Pak. J. Bot., 44: 203-211, Special Issue May 2012.

DIVERSITY AND CONSERVATION STATUS OF ECONOMICALLY IMPORTANT FLORA OF THE SALT RANGE, PAKISTAN

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Abstract

The Salt Range (Pakistan) was thoroughly explored for the vegetation studies during 2008-10. Vegetation sampling was conducted by the quadrat method along a straight transect. The quadrats were laid at five ecologically distinct regions within the Salt Range, namely Kalabagh Game Reserve, the Soone Valley, Chumbi Surla Wildlife Sanctuary, Domeli Game Reserve and Lehri Jindi Forest. The species found in the Salt Range are important not only for humans, but also for native wildlife species and domestic animals. Over-exploitation of medicinally important plants and other economically important species, and high grazing pressure in the Salt Range are responsible for the destruction and degradation of the habitat. Thus resultantly, many species are locally endangered, or critically endangered and currently at the verge of extinction. It is, therefore, an urgent need to make some serious efforts in conserving the natural health of the Salt Range by evoking awareness in the local communities, to promote sustainable utilization of economic species and re-introduce endangered or threatened species in the area.

Introduction

The Salt Range, Pakistan is bestowed with a great diversity of habitats and due to this fact the Range is significantly rich in species diversity. The habitats include high mountain peak like Sakesar, cooler climatic zone in Soone Valley, Thar desert in the west, Potohar plateau in the north east, hyper-saline lakes at Uchali complex, Mangla reservoir of river Jhelum at eastern end and dry mountains of Kalabagh near river Indus at the western end, exposed salt rocks at many places, brine and fresh water springs, and highly salt-affected foothill region at south eastern side (Chaudhry *et al*., 2001; Hameed *et al*., 2008; Ahmad *et al*., 2010). The vegetation is categorized as sub-tropical dry evergreen scrub forest (Nawaz *et al*., 2010).

The ridges of Bakrala and Jogi Tilla in the east of Jehlum are on one end of the Salt Range, which is along the River Jehlum in the southwest direction. The other end of this range is at Kalabagh across the River Indus in the northwest direction (Ahmad & Waseem, 2004). Soone is the largest and most prominent valley, spreading over an area of 20 km in length and 5 km in width. Khabbaki, Kahun, Vanhur and Jhanger are the other important valleys of the Salt Range (Ahmad *et al*., 2009).

The Salt Range is rich in paleontological remains, which is well known for floral (tracheophytes) and faunal (vertebrates and mollusks) fossils (Ahmad & Waseem, 2004). Floral diversity of the region is quite rich, which falls in sub-mountainous sub-tropical open scrub forest (Chaudhry *et al*., 2001; Ahmad *et al*., 2002, Nawaz *et al*., 2010). However, the region is exposed to severe habitat loss due to anthropogenic activities like population pressure, over-exploitation of resources and land clearing for construction and agricultural purposes (Ahmad *et al*., 2009).

Salt was originally deposited to lower layer during the formation of the Salt Range, but these layers are now exposed at many places, which is due to deformations during the post-Pleistocene era (Lillie *et al*., 1987). As a result, southern side of the Salt Range near River Jehlum is heavily salt-affected. Brine springs are the additional source of increasing salinity at many places in the Salt Range, which deposit salts along their route in the foothill region (Qadir *et al*., 2005).

Another important feature of the Salt Range is the Uchhali complex, which comprises internationally important wetlands (Khabeki, Uchhali and Jahlar lakes). These wetlands are well known for breeding habitats of some threatened and vulnerable waterfowl species, e.g., white-headed duck (Nawazish *et al*., 2006), which breeds only in the Salt Range. These lakes are either brackish or hyper-saline, supporting very specific plant species (Ahmad *et al*., 2002).

Dominant trees are *Acacia modesta*, *Olea ferruginaea*, *Tecomella undulata* and *Butea frondosa*, whereas dominant shrubs are *Dodonaea viscosa*, *Justicia adhatoda*, *Maytenus royleanus*, *Ziziphus nummularia* and *Buxus papillosa*. Over 60 palatable grass species have been recorded from the area, the dominant among them are *Cgrysopogon serrulatus*, *Heteropogon contortus*, *Dichanthium foveolatum*, *Cynodon dactylon*, and *Aristida mutabilis* (Chaudhry *et al*., 2001; Ahmad *et al*., 2008).

Since each habitat in the Salt Range inhabits different type of vegetation composition and structure, therefore, the present study is an attempt to quantify different plants communities at each habitat type. More so, conservation status of economic flora, ecological threats facing by the native species, and sustainable utilization of economically important plant species was comprehensively discussed in the study.

Materials and Methods

The Salt Range, Pakistan was thoroughly surveyed during 2008-10 for the structure and composition of economically important plant species. Five ecologically distinct study sites (Fig. 1, Table 1), the major habitats, were selected for the study namely Chumbi Surla Wildlife Sanctuary (Chakwal), Domeli Game Reserve (Jhelum), Kalabagh Game Reserve (Kalabagh), Soone valley (Khushab) and Lehri Jindi (Jhelum). Micro-habitats within each major habitat were selected on the basis of vegetation structure and composition, altitude, slope and aspect of the hills.

