Characterization of bitter vetch (Vicia ervilia (L.) Willd.) landraces conserved on-farm in Lemnos Island

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Characterization of bitter vetch (*Vicia ervilia* (L.) Willd.) landraces conserved on-farm in Lemnos Island

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Abstract. Lemnos Island presents a rich biodiversity in legume genetic resources both in wild and cultivated species that provide ecological benefits and have high nutritious value as food and feed. Among the cultivated genetic material that is conserved on farms, landraces of a neglected fodder crop, bitter vetch, have evolved under harsh climatic conditions when grown under traditional farmer practices. Lemnian bitter vetch landraces, along with other populations collected on farms and landraces with Greek origin conserved *ex situ* were characterized using 24 agro-morphological traits and the phenotypic diversity among and within populations was estimated. The mean total phenotypic diversity of the whole collection was H_T=0.52 while the mean phenotypic diversity among populations studied (G_{ST}) was 0.31. A significant variability was revealed among Lemnian populations regarding their morphological and agronomical traits. Applying Discriminant Analysis the three landraces from Lemnos were clustered in separate groups and differentiated from each other mainly due to their days to flowering, days to pod setting and their productivity. On-farm cultivated bitter vetch landraces of Lemnos consist therefore a variable genetic material and on farm management seems to be a valuable conservation practice in the case of this isolated island.

Keywords. Conservation practices – Diversity – Greece – Lemnos Island – Neglected crop.

Caractérisation de variétés de vesce amère à la ferme* (Vicia ervilia *(L.) Willd.) De l'île de Lemnos

Résumé. *L'île de Lemnos présente une riche biodiversité en ressources génétiques de légumineuses, tant en espèces sauvages que cultivées, qui présente des avantages écologiques. Ces espèces ont une valeur nutritive élevée pour l'alimentation humaine et animale. Parmi le matériel génétique cultivé conservé dans les fermes, les races locales d'une culture fourragère négligée (la vesce amère) ont été développées sous des conditions climatiques difficiles et cultivées selon les pratiques paysannes traditionnelles. Dans la présente étude sur les races locales de vesce amère de Lemnos, des populations provenant de fermes et d'autres populations locales d'origine grecque, conservées* ex situ*, ont été recueillies. Celles-ci ont été caractérisées sur la base de 24 traits agro-morphologiques et la diversité phénotypique au sein des populations a été estimée. La diversité phénotypique totale moyenne était H_T = 0,52 tandis que la diversité phénotypique moyenne parmi les populations étudiées (G_{ST}) était de 0,31. Une variabilité significative a été révélée parmi les populations de Lemnos en ce qui concerne leurs traits morphologiques et agronomiques. En appliquant l'analyse discriminante, les trois races locales de Lemnos ont été regroupées en différents groupes et différenciées les unes des autres, principalement en fonction de leur date de floraison, de la date de formation des gousses et leur productivité. Les variétés locales de vesce amère de Lemnos cultivées à la ferme constituent donc un matériel génétique variable. Ainsi, la gestion à la ferme semble être une pratique de conservation précieux dans le cas de cette île isolée.*

Mots-clés. *Pratiques de conservation – Diversité – Grèce – Île de Lemnos – Culture négligée.*

I – Introduction

Bitter vetch (*Vicia ervilia* (L.) Willd.) is one of the oldest cultivated grain legume crops in the Mediterranean region. Although bitter vetch was a common crop in the past, it is recently considered a neglected crop (López Bellido, 1994). However, bitter vetch populations are still cultivated on farms

(Thomas *et al.,* 2012; El Fatehi *et al.,* 2016). In Greece, bitter vetch landrace populations can still be found in areas such as isolated islands conserved by individual farmers mainly as a heritage element.

Lemnos is a North Aegean Island (Greece) rich in wild and cultivated plant species that preserves its agricultural character. Among the wild plant species recorded, 19% are legumes (Panitsa *et al*., 2018), while agrobiodiversity is still maintained in cultivated pulses and fodder legumes including also bitter vetch landraces (Thomas *et al.*, 2012, Bebeli *et al*., unpublished data). Landrace populations have evolved overtime under farmers' traditional cultivation practices and natural selection pressure (Terzopoulos and Bebeli, 2010), present local adaptability and are characterized by various levels of variability which can be measured using morphological descriptors. The study of landrace populations genetic diversity is prerequisite for their effective conservation and exploitation. Therefore the aim of the present study was the characterization and diversity assessment of three Lemnian bitter vetch landraces along with other on farm cultivated and *ex situ* preserved accessions.

