DIVERSITY OF LOCAL LANDRACES COLLECTED DURING 2009-2010 PERIOD AND THEIR REPRESENTATIVENESS IN ABANIAN GENE BANK

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ABSTRACT

Diversity of 630 geo-observations representing local landraces (27 genera and 36 species) collected in Albanian territory during SEEDN² Project on Plant Genetic Resources (2009-2010), and their representativeness in genebank was carried out. The number of observations per species and per district, the area of occupancy, the diversity indices and the richness estimators were assessed using grids cells of 1 x 1 km of 10 x 10 km. The genetic representativeness of collected local landraces was detected creating the circular buffer zones with a 1 and 10 km radius around the genebank ex situ data, and circular buffer zones with a 1 km radius around the external SEEDN² collecting data. Geospatial analysis detects areas of high alpha diversity, similarity and differences between 10 principal regions of Albania. Combination of diversity indices as Simpson index (1-D), Shannon-Weiner, Brillouin, and alpha diversity index, found the areas of Elbasan, Korca, Tirana, Shkodra and Vlora regions were richer and more even than other areas. Cluster analysis using similarity method on correlation found higher similarity among Vlora and Gjirokastra, Fieri, Shkodra and Tirana regions (similarity index range from 49.61% to 64.22 %, and correlation coefficient range from 0.63 to 0.86). Comparisons methodology of genebank ex situ data with SEEDN² external data proved the presence of new alleles (12 genera, 17 species) in collected germplasm of local landraces, increasing their representativeness in genebank. The ecological areas of Tirana, Korca, Elbasan, Vlora and Shkodra regions, found as more relative stable ecosystem areas, should be used for the assessment of the current status of conservation of plant genetic resources and for the prioritization of potential ecological areas suitable for in situ conservation.

Key words: Diversity indices, geographic analysis, local landraces.

INTRODUCTION

Plant genetic resources (PGR) play a key role in contributing to the sustainable development of agriculture, helping to increase agricultural food productions. Genetic diversity allows crops to evolve and adapt and it is a major resource for plant breeders to use and meet the challenges in maintaining food security and environmental stability. Wild and new plant species provide an invaluable source of genes that can be used for the improvement of cultivated species. Albania is very rich in biological and landscape diversity, in local landraces, cultivated crops and in wild plant species (~3250 species, more than 29% of European Flora) (Demiri, 1983; Flore de L’Albanie, 1980; Paparisto
et al., 1988; Hammer et al., 1996; Gixhari et al., 2013; GBIF database (http://data.gbif.org). This diversity is attributable to the country geographic position as well as geological, hydrological, climatic, and soil and relief factors.

Geographic information systems (GIS) provide important information about the geographic distribution and diversity present in specific geographic areas (Maxted et al., 1995) of a target species, and are useful for eco-geographical analysis (Guarino et al., 2002). Diversity indices (Magurran, 1988) serve as valuable tools that enable researchers to quantify diversity in a community and describe its numerical structure.

At present the Albania genebank maintains more than 4100 accessions (Gixhari et al. 2012; 2014), including more than 140 species of cultivated and wild plants. The majority of the accessions stored are represented by local landraces and improved cultivars. The information on plants biodiversity in Albania is generally lacking especially in terms of species. There are still flora/or taxonomic groups, especially crop wild relatives which are unknown or have not been studied.

Because the Albanian territory has highly heterogeneous environmental conditions, the aim of this study was to assess the geographic distribution, and diversity of local landraces collected during SEEDN€ Project (South East European Development Network on Plant Genetic Resources) in 2009-2010 and their representativeness in Albanian genebank.

MATERIAL AND METHODS

Data collection
The study used the ex situ data of PGR present in Albanian genebank data-base (AGB ex situ data), and external data (SEEDN€ collecting data) gathered from SEEDNet collecting results during 2009 and 2010. The study was conducted in ten principal region of Albania: Berat (BR), Dibra (DI), Durrees (DR), Elbasan (EL), Fieri (FR), Gjirokastra (GJ), Korca (KO), Shkodra (SH), Tirana (TR), and Vlora (VL) areas. The geographic areas separated into small grid square cells of 1 x 1 km and 10 x 10 km were used (Parra-Quijano et al. 2012; Gixhari et al., 2014) to assess genetic diversity and the representativeness of local landraces collected during period 2009 and 2010 in Albania. The analysis focuses only on the study of alpha diversity at the species levels per unit grid cells and uses the sampling and collecting plant genetic diversity methodology (Allard, 1970; Bennett, 1970; Brown et al., 1995).