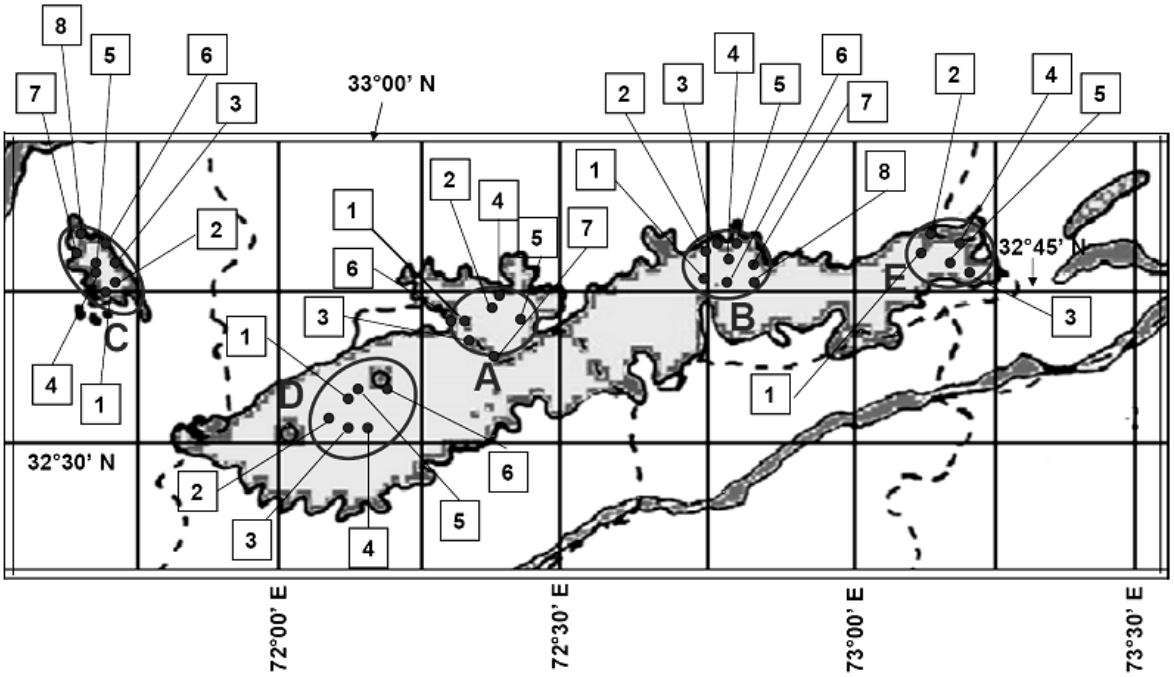


Fig. 1. Vegetation study sites in the Salt Range, Pakistan
A. Chumbi Surla Wildlife Sanctuary (1: *Chrysopogon serruletus*, 2: *C. serruletus-Dodonaea viscosa*, 3: *C. serruletus-Sporobolus arabicus*, 4: *C. serruletus-Cymbopogon jwarancusa*, 5: *C. serruletus-Justicia adhatoda*, 6: *Cynodon dactylon-C. serruletus*, 7: *Imperata cylidrica-C. serruletus*), B. Domeli Game Reserve (1. *Acacia modesta-C. jawaranusa*, 2. *A. modesta-Cynodon dactylon*, 3. *Dichanthium annulatum*, 4. *Heteropogon contortus-Saccharum griffithii*, 5. *C. dactylon*, 6. *J. adhatoda-C. serrulatus*, 7. *A. modesta-Dactyloctenium scindicum*, 8. *C. jwarancusa*), C. Kalabagh Game Reserve (1. *Capparris decidua-C. jwarancusa*, 2. *C. decidua-Carissa opaca*, 3. *C. opaca-J. adhatoda*, 4. *C. opaca-C. jwarancusa*, 5. *C. opaca-Dichanthium foveolatum*, 6. *C. deciduas-D. foveolatum*, 7. *C. decidua-J. adhatoda*, 8. *C. opaca-C. jwarancusa*), D. Soone Valley (1. *Withania somnifera-C. jwarancusa*, 2. *C. dactylon*, 3. *C. dactylon-Desmostachya bipinnata*, 4. *W. somnifera*, 5. *C. dactylon-D. bipinnata*, 6. *C. dactylon-A. modesta*), and E. Lehri Jindi forest (1. *A. modesta-C. jwarancusa*, 2.*A. modesta-C. serrulatus*, 3. *A. modesta-D. scindicum*, 4. *A. modesta-D. viscosa*, 5. *C. jwarancusa*).

Table 1. Habitat description of different vegetation study sites in the Salt Range, Pakistan.

Major habitat	Micro-habitat	Altitude (m)	Micro-habitat description
Chumbi Surla Wildlife Sanctuary (Chakwal)	1. *Chrysopogon serruletus*	680	Top hills on western side, more or less flattened, slope 15%, grey sandstones
	2. *C. serruletus-Dodonaea viscosa*	582	Valley of village Khokher Zer on the northern side, slope 15%, grey sandstones
	3. *C. serruletus-Sporobolus arabicus*	795	Moderately steep slopes of about 45° on the southwestern side, sandstones
	4. *C. serruletus-Cymbopogon jwarancusa*	642	Stoop slopes of about 60° on the northern side
	5. *C. serruletus-Justicia adhatoda*	637	Valleys on the eastern side, soil typically reddish sandy clay
	6. *Cynodon dactylon-C. serruletus*	709	Western periphery of the wildlife sanctuary, slope about 15°, soil sandy clay
	7. *Imperata cylidrica-C. serruletus*	787	Southern peripheral side along water channel, slope 15°, soil sandy clay
Domeli Game Reserve (Jhelum)	1. *Acacia modesta-C. jawaranusa*	315	Moderately steep slopes of about 45°, hills facing northwestern aspect
	2. *A. modesta-Cynodon dactylon*	297	Top hill region with about 30° slope, facing southwestern aspect
	3. *Dichanthium annulatum*	331	Steep slopes of about 60° near village Barali
	4. *Heteropogon contortus-Saccharum griffithii*	413	More or less flattened valley
	5. *C. dactylon*	349	Flat planis near village Phadyal
	6. *J. adhatoda-C. serrulatus*	344	Moderate slopes of about 45° on the southern side
	7. *A. modesta-Dactyloctenium scindicum*	417	Foothill region along water channel

Table 1. (Cont'd.).