II – Materials and methods

1. Plant material and experimental design

Three Lemnian landraces (AUA7, AUA9 and AUA10) (Fig. 1) were characterized and subjected to analysis of phenotypic diversity, along with six other Greek on farm collected landraces, thirty-two landrace material originated from Greece, obtained from the Genebank of IPK Gaterslaben and eight accessions of foreign origin, obtained from the Genebank of USDA. The experiment was carried out at Agricultural University of Athens, Greece (N 37°59'10'', E 23°42'29'', altitude 24 m). A randomized complete block design with two replications was applied. Plants spaced at 30 cm from row to row and plant to plant distance. Ten plants per population of each replication were measured (Livanios *et al*., 2017).

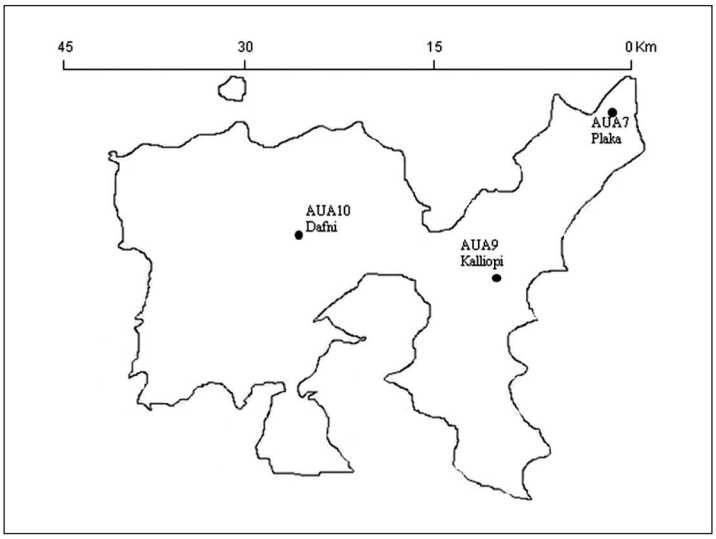

Fig. 1. Lemnos Island, representation of the three sites where Lemnian landraces were collected.

2. Agro-morphological traits

Twenty-four morphological and agronomical traits were measured based on common vetch (*Vicia sativa* L.) descriptors list (UPOV, 2011) and lentil (*Lens culinaris* Medic.) descriptors list (IBPGR and ICARDA, 1985). Measurements were taken throughout the life cycle of the plants and included morphological characters traits recorded at the vegetative and reproductive stage. In addition traits related to seed yield and seed morphology were recorded (Livanios *et al.,* 2017).

3. Statistical analysis

Data from all continuous traits were transformed to ordinal by dividing their range into equal classes forming discrete ranks (Livanios *et al.,* 2017). Class frequencies were used to describe and assess Lemnian landraces and the rest of the bitter vetch accessions diversity (Nei, 1973). For each trait, total phenotypic diversity (H_T), inter– population (G_{ST}), intra– population phenotypic diversity (H_S), its average across all populations (H_S mean), as well as mean phenotypic diversity within each Lemnian landrace across all traits (H_P mean) were calculated according to Terzopoulos and Bebeli (2010). Comparisons of Lemnian landraces with all populations (H_P mean) were carried out (HSD, $p \leq 0.05$) using the statistical software JMP-8. Finally, Discriminant analysis was applied in order to distinguish the bitter vetch populations studied and define the uniqueness of each one of the three Lemnian landraces.

III – Results and discussion

Lemnos has still today a wealth of crop landraces due to its geographical position, and its long agricultural history. The survival of the bitter vetch landrace populations on farm in Lemnos is a very interesting case, since this crop is considered neglected and rare (Thomas *et al.,* 2012, Bebeli *et al.*, unpublished data 2019). All Lemnian landraces were characterized by existence of red pigmentation in plants stems, absence of pigmentation in their leaflets, production ofa small number of primary branches (1 to 5) and a small amount of seeds per plant (1 to 402 seeds).

