Digital supplementary material to

PAKNIA, O. & PFEIFFER, M. 2014: Niche-based processes and temporal variation of environment drive beta diversity of ants (Hymenoptera: Formicidae) in dryland ecosystems of Iran. – Myrmecological News 20: 15-23.

Appendix S1: Measuring of environmental variables.

Habitat heterogeneity: We recorded horizontal habitat structure at each sample site during May-July 2007 to settle the habitat heterogeneity. We determined the horizontal structure of the habitat by a modified method described by BOTES & al. (2006). A 1 m^2 plastic grid was placed over each pitfall trap, in total 30 grids for each pitfall transect. For measuring the habitat heterogeneity factors we took one photo from top of each grid. We positioned our camera (Canon Powershot IS2) at a 150 cm distance top of the center of each grid, in a vertical angel and shot. With this method we captured each grid and ground covered within it in a one shot. Later we measured three factors: vegetation cover, bare soil, and exposed rock within each grid from the photos by Adobe® Photoshop® CS3 Extended software. Mean ground vegetation cover, bare soil and exposed rock were calculated for each sampling transect.

Climate variables: We extracted five climate variables (mean annual temperature, mean diurnal temperature range, mean annual precipitation, mean summer precipitation and relative humidity) from the Worldclim database at ~ 1 km spatial resolution data layer (HIJMANS & al. 2005). To do this we overlaid site localities on these data layers separately and extracted values using ArcView 3.2 software. We normalized these variables by log-transformation.

Productivity: We used the normalized difference vegetation index (NDVI) as the surrogate of productivity. Normalized difference vegetation index, based on a ratio of red and near-infrared reflectance, responds to the absorption of red light by chlorophyll and is a measure of greenness. It has been shown that NDVI has strong relationship with net primary productivity (NPP) (BOX & al. 1989) and this relationship is relatively consistent over different ecosystems (FAIRBANKS & MCGWIRE, 2004). The NDVI data were collected from the moderate Resolution Imagining Spectroradiometer (MODIS) an instrument aboard NASA's Terra and Aqua satellites. The NDVI data used in this study were obtained from the Land Processes Distributed Active Archive Center (LP DAAC) (https://lpdaac.usgs.gov/lpdaac/products/modis_products_table) which is a component of NASAs Earth Observing System (EOS). We generated NDVI values at a 500 - m spatial resolution and temporal resolution of 16 days for each site by overlaying site localities on NDVI data layers by ESRI ARCGIS software. There are 23 such layers for a whole year (May / July 2006 – May / July 2007). We calculated the yearly mean values of 23 NDVI images and applied them as explanatory variable for each site.

Elevation: The elevation variable used in our models was generated by overlying site localities on an elevation data layer, which was obtained from the Shuttle Radar Topography Mission (SRTM) (http://dds.cr.usgs.gov/srtm/).

References

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BOX, E.O., HOLBEN, B.N. & KALB, V. 1989: Accuracy of the AVHRR vegetation index as a predictor of biomass, primary productivity and net CO2 flux. – Plant Ecology 80: 71-89.

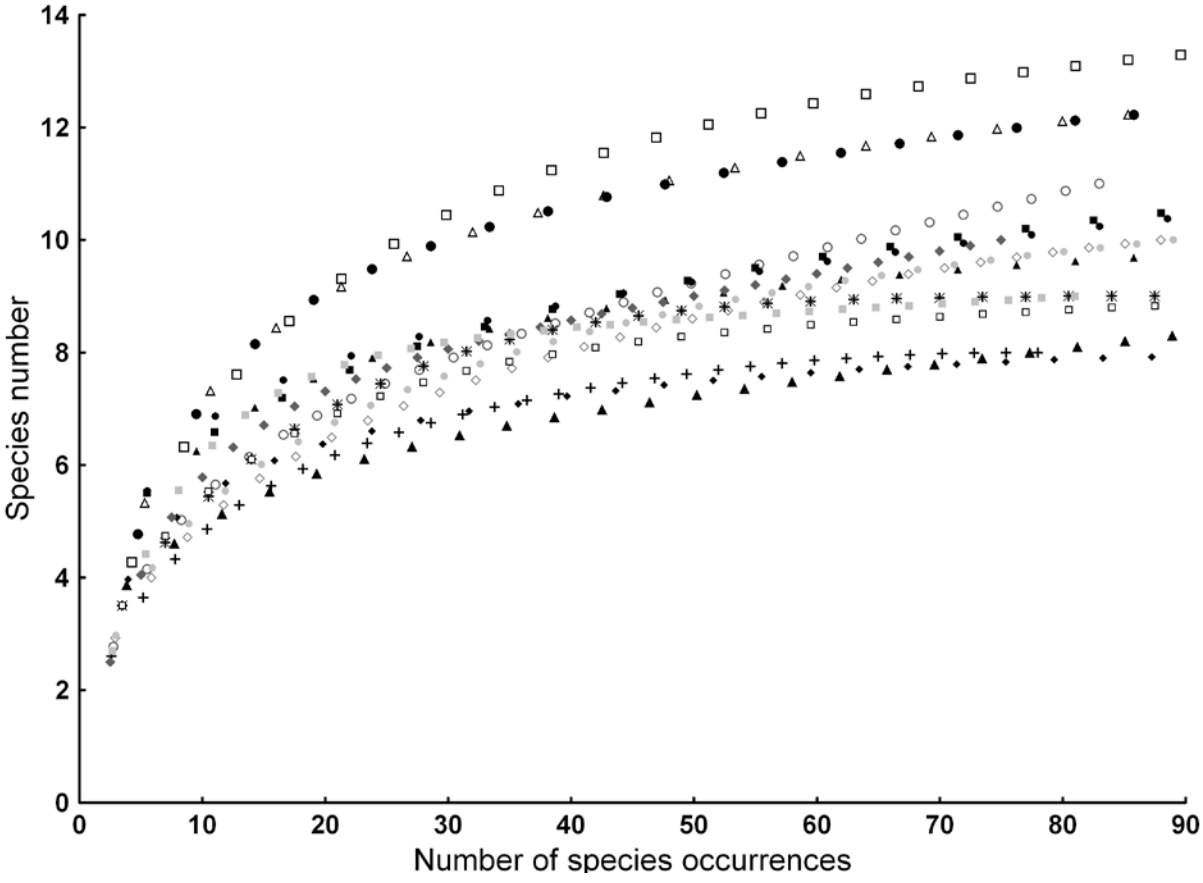
FAIRBANKS, D.H.K. & MCGWIRE, K.C. 2004: Patterns of floristic richness in vegetation communities of California: regional scale analysis with multi-temporal NDVI. – Global Ecology and Biogeography 13: 221-235.

