Impact of Phanerogam and Soil Characteristics on Bryophyte Assemblages with Respect to Restoration Practices (Case Study: IJzermonding, Belgium)

Reza Erfanzadeh

Assistant Professor, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.

Received: 16 November 2010 / Accepted: 21 August 2011 / Published Online: 8 October 2012

ABSTRACT The effect of soil and phanerogam characteristics on bryophytes composition, richness, abundance and functional groups were investigated in order to understand the factors responsible for bryophytes distribution patterns. Three different sand dunes were selected: untouched, artificial sod-covered and planted by Ammophila. Along 10 transects perpendicular to the shore, a total of 142 permanent relevés, located in three sand dunes, were sampled. In each plot, total cover of vascular herbaceous and bryophytes, and the percentage of litter were estimated. The average of vascular herbaceous height was measured. In each plot, EC, pH, CaCo3, texture and organic matter content of the upper 5 cm layer were also measured. Analyses using DCA and GLM showed that bryophytes abundance was decreased by EC and phanerogam abundance, while pH increased the species richness of bryophytes. EC increased the relative abundance of sexual species while decreased the relative abundance of asexual bryophytes species. The relative abundance of colonists increased in planted Ammophila sand dune while the relative abundance of perennial stayers was the highest in untouched sand dune. The successional stage should also be important in distribution pattern of bryophytes.

Key words: Bryophyte, Phanerogam cover, Sand dune, Soil characteristics, Restoration management, Succession

1 INTRODUCTION
Explaining observed patterns in species diversity over space is a fundamental goal of plant ecology (Mill and Macdonalds, 2004). Understanding the most important factors driving distribution patterns of plant communities can constitute a tool for vegetation management and conservation (Mueller-Dombois and Ellenberg, 2002). Bryophytes play an important role in the structure and function of plant communities, especially if they reach a high cover (van Tooren et al., 1990). A dense cover of bryophytes prevents water evaporation from the soil surface (Stoutjesdijk and Barkman 1992), increase habitat heterogeneity (Rundel 1978) and productivity of phanerogams (Rieley et al., 1979, Crittenden 1983). Nevertheless, bryophytes have...
received relatively little attention in compare with phanerogams to be studied on their relationships with environmental condition, probably because of their cryptic nature and small size (Mills and Macdonald 2004).

Many biotic and abiotic factors can affect on species composition and distribution of bryophytes including phanerogams. The phanerogams determine the microclimate of cryptogams (Martinez-Sanchez et al., 1994) and their nutrient availability (During and Verschuren 1998). Vascular plants could facilitate bryophytes and the cover of some bryophytes species increased with increasing percentage cover of vascular plant, because this creates a better microclimate, e.g. optimized temperature (Ingerpuu et al., 2005). While in other cases, it has been repeatedly reported that total cover of phanerogams decreased total cover of bryophytes (Zamfir et al., 1999; Bergamini et al., 2001; Ejrnæs and Poulsen 2001) and bryophytes were only common under a sparse upper layer and were light-limited through vascular plant cover (Kull et al., 1995). As a result, the impact of phanerogams on bryophytes has frequently been investigated in the past but conclusions are often contradictory, feeling to need more study on this subject.

In addition, soil condition can also affect diversity, distribution, composition and survival of bryophytes. The occurrence and abundance of some bryophytes species is be found to be determined by the presence of a specific substrate and soil (Watson 1980; Kinnerer 1993; Vitt et al., 1995; Martinez and Maun 1999). It was reported that soil condition was the most important factors affected and predicted bryophytes species distribution. For instance, some species exhibited an increasing probability of occurrence with being the loamy-sandy soils. It was also concluded that some species were only found in forest habitat because of the presence of acidic habitats and the higher soil moisture content. In addition, the occurrence of some bryophytes species could be significantly predicted from the presence of pebbly soils cover with pH ranging between 6 and 9 (Dull 1992). Therefore, it can be expected that soil conditions and characteristics of the phanerogam community will determine the species composition and pattern of bryophytes in sand dune habitat.

