally converge to the centre. A perennial spring originating from amongst the south-facing slopes of the hills has imparted a markedly distinct tinge to the vegetation all along its course. The area drains down into Kabul River.

Physiographically the area belongs to Khattak Hills lying at their southern edges along Peshawar Basin (Dichter & Popkin, 1967). These hills are regarded to be a culmination of the mountain backbone which extends down through Hazara. The rocks consist of limestone which is fine to coarsely crystalline, very hard and compact and thin-bedded to massive. It has been called Cherat Limestone by Tahirkheli (1970). It has a finely uniform lithology and yellowish brown, brownish grey and light to dark in colour. The soils are shallow, poorly developed and sand-dominated.

Climatically the area lies in semi arid region with 25-38 cm rainfall, about 66% of which is received in hot and 33% in cold seasons. January is the coldest month with temperatures ranging between 0 and 10°C whereas the temperature in the hottest month remains between 20 and 40°C.

Materials and Methods

The arboreal vegetation was sampled in 10 x 4 m quadrats and for herbs 20 x 50 cm quadrats were used. The quadrats were laid systematically on sites selected randomly. The information on community parameters including density, canopy-coverage, basal area and frequency was collected and the importance value of different species was calculated according to Cox (1967). The woody species of dbh more than 2 cm were sampled in large quadrats. Daubenmire's technique (1959) was employed for the estimation of canopy-coverage. The method used for the soil texture was that of the American Society for Testing and Materials (1964) and for the determination of other chemical properties of the soil Jackson's techniques (1962) were followed.

The nomenclature followed for plants is that of Stewart (1972). These findings are based on the data collected from 1983 to 1986.

Results and Discussion

The vegetation of the area has been referred to as dry subtropical broad-leaved forests by Champion *et al.*, (1965). It is northward extension of dry subtropical semievergreen forests. The exposed and sharp ridges were almost devoid of any vegetation except the places where some fine gravel had accumulated, these places were occupied mainly by grasses. The forest is confined to the lower slopes of the valley comprising low xerophytic trees and shrubs. There were 3 plant communities recognized on north and south-facing aspects each. Lower slopes were dominated by arboreal vegetation, the middle by tall shrubs with very scanty understorey vegetation and the top exposed slopes by grasses. The arborescent vegetation extends upto 900 m, the shrubby vegetation is confined between 900 and 1000 m and the grasses dominate the slopes from 1000 m upwards. Common arborescent species are *Olea ferruginea, Acacia modesta* and *Monotheca buxifolia;* occasional trees are *Maytenus royleanus, Segeretia thea* var. *brandrethiana, Grewia optiva, Rhamnus pentapomica, Ziziphus mauritiana, Z. nummularia* and *Acacia farnesiana. Dodonaea viscosa,* although a tall shrub, has attained the stature of a small tree in some places. It is more prevalent and extends upto higher elevation reaching almost the top on south-facing aspects.

North-facing Aspects: The vegetation seems best divisible into 3 distinct plant communities on north-facing slopes. Lower gentle slopes are inhabited by *Olea-Dodonaea-Cymbopogon* community; the middle slopes are occupied by *Dodonaea-Cymbopogon* community; and moderately steep top slopes support *Cymbopogon* community. The forest comprises 4 woody species viz., *Olea ferruginea, Acacia modesta, Monotheca buxifolia* and *Rhamnus pentapomica.* There are 32 understorey species in the forest community and 19 in Dodonaea and grass zones each, the difference may primarily be due to varying

degree of shade which has carved more microhabitats for a variety of species under forest canopy.

Olea-Dodonaea-Cymbopogon Community: The leading dominants are *Olea ferruginea, Dodonaea viscosa* and *Cymbopogon jwarancusa* (Table 2 & 3). The community is confined to lower slopes of the valley. The soil is moderately coarse and $CaCO_3$ contents of the soil are considerably low (Table 1). The slopes are gentle and sufficiently cool and a relatively deep well developed soil coupled with the accumulation of organic matter has considerably helped in checking erosion and rendering the water available to the forest floor vegetation for a longer period of time. *O. ferruginea*, the leading dominant, is highly palatable (Said, 1951) and was found ebbing in relatively disturbed sites. Being unpalatable, *D. viscosa* escapes grazing but, for its high fuel value, becomes the target of human axe. All the arborescent species were found regenerating. *D. viscosa* is largely represented

Table 1. Soil characteristics.

