Biodiversity and plant-environmental interaction in semi-arid rangeland in western Iran

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Introduction

Of the total land area of Iran (164,819,500 ha), 55% is rangeland. Most rangeland is located in the arid and semi-arid areas. In the Kermanshah province in western Iran (2,443,400 ha total area, 30% rangeland), 26% of the rangeland is considered as good rangeland, 27% fair, and 48% poor (BADRIPOUR, 2004).

The loss of biodiversity under land use intensification is a particularly relevant issue on rangelands because of their vulnerability to land use conversions (FLATHER and HUL 2000). REZAEI et al. (2005) suggested the most important biophysical resource of rangeland to be the soil because of strong relationships with plant properties and plant cover.

The objective of this study was to analyze plant diversity and to explore plant-environmental interactions, including interactions with soil parameters, in the semi-arid rangeland of the Kermanshah province.

Material and Methods

The study areas are formed by two catchments, the Kabodeh (1,494 ha) and the Merek (24,207 ha) catchment, located in the Kermanshah province. The rangeland area of both catchments accumulates to 6,741 ha. Some dominant species are *Aegilops sp., Phlomis* sp*, Bromus danthoniae, Festuca arundinacea, Bromus tectorum, Euphorbia* sp.*, Gundelia tournefortii, Taeniatherum crinitum, Heteranthelium piliferum*. The rangeland is grazed mostly by sheep, goats, and sometimes cattle, including both sedentary and migrating animals.

For field sampling, a stratified double sampling design was used. To this end, both study areas were stratified into classes of rangeland condition after selecting the 44 study sites on satellite images.

Per site, vegetation was sampled in eight quadrates of 1*1 m² for herbaceous plants and four subplots of 10*10 m² for trees and shrubs. Species number, biomass and percentage cover was measured and plant diversity calculated. Soil was sampled in two locations per site (0-20 cm) and analyzed for available phosphorus (P), available potassium (K), organic carbon (OC), pH, and soil texture.

Data collected per site were averaged for further analyses. Detrended correspondence analysis (DCA), canonical correspondence analysis (CCA), and correlation matrix were used (CANOCO and SPSS software) for interpretation of species diversity and plant-environmental interaction.

Results and Discussion

In total, 108 plant species were found in the 44 sites. With DCA of the vegetation data, eigenvalues of 0.329, 0.140, 0.106 and 0.084 were found for axes one to four, respectively, and the variation accounted for by each axis was 13.2, 5.7, 4.2 and 3.4%, respectively. The first two axes thus described most of the dispersion of the species. Fig. 1 shows their spatial distribution in a DCA ordination diagram. Some species at the positive end of the first axis were *Medicago radiata, Medicago rotata, Dianthus* sp., *Trifolium tomentosum, Boissiera squarrosa,* i. e. species more abundant in the Kabudeh catchment in the best class of rangeland. This might be due to exclosures in these areas, where the number of species, diversity, biomass, percentage cover, and the amount of palatable plants such as *Trifolium* spp. and *Medicago* spp. were larger than in other areas. KARAAIJ and MILTON (2006) also reported that species richness in a 7-year study was significantly higher in fenced than in open plots.

