Variability of *Malus* Trees in Lithuanian Forests

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The objective of this study was to determine the differences between wild *Malus* species and among individual trees within each of wild *Malus* species. A relationship of tree variables may indicate the multitrait distinction of trees. Single linkage cluster analysis was performed on the wild apple tree data from the Lithuanian southwestern and central Forests. Tree diagram and Euclidean distance matrix for the multitrait distinction of wild apple trees (*M. sylvestris*, *M. sylvestris* ssp. *praecox* and *M. sylvestris* × *M. domestica*) were obtained. There were no significant interspecific differences among *Malus* forest trees in their vitality and growth traits. Age class distribution in wild apple tree populations was determined according to the estimates of *Malus* tree distinction (the among-tree Euclidean distances). An evidence of the relationship of tree distinction to age in the evaluated wild apple population was detected.

Survival of wild apple trees depends on the neighbouring tree species. *Quercus robur, Populus tremula, Fraxinus excelsior* and *Padus avium* trees grew with the oldest wild apple trees of 12-15 age classes. *Quercus robur* was found in the habitats of wild apple trees of all age groups.

Small rivers in forests are the centres of biological diversity. Wild apple trees survive mostly near the small forest rivers. To assure the continuity of evolution of *Malus sylvestris* Mill. the network of its gene conservation populations should be established on the forest sites of river valleys, incorporating and preserving unique and old trees and planting seedlings originating from the within of surrounding forests.

Key words: *Malus sylvestris* Mill., wild apple, multitrait distinction, age distribution, neighbouring tree species.

Introduction

To achieve an efficient selection, the breeder needs the largest variability and genetic diversity because the larger the diversity within a breeding population, the more efficient will be the selection (Laurens and Lelezec, 1997). A broad germplasm range is very useful to breed all the characters as well. It is therefore necessary to collect and conserve a large number of accessions in germplasm orchards. Their characterization and evaluation are crucial for an efficient use in breeding programmes. This is what we are trying to achieve with wild apple germplasm network, in collaboration with the partners from the Lithuanian Institute of Horticulture.

Significant interspecific diversity of leaves', fruits' and seeds' shape and colour is characteristic of wild apple trees growing in the Lithuanian Forests. In the forests of Central Lithuania and West Žemaitija biogeographical regions crossing of *Malus sylvestris* Mill. (Common crab apple), *M. sylvestris* ssp. *praecox* and *M. sylvestris* × *M. domestica* (wild hybrids) occurs (Petrokas, in press). Therefore, an assessment of *Malus* tree determination, relationship and relative multitrait distinction with the objective to promote survival of *Malus* fruit trees occurring in the forests is the purpose in this report. The most important objective of this study was to define the age structure of the wild apple population, based on tree growth and vitality traits.

Short review

Trees may become externally differentiated over time. The ageing of the tree as a whole is clearly visible in a number of different phenomena: (1) decreased growth rate of branches and roots, (2) smaller leaves with a larger number of leave veins per unit area, and (3) an increasing number of dead branches (Went, 1942). Ross Whetten (North Carolina State University, USA) is exploiting the idea that long-lived trees by having genetically different branches and shoots within the crown can continue to resist attacks by insects or pathogens of much shorter generation times (Kinlaw and Harry, 1994). So, the vitality of trees depends on their age. Taking that into account, in evaluating tree vitality it is imperative that wood properties be analysed. It is known that *M. sylvestris* wood has sapwood and false heartwood. The darkening of false heartwood and the whole wood indirectly indicates the intensity of a possible pathological process or necrosis of cellular tissue parenchyma. Heartwood darkening is characteristic of

all periods of age of *M. sylvestris* (Petrokas, in press). Changes in the central part of the stem, which occur due to the major reduction of the physiological functions, show the dependence of trees on the environment. These changes are largely produced by an increasing drought condition due to increasing difficulties of water transport and a consequent curbing of meristematic activity (Went, 1942). Therefore, due to comparatively higher vitality of crowns, resistance to frost, drought and pathogenic fungi "sapwooden" wild apple trees are the most appropriate for wood production and for making certain species regeneration (Petrokas, 1999). The vitality of wild apple trees also reflects in the number of water-sprouts. In fruit-trees especially, long water-sprouts arise from the upper sides of branches particularly if the tree starts to die from various causes other than old age (Mitchell, 1994).

At present, survival of *Malus* species in forest communities mostly depends on forest and game management. Owing to the thorns and deeply chapped bark common crab apple trees (*M. sylvestris*) are more resistant to browsing and stripping off the bark as compared to partialy cultural wild apple trees (*M. sylvestris* × *M. domestica*) cultural seed – derived. Partialy cultural apple trees on poor sites near the edge of the forest and in glades are more damaged by ungulates. The edge of forests attracts ungulates because good visibility and abundant forage resources (Padaiga, 1996). Roes, red deer and boars feed on fruit, shoot and leaves of apple trees. These animals spread the seeds of wild fruit trees over their habitats. It must be noted that foresters favour a decrease in number of apple trees left in cutovers with only a few surrounding trees. It is known that "plant communities whose component taxa have genetically adapted to the stability of a predictable environment are most fragile" (Fjeldsa and Lovett, 1997). Along with injury caused by ungulates, there is a threat of contamination by the genes of cultural apple trees because only in dense stands the bees carry pollen in closed groups of trees (Levin and Kerster, 1969). In the season when honey is gathered the bees orient according to plant distribution and more frequently fly to the areas where trees sparsely grow, to the edge of the forests and cutovers. The scale of pollen and seed transport depends upon stand density and species diversity since both the bees and ungulates orient according to the distribution of plants. Therefore the protected common wild apple trees themselves must be girdled by sufficiently large buffer zones (areas with reduced intensity of utilization).