	North Facing Slopes			South Facing Slopes		
	Top (C)	Middle (DC)	Lower (ODC)	Top (CD)	Middle (DC)	Lower (OAD)
Saturation Percentage (S.P)	22	26	28	27	28	29
pH	7.1	7.2	7.2	7.5	7.4	7.4
Electrical Conductivity of soil Extract in m. mhos/cm at 25°C	0.26	0.26	0.32	0.32	0.22	0.24
Na meq/l	0.22	0.22	0.37	0.32	0.19	0.25
Ca & Mg meq/l	2.50	2.50	3.50	3.75	2.75	2.75
Organic Matter %	0.39	0.29	0.53	0.16	0.12	0.27
Sand %	66.5	72.5	61.1	66.2	58.7	50.8
Silt %	20.1	16.8	24.0	22.3	27.4	31.0
Clay %	13.3	10.6	14.7	11.3	13.7	18.1
Soil Texture	Sandy loam	Loamy sand	Sandy loam	Sandy loam	Sandy loam	Loam
$CaCo_3$ %	0.70	0.87	0.62	0.75	1.00	0.25
Sodium Adsorption Ratio S.A.R.	0.20	0.20	0.28	0.23	0.16	0.21
Total Dissolved Solid T.D.S. ppm	166	166	205	205	141	154

C, *Cymbopogon* community; DC, *Dodonaea-Cymbopogon* community; ODC, *Olea-Dodonaea-Cymbonogon* community; CD, *Cymbopogon-Dodonaea* community; and OAD, *Olea-Acacia-Dodonaea* community.

Table 2. Community attributes of woody species on lower slopes.

Species	Facing North				Facing South			
	RD	RBA	RF	IV	RD	RBA	RF	IV
Acacia modesta	10.23	15.1	18.4	43.7	37.9	26.3	38.4	102.6
Maytenus royleanus	+	+	+	+	5.1	0.3	15.3	20.7
Monotheca buxifolia	15.0	5.2	22.7	42.9	13.8	10.5	12.8	37.1
Olea ferruginea	74.3	79.5	57.9	211.7	43.1	62.7	33.3	139.1
Rhamnus pentapomica	0.3	T	0.8	1.1	—	—	—	—
Sageretia thea var. *brandrethiana*	+	+	+	+	+	+	+	+
Cotoneaster affinis var. *bacillaris*	+	+	+	+	—	—	—	—
Ziziphus mauritiana	+	+	+	+	—	—	—	—
Z. nummularisa	+	+	+	+	—	—	—	—

RD = Relative Density;' RBA = Relative Basal Area; RF = Relative Frequency; IV = Impportance Value; T = traces' + = present but insignificant; — = absent.

by shrubby types and only a few individuals could attain the stature of tree i.e. more than 3 cm dbh. Its lower importance value here than the south-facing forest zone may primarily be due to mesic conditions which made many species to inhabit the site and resulting in greater competition. Overall rate of regeneration of woody species is low. *C. jwarancusa* was more frequent on open and exposed places which formed a sort of mosaic in forest canopy. Its density was found to be more than three times and frequency twice that of *D. viscosa* and this made the grass to attain prominence. *Cotoneaster affinis* var. *bacillaris*, a single lonely tree, was noticed near upper edge of the slopes.

The stand supports largest number of species and it hints at its early successional status. The forest seems gradually blending with *Dodonaea*-dominated vegetation upwards.

Dodonaea-Cymbopogon Community: The site is considerably exposed and comprises undulating land with low gradient. The soil is poorly developed and coarse (Table 1). The middle slopes are inhabited by *Dodonaea-Cymbopogon* community dominated by *Dodonaea viscosa* and *Cymbopogon jwarancusa* (Table 4). *D. viscosa* is a very common plant of dry hills in the sub-Himalayan tracts and grows on denuded soils where little else can grow (Stewart, 1958 & 1972); quick growth and gregarious habit make it an excellent competitor (Abdulla, 1973). It was found regenerating and was represented mostly by young specimens less than 3 cm. dbh. *C. jwarancusa* was more prevalent in open places whereas *Cenchrus ciliaris* was more frequent along water courses. *D. viscosa* and *C. ciliaris* receded with increasing elevation but *C. jwarancusa* was found increasing. Some small

Table 3. Community attributes of understorey species on lower slopes (Tree Zone).