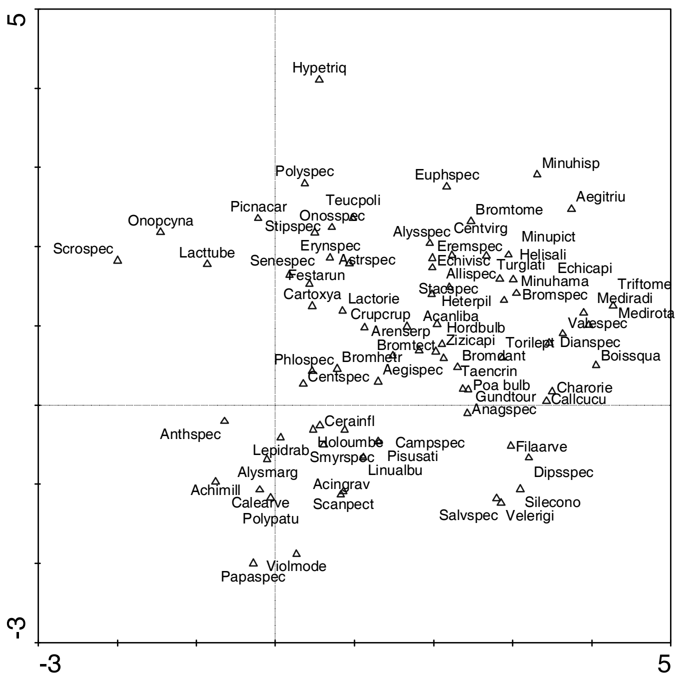

Fig. 1: DCA ordination diagram displaying main plots and plant species. For species labels, please see Appendix.

Fig. 2 and Tab. 1 show strong positive correlations between percentage cover and biomass, percentage cover and species number, as well as species number and biomass, between OC and P as well as K, and between P and K. In addition, there were positive relationships between percentage cover and OC, as well as K. OC was also negatively correlated with pH. The most important environmental variables for the spatial distribution of many species were P, K, and OC. These results are similar to those of DALLE (2004) who found that in his study area in Ethiopia, P, K, and CEC were the most important environmental variables determining species distribution. Analysis of frequency data for the spatial distribution of species in each main plot gave results similar to the presented accumulative data.

In other studies of rangeland in the Kermanshah province, an interaction between diversity and environmental variables had not been found. That was the reason to use multivariate techniques in this study to analyse the relationship between environmental variables and plant species.

The current study illustrates that the more fertile sites, which had more P, K, and OC, had also a larger percentage cover. However, there was no significant correlation between P and percentage cover. This might be due to P fertilization that some farmers applied to part of the sample units 2-5 years ago (data not shown).

In contrast to biomass and percentage cover variables, there were no significant relationships between species number and environmental variables. Similar results were found by DALLE (2004) and REED et al. (1993).

In conclusion, these results suggest that in this area, management measures like exclosures seem to have a larger impact on species numbers, biomass, percentage cover, and amount of palatable plants than the environmental factors measured.

Tab. 1: Correlation matrix of environmental variables

	Cover	Bio-mass	Species No.	Clay	Silt	Sand	OC	K	P	pH
Cover (%)		**	**	ns	ns	ns	*	*	ns	ns
Biomass (m^{-2})	0.69		**	ns	ns	ns	ns	ns	ns	ns
Species No.	0.54	0.53		ns	ns	ns	ns	ns	ns	ns
Clay (%)	-0.12	-0.16	0.17		ns	**	ns	ns	ns	ns
Silt (%)	0.01	-0.04	-0.07	-0.15		*	ns	ns	ns	ns
Sand (%)	0.13	0.18	-0.15	-0.09	-0.32		*	ns	ns	ns
OC (%)	0.30	0.04	-0.13	-0.29	-0.05	0.30		**	**	*
K (ppm)	0.30	-0.08	-0.01	0.10	0.11	-0.14	0.57		**	ns
P (ppm)	0.02	-0.21	-0.08	0.01	0.09	-0.06	0.42	0.64		ns
pH	-0.13	-0.05	0.62	-0.10	0.24	-0.03	-0.32	-0.20	0.02	

Rho-value and statistical significance were derived using Spearman's rank correlation.