Our objectives were to assess the effect of (i) characteristics of the phanerogam layer (phanerogam cover and height) and (ii) soil factors (litter percentage, pH, EC, texture, organic matter content and CaCo3) on species composition, richness, and abundance and functional groups of the bryophytes layer. Because study area was restored through some kind of restoration projects in which some parts covered with natural sods, some parts planted with Marram grass and some parts remain untouched, we also considered (iii) the relationship between the kinds of restoration treatments with the abundance of different species of bryophytes.

2 MATERIALS AND METHODS

2.1 Study area

The study area is part of the Flemish Nature Reserve De IJzermonting, which is situated along the Belgian coastline. It concerns the sand dune part of the nature reserve, which borders the intertidal estuary area along the river bank. The area underwent large-scale restoration measures in the intertidal-supratidal salt marsh-sand dune ecotone; the sand dune area itself was largely untouched. To protect the hinterland for flooding, several sand dikes were created, some of which were planted with *Ammophila arenaria* while others were covered with natural sods from other dune area in 2001. Sand dunes are therefore differentiated in recently created Marram dune with *Ammophila* dominance, recently sod-covered sand dunes with low grass dominance, and untouched sand dunes with high pleurocarpous cover up to
Impact of Phanerogam and Soil Characteristics on Bryophyte Assemblages

ECOPERSIA (2013) Vol. 1(1)

untouched sand dunes with moss dominance. The high variation in vascular plant composition and soil characteristic was created substantial spatial heterogeneity in the study area.

2.2 Data collection
The study area was divided into three habitats according to the kind of restoration management. Along 10 transects, perpendicular to the shore, a total of 142 permanent relevés (each 2*2m) were established with 3 meters distance in between. 15 plots were located in sod-covered dune, 77 plots were located in intact dune (hereafter called ‘no-restoration’ dune) and 50 plots were located in Marram dune.

The cover of all occurring vascular herbaceous species and bryophytes were estimated in each plot using the decimal Londo-scale (Londo, 1976). Samples were taken in July and September in 2005.

Additionally, Plant height was measured by meter in many plots and was estimated in others according to the measured plots. The bryophyte specimens were collected to be identified in the laboratory.

In each plot, soil samples were also collected in upper 5 cm and carried to the laboratory for texture and chemical analyses. Analysis of soil texture, EC and organic matter content was executed in the laboratory. After shaking 5 grams of soil in 50 mm distilled water for two hours, the electric conductivity (EC) was measured with a WTW Inolab EC meter level 1 and pH with pH meter. Organic matter content was measured after ignition of soil samples at 550 °C and CaCo3 at 900 °C. Soil texture was determined with a Coulter LS Particle Size Analyzer. As soil texture characteristic, we used the median particle size (D50) (Erfanzadeh et al., 2010).

2.3 Functional types
The selection of functional types was based on previous studies (During 1979, Kürschner 2004, Söderström and Gunnarsson 2003) and prior expectations about possible relationships with the phanerogam characteristics and soil factors. Two groups (colonists and perennial stayers) were determined, comparing the contribution of each species to the life strategy. Three groups (sexual, asexual and sexual-asexual) were determined, comparing the contribution of each species to the productive strategy (Siebel and During, 2006). For each functional type, we calculated the relative abundance of each category value in every plot, by summing the cover data of all species with that functional type, and dividing it by the sum of the cover of all categorized species in the plot.

2.4 Data Analysis
Bryophytes community composition was assessed by detrended correspondence analysis (DCA), using CANOCO (Lepš and Šmilauer 1998). Since axes 1 and 2 explained a large proportion of the variation (table 1), only scores on the first two axes were used as a measured for bryophytes species composition.

Among EC, organic matter content and CaCo3 strong intercorrelations were presence, therefore, we retained EC and ignored organic matter content and CaCo3. In addition, we ignored litter percentage because of strong intercorrelation with herbaceous height. A general linear model was used to study the effect of soil and phanerogam characteristics on bryophytes functional groups, total cover, richness and composition. Restoration managements were introduced into the model as fixed factor (three categories), soil and phanerogam characteristics and their interactions with restoration management as covariates. A LSD test was used to evaluate the significantly differences among restoration managements.
Table 1 The mean ±SE of ground cover and herbaceous height in restoration treatments.