Species	Facing North				Facing South			
	RD	RCC	RF	IV	RD	RCC	RF	IV
Acacia modesta	0.3	1.3	0.3	1.9	6.8	0.7	4.5	12.0
Aerua persica	—	—	—	—	0.5	T	0.6	1.1
Amaranthus graecizans	T	T	0.1	0.1	—	—	—	—
Aristida cyanantha	4.5	0.9	3.5	8.9	5.3	1.2	5.7	12.2
Astragalus scorpiurus	—	—	—	—	0.9	0.2	1.1	2.2
Boerhaavia coccinea	—	—	—	—	0.9	0.2	1.1	2.2
Chenopodium album	0.1	T	0.1	0.2	2.9	0.4	2.8	6.1
Conyza aegyptica	—	—	—	—	5.3	0.7	4.5	10.5
Cymbopogon jwarancusa	30.3	15.0	32.4	77.7	19.3	9.5	16.5	45.3
Cynodon dactylon	1.0	0.3	1.1	2.4	0.5	T	0.6	1.1
Desmostachya bipinnata	+	+	+	+	0.9	0.6	1.1	2.6
Dodonaea viscosa	8.9	60.3	14.2	83.4	39.6	73.3	44.9	157.8
Eruca sativa	T	T	0.1	0.1	—	—	—	—
Euphoribia clarkeana	—	—	—	—	0.5	T	0.6	1.1
E. prostrata	+	+	+	+	—	—	—	—
Filago hurdwarica	13.9	7.1	9.5	30.5	—	—	—	—
Fumaria indica	+	+	+	+	—	—	—	—
Gagea elegans	1.2	0.2	1.0	2.4	—	—	—	—
Galium aparine	1.1	0.5	1.9	3.5	—	—	—	—
Gnaphalium affine	6.1	1.0	4.7	11.8	—	—	—	—
Kickxia ramosissima	—	—	—	—	0.5	T	0.6	1.1
Launaea procumbens	6.1	2.8	8.6	17.5	—	—	—	—
Maytenus royleanus	+	+	+	+	2.4	9.7	2.8	14.9
Medicago laciniata	T	0.2	0.1	0.3	—	—	—	—
Mollugo nudicaulis	+	+	+	+	0.9	0.2	1.1	2.2
Monotheca buxifolia	0.4	2.2	0.8	3.4	—	—	—	—
Olea ferruginea	+	+	+	+	1.4	0.2	1.7	3.3
Otostegia lambata	T	0.2	0.1	0.3	—	—	—	—
Oxalis corniculata	6.4	2.1	9.2	17.7	3.9	1.5	4.5	9.9
Paspalidium flavidum	+	+	+	+	—	—	—	—
Paspalum commersonii	+	+	+	+	—	—	—	—
Rhazya stricta	+	+	+	+	—	—	—	—
Rhynchosia minima	—	—	—	—	0.5	T	0.6	1.1
Sageretia thea var. *brandrethiana*	—	—	—	—	1.9	0.5	0.6	3.0
Solanum incanum	T	T	T	T	—	—	—	—
Stellaria media	16.2	4.5	8.1	28.8	—	—	—	—
Stipa jacquemontii	+	+	+	+	4.8	0.6	3.9	9.3
Veronica arvensis	3.1	0.8	3.4	7.3	—	—	—	—
Vicia hirsuta	T	T	T	T	—	—	—	—
Withania coagulans	+	+	+	+	—	—	—	—

RD = Relative Density;' RCC = RelativeCanopy Coverage; RF = Relative Frequency; IV = Impportance Value; T = traces' + = present but insignificant; — = absent.

Table 4. Community attributes of understorey species on middle slopes (Shrub Zone).