Major habitat	Micro-habitat	Altitude (m)	Micro-habitat description
	8. *C. jwarancusa*	315	More or less flat foothill region
Kalabagh Game Reserve (Kalabagh)	1. *Capparris decidua-C. jwarancusa*	758	Moderate slope of about 45°, facing northeastern aspect
	2. *C. decidua-Carissa opaca*	655	Steep slopes of about 60°, facing southwestern aspect
	3. *C. opaca-J. adhatoda*	459	Steep slopes facing northwester aspect
	4. *C. opaca-C. jwarancusa*	318	More or less flat area of about 15° slope on the northeastern side
	5. *C. opaca-Dichanthium foveolatum*	426	Moderate slopes of about 45°, facing southwestern aspect
	6. *C. deciduas-D. foveolatum*	397	Steep slopes of about 60°, facing western aspect
	7. *C. decidua-J. adhatoda*	607	More or lass flat plains near the eastern peripheral area
	8. *C. opaca-C. jwarancusa*	296	Top hill region of about 30° slope, facing northeastern aspect
Soone Valley (Khushab)	1. *Withania somnifera-C. jwarancusa*	907	Area around Khabbeki Lake with moderately steep slopes of about 45°
	2. *C. dactylon*	1034	Area near village Khoora with steep slopes of about 60°
	3. *C. dactylon-Desmostachya bipinnata*	855	Area near Dape Sharif, more or less flat area
	4. *W. somnifera*	827	Area near village Anga, steep slopes of about 60°
	5. *C. dactylon-D. bipinnata*,	894	Area around *Citrus* Garden, Kanhatti with steep to moderately steem slopes of about 50°
	6. *C. dactylon-A. modesta*	882	Area around Jahlar Lake with moderately steep slopes of abour 30°
Lehri Jindi Forest (Jhelum)	1. *A. modesta-C. jwarancusa*	406	Fenced protected area inside the Wildlife Enclosure-I
	2. *A. modesta-C. serrulatu*	427	Unprotected area outside the Wildlife Enclosure-II
	3. *A. modesta-D. scindicum*	348	More or less flat area near village Drat
	4. *A. modesta-D. viscosa*	426	Unprotected area outside the Wildlife Enclosure-I
	5. *C. jwarancusa*	468	Protected area inside the Wildlife Enclosure-II

Vegetation surveys were conducted by the quadrat sampling method. The quadrats were laid along a straight transect line of 200 m (Fig. 2). Each qudarat was separated from a consecutive quadrat by a distance of 10 m, and each consecutive quadrat laid alternatively on opposite side of a transect line. A total of 10 quadrats were laid along a transect line, i.e., 5 on each side of a transect line. Five transect lines were laid at each micro-habitat.

Collected plant samples were carefully pressed and dried for herbarium preparation, and labeled voucher specimens were deposited to the Herbarium of Botany Department, University of Agriculture, Faisalabad for future reference. For the identification of plant samples, all available literature, mainly Flora of Pakistan (Nasir & Ali, 1972-94; Ali & Qaiser, 1995-2011) was followed. Ecological data for density, frequency and cover were recorded for each species, relative values of density, frequency and percent cover were calculated for their importance values. The conservation status of each species was assessed in accordance with Hussain (1983) and Ludwig & Reynolds (1988).