<table>
<thead>
<tr>
<th>Restoration treatment</th>
<th>Herbaceous height (cm)</th>
<th>Litter (%)</th>
<th>Dominant vascular plant</th>
<th>Dominant bryophyte species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact area</td>
<td>22.9±1.4</td>
<td>10.9±0.1</td>
<td>Festuca rubra</td>
<td>Homalothecium lutescens</td>
</tr>
<tr>
<td>Sod covered</td>
<td>20.7±3.1</td>
<td>11.0±2.4</td>
<td>Festuca rubra</td>
<td>Homalothecium lutescens</td>
</tr>
<tr>
<td>Maram planted</td>
<td>76.7±3.3</td>
<td>16.5±1.0</td>
<td>Ammophyla arenaria</td>
<td>Tortula rurals var. ruriformis</td>
</tr>
</tbody>
</table>

3 RESULTS
3.1 Effect of environmental variation on species composition
The vascular plant cover varies from very dense to very scarce, vegetation height varies substantially too in the study area. Field survey showed that dominant vascular plant and bryophyte species in three kinds of restoration treatments are different (table 1). Table 1 and 2 show also some more details about soil and ground cover of different restoration treatments. The most abundant bryophytes species in all three kind managements were: Barbula convulata, Barbula unguilata, Brachythecium albicans, Brachythecium rutabulum, Bryum argenteum, Bryum bicolor, Bryum capillare, Cladonia furcata, Cladonia pxidata, Eurhynchium praelongum, Homalothecium lutescens, Hypnum cupressiform, Leptobrium pyriforme, Pseudoscleropodium purum, Rhychost megapolitanum, Tortula rurals var. ruriformis.

The first two DCA axes explained about 13.5 and 11.3% of the total species variability, respectively (table 3). DCA1 was significantly correlated with herbaceous height while DCA2 was significantly correlated with the herbaceous cover and restoration managements (table 4).

3.2 Relationship between environmental variables and bryophytes cover and richness
EC, pH and restoration managements and interaction between restoration managements and herbaceous cover (table 4) significantly affected bryophyte species richness. Bryophytes richness was increased (b=0.46, t= 2.12, p<0.05) with increasing pH and decreasing EC (b=-0.007, t= -2.01, p<0.05).

The GLM analysis showed that the average richness in no-restoration plots is significantly less than sod-covered and Marram plots (0.42 m² versus 0.55 m² and 0.53 m²). There was no significant differences between sod-covered and Marram plots in species richness.

Total cover of bryophytes was significantly affected by EC and herbaceous cover (table 4). There was negative correlation between total cover of bryophytes with EC (b=-2.2, t=-2.33, p<0.05) and herbaceous cover (b=-0.47, t=-2.00, p<0.05) (Figure 1).
### Table 2
The mean ±SE of soil factors in restoration treatments.

<table>
<thead>
<tr>
<th>Restoration treatment</th>
<th>EC (µS/cm)</th>
<th>pH</th>
<th>Organic matter (%)</th>
<th>CaCo3 (%)</th>
<th>Texture (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact area</td>
<td>118±3.5</td>
<td>7.9±0.2</td>
<td>2.8±0.2</td>
<td>5.0±0.2</td>
<td>219±3.4</td>
</tr>
<tr>
<td>Sod covered</td>
<td>122±4.2</td>
<td>8.1±0.3</td>
<td>2.4±0.1</td>
<td>4.9±0.1</td>
<td>220±1.2</td>
</tr>
<tr>
<td>Maram planted</td>
<td>114±1.7</td>
<td>7.9±0.4</td>
<td>1.7±0.1</td>
<td>4.8±0.1</td>
<td>223±1.0</td>
</tr>
</tbody>
</table>

### Table 3
Eigenvalues for DCA axes and correlation between axes and species-environment.

<table>
<thead>
<tr>
<th>Axes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total inertia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eigenvalues</td>
<td>0.89</td>
<td>0.62</td>
<td>0.41</td>
<td>0.21</td>
<td>6.64</td>
</tr>
<tr>
<td>length of gradients</td>
<td>5.75</td>
<td>4.80</td>
<td>3.69</td>
<td>3.76</td>
<td></td>
</tr>
<tr>
<td>Cumulative percentage variance of species data</td>
<td>13.5</td>
<td>24.8</td>
<td>29.00</td>
<td>32.10</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4
Result of the general linear model analysis for composition, total cover, richness and functional groups. Only significant responses are shown.