Species	Facing North				Facing South			
	RD	RCC	RF	IV	RD	RCC	RF	IV
Acacia modesta	+	+	+	+	0.7	1.3	1.3	3.3
Aristida cyanantha	+	+	+	+	6.0	1.3	8.9	16.2
Astragalus scorpiurus	+	+	+	+	0.3	T	0.6	0.9
Boerhaavia coccinea	—	—	—	—	0.7	T	1.3	2.0
Calotropis procera	—	—	—	—	0.3	T	0.6	0.9
Cenchrus ciliaris	7.7	18.3	15.9	41.9	—	—	—	—
Cymbopogon jwarancusa	17.5	16.4	24.0	57.9	28.9	6.6	22.4	57.9
Cyperus bulbosus	—	—	—	—	15.5	1.9	6.4	23.8
Dalbergia sissoo	—	—	—	—	+	+	+	+
Dicliptera roxburghiana	29.1	1.9	9.9	40.9	—	—	—	—
Dodonaea viscosa	19.4	50.8	34.0	104.2	42.7	81.9	50.0	174.6
Euphoribia hirta	—	—	—	—	0.3	T	0.6	0.9
Maytenus royleanus	1.9	2.9	1.9	6.7	+	+	+	+
Mollugo nudicaulis	+	+	+	+	—	—	—	—
Monotheca buxifolia	—	—	—	—	+	+	+	+
Olea ferruginea	+	+	+	+	+	+	+	+
Otostegia lambata	1.1	1.2	1.9	4.2	0.7	0.9	1.3	2.9
Oxalis corniculata	11.6	1.2	8.6	21.4	+	+	+	+
Rhazya stricta	+	+	+	+	1.8	4.6	3.2	9.6
Rumex hastatus	11.6	7.2	6.0	24.8	+	+	+	+
Saccharum spontaneum	—	—	—	—	+	+	+	+
Sageretia thea var. *brandrethiana*	+	+	+	+	—	—	—	—
Solanum incanum	—	—	—	—	+	+	+	+
Taraxacum officinale	+	+	+	+	—	—	—	—
Trigonella incisa	+	+	+	+	1.0	0.1	1.9	3.0
Withania coagulans	+	+	+	+	0.7	0.9	1.3	2.9
Ziziphus nummularia	+	+	+	+	+	+	+	+

specimens of very rare arborescent species viz., *Maytenus royleanus, A. modesta, O. ferruginea, Sageretia thea* var. *brandrethiana* and *Z. nummularia* were also noticed and their presence hints at the transitory status of the vegetation. The signs of heavy grazing and cutting of *D. viscosa* were found all over. In due course of time, provided sufficient protection is given, it probably would change into a forest type of vegetation.

Cymbopogon Community: The top slopes were largely exposed, dry and moderately steep. The effect of wind was quite pronounced and occasional arborescent species were extremely deformed and stunted. These slopes are dominated by *Cymbopogon jwarancusa* (Table 5). Of the total coverage, 68% is contibuted by the dominant species. Other grass which could attain some significance was *Cenchrus ciliaris*. Both the grasses were more frequent in water courses. *Cyperus bulbosus* and *Chenopodium ambrosiodes* were also noticed growing in water courses. The vegetation stretches over 50 m on the slopes and merges gradually with *Dodonaea* zone downwards. The presence of some very rare and extremely deformed and small specimens of *O. ferruginea, M. royleanus, S. thea* var. *brandrethiana* and *Periploca aphylla* shows that the arborescent species can inhabit the site provided they get sufficient protection.

South-Facing Aspects: South-facing slopes are relatively dry, exposed and steep. The soil is shallow, poorly developed, sand-dominated with low $CaCO_3$ (Table 1). Organic matter contents of the soil are relatively low. The slopes are inhabited by three distinct plant communities. Lower valley slopes, with comparatively deeper soil, support arboreal vegetation represented by *Olea-Acacia-Dodonaea* community; the middle and relatively steep and dry slopes are occupied by *Dodonaea-Cymbopogon* community; and top most exposed slopes are inhabited by *Cymbopogon-Dodonaea* community. Total number of species recorded in these communities are 23, 22 and 14 respectively.

Olea-Acacia-Dodonaea Community: Lower valley slopes are relatively dry and exposed. The soil is shallow with low $CaCO_3$ contents; organic matter is relatively low (Table 1). The slopes are inhabited by *Olea-Acacia-Dodonaea* community dominated by *Olea ferruginea, Acacia modesta* and *Dodonaea viscosa* (Tables 2 & 3). *O. ferruginea,* despite being the leading dominant, is conspicuously subdued because of tough competition from *A. modesta;* yet another reason seems to be its palatability which makes it the prime target of grazing and browsing. *O. ferruginea* is represented by relatively a few large specimens which are clustered in places and extensively branched at breast height because of being damaged, in young stage, by grazing. The exaltation of *A. modesta,* the codominant, is largely because of its fondness of relatively dry and exposed conditions (Sheikh & Hafeez, 1977). *A. modesta,* contrary to *O. ferruginea,* is represented by many young plants which are more evenly distributed (Table 2). The importance value of *D. viscosa,* the dominant from the shrub layer, was found to be high. The gaps in the forest canopy are all occupied by young and old specimens of *D. viscosa* hinting at its remarkable quality to perpetuate under harsh conditions of temperature and moisture. *D. viscosa* and *A. modesta* were found growing gregariously suggesting as if they possess non-overlapping niches (Chaghtai *et al.*, 1984). The woody dominants are all regenerating but the rate of their survival is very low as the young plants are being grazed upon more frequently.

