Summary of professional accomplishments

1. Name, Surname: Małgorzata Katarzyna Sułkowska

2. Owned diplomas, degrees/art - with the name, place and year of obtaining them and the title of doctoral dissertation.

2.1. Higher education:

Biology - Masters of Science (1986-1991); specialisation in Environmental Biology, University of Warsaw in Warsaw. Diploma: Master of biology, 11 July 1991. Thesis on. "Safe place" of survival of juvenile hornbeam seedlings on oak and hornbeam habitats in the Bialowieża Primeval Forest.

2.2. Post-graduate studies:

Forestry management and forest environment protection - extramural doctoral studies (1996 - 1999); Faculty of Forestry, Agricultural University, Warsaw

"The manager of research projects" - extramural postgraduate studies (2011 - 2012); Higher School of Economics and Innovation (Lublin). Thesis on. "Environmentally friendly technology to protect plants from using the nun moth sex pheromone." Diploma 23 February 2012.

2.3. PhD (2004): PhD in forestry science in forestry range

PhD degree in Forestry obtained with honors of Faculty Board, 15.06.2004 r., Agricultural University, Faculty of Forestry, Warsaw - on. "Genetic variation of selected traits of the biology of beech (*Fagus sylvatica* L.)," under the guidance of Professor Ladislav Paule (Technical University of Zvolen, Slovakia).

3. Information concerning my earlier employment in scientific institutions/artistic.

2004 – up to now Assistant Professor, Department of Genetics and Physiology of Forest Trees (currently the Department of Sylviculture) Forest Research Institute in Sękocin Stary

1993 – 2004 – assistant in the Department of Genetics and Physiology of Forest Trees of the Forest Research Institute in Sękocin Stary

1991 – 1993 – trainee and technologist Department of Forest Ecology Forest Research Institute in Sękocin Stary

3.1. Scientific training

September - 1993, Botanical Garden of the Polish Academy of Sciences, Powsin, scientific training - to acquaint with the technique of isoenzyme analysis of the genetic variability of wheat.

October - November 1993, Adam Mickiewicz University in Poznan, scientific training - to acquaint with the technique of isoenzyme analysis of Scots pine.

January - 1994, Austria, Federal Forest Research Centre in Vienna, scientific training - to acquaint with the technique of isoenzyme analysis of Norway spruce.

February - March 1994, Slovakia Technical University in Zvolen, scientific training - to acquaint with the technique of isoenzyme analysis for silver fir and beech.

June – 2003, Gdańsk, Department of Microbiology Technical University of Gdansk, Immunodetection of proteins. Scientific workshops.

July - 2009, scholarship generated by the project COST Action E52 Evaluation of Beech Genetic Resources for Sustainable Forestry - Functional Training School And Computational Genomics In Beech in Plant Genetics Institute, National Research Council, Sesto Fiorentino, Italy.

November - 2011, France, INRA Cestas - University of Bordeaux 1, EVOLTREE SUMMER SCHOOL - "Evolutionary quantitative genetics in natural population of trees", obtained a scholarship to go abroad.

3.2. Scientific guardianship on trainee

June - October 2010 I held the mentoring during the scientific trainee of Ms. MSc. Agata Ludwikowska in the Department of Sylviculture and Genetics of Forest Trees in Forest Research Institute (Sękocin Stary). Trainee took note of the following laboratory analysis techniques: the use of protein markers in studies of forest tree populations on the example of beech and silver fir and the use of nuclear and cytoplasmatic molecular markers for example of the assessment of population genetic variability of wild service tree.

3.3. Other scientific experience acquired in Poland and abroad (country, institution, type of residence, period of stay).

September 2007 - Warszawa, Service for Molecular Biology, MBS " Bioinformatics, genomics and systematic biology". Scientific Workshop.

February 2009 - Warszawa, Service for Molecular Biology, MBS "Genetic Data Analysis – the use of statistical package R-Project ". Scientific Workshop.

October 2009 - France, INRA Orleans, NOVELTREE & TREEBREEDEX Workshop on long-term breeding strategies applied to forest trees. Scientific Workshop.

March 2010 - Warszawa, SAS 'Data processing with the SAS Enterprise Guide ". Scientific Workshop.

July 2010 - Warszawa, SAS Institute, "Data Integration Studio, Data Quality, OLAP, Business Intelligence" Summer School - SAS technology. Scientific Workshop.

September 2010 - Switzerland, University of Fribourg "Evolutionary and Ecological Genomics of Adaptation". Scientific Workshop.

March 2011 - Sękocin Stary, Forest Research Institute, the General Directorate Forest State, "Winter School - Strategy for development of forests and forestry in Poland up to 2030". Scientific Workshop.

January 2012 – Slovakia, Technical University Zvolen, *ConGRESS* project, "Utilization of genetic approaches for effective conservation of endangered species *ConGRESS* project". Scientific workshops, obtained a scholarship to go abroad.

February 2012 – Warszawa, StatSoft Poland, "Using statistical software - the method of data visualization." Scientific workshops.

March 2012 - Sękocin Stary, Forest Research Institute, the General Directorate Forest State, "Winter School – Environmental and economic aspects of production and use of wood ". Scientific workshops.

April 2012 – Warszawa, StatSoft Poland, "Using of statistical software - multi-dimensional analysis and data mining." Scientific workshops.

September 2012 – Warszawa, StatSoft Poland, "Using of statistical software - basic course." Scientific workshops.

June 2013 – Warszawa, Service for Molecular Biology, MBS, "Genetics in nature conservation". Scientific workshops.

March 2014 – Sękocin Stary, The Brain, „Art of public speaking. "Psychological workshop, development of the personality.

April 2014 – Warszawa, Agricultural University COST ACTION FP0905, "Opportunities for enhancement of Integrated Pest Management". Scientific workshops and symposium.

3.3. Scientific functions held

Member of the Management Committee Cost Action E52 Evaluation of the Genetic Resources of Beech for Sustainable Forestry "- nomination of the Minister of Science and Information Technology - years 2006-2010

Secretary of Warsaw Branch of the Polish Botanical Society- the years from 2009 to 2010

Member of the Board of the Polish Botanical Society –the years from 2010 r. to 2013

Section Editor (genetics) - Leśne Prace Badawcze - the years from 2010 to 2011

Assistant Editor in *Folia Forestalia Polonica* Series A- Forestry Journal the years from 2011; currently.