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Independent variables</th>
<th>Mean square</th>
<th>F-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AX1</td>
<td>Herbaceous height(cm)</td>
<td>6.61</td>
<td>11.76</td>
<td>0.001</td>
</tr>
<tr>
<td>AX2</td>
<td>Restoration management</td>
<td>1.74</td>
<td>3.65</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>Herbaceous cover(%)</td>
<td>5.96</td>
<td>12.4</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Restoration management</td>
<td>4733.88</td>
<td>7.88</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td>3022.29</td>
<td>5.43</td>
<td>0.021</td>
</tr>
<tr>
<td>Total cover of bryophytes</td>
<td>Herbaceous cover*restoration</td>
<td>2825.01</td>
<td>5.08</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>Herbaceous cover (%)</td>
<td>3368.67</td>
<td>6.06</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>Restoration management</td>
<td>4.65</td>
<td>5.9</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td>3.2</td>
<td>4.06</td>
<td>0.046</td>
</tr>
<tr>
<td>Bryophytes species richness</td>
<td>pH</td>
<td>3.7</td>
<td>4.4</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>Restoration * Herbaceous cover</td>
<td>2.47</td>
<td>3.1</td>
<td>0.027</td>
</tr>
<tr>
<td></td>
<td>Herbaceous height(cm)</td>
<td>0.61</td>
<td>16.17</td>
<td>0</td>
</tr>
<tr>
<td>Relative abundance of colonist</td>
<td>pH</td>
<td>0.26</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Restoration management</td>
<td>0.71</td>
<td>16.66</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Herbaceous height(cm)</td>
<td>0.61</td>
<td>16.17</td>
<td>0</td>
</tr>
<tr>
<td>Relative abundance of perennial stayers</td>
<td>pH</td>
<td>0.26</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Restoration management</td>
<td>0.71</td>
<td>16.66</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Herbaceous height(cm)</td>
<td>0.61</td>
<td>16.17</td>
<td>0</td>
</tr>
<tr>
<td>Relative abundance of sexual</td>
<td>pH</td>
<td>0.09</td>
<td>4.7</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>Restoration management</td>
<td>0.09</td>
<td>4.7</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td>0.09</td>
<td>4.7</td>
<td>0.032</td>
</tr>
<tr>
<td>Relative abundance of asexual</td>
<td>pH</td>
<td>0.17</td>
<td>8.37</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Restoration management</td>
<td>0.17</td>
<td>8.37</td>
<td>0.004</td>
</tr>
<tr>
<td>Relative abundance of sexual-asequal</td>
<td>pH</td>
<td>0.75</td>
<td>8.1</td>
<td>0.005</td>
</tr>
</tbody>
</table>

45
3.3 Relation between environmental variables and bryophyte functional groups

Herbaceous height, pH and restoration management affected the relative abundance of colonists and perennial stayers (table 4). Relative abundance of colonists increased with herbaceous height ($b=0.004$, $t=4.02$, $p<0.01$) and pH ($b=0.13$ and $t=2.64$, $p<0.01$). In contrast, the relative abundance of perennial stayers decreased with herbaceous height ($b=-0.004$, $t=-4.02$, $p<0.01$) and pH ($b=-0.13$ and $t=-2.64$, $p<0.01$). LSD revealed that the relative abundance of perennial stayers and colonists were different among restoration management with highest of colonists in Marram plots and highest perennial stayers in no-restoration plots ($F=16.66$ and $p<0.01$). There was no significantly difference between sod-covered plots with Maram plots and no-restoration plots for relative abundance of colonists and perennial stayers.