HIJMANS, R., CAMERON, S., PARRA, J., JONES, P. & JARVIS, A. 2005: Very high resolution interpolated climate surfaces for global land areas. – International Journal of Climatology 25: 1965-1978.

Appendix S2: Descriptions of the 16 study sites with elevation, mean annual temperature, mean diurnal temperature range, mean annual precipitation, mean summer precipitation, relative humidity, habitat heterogeneity, and mean annual NDVI.

Observ. site	Elevation (m. a.s.l.)	Mean annual temp. (°C)	Mean diurnal temp. range (°C)	Mean annual precipitation (mm)	Mean summer precipitation (mm)	Relative humidity	Habitat heterogeneity	Mean annual NDVI
1	1228	14.1	12.7	268	15	58	22.21	0.136
2	1257	14.0	12.9	270	16	59	21.58	0.147
3	1536	13.5	10.8	144	12	50	18.12	0.115
4	1707	13.3	10.6	147	13	50	39.02	0.116
5	1176	16.3	13.1	127	7	43	9.50	0.103
6	1096	16.2	13.1	125	7	43	7.80	0.093
7	1047	18.4	14.4	121	0	41	18.13	0.100
8	1055	18.5	14.5	123	0	42	39.02	0.100
9	1698	16.0	16.2	122	3	40	36.34	0.132
10	1794	16.2	16.4	123	2	38	20.66	0.144
11	2728	15.1	14.6	863	7	46	130.58	0.198
12	2628	15.4	14.4	860	6	44	62.42	0.221
13	17	25.3	9.6	236	0	55	23.87	0.137
14	18	25.1	9.6	236	0	55	23.86	0.157
15	16	26.2	9.0	225	0	55	17.53	0.131
16	15	26.2	8.9	225	0	55	19.06	0.134

Appendix S3: Sample-based accumulation curves of the observed species richness of sixteen sampled sites.



Appendix S4: List of 56 ant species with significant indicator values and their corresponding mean, standard deviation, and *P* values.