COST Action no. FP1202, Strengthening conservation a key issue for adaptation of marginal / peripheral Populations of forest trees is climate change in Europe (MAP-FGR): Working Group 1 and 2 - by choice - the invitation of Dr. Ing. Piotr Markiewicz, Regional Directorate of State Forest in Warszawa (Management Committee, Poland) - the years 2012 to 2016

Member of the Board Main Audit Committee Polish Botanical Society the years from 2013; currently.

Vice-Chairman of Warsaw Branch of the Polish Botanical Society the years from 2013; currently

3.4. Awards

Award Director of the Forest Research Institute of the third degree for outstanding scientific work - "Physiological and biochemical aspects of long-term storage generative and vegetative organs and tissues of forest trees" project - Forest Research Institute, Warszawa, March 1998

Award Director of the Forest Research Institute of the second degree for realization and outstanding dissertation defense - " Genetic variation of selected traits of the biology of beech (*Fagus sylvatica* L." - Forest Research Institute, Warszawa, August 2004

Award Director of the Forest Research Institute of the second degree for the team composed of: Prof. Iwona Skrzecz, **Dr. Małgorzata Sułkowska**, MSc. Anna Tylman, for achievements related to the development of Folia Forestalia Polonica Journal – Series A Forestry – Forest Research Institute, Warszawa, March 2013

4. Indication achievements * under Art. 16 paragraph. 2 of the Act of 14 March 2003. On Academic Degrees and Titles and on Degrees and Title in Art (Dz. U. No. 65, item. 595, as amended.):

B. A series of publications as a basis to apply for a habilitation degree on:

„Intergenerational differences of Polish populations genetic structure of beech (*Fagus sylvatica* L.)"

It includes the following publications:

1. **Sułkowska, M**. 2006: Zróżnicowanie ekotypowe populacji buka zwyczajnego (*Fagus sylvatica* L.) w Polsce. *Sylwan,* **150** (7): 38-50. English abstract.
2. Bodył, M., **Sułkowska, M.** 2007: Ocena zróżnicowania nasion buka zwyczajnego (*Fagus sylvatica* L.) w Polsce w latach 1992–2004. *Sylwan,* **151** (9): 12–21. English abstract
3. **Sułkowska, M.,** Kowalczyk, J., Przybylski, P. 2008: Zmienność genetyczna i ekotypowa buka zwyczajnego (*Fagus sylvatica* L.) w Polsce (Genetic and ecotype diversity of European beech (*Fagus sylvatica* L.) in Poland). *Leśne Prace Badawcze,* **69** (2): 133-142. English abstract
4. **Sułkowska, M.** 2010: Genetic and ecotype characterization of European beech (*Fagus sylvatica* L.) in Poland. *Acta Silvatica et Lignaria Hungarica,* Vol. **6** (2010): 115-122.
5. **Sułkowska, M.,** Charkot, S. 2010: Genetic foundations of ecotype differentiation of European beech (*Fagus sylvatica* L.) in Poland. *Annals of Warsaw University of Life Sciences SGGW,* Forestry and Wood Technology, No 73: 15-23.
6. **Sułkowska, M.,** Nowakowska, J. 2011: Genetic structure of European beech of mother and progeny stands in Poland on the basis of DNA chloroplast markers. *Forestry Ideas,* Vol. **17**(2011): 1(41): 21-26.
7. **Sułkowska, M.,** Gömöry, D., Paule, L. 2012: Genetic diversity of European beech in Poland estimated on the basis of isoenzyme analyses. *Folia Forestalia Polonica, series A, Forestry,* Vol. **54** (1): 48–55.

Inventory of all publications with evaluation of points value according to year of publication – attachment 4.

Certificates, confirming the percentage and the scope of authorship work of in a series of thematic articles attached – attachment 5.

C. Overview of the scientific/artistic aim of above mentioned elaboration/elaborations and the results achieved, together with a discussion of their possible utilisation.

The results discussed below publication are related to analyses the dynamics of changes in the genetic structure of populations of selected Polish beech (*Fagus sylvatica* L.), based on the genetic characteristics of the mother and progeny tree stands in the natural range of the species and mating system evaluation of mother mature tree stands. Characteristics of genetic structure diversity of population was developed based on protein markers (isoenzymes) and the genetic information contained in DNA nuclear and chloroplast.

The main theses of work are: ecotype variability of beech in Poland based on analyses of the habitats and dendrometry and phytosociology of mother populations, the use of protein markers and assessment of mating system in studied populations maternal and progeny populations of beech, examine of the phylogenetic relationships among the studied populations within species based on RAPD markers, assessment of gene flow between generations based on microsatellite DNA analysis of studied provenances.

The results of studies are an important part of the breeding characteristics of studied populations of beech in natural range of the species in Poland. In addition they have been discussed the possibilities of applying results in practice of forest management, including regionalisation of genetic resources and the importance of gene flow in shaping the current gene structure of studied populations of beech.

In the series of publications the attentions was focused on the issues:

- beech population variation in aspect of the history of the migration of the species after a period of glaciation (**Sułkowska** 2006, Bodył, **Sułkowska** 2007, **Sułkowska** et al. 2012)
- habitat diversity of selected for study beech populations (**Sułkowska** et al. 2008, **Sułkowska**, Charkot 2010)
- preservation gene pool of parental populations in analyzed generations of beech progeny provenances (**Sułkowska** 2010, **Sułkowska**, Nowakowska 2011).

The significance of these problems were shown in a series of publications on the following topics:

1. Beech population variation in aspect of the history of the migration of the species after a period of glaciation.

1a. **Sułkowska, M.** 2006: Zróżnicowanie ekotypowe populacji buka zwyczajnego (*Fagus sylvatica* L.) w Polsce. *Sylwan* **150,** (7): 38-50. English abstract.

Aim of the study: evaluation of the biological diversity of beech (*Fagus sylvatica* L.) in its natural range of distribution in Poland, in the aspects of genetic, physiological and ecological variation of selected population in terms of:

- tests of seedlings in forest nursery enabling growth and adaptation traits observations,
- establishment of provenance trial and investigations of growth characteristic increment and resistance to unfavourable environmental factors in specific habitat conditions,
- assessment of genetic variation based on isozyme analysis, beech population in Poland in the natural range of occurrence, with particular emphasis on compact forest complexes in the Bieszczady Mountains and selected tree stands (WDN) chosen for tests origins.