Geographic diversity distribution
Each local landrace plant species (individual or population), representing a geo-referenced observation of ex situ data of genebank and external SEEDN€ collecting data, was entered into the GIS analysis, as presence points (Hijmans et al., 2001; Gixhari et al., 2012). Assessment of diversity and geographic distribution of local plant landraces was realized calculating diversity indices of plant species observed per each collecting region of Albania. The measurement of diversity and geographic distribution was realized: analysing the number of observations per species and per region, and the area of occupancy by a specific species (= indicator of abundance / or rarity of a particular species). Species richness (S), Simpson index (1–D), Shannon (H) and Brillouin index (B), Evenness (e^H/S), Equitability (J) and Fisher alpha index, were the diversity indices and richness estimators used.

Representativeness gaps detection
The relative genetic representativeness gaps of local landrace species were detected creating the circular buffer zones with a 1 and 10 km radius around the AGB ex situ data, and circular buffer zones with a 1 km radius created around the external SEEDN€ collecting data. When the external data zones intersect the AGB ex situ data with a 1 km radius there were “no gaps of the representativeness” (NGR) of local landrace species stored ex situ in genebank. When external buffer zones (SEEDN€ collecting data) only intersect the AGB ex situ data with a 10 km radius, there were “mid-priority gaps of the representativeness” (MPGR) of local landraces in genebank, and when the external SEEDN€ data do not intersect any of the AGB ex situ data (those with a 1 km or 10 km radius), there were “high-priority gaps of the representativeness” (HPGR) of local landraces in genebank (Parra-Quijano et al., 2012; Gixhari et al. 2014). Maps containing mid and high-gaps of the representativeness of local landraces in genebank were created using DIVA-GIS tools (http://www.diva-gis.org/Data) according to Scheldeman et al., (2010) and Parra-Quijano et al., (2012) methodology.
Analysis of distances: A cluster analysis method on correlation was used to identify groups of relatively similar material (Guarino, 1995), and to measure distances/similarities between geo-referenced points. Quantitative diversity indices were calculated using the SAS tools (2012).

RESULTS

Collecting data
A large amount of information for 689 ex situ data of genebank and 630 external SEEDNet collecting data, was gathered and analysed for each plant species. Data quality including the accuracy and precision of geographic coordinates firstly presence or geo-referenced data were checked for inconsistencies (Chapman 2005a). Data points without coordinates were removed from ex situ and external data. Data points with incorrect coordinates on the administrative unit (region) were assigned coordinates where possible while duplicate or doubtful data were removed (Scheldeman et al., 2010; Gixhari et al., 2013).

Geographic diversity distribution
Geographic distribution of 1319 geo-referenced observation, including 689 ex situ data of local landraces stored in genebank and 630 external data (or SEEDNet collecting data) collected in ten regions of Albania, were entered into the GIS analysis as presence points (Hijmans et al., 2001; Gixhari et al., 2012). Mid and high-gaps of the representativeness of local landraces in genebank, assessed according to Parra-Quijano et al., (2012) method and mapped using DIVA-GIS tools (http://www.diva-gis.org/Data) and Scheldeman et al., (2010) methodology is given in Figure 1. Geospatial analysis detects areas of high alpha diversity, similarity and differences between 10 principal regions of Albania related plant species diversity and number of samples per species collected during SEEDNet project in 2009-2010. Study results show that higher number of species richness was found in EL, KO, TR, SH, BR and VL areas. Higher number of individuals per species was found in TR, GJ, EL, SH and DI regions.