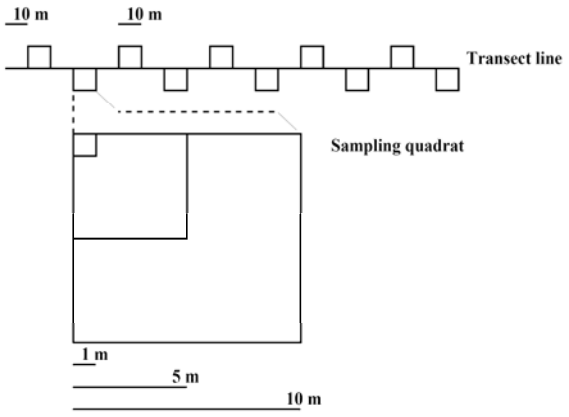
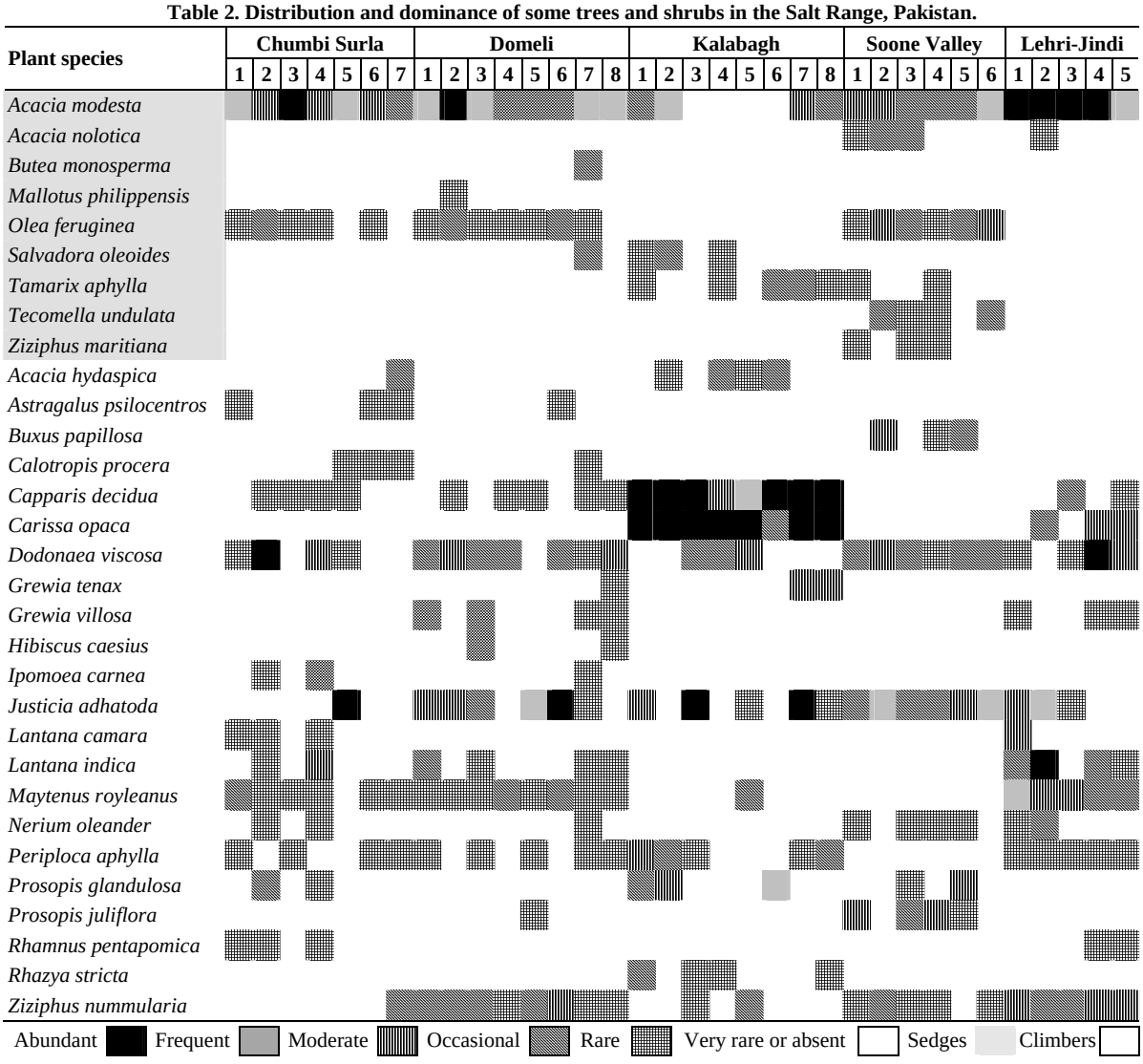


Fig. 2. Vegetation sampling layout of a transect and quadrats.

Vegetation was studied at 7 ecologically different sites in the Chumbi Surla Wildlife Sanctuary, which were selected on the basis of altitude, aspect and slope of the hills (Table 1). *Chrysopogon serrulatus* was the most

dominant component of the vegetation at all the study sites. The top hill (more or less flat) region was predominantly occupied by a number of grasses, where the most dominant component of the vegetation was *C. serrulatus*. *Digitaria sanguinalis* and *Heteropogon contortus* were two other frenquently recorded grasses, but their distributional pattern was little scattered (Tables 2, 3, 4, 5). Only a few trees of *Acacia modesta* and *Olea ferruginaea* were recorded in the region (Table 2), but the presence of other taller vegetation is rare. *Diclyptera bupleuroides* was the only herbaceous species that was frequently recorded (Table 4).

Table 2. Distribution and dominance of some trees and shrubs in the Salt Range, Pakistan.



Communities: Chumbi Surla (1: *Chrysopogon serruletus*, 2: *C. serruletus-Dodonaea viscosa*, 3: *C. serruletus-Sporobolus arabicus*, 4: *C. serruletus-Cymbopogon jwarancusa*, 5: *C. serruletus-Justicia adhatoda*, 6: *Cynodon dactylon-C. serruletus*, 7: *Imperata cylidrica-C. serruletus*), Domeli (1. *Acacia modesta-C. jawaranusa*, 2. *A. modesta-Cynodon dactylon*, 3. *Dichanthium annulatum*, 4. *Heteropogon contortus-Saccharum griffithii*, 5. *C. dactylon*, 6. *J. adhatoda-C. serrulatus*, 7. *A. modesta-Dactyloctenium scindicum*, 8. *C. jwarancusa*), Kalabagh (1. *Capparris decidua-C. jwarancusa*, 2. *C. decidua-Carissa opaca*, 3. *C. opaca-J. adhatoda*, 4. *C. opaca-C. jwarancusa*, 5. *C. opaca-Dichanthium foveolatum*, 6. *C. deciduas-D. foveolatum*, 7. *C. decidua-J. adhatoda*, 8. *C. opaca-C. jwarancusa*), Soone Valley (1. *Withania somnifera-C. jwarancusa*, 2. *C. dactylon*, 3. *C. dactylon-Desmostachya bipinnata*, 4. *W. somnifera*, 5. *C. dactylon-D. bipinnata*, 6. *C. dactylon-A. modesta*), Lehri Jindi (1. *A. modesta-C. jwarancusa*, 2.*A. modesta-C. serrulatus*, 3. *A. modesta-D. scindicum*, 4. *A. modesta-D. viscosa*, 5. *C. jwarancusa*)

Results

Dodonaea viscosa, along with *C. serrulatus* dominated the valleys in the wildlife sanctuary, however, grasses like *Sporobolus arabicus* and *Dactyloctenium scindicum* were two other grasses that represented the major portion of vegetation cover. Trees, shrubs and herbaceous species are relatively less frequent in the valleys. Moderately steep slopes with grey sandstones were completely dominated by a tree, *A. modesta*, and two grasses *C. serrulatus* and *S. arabicus*. *Lespedeza juncea* and *Lantana indica* also contributed to a significant proportion of vegetation cover.