However, diversity was observed among them regarding many traits such as their flower color, with AUA10 to present high intra-population variability, with white, white-purple and white-pink flowers. On the contrary AUA7 and AUA9 presented only white-purple flowers. AUA10 was also differentiated due to its early flowering (98-113 days) and maturation (120-134 days) in comparison to the other two Lemnian landraces that presented 114-129 days and 135-149 days, respectively. In addition variability was observed among the three landraces based on their plant height, as AUA7 had shorter plants reaching only 27 cm height compared to AUA9 and AUA10 that their plant height ranged from 28 to 42 cm. AUA10 proved to be the most productive one among the three Lemnian landraces due to its higher number of pods and seeds per plant with 110.3 and 289.5 on average, respectively. AUA10 also resulted in a higher seed weight per plant, reaching on average 10.88 g of seeds per plant, while AUA7 and AUA9 had on average 5.81 and 7.27 g of seeds per plant. On the other hand, AUA7 was the Lemnian landrace that resulted in higher stems dry weight, presenting a mean of 18 g. Applying Discriminant Analysis in the whole collection of landraces studied, each one of the three landraces originated from Lemnos was assigned to a different group, confirming the diversity present in Lemnos bitter vetch germplasm.

The mean total phenotypic diversity of the whole collection was HT=0.52 while the mean phenotypic diversity among populations studied (G_{ST}) was 0.31. Regarding the whole collection, the mean phenotypic diversity within each population across all traits ranged between 0.27 and 0.47 with an average of 0.36. The three Lemnian landraces presented average values (0.36 for AUA7 and AUA10, 0.37 for AUA9) similar to other populations (data not shown). A large variability was confirmed therefore among the three Lemnian landraces that developed different agro– morphological traits under their adaptation, and the various cultivation practices and selection implemented by farmers.

IV – Conclusions

The utilization of landrace populations by farmers is critical, as it will help to ensure that genetic resources will be available for future generations through on-farm conservation. A valuable collection of bitter vetch landraces conserved on farm was identified. Lemnian landraces were characterized by similar levels of mean phenotypic diversity within each population across all traits compared to other accessions. Cultivation of crop landrace populations continuously, even in small fields for preservation of cultural heritage, reveals conservation of bitter vetch diversity in the Island of Lemnos and therefore should be encouraged and rewarded.

References

El Fatehi S, Béna G, Sbabou L, Filali-Maltouf A and Ater M, 2016. Genetic diversity of Moroccan bitter vetch *Vicia ervilia* (L.) Willd. landraces revealed by morphological and SSR markers. AJCS 10, 717-725.

IBPGR and ICARDA, 1985. *Lentil Descriptors*. IBPGR Secretariat, Rome, Italy.

Livanios I, Lazaridi E and Bebeli PJ, 2017. Assessment of phenotypic diversity in bitter vetch (*Vicia ervilia* (L.) Willd.) populations *Genet Resour Crop Evol* 65, 355-371.

López Bellido L, 1994. Neglected Crops: 1492 from a Different Perspective. In: *Plant Production and Protection* Series No. 26. FAO, Rome, Italy. Eds Hernándo Bermejo JE and León J pp. 273-288.

Nei 1973. Analysis of gene diversity in subdivided populations. *Proc Natl Acad Sci* 70, 3321-3323.

Panitsa M, Bergmeier E, Meyer S, Bebeli PJ, Georgiadis N, Dimitropoulos G and Sfakianou D, 2018. Report of Lemnos agro– pastoral ecosystems flora. www.terra-lemnia.net.

Terzopoulos PJ and Bebeli PJ, 2010. Phenotypic diversity in Greek tomato (*Solanum lycopersicum* L.) landraces. *Sci Hortic-Amsterdam* 126, 138-134.

Thomas K, Thanopoulos R, Knupffer H and Bebeli PJ, 2012. Plant genetic resources of Lemnos (Greece), an isolated island in the Nothern Aegean Sea, with emphasis on landraces. *Genet Resour Crop Evol* 59, 1417-1440.

UPOV, 2011. *International Union for the Protection of new Varieties of Plants. Common Vetch (Vicia sativa L.) Guidelines for the conduct of tests for distinctness, uniformity and stability.* Geneva, Switzerland**.**