Twelve selected beech seed stands (WDN), representing natural geographic range of the species in Poland were chosen for provenance trial experiment They are forest stands of native origin and illustrates the largest compact forest complexes with a high proportion of beech, e.g.: the Bieszczady and Świętokrzyskie Mountains, Roztocze and Pomeranian regions.
In the natural range of the species, which were well-preserved fragments of large forest complexes, with particular emphasis on Bieszczady beech, often monospecific species character tree stands, 26 populations were selected for the assessment of genetic variation beech in Poland.

Summary of results: the importance of differentiation of European beech investigated populations in terms of morphological characteristics of seeds and leaves and adaptive traits, growth and phenological variation have been confirmed. It has been stressed the importance of variation within-provenance for the overall assessment of the variability of provenance, depended on the selection that occurs between individuals within populations subject to certain climate and habitat factors . The completed studies emphasize the need for the selection of provenances to environmental conditions, with particular emphasis on their phenological diversity. With the obtained results were derived the following conclusions:

- Size measurements of seeds and leaves showed differences in length and width and the ratio coefficient (D / S) average population characteristics at the significance level $\alpha = 0.001$. Size variation of seeds and leaves were traits that enable distinguish to populations of beech typical for mountain and lowland habitats. The beech provenance of North and Central Poland were characterised by bigger seeds and leaves than mountain populations (Southern Poland).

- Phenological observations allow to distinguish provenances of beech, starting early vegetation season, which at almost the same time period of flushing by all individuals, with high resistance to frost: Śnieżka, Lądek and Łagów (mostly mountain provenances) and provenance characterized by a long period of development of leaves, with high variability distinguished in phenological phases: Staszów, Brzeziny, Kartuzy and Młynary (provenance from lower elevations relative to sea level).

- Characteristics of growth traits enabled to distinguished plasticity provenance, well adapting to new environmental conditions, with high survival rates and annual increments (Sudeten provenances) and low plasticity from the edge of their range (Kartuzy provenance).

- The results of the assessment of genetic variability, based on isozyme analysis indicate a slight genetic depletion of populations from the north Poland (Młynary and Świerczyna) compared to the southern populations (Moczarne and Lądek), which can confirm the main routes of the migration of the species after a period of glaciation from the refuge in the southern part of the European continent.

1b. Bodył, M., **Sułkowska, M.** 2007: Ocena zróżnicowania nasion buka zwyczajnego (*Fagus sylvatica* L.) w Polsce w latach 1992–2004. *Sylwan,* **151** (9): 12–21. English abstract.

Aim of the study: estimation of beech (*Fagus sylvatica* L.) the size and health differentiation seed of Polish provenances has been the aim of the studies in the years 1992-2004. Beech seeds were collected in 1992., in thirteen beech tree stands, and after completing their assessment of the size and standard health condition and germination tests were prepared for sowing in order to establish provenance trial. In the following years measurements and observations beech seeds were continued, based on samples supplied to the IBL seed testing station in Sękocin Stary.

Summary of results: Information about regions selected for testing seed provenances, concerning, inter alia: climate, geology of the area and phytosociology of communities were collected. They represent the natural variability of beech in Poland for high mountain communities, with a severe climate, short growing season, and poor soils to fertile soils of Pomerania under the influence of milder maritime climate with a long growing season. Stands described on the basis of available information from Forest Divisions: management plans for forest holdings and inventory descriptions of tree stands.

Standard health condition evaluation performed for seeds collected in selected seed stands showed that most of the seeds of provenances predicted to establish experiment showed very high percentage of healthy of seeds - normally above 80%. This feature showed geographical variation character. Seeds harvested in the Sudety Mountains had the highest percentage of healthy seeds - 96%.

The average length of seeds of populations were characterised by values from 14.63 mm - Sucha to 16.86 mm - Staszów. The coefficient of variation for this trait was set out within the range of 7.11 - 9.99%, respectively Wetlina and Sucha. Average width of seed values ranged from 8.28 mm to 9.44 mm to Wetlina - Staszów. The highest variability of this trait stand out Ladek provenance - the coefficient of variation 12.63%, while the least variable was the provenance Świerczyna - 8.99%. The mean values of shape coefficient of seeds investigated provenances were contained within values: Sucha 1.70 - 1.84 Kartuzy and Świerczyna and the coefficient of variation ranging from 8.99% Świerczyna - 13.51% to - Łagów. Beech provenance from Northern and Central Poland were characterised by a significantly larger seeds than mountain populations (Southern Poland). The average seed size estimated on the basis of all investigated provenances were as follows: length - 15.80 mm, width 8.85 mm, length/width ratio - 1.80.

Characteristics of seed size of Polish provenances indicates that they were shorter, but more slender than in neighboring regions, and the overall length and width of the seeds were correlated with the altitude above sea level seed stands of beech, in which there were collected. Similar results were obtained in the neighboring regions in Ukraine (Parpan et al. 1987)[1]; and in the Czech Republic and Slovakia (Šmelková 1991)[2].

[1] Parpan, W.I., Zelez, P.A. & Yatsyk, R.M. 1987. Ob ismienciwosci semian buka ewropieyskowo. Lesovodstvo y Agrolesomelioratsiya 74: 52–56.

[2] Šmelková, L. 1991. Variation in beech (*Fagus sylvatica* L.) seed. In: Proceedings IUFRO – Buchensymposium. Š. Korpeľ & L. Paule (eds.). Zvolen 3 – 6. 6. 1988: 93–99.

The results of analyzes of the characteristics of beech seeds of data, collected in the years 1995 - 2004, indicate significant differences mass of one thousand of seeds and vitality between populations, occurring in the country within the natural range of the species. Carpathian, Sudeten and Pomeranian seeds were characterized by the highest vitality, while the lowest one reached the seeds produced in stands growing on uplands of the eastern Poland. The lowest mass of one thousand seeds was found in mountain populations, while the highest one in Pomeranian. However weight of seeds but did not affect their viability. Seeds produced in the mast years were characterized by high vitality, when in poor years were not too vigorous. Routine assessment of health condition of tree seeds in addition to the management aspect, by specifying the sowing value of seeds for forest nurseries, may also serve a different role. The long-term periodic observations and recording quality of forest tree seeds it provides a lot of data on the changes in seed viability over time and its spatial differentiation. These information obtained may be used by the administrative units of the Forest States to optimise when making planning decisions, sylviculture and economy.