Table 3. Distribution and dominance of some herbs in the Salt Range, Pakistan.

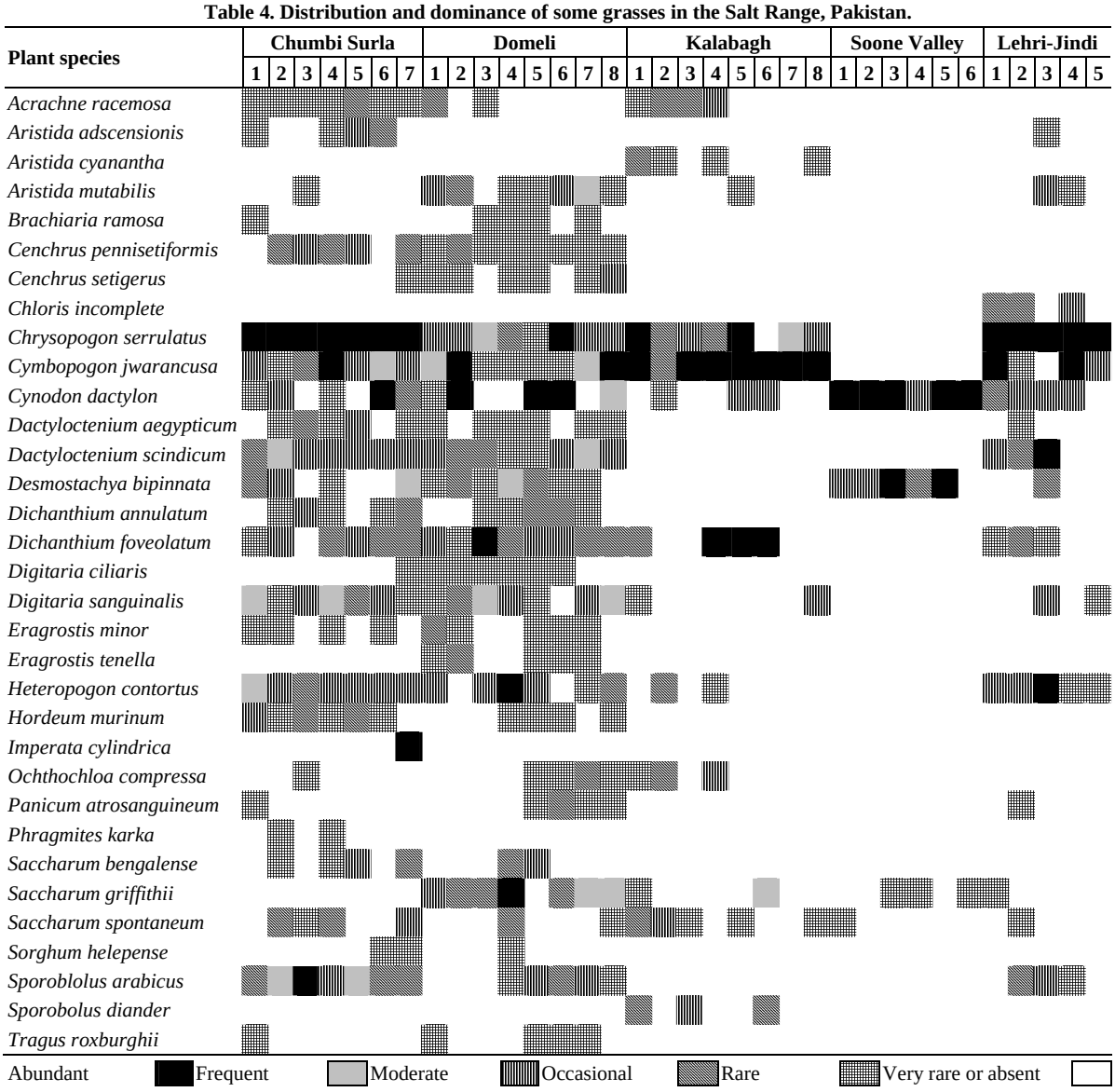
Plant species	Chumbi Surla							Domeli								Kalabagh								Soone Valley						Lehri-Jindi				
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	1	2	3	4	5
Abutilon fruticosum																																		
Achyranthus aspara																																		
Aerva javanica																																		
Boerhavia procumbens																																		
Capparis spinosus																																		
Cleome scaposa																																		
Cynoglossum lanceolatum																																		
Datura metel																																		
Diclyptera bupleuroides																																		
Evolvulus alsinoides																																		
Fagonia indica																																		
Heliotropium strigosum																																		
Launaea procumbens																																		
Lespedeza floribunda																																		
Lespedeza juncea																																		
Leucas nutans																																		
Malvestrum coromendelianum																																		
Ochthochloa compressa																																		
Opuntia monocantha																																		
Oxalis corniculata																																		
Peganum harmala																																		
Polygala erioptera																																		
Pupalia lappacea																																		
Rhynchelytrum repens																																		
Salvia moocroftiana																																		
Sida cordta																																		
Solanum incanum																																		
Solanum nigrum																																		
Solanum surratense																																		
Sophora mollis ssp. *griffithii*																																		
Vernonia cinerascens																																		
Withania somnifera																																		