Figure 1. Geographic distribution of SEEDNet collecting data in comparison with ex situ data of genebank.
Combination of diversity indices as Simpson index ($1-D > 0.80$), Shannon-Weiner ($H > 2.20$), Brillouin index ($B > 2.0$), and Fisher-alpha diversity index ($\alpha > 6.0$), found the areas with high diversity of plant species were EL, KO, TR, SH and VL regions (Table 1). Comparison of relative abundance, equitability index ($J > 0.80$) and evenness ($e^H/S > 0.70$) of individuals among the species show that species diversity of TR, KO, EL, FR and DR regions were more abundant and numerically more equal than other areas (Table 1).

Results of the study demonstrate that the individuals in TR, KO, EL, VL and SH region areas are distributed more equitably among the species. These areas seem to be relatively more undisturbed habitats in comparison with collecting areas of other regions (BR, DI, FR, and GJ) that seem as more disturbed habitats.

Table 1. Comparison of diversity indices between 10 observed areas of Albania

<table>
<thead>
<tr>
<th>Variables</th>
<th>BR</th>
<th>DI</th>
<th>DR</th>
<th>EL</th>
<th>FR</th>
<th>GJ</th>
<th>KO</th>
<th>SH</th>
<th>TR</th>
<th>VL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxa_S</td>
<td>15</td>
<td>13</td>
<td>8</td>
<td>23</td>
<td>12</td>
<td>10</td>
<td>15</td>
<td>13</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Individuals</td>
<td>60</td>
<td>64</td>
<td>17</td>
<td>28</td>
<td>58</td>
<td>78</td>
<td>78</td>
<td>78</td>
<td>78</td>
<td>51</td>
</tr>
<tr>
<td>Simpson_1-D</td>
<td>0.75</td>
<td>0.84</td>
<td>0.82</td>
<td>0.92</td>
<td>0.85</td>
<td>0.79</td>
<td>0.91</td>
<td>0.87</td>
<td>0.89</td>
<td>0.85</td>
</tr>
<tr>
<td>Shannon_H</td>
<td>1.93</td>
<td>2.12</td>
<td>1.87</td>
<td>2.72</td>
<td>2.20</td>
<td>1.89</td>
<td>2.56</td>
<td>2.31</td>
<td>2.39</td>
<td>2.28</td>
</tr>
<tr>
<td>Evenness_e^H/S</td>
<td>0.46</td>
<td>0.64</td>
<td>0.81</td>
<td>0.66</td>
<td>0.75</td>
<td>0.66</td>
<td>0.76</td>
<td>0.67</td>
<td>0.84</td>
<td>0.65</td>
</tr>
<tr>
<td>Brillouin</td>
<td>1.65</td>
<td>1.86</td>
<td>1.42</td>
<td>2.47</td>
<td>1.75</td>
<td>1.66</td>
<td>2.22</td>
<td>2.04</td>
<td>2.14</td>
<td>1.93</td>
</tr>
<tr>
<td>Equitability_J</td>
<td>0.71</td>
<td>0.83</td>
<td>0.90</td>
<td>0.87</td>
<td>0.89</td>
<td>0.82</td>
<td>0.90</td>
<td>0.85</td>
<td>0.93</td>
<td>0.84</td>
</tr>
<tr>
<td>Fisher_alpha</td>
<td>6.42</td>
<td>4.93</td>
<td>5.90</td>
<td>8.02</td>
<td>7.96</td>
<td>3.48</td>
<td>7.57</td>
<td>5.56</td>
<td>4.46</td>
<td>7.16</td>
</tr>
</tbody>
</table>

Simpson 1-D > 0.80; Shannon H > 2.20; Brillouin B > 2.0; Fisher-alpha $\alpha > 6.0$; Evenness ($e^H/S > 0.70$); Equitability $J > 0.80$

Similarities and correlations between observed areas

Cluster analysis method using similarity and correlation matrix data proved the presence of similarity and diversity among collecting areas in comparison. Highest similarity and positively correlated was found among region of VL and GJ, FR, SH and TR regions (similarity index range from 49.61% to 64.22 %, and coefficient of correlation $r$ range from 0.63 to 0.86). High similarity was also found between areas of SH and DI, GJ, KO and BR region areas (similarity index range from 49.64% to 60.99 %, and coefficient of correlation $r$ range from 0.58 to 0.80) (Table 2, Figure 2).