Olea-Acacia-Dodonaea community supports lesser number of under-storey species

than *Olea-Dodonaea-Cymbopogon* community on north-facing aspect; the former is sufficiently closed and it seems to be the most plausible explanation of this discrepancy.

Dodonaea-Cymbopogon Community: The middle slopes are relatively steep, dry, exposed and degraded. The vegetation is scrubby and patchy. The soil is shallow and organic matter is least (Table 1).

These slopes are occupied by *Dodonaea-Cymbopogon* community dominated by *Dodonaea viscosa* and *Cymbopogon jwarancusa* (Table 4). Vegetation in general and *D. viscosa* in particular decreases and becomes scanty with increasing altitude mainly for the steepness and exposure of slopes (Champion *et al.*, 1965). *A. modesta* was the only woody species found invading the habitat. Other arborescent plants reported from north-facing sites were spotted occasionally. *O. ferruginea* was bushy, stunted and almost stuck to the ground because of grazing. A big tree of *Dalbergia sissoo* was also noticed.

Of the 22 species recorded here, 9 were extremely rare.

Cymbopogon-Dodonaea Community: The site is considerably degraded. The slopes are steep and exposed and the effect of wind is quite pronounced. The soil is shallow with low organic matter (Table 1).

South-facing top slopes are inhabited by *Cymbopogon-Dodonaea* community dominated by *Cymbopogon jwarancusa* and *Dodonaea viscosa* (Table 5). *C. jwarancusa* has outcompeted *D. viscosa* largely because of the openness of the site. The number of supporting species has also been curtailed to 14 primarily because of the availability of a few niches only. *C. jwarancusa*, despite being the target of grazing animals, seems doing far better than *D. viscosa*, the codominant. The reason of *D. viscosa* playing second fiddle to *C. jwarancusa* seems to be the inabiltiy of the former to withstand wind and desiccation. The frequency and the stature of *D. viscosa* decreased with increasing elevation. No arborescent dominant of the tree zone was noticed here. The presence of a single highly deformed and straggling specimen of *Salvadora oleoides* near the top of the hill hints at the xeric conditions prevailing there (Chaghtai & Yusaf, 1976). Some specimens of *Nannorrhops ritchieana* were also noticed.

The vegetation in the close vicinity of the shrine of Bahadur Baba was completely protected and some plants which were not seen anywhere on north - and south-facing sites were found growing here. A tall *Grewia optiva*, with many young specimens scattered around, was noticed on a ridge along a seasonal nullah. *Acacia farnesiana*, *S. oleoides* and *Pistacia integerrima* were also seen growing near the shrine complex. *Adhatoda zeylanica*, in association with *O. ferruginea* and *M. buxifolia*, was found to be very frequent on the slopes guarding the main entrance to the shrine complex.

Table 5. Community attributes of understorey species on top slopes (Grass Zone).

Species	Facing North				Facing South			
	RD	RCC	RF	IV	RD	RCC	RF	IV
Acacia modesta	+	+	+	+	—	—	—	—
Andrachne aspera	+	+	+	+	2.7	1.6	3.7	6.9
Astragalus scorpiurus	—	—	—	—	6.7	1.9	5.5	14.1
Boerhaavia coccinea	—	—	—	—	2.7	0.5	3.7	6.9
Cenchrus ciliaris	14.6	21.6	18.8	55.0	10.7	2.8	12.9	26.4
Chenopodium ambrosioides	+	+	+	+	—	—	—	—
Cymbopogon jwarancusa	56.3	68.4	51.1	175.8	44.0	19.8	37.0	100.8
Cyperus bulbosus	+	+	+	+	—	—	—	—
Dodonaea viscosa	3.4	1.1	5.2	9.7	9.3	36.4	12.9	58.6
Kickxia ramosissima	0.7	0.2	1.0	1.9	—	—	—	—
Lonicera quinquelocularis	+	+	+	+	—	—	—	—
Maytenus royleanus	+	+	+	+	—	—	—	—
Mollugo nudicaulis	0.7	0.2	1.0	1.9	2.9	0.2	1.8	4.7
Olea ferruginea	+	+	+	+	—	—	—	—
Otostegia lambata	8.3	4.8	11.5	24.6	4.0	6.4	5.5	15.9
Oxalis corniculata	14.6	2.0	9.4	26.0	5.3	0.9	7.4	13.6
Periploca aphylla	+	+	+	+	+	+	+	+
Polypogon fugax	0.7	0.2	1.0	1.9	—	—	—	—
Rhazya stricta	—	—	—	—	2.7	12.8	3.7	19.2
Rumex hastatus	0.7	1.4	1.0	3.1	4.0	5.9	1.8	11.7
Salvia aegyptiaca	4.0	1.4	1.8	7.2	—	—	—	—
Trigonella incisa	—	—	—	—	+	+	+	+
Withania coagulans	+	+	+	+	1.3	9.2	1.8	12.3