Abundant Frequent Moderate Occasional Rare Very rare or absent

Communities: Chumbi Surla (1: *Chrysopogon serruletus*, 2: *C. serruletus-Dodonaea viscosa*, 3: *C. serruletus-Sporobolus arabicus*, 4: *C. serruletus-Cymbopogon jwarancusa*, 5: *C. serruletus-Justicia adhatoda*, 6: *Cynodon dactylon-C. serruletus*, 7: *Imperata cylidrica-C. serruletus*), Domeli (1. *Acacia modesta-C. jawaranusa*, 2. *A. modesta-Cynodon dactylon*, 3. *Dichanthium annulatum*, 4. *Heteropogon contortus-Saccharum griffithii*, 5. *C. dactylon*, 6. *J. adhatoda-C. serrulatus*, 7. *A. modesta-Dactyloctenium scindicum*, 8. *C. jwarancusa*), Kalabagh (1. *Capparris decidua-C. jwarancusa*, 2. *C. decidua-Carissa opaca*, 3. *C. opaca-J. adhatoda*, 4. *C. opaca-C. jwarancusa*, 5. *C. opaca-Dichanthium foveolatum*, 6. *C. deciduas-D. foveolatum*, 7. *C. decidua-J. adhatoda*, 8. *C. opaca-C. jwarancusa*), Soone Valley (1. *Withania somnifera-C. jwarancusa*, 2. *C. dactylon*, 3. *C. dactylon-Desmostachya bipinnata*, 4. *W. somnifera*, 5. *C. dactylon-D. bipinnata*, 6. *C. dactylon-A. modesta*), Lehri Jindi (1. *A. modesta-C. jwarancusa*, 2.*A. modesta-C. serrulatus*, 3. *A. modesta-D. scindicum*, 4. *A. modesta-D. viscosa*, 5. *C. jwarancusa*)The steepest slopes in the wildlife sanctuary were exclusively dominated by grasses like *C. serrulatus* and *Cymbopogon jwarancusa*, however, some other grasses like *D. sanguinalis, D. scindicum, H. contortus* and *S. arabicus* also shared the major portion of vegetation cover. Study sites with reddish clay and moderate slopes were dominated by a shrub, *Justicia adhatoda* and a grass, *C. serrulatus*. A number of other grasses like *Aristida adscensionis, Cenchrus pennisetiformis, C. jwarancusa, Dactyloctenium aegyptium, D. scindicum, Dichanthium foveolaum, H. contortus* and *Saccharum bengalense* shared the dominance at this habitat.

Peripheral areas on the western side of the sanctuary were solely dominated by grasses like *C. serrulatus* and *Cynodon dactylon*. Other major components of the vegetation were grasses like *C. jwarancusa, D. scindicum*, and *D. sanguinalis*, and a tree *A. modesta*, but the habit of this species was extremely reduced at this habitat. Peripheral area on the southern side along water channel was dominated by two grasses, *C. serrulatus* and *Imperata cylindrical*, along with few other grasses like *C. jwarancusa, D. scindicum* and *H. contortus*. However, no dicotyledonous species frequently contributed to the vegetation structure at this habitat. Quite a few sedges were the component of aquatic or semi-aquatic vegetation, *Cyperus niveus* was the most dominant among them (Table 5).

Table 4. Distribution and dominance of some grasses in the Salt Range, Pakistan.



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Eight study sites were selected for the study of vegetation in Domeli region, where *A. modesta* along with grasses like *C. dactylon*, *C. jwarancusa* and *C. serrulatus* predominantly occupied most of the habitats. Several other also shared to the vegetation composition, but no single plant community dominated the northwestern site of the region. The distribution of *A. modesta* and *C. jwarancusa* were relatively more abundant with moderately steep slopes than the other species (Tables 2, 4). Top hills of the region were dominated by large trees of *A. modesta* along with quite a few grasses, mainly *C. jwarancusa*, *C. dactylon* and *C. serrulatus*. Barali area with steep slopes showed the dominance of *D. foveolatum*, however *C. serrulatus*, *D. sanguinalis* and *A. modesta* were the major component of vegetation.

Heteropogon contortus was the major component of vegetation of the valleys in the Domeli region, however, quite a few grasses (mainly *Desmostachya bipinnata* and *D. sanguinalis*) also contributed significantly to the composition of vegetation structure. Phadyal area mainly encompasses flat foothills, which was exclusively dominated by spreading *Cynodon dectylon*. A shrub

Justicia adhatoda and some tussock grasses like *D. foveoletum*, *H. contortus* and *S. arabicus* significantly share the habitat. Moderate slope on the southern site were dominated by *J. adhatoda*, *C. serrulatus* and *C. dactylon*. However, a number of grasses also contributed to the vegetation structure to some extent.