(**p < 0.01, * p < 0.05, and ns = not significant)

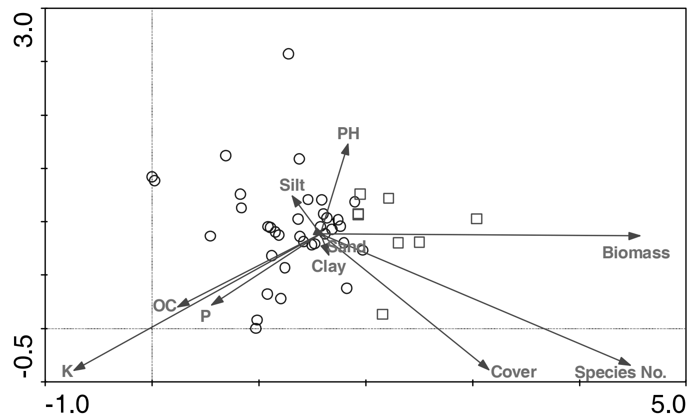

Fig. 2: Ordination diagram based on DCA indirect gradient analysis of samples and environmental variables in the Kabodeh and the Merek catchments (squares and circles, respectively).

Appendix: Plant species codes

Acanliba (Acantholimon libanoticum), Achimill (Achillea millefolium), Acingrav (Acinus graveolens), Aegispec (Aegilops sp.), Aegitriu (Aegilops triuncialis), Allispec (Allium sp.), Alysmarg Alyssum marginatum, (Alysspec) Alyssum sp., (Anagspec)

Anagallis sp., (Anthspec) (Anthemis sp.), Arenserp (Arenaria serpyllifolia), Astrspec (Astragalus sp.), Boissqua (Boissiera squarrosa), Bromdant (Bromus danthoniae), Bromhetr (Bromus hetrantum), Bromspec (Bromus sp.), Bromtect (Bromus tectorum), Bromtome (Bromus tomentellus), Calearve (Calendula arvensis), Callcucu (Callipeltis cucullaria), Campspec (Campanula sp.), Cartoxya (Carthamus oxyacantha), Centspec (Centaurea sp.), Centvirg (Centaurea virgata), Cerainfl (Cerastium inflatum), Charorie (Chardinia orientalis), Crupcrup (Crupina crupinastrum), Dianspec (Dianthus sp.), Dipsspec (Dipsacus sp.), Echicapi (Echinaria capitata), Echivisc (Echinops viscosus), Eremspec (Eremopoa sp.), Erynspec (Eryngium sp.), Euphspec (Euphorbia sp.), Festarun (Festuca arundinacea), Filaarve (Filago arvensis), Gundtour (Gundelia tournefortii), Gypscapi (Gypsophila capillaris), Helisali (Helianthemum salicifolium), Heterpili (Heteranthelium piliferum), Holoumbe (Holosteum umbellatum), Hordbulb (Hordeum bulbosum), Hypetriq (Hypericum triquetrifolium), Lactorie (Lactuca orientalis), Lacttube (Lactuca tuberasa), Lepidrab (Lepidium draba), Linualbu (Linum album), Mediradi (Medicago radiata), Medirota (Medicago rotata), Minuhama (Minuartia hamata), Minuhisp (Minuartia hispanica), Minupict (Minuartia picta), Onopcyna (Onopordum cynarocephalum), Onosspec (Onosma sp.), Papaspec (Papaver sp.), Phlospec (Phlomis sp.), Picnacar (Picnomon acarna), Pisusati (Pisum sativum), Poa bulb (Poa bulbosa), Polypatu (Polygonum patulum), Polyspec (Polygonum sp.), Salvspec (Salvia sp.), Scanpect (Scandix pecten-veneris), Scrospec (Scrophularia sp.), Senespec (Senecio sp.), Silecono (Silene conoidea), Smyrspec (Smyrniopsis sp.), Stacspec (Stachys sp.),Stipspec (Stipa sp.), Taencrin (Taeniatherum crinitum), Violspec (Viola sp.), Teucpoli (Teucrium polium), Torilept (Torilis leptophylla), Triftome (Trifolium tomentosum), Turglati (Turgenia latifolia), Valespec (Valerianella sp.), Velerigi (Velezia rigida), Violmode (Viola modesta Fenzl), Zizicapi (Ziziphora capitata).

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