

Evaluation of genetic resources in Noble Hardwoods

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Introduction

During the last decades, forestry in Europe has shown a growing awareness of the high importance of a specific group of tree species known as Noble Hardwoods. The acknowledgement of their eminent silvicultural, economic and/or ecological values led to their upgrading from a former status of 'minor' species.

Out of this awareness arose a major concern to safeguard the existing resources of these species (isolated individuals, relict populations, small-scale homogeneous stands). Because one can not protect what one does not know, substantial efforts have been needed, in the first place, to identify the still existing resources.

Furthermore, the gene conservation programmes, set off in different European countries, very rapidly urged for an effective characterization of these resources once they had been identified. In this way a varying set of criteria, techniques and traits was developed and applied in each country, aiming at:

- determination of wild forms *vis-à-vis* cultivated and hybrid forms (e.g. wild apple)
- assessment of the levels of (genetic) diversity within the entities
- characterization of diversity between geographically disjunct entities.

The EUFORGEN Noble Hardwoods Network provides a mechanism for monitoring the practices currently used throughout Europe for such evaluation of genetic resources. In order to carry out an overview of the current evaluation methods and practices in different countries, a questionnaire was chosen as the most appropriate way to gain good information from all the participating countries (see list of Participants).

It was agreed to classify the different traits used for evaluation of Noble Hardwoods genetic resources into four categories: morphology, phenology, resistance characteristics and biochemical/genetic traits.

The received information was rearranged into a fairly limited number of tables representing the individual Noble Harwood species. The aim is to provide each member of the Network (and other scientists concerned) with a guide indicating where to search for additional information in order to compare, complete, refine and/or optimize their own evaluation techniques.

The purpose of this task is certainly not to produce one uniform methodology for the evaluation of Noble Hardwood species in all countries. The form of the questionnaire used for conducting this survey allowed for obtaining well-balanced and standard information. However, one should keep in mind that putting the available information into a fixed questionnaire inevitably entails a certain loss of information which does not fit into the presented form and can not be comprehended in the following overview tables (Tables 1-16).

Some similarities and common features between the different countries could be observed:

1. For all species considered, the evaluation of genetic resources is most often done on the basis of morphological and phenological traits, as these are readily observable and do not require any sophisticated equipment (Fig. 1). Exception is made for the *Ulmus* species, for which tolerance/susceptibility to the Dutch elm disease is adopted as a major distinctive characteristic used.
2. Morphological observations most often focus on leaves and fruits/seeds (Fig. 2). Among all phenological traits observed, flushing and flowering appear to be the most important ones (Fig. 3).

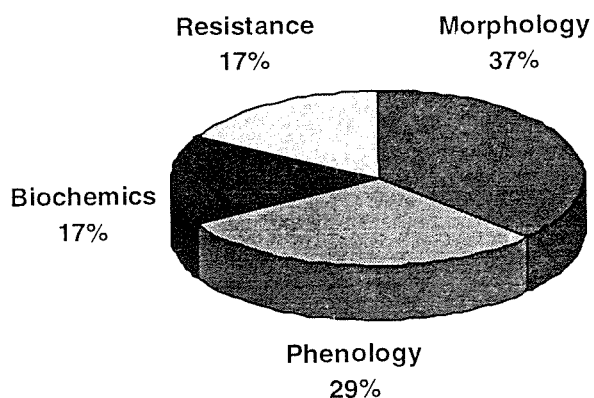


Fig. 1. Relative importance of evaluation techniques.

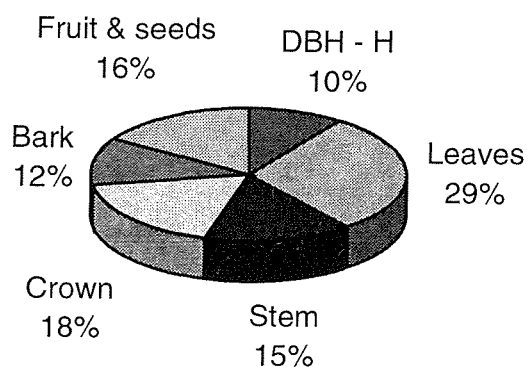


Fig. 2. Relative importance of morphological traits.

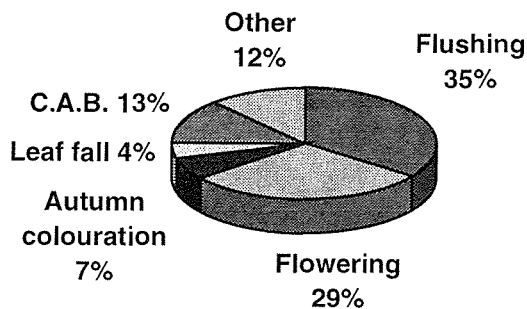


Fig. 3. Relative importance of phenological traits.

Legend for Tables 1 - 16.