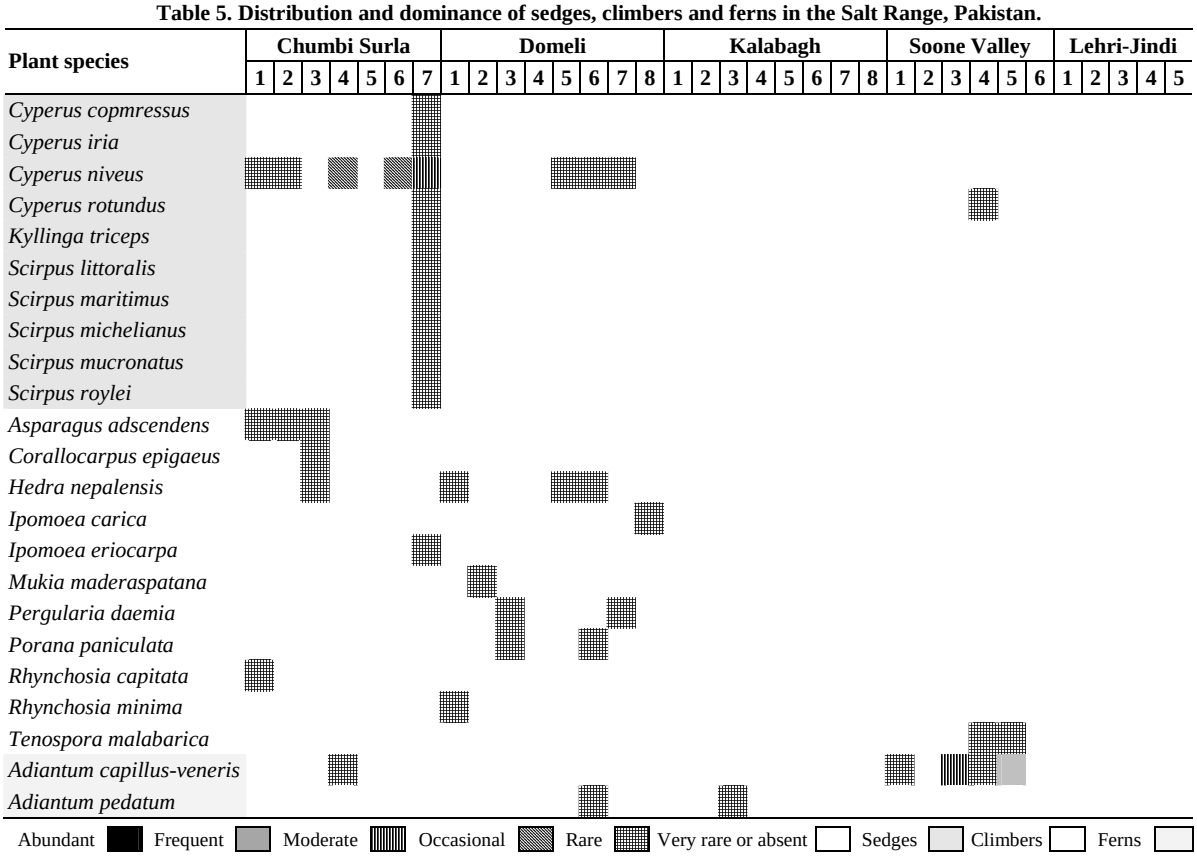
Major component of the vegetation in the foot-hill region was *A. modesta* and few grasses like *Aristida mutabilis*, *C. jwarancusa* and *D. aegyptium*, but no single species completely dominated the area. Foothill regions of the eastern site of Domeli were mainly dominated by *C. jwarancusa*, but two other grasses (*C. dactylon* and *D. sanguinalis*) and *A. modesta* also contributed significantly to the vegetation.

Kalabagh region was dominated by scrubby vegetation like *Capparis decidua* and *Carissa opaca*, grasses like *C. serrulatus*, *C. jwarancusa* and *D. foveoletum*. However, few scattered patches of *J. adhatoda* also recorded from the area. Habitats of northeastern aspect of moderately steep slopes, southwestern aspect of steep and moderately steep slopes and plane area were completely dominated by *C. opaca*, *C. decidua*, *C. serrulatus* and *C. jwarancusa*. However, northwestern steep slope and eastern plane were shared by *J. adhatoda* along with the other dominant species.

Vegetation of Soone Valley was almost completely dominated by *C. dactylon*, however, *D. bipinnata* and *Withania somnifera* contributed to a significant portion of vegetation structure. On the whole, vegetation cover was relatively much lower as compared to the other regions in the Salt Range. Scattered stands of *A. modesta*, *J. adhatoda* and *O. ferruginaea* were recorded from some habitats like Khoora and Jahlar.

Lehri Jindi area was completely dominated by *A. modesta* and *C. serrulatus*, however, *C. jwarancusa* also contributed significantly to vegetation cover inside the Wildlife Enclosure-I. *Dodonaea viscosa* and *C. jwarancusa* were also the significant component of vegetation inside the Wildlife Enclosue-II. Vegetation outside the wildlife enclosures was dominated by *Lantana indica*, *D. viscosa* and *C. jwarancusa*. *Heteropogon contortus* and *D. scindicum* significantly contributed to the vegetation structure at Drat area.

Table 5. Distribution and dominance of sedges, climbers and ferns in the Salt Range, Pakistan.