The vegetation along the course of a perennial spring, originating from the south-facing slopes of the hills and water flowing down on a hard bedrock with steep gradient, was found to be considerably different from that of the surrounding area. Some big plants of *Salix acmophylla*, each with 22 cm dbh, and *Ziziphus nummularia*, *G. optiva* and *Ficus palmata* were noticed; the herbs were *Mentha longifolia*, *Withania coagulans*, *Adiantum capillis-venaris*, *Calotropis procera*, *Polygonum glabrum* and *Scirpus* sp.

Successional Trends: Olea ferruginea is undisputedly the dominant woody species which inhibited both the aspects but is more adapted to the north-facing aspects. It is found regenerating on both aspects equally but is susceptible to grazing. It is known to form climax under the prevalent conditions in protected areas (Stewart, 1967). Its regener-

ation under these conditions reflect upon its potential to stage a come back provided protection is guaranteed. *Acacia modesta* emerged out as a codominant on south-facing slopes. Both the dominants had invaded the area almost simultaneously but *A. modesta*, in comparision with *O. ferruginea*, shows periods of good and poor establishment which is manifested by the gaps in size classes (Table 6). Its greater tolerance to xeric conditions made it attain considerable significance on south-facing slopes; but on north-facing mesic sites, it did regenerate but was completely outcompeted by *O. ferruginea*. The presence of relatively large number of older specimens suggests that the area had remained more protected in the distant past and these plants got established under the ideal conditions. *Dodonaea viscosa*, the codominant from shrub layer, was found in all habitats but was more frequent on south-than north-facing slopes. It exhibited wider ecological amplitude with regard to climate and edaphic conditions. *Monotheca buxifolia*, the other important tree, seems largely confined to north-facing aspects alone and exhibits high fidelity. *A. modesta*, because of its wider ecological amplitude, will always overshadow *M. buxifolia* and will not allow it to shoot into prominence.

Table 6. Number of woody species per hectare by size classes.

Diameter at breast height (cm)	Species		
	Olea ferruginea	*Acacia modesta*	*Monotheca buxifolia*
< 3	22	60	24
3.1-8.0	24	12	36
8.1-13.0	91	22	29
13.1-18.0	91	12	22
18.1-23.0	108	36	19
23.1-28.0	77	26	17
28.1-33.0	51	10	5
33.1-38.0	26	12	5
38.1-43.0	38	—	—
43.1-48.0	17	2	2
48.1-53.0	17	5	—
53.1-58.0	12	2	—
58.1-63.0	14	—	—
63.1-68.0	5	—	—
68.1-73.0	2	—	—
73.1-78.0	10	2	2
78.1-83.0	2	2	—
83.1-88.0	5	—	—
88.1-93.0	10	—	—
93.1-98.0	5	—	2
> 98	2	2	—

The two dominant species viz., *O. ferruginea* and *A. modesta* were found encroaching upon *Dodonaea*-dominated zone on both aspects; *O. ferruginea* was seen even on the top slopes. *D. viscosa* may encroach upon the top slopes slowly and dominate the scene provided it gets protection at least for a few years. The changed habitat would accommodate *O. ferruginea* and *A. modesta* both. The dominant species are self-perpetuating but the rate of their survival is extremely low largely due to biotic interference (Table 6). If protected, it appears that *O. ferruginea* and *A. modesta* will form the climax as has been predicted for some adjacent areas (Chaghtai & Yusaf, 1976). Apparently the final composition of the vegetation would be *Olea-Acacia* forest with *D. viscosa* constituting a prominent shrub stratum.

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