The relative abundance of sexual species was significantly affected by EC and herbaceous height while the relative abundance of asexual species was affected by pH and herbaceous height. Restoration management and herbaceous cover significantly affected the relative abundance of sexual-asexual species (table 4). Sexual species increased with EC ($b=0.07$, $t=1.97$, $p<0.05$) and height ($b=0.002$, $t=2.7$, $p<0.01$). Asexual species was increased with pH ($b=0.08$, $t=2.16$, $p<0.05$) and height ($b=0.002$, $t=2.89$, $p<0.01$). Sexual-asexual species was affected by herbaceous cover. It decreased with increasing herbaceous cover ($b=-0.006$ and $t=-3.33$, $p<0.01$).

4 DISCUSSION

In this study, it was considered restoration managements as an environmental factor and introduced to the model like other environmental factors (e.g. EC). However high correlation between DCAs as a proxy of
bryophytes composition with phanerogam height and cover, it seems that phanerogam characteristics have more effect on spatial distribution of bryophytes composition than soil characteristics. The high correlation (negative or positive) between bryophyte composition and phanerogam composition has already been shown in some temperate grassland (During and Lloret 1996, Zamfir et al., 1999). Nevertheless, we think that the spatial change in bryophytes composition also is a respond to the kind of restoration management and the succession stages. Marram plots mostly were characterized by colonists, while in no-restoration plots perennial stayers were most abundant. If we accept that no-restoration plots were in late successional stages and Marram plots in early successional stages (Packham and Willis 1997), it could be possible to appear some particular bryophytes in each restoration management in relation to their successional stages. The colonists often appear early in secondary succession series, together with or shortly after the fugitives (Joenje and During 1977). Having small spores less than 20 µm and long distance dispersed might help colonists to establish in newly created Marram more than other life strategies. In contrast, in no-restoration plots, perennials stayers species had more relative abundance than colonists. These results confirm the finding of During (1979), that perennial stayers fit in more or less constant environment, or such, which may last very long.

Total cover (abundance) of bryophytes was the second characteristic which considered in this study. Bryophyte abundance decreased with increasing phanerogam abundance. The competition between phanerogams and bryophytes might be the cause of negative correlation between phanerogams and bryophytes abundance (Zamfir et al., 1999). Established phanerogams can theoretically influence bryophytes negatively. A negative effect is the reduction of light availability (Ingerpuu et al., 2005) particularly for acrocarpous mosses in sunny, dry and xeric habitats (Kürschner 2004). In our case, competition for space might be more important. In fact, most bryophytes species in sand dunes are poor competitors and are suppressed by excessive vascular plant growth (Siebel and During 2006). Biomass and cover of bryophytes and vascular plants has been found to be negatively correlated in some other studies as well (Ingerpuu et al., 1998; Bergamini et al., 2001).

Bryophyte abundance decreased also with increasing EC. Most species in the study area are sensitive to salinity (Siebel and During 2006), which might affect the total cover of bryophytes. Nevertheless, EC was positively correlated with the cover of sexual species in our study area. Being some salt tolerance species in this group might explain the increasing of sexual species with EC such as *Bryum* ssp. Previous study also showed that the genus of *Bryum* can sometimes be found in upper salt marsh on bare ground, particularly on the ecoton between dune and marsh where the soils are sandy and saline. In addition, *Bryum capillare* were found the most common bryophytes in the high intertidal of salt marsh with high degree of salinity (Garbary et al., 2008).

The variation of pH among restoration managements was not too much (see table 1: a range of 7.9-8.1). Nevertheless, functional groups and richness of bryophytes was significantly affected by soil acidity. In previous study the heterogeneity of edaphic factors among sites was high and then was stated that pH could be an important factor influenced bryophytes layer. Zamfir et al. (1999) found that pH affected bryophytes species distribution in grassland habitat.

Bryophytes richness was higher in Marram dune than no-restoration dune. Being of
colonists, which related in early successional stages, with together most species related to late successional stage i.e. *Brachythecium rutabulum*, *Homalothecium lutescens*, *Hypnum cupressiforme*, *Pseudoscleropodium purum* increased the species richness in Marram dune. These species had appeared in Marram dune, although in very low abundance, probably because of shade and leaching effects of the grass, which may have favored these perennial stayers (During 1988). In contrast, in stable no-restoration plots colonists were absent or rare, which decreased their species richness.