1c. **Sułkowska, M.**, Gömöry, D., Paule, L. 2012: Genetic diversity of European beech in Poland estimated on the basis of isoenzyme analyses. *Folia Forestalia Polonica, series A, Forestry*, Vol. **54** (1): 48–55

Aim of the study: estimation of variability and genetic diversity of the beech (Fagus sylvatica L.) population within the natural range of occurrence in Poland. Assessment of the level of depletion of genetic variability of Polish population in relation to other European population of the species. The basis of reasoning in the study were the considerations for migrating routes of the species after last glaciation.

Summary of results: Genetic diversity and differentiation of 26 Polish beech populations was assessed using allozyme gene markers employing 9 enzyme systems: glutamate-oxaloacetate transaminase (GOT - EC 2.6.1.1), leucine aminopeptidase (LAP - EC 3.4.11.1), isocitrate dehydrogenase (IDH - EC 1.1.1.42), malate dehydrogenase (MDH - EC 1.1.1.37), menadione reductase, (MNR - EC 1.6.99.2), phosphoglucomutase (PGM - EC 2.7.5.1), phosphoglucose isomerase (PGI - EC 5.3.1.9), peroxidase (PX - EC 1.11.17) and shikimate dehydrogenase (SKDH - EC 1.1.1.25). Allelic frequencies were estimated for investigated gene loci, observed and expected heterozygosities value were calculated according to (Nei 1974)[3],) using BIOSYS 1 program (Swofford and Selander 1981)[4]. Effective number of alleles per locus (Crow i Kimura 1970)[5] and fixation index (Wright 1965)[6] were also calculated to estimate deviation from panmictic equilibrium in each population. The genetic distances among populations were assessed based on Nei (1972)[7] and dendrogram was constructed. The results were compared to the genetic diversity parameters of beech populations in the neighboring European regions: Slovakia, the Czech Republic, Ukraine, and even Romania, as published by Gömöry et al. (1995, 1998, 2003)[8910].

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[3] Nei, M. 1974. Estimation of average heterozygosity and genetic distance from a small number of individuals. *Genetics* 89:583–590.

[4] Swofford, D.L., Selander, R.B. 1981. Biosys-1. User Manual. University of Illinois.

[5] Crow, J.F., Kimura, M. 1970. Introduction to Population Genetics Theory. Harper and Row. New-York.

[6] Wright, S. 1965. The interpretation of population structure by F-statistics with special regard to systems of mating. *Evolution*. 19: 395–420.

[7] Nei, M. 1972. Genetic distance between populations. *American Naturalist* 106:283–292.

[8] Gömöry, D., Vyšný, J., Paule, L. 1995. Genetic differentiation of populations in the transition zone between *Fagus sylvatica* L. and *Fagus orientalis* Lipsky. *Proceedings of the 5th Beech Symposium of the IUFRO Project Group P1.10–00.* 19 – 24 September 1994. Mogenstrup. Denmark. *Forskningsserien* 11: 69 – 82.

Polish beech populations are characterized by high genetic diversity, similar to other European beech populations. It has been shown that all analyzed genetic loci were characterised by high, up to 100% level of genetic polymorphism. Provenances from North part of Poland (Młynary and Świerczyna) were characterized by a slight decrease in the average (and effective) number of alleles per locus and percentage of polymorphic loci. The population probably planted (Świebodzin), showed similarly low levels of genetic variation, such as the northern lowland populations. The highest genetic differentiation was found in the Bieszczady Mountains e.g. Caryna and Folusz as well as in Sudeten (Śnieżka). Analysis of paths of beech migration after the glacial period from one refugium for Central Europe could be an explanation of this phenomenon. Unexpectedly high polymorphism was observed in Brzeziny population, located on the border of the natural beech limit in Poland. This phenomenon can be explained by "founder effect" of the population, which colonised given area after a glaciation period.

The fixation index was found to be negative in beech populations from Carpathians and Świetokrzyskie Mountains, which can be explained by the excess of heterozygotes in the populations and some disturbances of typical mating system for unbalanced populations in Hardy - Weinberg equilibrium.

Generally, alleles found in investigated populations can be divided as unspecific regionally alleles it means is occurring on the whole range of beech of the studied area e.g. *Mdh-1* as well as genes encoding peroxidases: *Px-1* and *Px-2*. Some alleles were locally or regionally specific, namely *Lap-1A* (Sudety Mountains, Pomerania), *Got-2C* (Bieszczady Mountains, Gryfino, Romania), *Mdh-1B* (Świętokrzyskie Mountains, Romania), *Mdh-3D* (Romania), *Mdh-3D* (Ukraine), *Pgi-1D* (Bieszczady Mountains, West Slovakia), *Skdh-D* (Slovakia).

2. Habitat diversity of selected for study beech populations

2a. **Sułkowska, M.,** Kowalczyk, J., Przybylski, P. 2008: Zmienność genetyczna i ekotypowa buka zwyczajnego (*Fagus sylvatica* L.) w Polsce (Genetic and ecotype diversity of European beech (*Fagus sylvatica* L.) in Poland). *Leśne Prace Badawcze,* **69** (2): 133-142. English abstract.

Aim of the study: analysis of the diversity of adaptive traits of chosen to study populations of European beech in the natural range of the species in Poland in relation to the characteristics of the variability of their habitats. Changes in population genetic structure of mother populations relation to their progeny generations on the basis of analysis of isozyme also were evaluated.

Summary of results: nine beech experimental plots were established in populations representing selected regions of forest basic material. The plots represent whole range of variation of habitats on which the species is present in the Polish conditions, in the natural geographical limit. On the experimental plots with an area of 1 hectare each, 5 soil samples were collected from the following depth of soil profile 0-20 cm and 20-40 cm

[9] Gömöry, D., Hynek, V., Paule, L. 1998. Delineation of seed zones for European beech (*Fagus sylvatica* L.) in the Czech Republic based on isoenzyme gene markers. *Annales des Sciences Forestières* 55: 425–436.
[10] Gömöry, D., Paule, L., Schvadchak, M., Popescu, F., **Sułkowska, M.,** Hynek, V., Longauer R. 2003. Spatial patterns of the genetic differentiaton in European beech (*Fagus sylvatica* L.) at allozyme loci in the Carpathians and adjacent regions. *Silvae Genetica* 52(2): 78–83.