Material and methods

In Lithuania the biotopes of river valleys belong to the most valuable ecosystems (Baškytė et al., 1997). In the forests small rivers are found to be the centres of biological diversity. River valleys function as migration corridors of living beings and plants. The networks of the following Lithuanian rivers (Lasinskas, 1981) are most dense (more than 1.25 km/ sq. km): the Šešupė (in the biogeographical regions of Northern Panemunės, Sūduva Lowlands and a part of Nemunas Valleys), the Veivirža, Tenenys, Šyša and Veižas (the rivers of Littoral Lowland in the West Žemaitija) as well as the Mūša with tributaries and Apaščia (in the Žiemgala Lowland). The habitats of wild apple trees (*Malus sylvestris*, *M. sylvestris* ssp. *praecox* and *M. sylvestris* × *M. domestica*) have been determined according to the information gathered in the forest districts of Lithuania. A total of over 100 habitats were observed preferably deep in the forests of West Žemaitija, Northern Panemunės, Nemunas Valleys, Sūduva Lowlands, Dzūkija Highlands and in the biogeographical regions of Central Lithuania. Phytocenotic as well as edaphic conditions of tree growth were assessed.

To group wild apple trees, single linkage cluster analysis (STATISTICA for Windows 4.3) was performed on the standardised growth and morphology variables (Table 1). During the evaluation specific distinctive features of wild apple trees and partly cultural wild apple trees were taken into account (Table 2). SAS STANDARD procedure was used for data standardising (SAS User's Guide, 1985). The variables were standardised to a mean of 0 and a standard deviation of 1. Tree diagram and Euclidean distance matrix for wild apple trees were obtained. The age distribution of the evaluated wild apple trees was determined according to their linkage distances and the among-tree Euclidean distances - estimates of tree distinction.

Results

The structure of wild apple tree population is complex (Fig. 1). There were no significant interspecific differences among *Malus* forest trees in their growth and morphology trait relationship. *M. sylvestris* ssp. *praecox* and *M. sylvestris* × *M. domestica* frequently are the nearest neighbours of *M. sylvestris* Mill. Therefore, determination of age structure of the wild apple population according to tree growth and vitality traits and the among-tree Euclidean distances is correct (Fig. 2).

Table 1. Morphological variables and their meanings for *Malus* tree data

Quantitative variables	Meanings of variables
Trunk diameter	In cm (at breast height over the bark)
Stem height	In metres
Crown height	In metres
Crown diameter	In metres
*Tree age***	**In classes** (10 years)
Qualitative variables	**Meanings of variables**
Stem growth habit	Upright
	Straightened up
	Spreading upwards
	*Leaning over**
Stem expression	Up to the upper crown
	Up to 1/2 of crown height
	Up to the crown (3)
	*Few stems from the ground**
Heartwood condition	Absent
	Light
	Dark
	Rotten
Water-sprouts amount	Absent
	Few
	Medium
	Abundant

**Deleted cases from analysis data set*
***Not in the cluster analysis*

Table 2. Morphology traits of *Malus sylvestris* Mill., *M. sylvestris* Mill. ssp. *praecox* and *M. domestica* Borkh. trees

Traits	*Malus sylvestris*	*Malus sylvestris* ssp. *praecox*	*Malus domestica*
Fruits			
Size	2-2,5 cm	2-2,5 cm	>3,5 cm
Shape	flat-round	round	oblong
Ground colour of skin	light-yellow	yellow	yellow-green
Over colour of skin	yes	no	yes
Relation of length: pedicle/fruit	<1	=1	<1 <
Twigs			
Spines	yes	no	no
Colour of young shoots	dark brown	red-brown	bronze
Buds			
Tomentum	no	yes	yes
Leaves			
Length	<6 cm	<9 cm	>11 cm
Width	<4 cm	<6 cm	>5,5 cm
Thickness	thin	thick	thick
Shape	wide oval	wide oval reversed	oval
Base	round	wedge-shaped	wedge-shaped
Spike	bent	straight	straight
Tomentum	no	sparse	yes