We showed that pH could increase bryophyte species richness, which is accordance with previous studies (Mill and Macdonalds, 2004; Hylander and Dynesius, 2006; Virtanen *et al.*, 2000).

5 CONCLUSION
Restoration management was the most important environmental factor which significantly affected on most bryophytes characteristic such as composition, total cover, functional group and richness. It can be concluded that restoration management determined the successional stages and then successional stages affected the kind of soil and phanerogam characteristics and finally soil and phanerogam characteristics impacted the cryptogam layer. One might expect that in Marram dune, perennial stayers should be dominant in bryophytes layers because of more herbaceous height, which could increase leaching and shade appropriate for perennial stayers. But in this study, colonists which usually appear in sunny and dry places, are dominant in Marram dune. Perhaps, Marram dune was dominated by colonists because of their lower age (early successional stages) in this restoration management.

6 ACKNOWLEDGEMENT
I thank M. Hoffmann for scientific and technical help with mosses and lichen identification and wish to thank the INBO (Research Institute for Nature and Forest, Belgium) for logistic support. I thank H.J. During for kindly helpful comments on earlier draft of this manuscript.

7 REFERENCES


Kürschner, H. Life strategies and adaptations in bryophytes from the near and Middle East. Turk. J. Bot., 2004; 28: 73-84

Lepš, J. and Šmilauer, P. Multivariate analysis of ecological data using CANOCO. Published by the press syndicate of the University of Cambridge. UK. 2005.


Siebel, H.N. and During, H.J. Beknopte mosflora van Nederland en Belgie“. KNNV Uitgeverij, Utrecht, NL. 2006.

Smith, A.J.E. The moss flora of Britain and Ireland. Published by the Press Syndicate of the University of Cambridge. UK. 1980.


تأثیر خصوصیات خاک و گیاهان آنلی بر پویش خزه‌ای‌ها در ارتباط با عملیات‌های مختلف اصلاحی (مطالعه موردی: آبزیوندینگ، بلژیک)

رضا عرفانزاده

استادیار، دانشکده منابع طبیعی، دانشگاه تربیت مدرس، تهران

چکیده در این تحقیق تأثیر خصوصیات مختلف خاک و گیاهان آنلی بر تکیه، غنا، فراوانی و گروه‌های عملکردهای خزه‌ای‌ها به منظور بهتر عواقب موثر بر پراکنش آنها مورد مطالعه قرار گرفت. بدین منظور سه منطقه مابعد از لحاظ فعالیت‌های اصلاحی منطقه‌بندی بودند انتخاب شدند شامل: پوشانه شده با چمن مصنوعی، کاشت شده با گیاه Ammophila و منطقه دست تخلیه داده‌های خاک و پویش از ۱۴۲ پلات ۴ متری بهره‌مندی در طول ۱۰ ترانسکت عمومی بر خط ساحلی مستقر شده بودند. بر دشت شدند. در هر پلات پویش گیاهان آنلی، خزه‌ای‌ها و درصد لاشه‌گری تخمین‌زده شدند. همچنین در هر پلات pH, EC, CaCO3, pH, EC, GLM و دیگر متغیر‌های تأثیرگذار الگویی داده شدند. تابع داده‌ها توسط ANOVA و تحلیل DCA و GLM اندازه‌گیری شد. سپس داده‌ها توسط DCA و تحلیل GLM و فراوانی گیاهان آنلی کاشش می‌پایه. همچنین غنای گونه‌ای‌ها با pH رابطه مستقیم دارد. با توجه به تحلیل DCA و تحلیل GLM، فراوانی گروه عملکردهای خزه‌ای‌ها جنسی و کاشش خزه‌ای‌های غیرجهنی شد. از جمله این مطالعات که با استفاده از گروه فراوانی را داشتند در حال حاضر بهترین گونه‌های دامپی در منطقه دست تخلیه داده‌های Ammophila فراوانی را داشتند. این تحقیق نشان داد که مرحله جانشینی در الگوی پراکنش خزه‌ای‌ها مهم می‌باشد.

کلمات کلیدی: پویش گیاهان آنلی، تیه‌های ماسه‌ای، تولای پویش، خزه‌ای‌ها، عملکرد خاکی، مدیریت احیاء