Basic characteristics of the soil properties were compared with genetic variation parameters (including: the percentage of polymorphic loci, the average number of alleles per locus, heterozygosity) of populations of mother tree stands and their progeny. The analysis of regression was performed and correlation of all studied characteristics and significance correlation were estimated. For characteristics significantly correlated were indicated Pearson's correlation coefficients with a significance level of correlation. Characteristics of genetic variability of investigated population of beech and their progeny were performed on the basis of analysis of protein markers: leucine aminopeptidase (LAP - EC 3.4.11.1 - *Lap 1*), glutamate-oxaloacetate transaminase (GOT - EC 2.6.1.1 - *Got 2*), menadione reductase (MNR - EC 1.6.99.2), malate dehydrogenase (MDH - EC 1.1.1.37 - *Mdh 1*, Mdh 2, Mdh 3), shikimate dehydrogenase (SKDH - EC 1.1.1.25), phosphoglucose isomerase (PGI - EC 5.3.1.9 - *Pgi 2*) and phosphoglucomutase (PGM - EC 2.7.5.1) and following DNA - RAPD markers: H02, H12, P06, W09, W11 (Operon concern).

A significant correlations between genetic differentiation of investigated beech provenances and their offspring, and the mineral content and basic ion soluble components in the soil easily adsorb by plants were found. Correlations were found for such elements like boron, potassium, and molybdenum, which are essential for proper growth and functioning of the plant. Beech provenances from fertile habitats, where typically soil pH are higher were characterised by a higher level of genetic variability. The significance of the correlation among the calculated parameters of genetic variation and chemical properties of the soil, is a confirmation of not to transfer of the population outside areas with a similar range of variation of habitats.

The results obtained in the form of recommendations have been submitted to the General Directorate of Forest State - **M. Sulkowska 2007**. Preliminary guidelines on the use of ecotypes of beech (*Fagus sylvatica* L.) on a commercial scale. Forest Research Institute (manuscript) as part of the project documentation - BLP248 Genetic determinants of variability of ecotypes of beech (*Fagus sylvatica* L.).

2b. **Sulkowska, M.**, Charkot, S. 2010: Genetic foundations of ecotype differentiation of European beech (*Fagus sylvatica* L.) in Poland. Annals of Warsaw University of Life Sciences SGGW, Forestry and Wood Technology No 73, 2010; 15-23.

Aim of the study: nine beech tree stands were selected, whose selection criterion was the range of variability of habitats represented by provenances: fertile Pomeranian beech site type (Gryfino and Kartuzy), fertile Sudety beech type (Zdroje), fertile Carpathian beech type (Lutowiska and Łosie), and acid beech site type (Miechów, Suchedniów, Tomaszów Lubelski and Zwierzyniec). Site conditions of beech population were characterise in terms of climate and soil, phytosociological characteristics of plant communities was carried out and the range of the ecological index numbers was defined.

The consequence of the migration process of beech after a period of glaciation was depletion the genetic diversity of the population in the newly inhabited areas due to: - narrowing of the genetic pool to the variability of individuals who participated in the migration process, selection of genotypes during the settlement process (forming of communities) - as a result of interbreeding of closely related individuals of small groups. Some genotypes have been favoured due to environmental factors, in effect followed by the elimination of individuals which are not resistant from population and speciation intending to create soil ecotypes.

Summary of results: nine beech tree stands selected to study were classified as the following plant associations, representing *Galio-odorati-Fagetum* (Gryfino and Kartuzy), *Dentario glandulosae-Fagetum* (Lutowiska and Łosie), *Luzulo-luzuloides-Fagetum* (Miechów, Suchedniów, Tomaszów, Zwierzyniec) and *Dentario enneaphyllidis-Fagetum* (Zdroje). Characteristics of site conditions of populations e.g.: climate, soil and phytosociological classification were used to estimate the ecological index numbers (Zarzycki et al. 2002)[11].

Characteristics of genetic variability of investigated population of beech was performed based on the analysis of proteins: leucine aminopeptidase (LAP - EC 3.4.11.1 - *Lap 1*), glutamate-oxaloacetate transaminase (GOT - EC 2.6.1.1 - *Got 2*), menadione reductase (MNR - EC 1.6.99.2), malate dehydrogenase (MDH - EC 1.1.1.37 - *Mdh 1*, Mdh 2, Mdh 3), shikimate dehydrogenase (SKDH - EC 1.1.1.25), phosphoglucose isomerase (PGI - EC 5.3.1.9 - *Pgi 2*) and phosphoglucomutase (PGM - EC 2.7.5.1) and following DNA - RAPD markers: H02, H12, P06, W09, W11 (Operon concern).

On the basis of izoenzyme and DNA analysis, the results of estimation of a genetic diversity of collected beech plant material revealed a high inter-population variation of investigated each marker frequencies and the estimated values of genetic parameters

The average number of alleles per locus estimated on the basis of isozyme analysis, ranged from 1.90 (Kartuzy, Zdroje) to 2.30 (Tomaszów), and in the case of DNA markers, Kartuzy population was also characterised by the lowest value of this parameter - 1.82; high average number of alleles per locus was recorded as well in the southern provenances of Poland: Łosie, Zdroje, Gryfino - 2.0. Genetic distance estimated on the basis of protein markers of studied populations divided them into two groups. One of them included population of slightly disturbed structure of expected state of equilibrium, in accordance with the law of Hardy-Weinberg equilibrium (observed heterozygosity shows differences in relation to the expected), i.e .: Gryfino - possibly artificial origin and Zwierzyniec - located on the border of the natural range. In the second group on one branch they were classified populations: Miechów and Zdroje, which growing on soils with calcareous substratum. Genetic distance estimated on the basis of DNA- RAPD markers indicated genetic homogeneity of investigated beech provenances with the exception of the Bieszczady population from Lutowiska.

Protein markers (isozymes) and DNA-RAPD markers showed that most of analyzed beech populations were characterized by stable genetic structure, there was not observed genetic depletion comparing populations from northern and southern of Poland.

3. Preservation of gene pool of mother populations in progeny generations of analysed beech provenances

3a. **Sułkowska, M.** 2010: Genetic and ecotype characterization of European beech (*Fagus sylvatica* L.) in Poland. *Acta Silvatica et Lignaria Hungarica,* Vol. **6** (2010): 115-122.

Aim of the study: characterisation of genetic and ecotype characteristics of nine populations selected for beech plant associations in Poland representing *Galio-odorati-Fagetum* (Gryfino and Kartuzy), *Dentario glandulosae-Fagetum* (Lutowiska and Łosie), *Luzulo-luzuloides-Fagetum* (Miechów, Suchedniów, Tomaszów, Zwierzyniec) and *Dentario enneaphyllidis-Fagetum* (Zdroje).