Species	Habitat	Indicator value (IV)	IV from randomized groups		*P* value
			Mean	Standard Deviation	
Camponotus aethiops (LATREILLE, 1798)	Western steppe	38.5	2.3	0.95	0.0002
Camponotus fedchenkoi MAYR, 1877	Northern steppe	56.7	2.2	0.94	0.0002
Camponotus gestroi EMERY, 1878	Western steppe	40.2	2.0	1.00	0.0002
Camponotus interjectus MAYR, 1877	Northern steppe	24.9	2.1	0.96	0.0002
Camponotus oasium FOREL, 1890	Western steppe	33.2	2.8	0.91	0.0002
Cardiocondyla sp. 1	Northern steppe	21.4	1.9	1.18	0.0002
Cardiocondyla sp. 2	Central desert	34.4	2.3	0.92	0.0002
Cardiocondyla sp. 3	Central desert	18.0	2.0	1.00	0.0002
Cataglyphis cf. *foreli* (RUZSKY, 1903)	Central desert	87.1	2.4	0.98	0.0002
Cataglyphis cinnamomea (KARAVAIEV, 1910)	Central desert	43.6	3.0	0.91	0.0002
Cataglyphis cugiai MENOZZI, 1939	Northern steppe	29.9	3.7	0.87	0.0002
Cataglyphis emeryi KARAVAIEV, 1911	Central desert	41.7	2.8	0.89	0.0002
Cataglyphis frigida persica (EMERY, 1906)	Western steppe	60.0	2.1	0.99	0.0002
Cataglyphis isis (FOREL, 1913)	Coastal desert	13.2	2.0	1.05	0.0002
Cataglyphis kurdistanica PISARSKI, 1965	Western steppe	50.8	3.0	0.93	0.0002
Cataglyphis livida (ANDRE, 1881)	Central desert	29.9	2.9	0.89	0.0002
Cataglyphis nigra (ANDRE, 1881)	Western steppe	25.0	3.9	0.88	0.0002
Cataglyphis noda BRULLE, 1833	Central desert	40.6	3.1	0.91	0.0002
Cataglyphis rubra (FOREL, 1903)	Coastal desert	45.0	2.9	0.94	0.001
Cataglyphis stigmata RADCHENKO & PAKNIA, 2010	Coastal desert	60.0	2.1	0.99	0.002
Crematogaster sp. 1	Northern steppe	28.0	3.3	0.88	0.0001
Crematogaster sp. 2	Northern steppe	44.9	2.1	0.98	0.0003
Crematogaster sp. 3	Western steppe	22.2	2.0	1.03	0.004
Crematogaster sp. 4	Coastal desert	60.0	2.1	0.96	0.0001
Lepisiota frauenfeldi (MAYR, 1855)	Coastal desert	13.8	1.7	1.34	0.0002
Lepisiota semenovi (RUZSKY, 1905)	Central desert	13.3	3.2	0.91	0.0002
Lepisiota sp. 3	Western steppe	10.7	1.8	1.27	0.0012
Lepisiota sp. 4	Coastal desert	10.3	1.8	1.41	0.0008
Messor cf. *caducus* (VICTOR, 1839)	Coastal desert	43.3	2.0	1.02	0.0002
Messor denticulatus SANTSCHI, 1927	Northern steppe	51.1	2.7	0.91	0.0002
Messor intermedius SANTSCHI, 1927	Western steppe	31.0	2.6	0.92	0.0002
Messor pratennatus ARNOLDI, 1970	Northern steppe	25.3	2.1	0.96	0.0002
Messor semirufus EMERY, 1925	Western steppe	8.9	1.9	1.20	0.0018
Messor turcmenochorassanicus ARNOLDI, 1977	Western steppe	22.5	2.0	1.02	0.0003
Messor subgracilinodis ARNOLDI, 1970	Western steppe	7.5	2.1	0.99	0.0016
Messor variabilis KUZNETSOV-UGAMSKY, 1927	Northern steppe	16.3	2.0	1.07	0.0002
Messor sp. 10	Coastal desert	14.7	2.0	1.00	0.0002
Monomorium cf. *destructor* (JERDON, 1851)	Coastal desert	28.7	1.9	1.04	0.0002
Monomorium dentigerum (ROGER, 1862)	Coastal desert	60.9	2.8	0.93	0.0001
Monomorium indicum kusnezovi SANTSCHI, 1928	Central desert	15.9	4.9	0.81	0.0002
Monomorium sp. 4	Coastal desert	60.4	2.7	0.91	0.0002
Monomorium sp. 5	Western steppe	23.3	1.9	1.13	0.0002
Monomorium sp. 6	Coastal desert	16.7	1.8	1.30	0.0002
Monomorium sp. 7	Coastal desert	25.0	1.9	1.10	0.0002
Pheidole sp. 1	Western steppe	12.0	1.9	1.03	0.0002
Pheidole sp. 2	Western steppe	66.6	2.2	0.96	0.0002
Plagiolepis sp. 1	Northern steppe	6.0	1.8	1.26	0.0212
Plagiolepis sp. 2	Western steppe	5.9	1.9	1.06	0.0106
Plagiolepis sp. 3	Western steppe	17.8	2.0	1.04	0.0002
Plagiolepis sp. 4	Western steppe	10.4	1.9	1.06	0.0002
Proformica epinotalis KUSNETSOV-UGAMSKY, 1927	Northern steppe	11.0	2.1	0.97	0.0004
Tapinoma erraticum (LATREILLE, 1798)	Northern steppe	6.6	1.9	1.03	0.0016
Tetramorium armatum SANTSCHI, 1927	Northern steppe	6.2	2.5	0.93	0.006
Tetramorium schneideri EMERY, 1898	Northern steppe	56.8	2.5	0.94	0.0002
Tetramorium striativentre MAYR, 1877	Central desert	21.9	3.9	0.87	0.0002
Tetramorium sp. 4	Western steppe	32.7	2.2	0.97	0.0002