Communities: Chumbi Surla (1: *Chrysopogon serruletus*, 2: *C. serruletus-Dodonaea viscosa*, 3: *C. serruletus-Sporobolus arabicus*, 4: *C. serruletus-Cymbopogon jwarancusa*, 5: *C. serruletus-Justicia adhatoda*, 6: *Cynodon dactylon-C. serruletus*, 7: *Imperata cylidrica-C. serruletus*), Domeli (1. *Acacia modesta-C. jawaranusa*, 2. *A. modesta-Cynodon dactylon*, 3. *Dichanthium annulatum*, 4. *Heteropogon contortus-Saccharum griffithii*, 5. *C. dactylon*, 6. *J. adhatoda-C. serrulatus*, 7. *A. modesta-Dactyloctenium scindicum*, 8. *C. jwarancusa*), Kalabagh (1. *Capparris decidua-C. jwarancusa*, 2. *C. decidua-Carissa opaca*, 3. *C. opaca-J. adhatoda*, 4. *C. opaca-C. jwarancusa*, 5. *C. opaca-Dichanthium foveolatum*, 6. *C. decidua-D. foveolatum*, 7. *C. decidua-J. adhatoda*, 8. *C. opaca-C. jwarancusa*), Soone Valley (1. *Withania somnifera-C. jwarancusa*, 2. *C. dactylon*, 3. *C. dactylon-Desmostachya bipinnata*, 4. *W. somnifera*, 5. *C. dactylon-D. bipinnata*, 6. *C. dactylon-A. modesta*), Lehri Jindi (1. *A. modesta-C. jwarancusa*, 2.*A. modesta-C. serrulatus*, 3. *A. modesta-D. scindicum*, 4. *A. modesta-D. viscosa*, 5. *C. jwarancusa*)

Discussion

Variation in habitat ecology, vegetation structure, its composition and diversity is considerably high all over the Salt Range. Location-wise, two extremes of the Salt Range were Kalabagh Game Reserve on the western end with relatively drier habitat (Frisina *et al*., 2007) and Lehri Jindi Forest on the eastern end, where annual rainfall is relatively higher (Nawaz *et al.*, 2010). Among trees and shrubs, Kalabagh was dominated by *Carissa opaca* and *Capparis decidua*, whereas Lehri Jindi by *Acacia modesta, Dodonaea viscosa* and *Lantana indica.* However among grasses, Kalabagh was dominated by *Cymbopogon jwarancusa* and *Dichanthium foleolatum,* but Lehri Jindi exclusively by *Chrysopogon serrulatus.* Altitude of the Soone valley was the highest in the Salt Range including the highest peak of Sakesar (Nawazish *et al.*, 2006, Ahmad *et al*., 2010), where the climate is relatively cooler and very different from the other habitats in the Salt Range. This habitat was completely dominated by *Cynodon dactylon* and *Desmostachya bipinnata.*

Chunbi Surla Wildlife Sanctuary and Domeli Game Reserve was a typical habitats with grey sandstones and reddish clay, which is a specific feature of the Salt Range (Chaudhry *et al*., 2001). *Acacia modesta* was a dominant component of vegetation at both habitats along with *Justicia adhatoda.* However, grassy vegetation showed little variation regarding its structure and composition. *Chrysopogon serrulatus* formed completely dominated the Chumbi Surla region, whereas this species was equally shared by *C. jwarancusa*, *C. dactylon* and *Dichanthium foveolatum.* However, vegetation diversity all over the Salt Range was quite high, and the structure and composition of the vegetation depended upon climate of the area, altitude, slope and aspect of the hills.

Altitude plays a key role in distribution of plants species in the mountainous regions (Ahmed *et al*., 2006). Distribution of *C. dactylon* and *D. bipinnata* restricted to the valley and foothill region, whereas along with *Imperata cylindrica,* the latter was found more dominant at moist habitats. *Chrysopogon serrulates* was a dominant component of higher altitudes all over the Salt Range, whereas, *C. jwarancusa* formed a major portion of vegetation at steeper slopes. Flat top hill region supported the dominance of *Dactyloctenium scindicum.* Overall, grass vegetation dominates all the Salt Range region, where a large number of diversity has been reported by several authors in the family Poaceae. For example, Chaudhry *et al*., (2001) reported 41 species from Chumbi Surla, Ahmad *et al*., (2008) 21 species from the Soone Valley, Nawaz *et al*., (2010) 21 species from Lehri Jindi, and Ahmad *et al*., (2010) 62 species from the Salt Range.

Tree cover is relatively rare all over the Salt Range, however, *A. modesta* was a dominant component of the vegetation. Size and cover of this species were the maximum at the protected area of Lehri, but over-exploitation and high grazing pressure have resulted in reduced population size and percent cover in non-protected areas (Ahmad *et al.*, 2009) Few other trees, such as *Olea ferruginaea, Tecomella undulata, Butea monosperma, Salvadora oleoides* and *Mallotus philippensis* were less frequently recorded. Distribution of *O. ferruginaea* was recorded only at higher altitudes, whereas that of *Tecomella undulata* had very restricted distribution and only recorded from the Soone Valley. *S. oleoides* and *B. monosperma* were restricted to the Domeli region. The Kalabagh region was dominated by a spiny *Carissa opaca* and leafless *Capparis decidua,* which was a characteristic feature of the Kalabagh vegetation. A sedge *Erioscirpus comosus* and under-shrub *Capparis spinosus* was restricted to the steepest slopes, i.e., 80° or more. Another shrub, *Cyperus niveus,* was the component of drier habitat, which is one of the few dry land species of family Cyperaceae (Hameed *et al*., 2012).

The Salt Range habitat was dominated by a few trees or shrubs and quite a few grasses. Conservation of status of most of the species endemic to the region was vulnerable, endangered or critically endangered; particularly those that have been under exploition by the local people for medicinal or other economic purposes (Ahmad *et al*., 2009). Conservation status of *O. ferruginaea, B. monosperma, S. oleoides* and *T. undulata* is currently under a serious threat, particularly that of *B. monosperma, S. oleoides* and *T. undulata,* which is near to extinction. A serious step must be taken immediately to conserve natural health of the Salt Range by evoking awareness in the local communities, promoting sustainable utilization of economic species and re-introducing vulnerable, endangered or threatened species in the area

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(Received for publication 16 April 2012)