[11] Zarzycki, K., Trzcińska-Tacik, H., Różański, W., Szeląg, Z., Wołek, J. 2002. Ekologiczne liczby wskaźnikowe roślin naczyniowych Polski. Instytut Botaniki im. Wł. Szafera. PAN. Kraków.

Characteristics of genetic variability of investigated population of beech was performed on the basis of isoenzyme analysis: leucine aminopeptidase (LAP - EC 3.4.11.1 - *Lap 1*), glutamate-oxaloacetate transaminase (GOT - EC 2.6.1.1 - *Got 2*), menadione reductase (MNR - EC 1.6.99.2), malate dehydrogenase (MDH - EC 1.1.1.37 - *Mdh 1*, Mdh 2, Mdh 3), shikimate dehydrogenase (SKDH - EC 1.1.1.25), phosphoglucose isomerase (PGI - EC 5.3.1.9 - *Pgi 2*) and phosphoglucomutase (PGM - EC 2.7.5.1) and following DNA - RAPD markers: H02, H12, P06, W09, W11 – mother populations.

Based on the obtained results, the basic genetic parameters were estimated and dendrograms of genetic similarity of populations and their progeny were constructed.

Summary of results: analysis of the ecological index numbers according to Zarzycki et al. (2002)[11], showed almost homogeneity site conditions of studied beech populations. Four types of plant associations selected for study populations despite its internal structure differentiation (number of species and their composition) are surprisingly homogenous with respect to site conditions, as it was indicated by ecological index numbers. The values of climate indexes: light indicated that was semi-shade; while thermal indicator, this was temperate cool climate conditions on lowlands and lower montane belt – depending on the elevation. Edaphic index values indicated that in terms of the mechanical composition soils were sandy loam or sandy-loam with a large share of skeletal parts, and in terms of humus were mineral soil humic substances. There are only differences determining moisture and acid factors of the soils.

In case of mother population on the basis of isoenzyme analysis it was shown, that the highest average number of alleles per locus – 2.3, population Miechów was characterized, while the lowest one Kartuzy and Zwierzyniec populations – 1.9. The percentage of polymorphic loci, as well as the average number of alleles per locus showed no clinal variation type but ecotype characteristics. A high percentage of polymorphic loci were found both in populations of the southern part of Poland as well as, central and northern one - 77.8%. An equally high percentage of polymorphic loci was distinguished for Tomaszów Lubelski population from border natural range of beech. High values and big differences were found between expected and observed heterozygosity in populations Gryfino, probably artificial origin and Zwierzyniec on the border natural range of species. Dendrogram constructed on the basis of genetic similarity matrix of distance between populations divides analysed populations into two main groups, when one of them includes Zwierzyniec and Gryfino populations. It is difficult to draw conclusions regarding genetic diversity of remaining populations within second group based on geographic regions, because there are close to located populations, which are geographically very distant, for example. Kartuzy and Suchedniów. This confirms the existence of the environmental impact on the genetic diversity of pattern of beech.

Isoenzyme analysis of the progeny generation of beech showed that the highest average number of alleles per locus - was characterized by a population of 2.7 Gryfino, and the lowest one in populations Łosie and Zwierzyniec - 2.3. A high percentage of polymorphic loci (88.9%) were found in most of the provenances with the exception of Łosie and Zwierzyniec (66.7%). High value of the observed heterozygosity was found in Łosie provenance, the low value of this parameter was characterized Zwierzyniec provenance – 0.240 and 0.219 respectively. The biggest difference between observed and expected heterozygosity was estimated in Miechów. Dendrogram constructed on the basis of genetic similarity matrix of distance between populations divides analysed populations into two main groups, which one of them consists of Tomaszów population, while second one covers remaining

populations. Populations of very far geographically distance, such as. Gryfino, Zdroje, Zwierzyniec and Lutowiska are located at the same region dendrogram.

Based on isozyme analysis it was found that genetic variation of analysed parameters (average number of alleles per locus, percentage of polymorphic loci and the value of observed and expected heterozygosity) have higher average values in progeny generations than in mother populations. This confirms that mating system of investigated populations is random, which can providing stability for future generations, without genetic depletion. The genetic stability of studied populations of beech is also reflected in the lack of differences between observed and expected heterozygosity of the progeny generations. The percentage of polymorphic loci, as well as the average number of alleles per locus revealed ecotype variations.

The results concerning DNA markers show a high degree of polymorphism from 81.82% up to 100% in all tested populations. Gryfino, Łosie and Zdroje populations were characterized by the highest percentage of polymorphic loci while the lowest one were - Kartuzy and Miechów. The value of heterozygosity was ranged from 0.268 - for Kartuzy population up to 0,334 - for Gryfino population.

The highest values of the average number of alleles per locus was observed in populations: Gryfino, Łosie and Zdroje. The smallest value of this trait was found for Kartuzy and Miechów. Zdroje population showed the highest effective number of alleles per locus, while the lowest was recorded for Miechów.

The results of the assessment of genetic variability of collected plant beech material based on isozyme and DNA analysis showed that the range of values of parameters characterizing the genetic variation does not indicate the existence of significant differences among populations of beech in Poland. It was a slight depletion of populations in the north Poland comparing to southern populations was noted. Characteristics of genetic variation within-population, however, indicates for a significant diversity of beech in Poland. The results obtained do not allowed to distinguish geographic regions with a similar level of genetic variation.

The necessity of use in the forest planning of local ecotypes of beech, taking into account the ecological plasticity of the species can provide breeding success in forest management.

3b. **Sułkowska, M.,** Nowakowska, J. 2011: Genetic structure of European beech of mother and progeny stands in Poland on the basis of DNA chloroplast markers. *Forestry Ideas*, Vol. 17(2011): 1(41): 21-26.

Aim of the study: the genetic structure characteristics of mother populations of beech and progeny generations on the basis of chloroplast cpDNA markers. For the studies were selected 6 Polish population in its natural geographical range: *Galio-odorati-Fagetum* (Gryfino, Kwidzyn), *Dentario glandulosae-Fagetum* (Bieszczadzki National Park), *Luzulo-luzuloides-Fagetum* (Suchedniów, Tomaszów), *Dentario enneaphyllidis-Fagetum* (Zdroje).