Morphology	M1 = Leaves; M2 = Fruits and seeds; M3 = Crown; M4 = Stem; M5 = Bark; M6 = Growth (DBH-H); M7 = Other
Phenology	Ph1 = Flushing; Ph2 = Flowering; Ph3 = Closure of apical bud; Ph4 = Leaf Fall; Ph5 = Autumn colouration; Ph6 = Other
Biochemical/genetic traits	BG1 = DNA analysis; BG2 = Isozymes
Res	Resistance characteristics

Table 1. *Acer pseudoplatanus*

	Morphology							Phenology						B/G		Res
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2	
Belgium																
Croatia																
Czech Rep.																
Germany																A
Netherlands																B
Romania																
Russ. Fed.																
Slovakia																

A = lamma shoots; B = buds.

Table 2. *Acer campestre*

	Morphology							Phenology						B/G		Res
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2	
Denmark																
Germany																A
Netherlands																B

A = lamma shoots; B = buds.

Table 3. *Acer platanoides*

	Morphology [†]							Phenology [†]						B/G [§]		Res [¶]
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2	
Croatia																
Denmark																
Finland																
Germany																A
Lithuania																
Poland																
Russ. Fed.																
Sweden																

A = lamma shoots; B = *Rhytisma acerinum*; C = *Oxyporus populinus*.

Table 4. *Tilia cordata*

	Morphology							Phenology						B/G		Res
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2	
Croatia																
Denmark																A
Finland																C
Germany																D
Lithuania																
Netherlands																F
Poland																
Russ. Fed.																
Slovakia																

A = pilot study on use of isozymes; B = reproductive biology (pollen tube growth); C = not fully operational; D = lamma shoots; E = inventory of fungi; F = buds; G = other: chemotaxonomy; H = *Pestalozzia hartigii*, *Apognominia tillae*, *Nectria ditissima*, *N. galligena*, *Fomes fomentarius*; I = Polyporaceae, *Armillaria mellea*, *Viscum album*; J = *Fomes igniarius*, *Fomes fomentarius*, *Cercospora microsora*, *Thyrostroma comactum*.

Table 5. *Tilia platyphyllos*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Croatia																	
Czech Rep.																	
Denmark																A	
Germany														B			
Netherlands																C	
Poland															D	E	
Romania																	
Slovakia																	G

A = pilot study on use of isozymes; B = lamina shoots; C = buds; D = other: chemotaxonomy; E = *Pestalozzia hartigii*, *Apognominia tiliae*, *Nectria ditissima*, *Fomes fomentarius*; F = using 10 qualitative morphological traits; G = inventory of fungi.

Table 6. *Alnus cordata*

	Morphology							Phenology						B/G		Res
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2	
Italy																

Table 7. *Alnus glutinosa*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Croatia																	
Czech Rep.																	
Germany																A	
Lithuania																	
Netherlands																B	
Poland																	C
Slovakia																D	E

A = lamina shoots; B = assessment of ecotype; C = *Taphrina alni*, *Inonotus radiatus*, *Armillaria mellea*; D = assessment of vitality and social position; E = inventory of fungi.

Table 8. *Sorbus torminalis*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Czech Rep.																	
France														A	B		
Germany														C			
Hungary																	
Poland																	
Slovakia																	D
Switzerland																	

A = assessment of mortality; B = CpDNA; C = lamina shoots; D = overall inventory of pathogens.

Table 9. *Sorbus domestica*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Austria																	A
France																	B
Germany																	C
Hungary																	
Poland																	
Slovakia																	D
Sweden																	
Switzerland																	E
																	F
																	G

A = assessment of frost hardiness; B = *Erwinia amylovora*; C = lamma shoots; D = overall inventory of pathogens; E = selection of plus trees; F = seed weight and germination; G = *Nectria* spp.

Table 10. *Sorbus aucuparia*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Croatia																	
Finland																	
Hungary																	
Netherlands																	
Poland																	
Russ. Fed.																	

Table 11. *Pyrus nivalis*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Austria																	A
Slovakia																	

A = flowers and twigs.

Table 12. *Pyrus pyraeaster*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Austria																	A
Germany																	B
Hungary																	C
Slovakia																	

A = flowers and twigs; B = buds; C = lamma shoots.

Table 13. *Pyrus communis*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Austria																	A
Lithuania																	

A = flowers and twigs.

Table 14. *Malus sylvestris*

	Morphology							Phenology						B/G		Res
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2	
Austria							A									
Belgium							A									
Germany							B						C			
Lithuania																
Russ. Fed.																

A = flowers and twigs; B = buds; C = lamma shoots.

Table 15. *Castanea sativa*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Croatia																A	
Italy																B	A
Spain							C										

A = *Endothia parasitica*; B = RFLP and RAPD; C = twigs.

Table 16. *Ulmus glabra*, *Ulmus minor*, *Ulmus laevis*

	Morphology							Phenology						B/G		Res	
	M1	M2	M3	M4	M5	M6	M7	Ph1	Ph2	Ph3	Ph4	Ph5	Ph6	BG1	BG2		
Belgium																A	
Croatia																A	
Czech Rep.																A	
Finland																B	
France														C		A	
Germany																D	
Lithuania				B													A
Netherlands																E	A
Poland																	
Romania																	
Slovakia																	A
Spain																	A

A = *Ophiostoma novo-ulmi*; B = *U. laevis* only; C = AFLP and microsatellites; D = lamma shoots; D = buds and twigs.