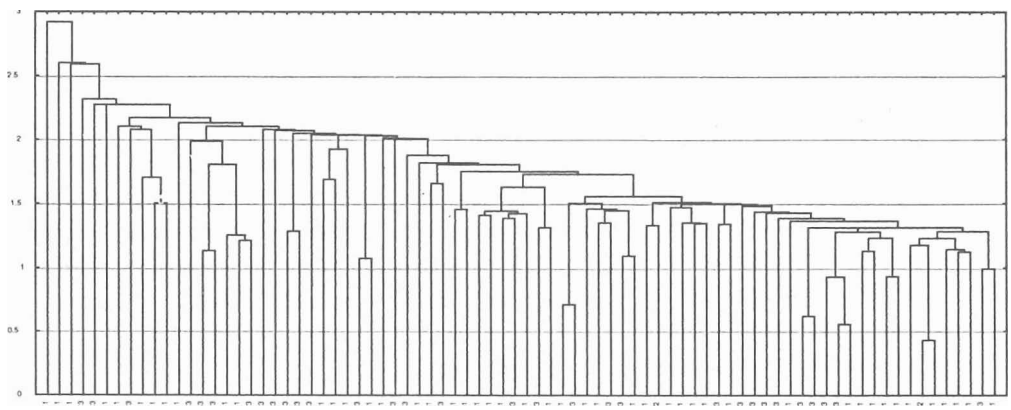

Fig. 1. Tree diagram for wild apple tree relationship: (1) *Malus sylvestris* Mill., (2) *M. sylvestris* ssp. *praecox* and (3) *M. sylvestris* × *M. domestica*

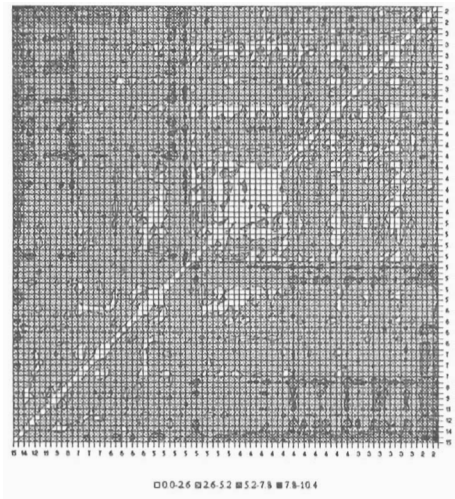

Fig. 2. Wild apple's population structure: pattern of the among-tree Euclidean distances in accordance with the tree age classes (from 2nd to 15 th)

The oldest wild apple trees of the 12th to 15th age classes were among the most distinct ones in the Euclidean distance matrix. Trees in the 4th to 5th age classes were the most similar according to their growth and vitality traits. It is an evidence of the relationship between the tree multitrait distinction and age distribution in the evaluated wild apple population. Most significant differences of wild apple trees according to their survival were in the Northern Panemunės region.

Most of the wild apple trees studied (71 %) were found inside the forest. Habitats of the rest were road edges, inner forest edges, riversides and cutting areas. Wild apple trees in all investigated biogeographical regions grew in the forests together with 14 other tree species. Whether it is in someway associated with age of the apple trees may be seen in Table 3. *Quercus robur* is a satellite of wild apple trees in all age groups. *Populus tremula* grows together with trees of 4th to 15th age classes whereas *Picea abies* and *Alnus glutinosa* were found only in the habitats of wild apple trees of the 1st to 7th age classes. However, the number of such cases is comparatively large. *Quercus robur, Populus tremula, Fraxinus excelsior* and *Padus avium* trees grow with the oldest wild apple trees of the 12th-15th age classes.

Wild apple trees survive mostly near small forest rivers. The oldest and the most distinct wild apple tree in the Obelynas forest district was found on a fertile slope of the Tirštelis rivulet. Although it is old (about 150 years), the trunk is healthy, the central part of stem is not injured by fungi. Wild apple tree having the largest trunk diameter (60 cm) in the Kaukinė forest district, healthy, about 150 years old too, was growing near the forest streamlet as well. The results of this study suggest that *M. sylvestris* Mill. grows better on forest sites near the small rivers. For propagation the seeds should be collected only from healthy trees which are devoid of damage caused by animals or frost and which grow in the middle of the forests.

Conclusions

1. There are no significant interspecific differences among *Malus* forest trees in their vitality and growth traits. The oldest evaluated wild apple trees (*M. sylvestris, M. sylvestris* ssp. *praecox* and *M. sylvestris* × *M. domestica*) of the 13th to 15th age classes according to their growth and vitality traits are among the most distinct in the evaluated population. Trees in the 4th to 5th age classes are most similar between themselves. So, there is an evidence of the relationship between tree multitrait distinction and age distribution in the evaluated wild apple population.

2. Wild apple trees grow together with 14 tree species in the Lithuanian Forests. *Quercus robur, Populus tremula, Fraxinus excelsior* and *Padus avium* grow together with the oldest wild apple trees of 12-15 age classes. *Quercus robur* is found in the habitats of wild apple trees of all age groups.

3. Wild apple trees survive mostly near the small forest rivers. In order to assure the continuity and evolution of *Malus sylvestris* Mill., the network of its gene conservation populations should be established on the forest sites of river valleys, incorporating and preserving unique and old wild apple trees and planting seedlings originating from the deepness of surrounding forests.

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