Summary of results: The genetic variation and differentiation of mother stands and their open-pollinated progeny were characterized on the basis of DNA microsatellite chloroplast markers: ccmp4, ccmp7 and ccmp10. Parameters of genetic diversity (H_S and H_T) and differentiation (G_{ST}) were counted and compared between mother and progeny generation of studied beech stands. Each

population was represented by thirty individuals of mother trees and thirty randomly selected open-pollinated individuals of their progeny in every provenance.

The extraction of total DNA was performed using Qiagen DNeasy™ Plant Minikit. Separation of DNA fragments was performed in 8% acrylamide gel – automatic sequencer ALFexpress II (Amersham Pharmacia Biotech). The obtained results were elaborated with ALFwin Fragment Analyser™ 1.0 software and PopGene ver. 1.32.

The analysis of genetic structure basis of DNA fragments of chloroplast markers revealed presence of haplotypes characterised by different length - from 116 to 152 base pairs. Population of Bieszczadzki NP revealed monomorphic structure for a locus ccmp7 - 147 base pairs, while the majority of populations showed the presence of eight different alleles for this marker. Other analysed gene loci were characterized by a set of five haplotypes with similar length DNA fragments from 116 to 120 base pairs. Generally, mother generations were characterised slightly higher genetic variability than progeny generations (respectively $H_T = 0.4916$; $H_S = 0.3606$).

The high genetic variability plays a crucial role in the maintaining of biodiversity at the species and ecosystem level and often determines the possibilities of survival of forest trees, adaptation and evolution possibilities in the face of probable climate changes. It plays an important role in protection against biotic and abiotic threats of populations. The differentiation gene pool of beech and other species populations of forest trees can ensure their survival and better adapt to unfavorable environmental conditions such as drought, gradations of insects or fungal pathogens.

Analyses showed practically the unchanged gene pool between progeny generation and studied mother populations of beech, which were characterised by a stable gene flow between generations.

D. Overview of other achievements of scientific - research (artistic).

1. Conservation of gene resources of beech
   1.1. **Sułkowska, M.** 2007: Stan i zachowanie zasobów genowych buka zwyczajnego (*Fagus sylvatica* L.) w Polsce. In: *Quo vadis, forestry*? Materiały Międzynarodowej Konferencji – Sękocin Stary, 29-30 czerwca 2006 r.: 579-589.

In the elaboration were discussed the issues of practical measures to assess the state of conservation of genetic resources and beech using its protection methods in situ (in place of its occurrence) and other active forms of the ex situ conservation, if such were necessary

As it was emphasised conservation of genetic resources of the population is the most widely used level of genetic diversity of species protection, it was thus indicated that the first stage of action should be to recognise the object of genetic variation. The techniques, which are useful in determining of the level of genetic variability of beech currently applied, using protein markers and molecular analyses based on DNA tests were presented. Then, it discussed the current state of knowledge regarding variability and genetic diversity of beech population in Poland. The resulting projection obtained on the basis of studies indicates, that the condition of our beech is good, while the genetic structure is close to genetic variability level to neighboring countries.

In methodology, it was mentioned to undertake studies to assess the genetic variability of representative in terms of site diversity of plant communities of beech in Poland of nine provenances. The paper also presents preliminary results of genetic studies (DNA and protein markers) of all studied populations and phenological observations of 5 populations of mountain beech origin and their offspring and the characteristics of growth observations at established the experimental plot in Jabłonna Forest division.

In conclusion it was indicated the need to consider in forest management the existence of soil ecotypes of this species.

1.2. **Sułkowska, M.** 2006: Akcja Cost E52: Ocena zasobów genowych buka w aspekcie zrównoważonego rozwoju lasów. Bruksela, Belgia 27.03-28.03.2006 r. Leśne Prace Badawcze 2006(3): 138-139.

The COST Action E52 tasks, which have already began the next stage of research on the international research program of beech stuies - "Evaluation of Genetic Resources of Beech" (Muhs, Von Wuehlisch 1993[12], Paule 1995[13]), in which I have participated as a representative of Polish from 1994, have been presented this elaboration. The aim of the program was to test the provenance of European beech in terms of breeding, developing methods to preserve genetic resources, assessment of species response to climate change and its plasticity and adaptation to given habitat conditions within the whole natural range.

The main objectives of the research conducted within the framework of COST Action E52, was to estimate the significance of beech forest ecosystems, against to the expected climate change, based on the analysis of the behavior of the population (offsprings of natural stands), in the climatic conditions of the system of established experimental plots within the current range of the species.

1.3. **Sułkowska, M.** 2007: Od genów do puli genowej i od drzew do lasów. *Leśne Prace Badawcze* 2007(2): 115.

In the elaboration were highlighted the needs to broaden the scope of cooperation among scientists, involved in the research on forest tree species, with particular attention to endangered and threatened species, in terms of the expected climate change.

The results of genetic and population studies, on the impact of variability and diversity of forest trees on the functioning of forest ecosystems, stressed the importance of developing new research techniques for the possibility of estimation of the complexity of these phenomena and the need to search of new forms of their description, including through the use of methods of geostatic forecasting and mathematical modeling.

[12] Muhs, H.J., Wuehlisch, Von G. 1993: Research on the evaluation of forest genetic resources of beech – a proposal for a long-range experiment In: The scientific basis for the evaluation of the genetic resources of beech. Proceedings of an EC workshop Ahrensburg 1–2 July 1993. str. 257–261.

[13] Paule, L. 1995: Gene conservation in European beech (*Fagus sylvatica* L.). Forest Genetics 2(2–3): 161–170.

1.4. **Sułkowska, M.** 2007: Ekofizjologia populacji buka zwyczajnego i ich wrażliwość na zmiany klimatyczne. *Leśne Prace Badawcze* 2007(3): 138-139.

It shows the importance of European beech (*Fagus sylvatica* L.) in deciduous forest ecosystems in Europe A long period of natural selection and adaptation to different site conditions of occupied areas, revealed as a result the structural and functional adaptation to existing forest ecosystems species. Understanding of how beech forests can adapt to the anticipated changes of environment and their ability to overcome different types of stress, which they "must" deal with in order to survive, is the basis for understanding the relationship between genetic and ecophysiological variation of occupied habitats. Useful in the study of adaptation are comparative (provenance) trials, established for the purpose of observation of the growth and acclimatisation of the same population in the different environmental conditions. Due to the expected increase in temperature and decrease in rainfall, conducted observations of growth features, productivity and natural regeneration processes, with particular emphasis on the adaptability of beech to the limited availability of water in the soil are very important. An important problem appears to define the conditions limiting the growth e.g. regarding the temperature factor enabling to conduct photosynthesis.