Table 2. Similarity and Correlation matrix among SEEDNet collected areas in 10 regions of Albania

<table>
<thead>
<tr>
<th>Regions</th>
<th>BR</th>
<th>DI</th>
<th>DR</th>
<th>EL</th>
<th>FR</th>
<th>GJ</th>
<th>KO</th>
<th>SH</th>
<th>TR</th>
<th>VL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>*</td>
<td>46.77</td>
<td>25.97</td>
<td>35.23</td>
<td>40.91</td>
<td>37.29</td>
<td>40.32</td>
<td>49.64</td>
<td>27.54</td>
<td>41.44</td>
</tr>
<tr>
<td>DI</td>
<td>0.40</td>
<td>*</td>
<td>24.69</td>
<td>35.53</td>
<td>34.78</td>
<td>47.54</td>
<td>43.75</td>
<td>60.99</td>
<td>39.44</td>
<td>46.96</td>
</tr>
<tr>
<td>DR</td>
<td>0.08</td>
<td>0.13</td>
<td>*</td>
<td>12.00</td>
<td>48.89</td>
<td>29.33</td>
<td>37.04</td>
<td>31.91</td>
<td>27.37</td>
<td>41.18</td>
</tr>
<tr>
<td>EL</td>
<td>0.24</td>
<td>0.25</td>
<td>0.20</td>
<td>*</td>
<td>23.60</td>
<td>36.65</td>
<td>45.69</td>
<td>46.67</td>
<td>46.45</td>
<td>33.70</td>
</tr>
<tr>
<td>FR</td>
<td>0.26</td>
<td>0.44</td>
<td>0.49</td>
<td>0.23</td>
<td>*</td>
<td>51.16</td>
<td>36.96</td>
<td>38.10</td>
<td>35.85</td>
<td>58.23</td>
</tr>
<tr>
<td>GJ</td>
<td>0.29</td>
<td>0.54</td>
<td>0.33</td>
<td>0.38</td>
<td>0.91</td>
<td>*</td>
<td>47.54</td>
<td>57.78</td>
<td>51.47</td>
<td>64.22</td>
</tr>
<tr>
<td>KO</td>
<td>0.33</td>
<td>0.37</td>
<td>0.70</td>
<td>0.52</td>
<td>0.43</td>
<td>0.49</td>
<td>*</td>
<td>55.32</td>
<td>49.30</td>
<td>43.48</td>
</tr>
<tr>
<td>SH</td>
<td>0.58</td>
<td>0.80</td>
<td>0.39</td>
<td>0.50</td>
<td>0.70</td>
<td>0.76</td>
<td>0.61</td>
<td>*</td>
<td>52.90</td>
<td>57.81</td>
</tr>
<tr>
<td>TR</td>
<td>0.11</td>
<td>0.34</td>
<td>0.36</td>
<td>0.59</td>
<td>0.59</td>
<td>0.70</td>
<td>0.49</td>
<td>0.65</td>
<td>*</td>
<td>49.61</td>
</tr>
<tr>
<td>VL</td>
<td>0.31</td>
<td>0.52</td>
<td>0.41</td>
<td>0.26</td>
<td>0.86</td>
<td>0.86</td>
<td>0.49</td>
<td>0.79</td>
<td>0.63</td>
<td>*</td>
</tr>
</tbody>
</table>
Contribution of SEEDN\textsuperscript{et} collecting data in the representativeness of local landraces in genebank: Ex situ collecting data of genebank, before SEEDN\textsuperscript{et} collecting activities, was compound by 689 accessions of 31 genera and 40 plant species. The external SEEDN\textsuperscript{et} collecting data contributed to the total of Albanian genebank database with 630 accession of 36 plant species and 27 genera. From a total of 630 collecting sites of SEEDN\textsuperscript{et} project, for 160 sites “no gaps of the representativeness” of local landrace was found. These collecting sites were situated in “no distant collecting areas” as the external buffer zones intersect the ex situ buffer zones of genebank with a 1 km radius. In this case SEEDN\textsuperscript{et} collecting results implied collecting of germplasm in populations located less than 2 km from those and fullness represented in the genebank database, so no new species (or alleles) were collected. Other 470 collecting sites were classified as “mid-distant collecting areas” (287 collecting sites), and in high-distant collecting areas (183 collecting sites). Collecting plant germplasm in mid-distant collecting areas (from 3 to 10 km radius) and especially in high distant collecting areas (far than 10 km from ex situ data of genebank), confirmed that some possible new species (or alleles) were expected to be found and some mid and high gaps of the representativeness of local landraces should be fulfilled. Comparisons methodology of ex situ data of genebank with SEEDN\textsuperscript{et} external data proved the presence of new alleles (12 new genera and 17 new plant species) in germplasm (local landraces) collected in ten different regions of Albania during 2009-2010. Conservation of new alleles (12 new genera and 17 new plant species) has increased the representativeness of local landraces in genebank.

Vertical distribution of observed plant species
From a total of 27 genera and 36 local plant landraces /species collected in all ten areas of Albania the higher number of them was presented by local fruit tree species: 13 genera (48%) and 22 species (61%). Near 71% of all diversity of local landraces collected was found between 0 m to 599 m above sea level. Analysis for the fruit tree species and samples found that 72% of observed fruit trees species was distributed between 100 m to 599 m above the sea level, and more than 25% was verified in the area belt between 400 to 599 m above sea. Cereals present 17%
of local germplasm collected: 7 genera (26%) and 7 species (19%). Higher percentage (46%) of local germplasm for cereals was found and collected between 1m to 400 m above sea level.

Analysis found negative relation among the number of samples and species observed in each areas and elevation differences of collecting sites from the sea level. Comparison of data showed decreasing of number of species and samples observed as the elevation from the sea side is increased. Regression analysis (trendline in logarithmic scale) showed that number of plant species, per each 100 m increasing of elevation from the sea, was decreased according to the equation: $y = -2.477\ln(x) + 29.461$ ($R^2 = 0.3194$), and number of observed samples per species was decreased according to the equation: $y = -16.94\ln(x) + 159.31$ ($R^2 = 0.4098$) (Figure 3).

![Vertical distribution of plant diversity species and individuals per species from the sea level.](image)

Figure 3. Vertical distribution of plant diversity species and individuals per species from the sea level.

Results of this study, congruent with results of Guarino et al., (2002); Jarvis et al., (2010); Parra-Quijano et al., (2012); Gixhari et al., (2012; 2014); suggest that the ecological areas of TR, KO, EL, VL and SH regions, found as more relative stable ecosystem areas, should be used for the assessment of the current status of conservation of plant genetic resources and for the prioritization of potential ecological areas suitable for in situ conservation.

CONCLUSIONS

Spatial analysis found significant differences of diversity for the local landraces collected during SEEDNet project (2009-2010) in ten regions of Albania, and detects the areas of Elbasan, Korca, Tirana, Shkodra and Vlora regions were richer and more even than collecting areas of other regions. Diversity observed in Tirana, Korca, Elbasan, Vlora and Shkodra regions founded as more relative stable ecosystems and ecological niches suggest that more different species of local landraces important for conservation should be still available in these areas. Ecosystems of Berat, Durres, Fieri, Gjirokastra and Dibra regions with low number of plant species surveyed, as well as terrain difficulties for collecting mission, suggests less relative stable ecosystems should be still available for...
conservation in the future, due to presence of more disturbed habitats and to rapid occupation of these areas by uncontrolled different constructions.

Comparisons methodology of genebank ex situ data with SEEDN\textsuperscript{et} external data proved the presence of new alleles (12 genera, 17 species) in collected germplasm of local landraces, increasing their representativeness in genebank. Results of this study suggest the ecological areas of Tirana, Korca, Elbasan, Vlora and Shkodra regions, found as more relative stable ecosystem areas, should be used for the assessment of the current status of conservation of plant genetic resources and for the prioritization of potential ecological areas suitable for in situ conservation.

Eco-geographic studies providing critical information about the diversity present in specific geographic areas can be used for the assessment of the current conservation status of plant genetic resources and to prioritize areas for in situ conservation.

REFERENCES

EURISCO database (http://eurisco.ipk-gatersleben.de);
GBIF (Global Biodiversity Information Facility) database (http://data.gbif.org);
SAS JMP Statistical Discovery (2012);