Determination of plasticity of ecosystems with beech was considered to be the basic task of creating a new rules for breeding of beech and to ensure the continuity of functioning in order to minimize the harmful effects of the impact of climate changes.

1.5. **Sułkowska, M.** 2010. Conservation of Genetic Resources of European beech (*Fagus sylvatica* L.) in Poland. Frýdl, J., Novotný, P., Fennessy, J., von Wühlisch G. (eds.) *Communicationes Instituti Forestalis Bohemicae* Vol. 25: 184-190.

Sułkowska, M. 2011. Conservation of Genetic Resources of European beech (*Fagus sylvatica* L.) in Poland. Reissue of *Communicationes Instituti Forestalis Bohemicae* Vol. 25. Frýdl, J., Novotný, P., Fennessy, J., von Wühlisch G. (eds.) .Landbauforschung vTI Agriculture and Forestry Research, Sonderheft 350: 184-190.

The studies summarises information concerning the geographical range of the species occupied distribution area and percentage in Polish forests. It was also identified factors determining current field of distribution of the site by the species, such as climate, soil conditions, temperature and humidity.

Basic plant communities of the country, in which the species composition, beech has its share were characterised. It was also stressed the high economic value of the species in the wood industry.

Then it were discussed the methods applied to protect the genetic resources of beech in Poland, which ought to ensure, inter alia, the continuity of the fundamental ecological processes in nature, preservation of biological and genetic resources of the species for future generations as well as to indicate the possibilities of restitution of beech habitats, which could be vulnerable to anthropogenic pressure.

In the elaboration also were pointed out the practical rules Matras et al. 1993)[14] and legal measures (Regulation of the Minister of the Environment of 9 March 2004.)[15], regulating the commercial marketing and conservation of genetic resources of beech in Poland. At the same time it was indicated the need of implementation of the next program of conservation of forest tree species, including beech for the years 2011-2035. Attention was paid also to put into forest practice, for methods of storing of beech seed material for period longer than 5 years, which has been developed at the Institute of Dendrology in Kórnik. It were also presented the procedure of modern long-term storage of the plant material using liquid nitrogen, in order to protect especially valuable gene pool of populations or single individuals.

Chosen studies, in the field of biology and genetic resources of the species, concerning the selection of particularly valuable or endangered populations of beech were discussed as well . It has been paid particular attention to provenance studies conducted for this species, allowing an estimation of its environmental plasticity and research using molecular biology methods to assess genetic variability and diversity of the species.

2. Site variability of beech in Poland in the aspect results of soil analysis

2.1. **Sulkowska, M.**, Liesebach, M., Wojcik, J., Dobrowolska, D. 2011. Soil characteristics in the International Beech Provenance Experiments of 1993/95 and 1996/98. W: "Genetic Resources of European Beech (*Fagus sylvatica* L.) for Sustainable Forestry". Proceedings of the COST E52 Final Meeting in Burgos 4 - 6 May 2010, Burgos, Spain. *Monografias INIA: Serie Forestial*. Nr 22-2011: 27-35.

The characteristics of the soil beech habitats in Europe was shown in the paper. It highlighted the importance of climate and soil properties to the character of border range of the species, especially in areas, where the temperature and precipitation do not reaching the optimal value. It was noted that beech prefers clearly two types of habitats: alkaline soil - an airy and acid brown soils as a rule on heavy clay underlay. It emphasised the importance of micro-site of soil for plant growth at a high standard of its fertility, whatever its acidity.

Forecasts concerning changes in the area of beech, in terms of projected climate change were later presented. Generally, it is estimated beech limit range would be shift in the direction of the current boreal forest zone, followed by regression of species from habitats of southern and western Europe, due to the predicted there long periods of drought during the growing season may be observed.

The characteristics of the 49 habitats of international provenance trials, whose research plots are mainly located within the range of distribution the species in Europe are shown in the next order. Criteria for assessing of soil conditions experimental plots were as it followed: former manner of usage of soil, typology, fertility, availability of nutrients, moisture. In this part of the study was also shown, as an example, a detailed characterisation of soil on the experimental plot in Oleszyce (Regional Forest State Directorate Krosno).

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[14] Matras, J., Burzyński, G., Czart, J., Fonder, W., Korczyk, A., Puchniarski, T., Tomczyk, A., Załęski, A. 1993: Program zachowania leśnych zasobów genowych i hodowli selekcyjnej drzew leśnych w Polsce. Warszawa: Dyrekcja Generalna Lasów Państwowych, Instytut Badawczy Leśnictwa.

[15] Rozporządzenia Ministra Środowiska z dnia 9 marca 2004 r. w sprawie wykazu obszarów i map regionów pochodzenia leśnego materiału podstawowego (Dz.U. 04, nr 67, poz. 621).

3. The use of molecular analyzes in studies of beech migration routes, after the last glaciation period

   3.1. **Sułkowska, M.**, Łukaszewicz, J. 2013. Historia poglądów na temat zasięgu buka zwyczajnego w świetle badań molekularnych. *W:* Zastosowanie metod analiz DNA we współczesnym leśnictwie. *Postępy techniki w leśnictwie.* Stowarzyszenie Inżynierów i Techników Leśnictwa i Drzewnictwa, nr 122: 17-21.

This paper presents a synthesis of historical opinions regarding the range of beech according to the environmental and palaeobotanical survey, from the end of the nineteenth century to the present. Initially, the only reliable tool for assessment the distribution of species (including beech) were the results of analyses of pollen and macroremains of plants. As it has been shown, the results of such studies are often subject to errors, due to the mixing of layers of soil and lack of opportunity to indicate the initial stand of the species (refugium) during the glaciations.

The utilisation of modern techniques of molecular studies based on DNA and protein markers has been presented as a tool for determining the stand of beech in Europe during the glaciation, from where migration of the species to now inhabited territories has been started. At the present, it was considered that the migration of beech to almost whole of Europe took place from the area of currently Slovenia. In the studies was underlined that the current population genetic structure of beech was formed under the influence of often running opposite factors, relating in particular to gene flow between populations, which involves the elimination of individuals from habitat, which were not adapted for prevailing conditions of the growth.

At the same time own contribution of authors of the paper to the analysis of diversity of the species and suggestions on the migration paths of beech in Poland was presented.

4. Zmienność genetyczna i zachowanie zasobów genowych jarzębu brekinii

   4.1. **Sułkowska, M**. 2007 Principles of the Wild Service Tree (*Sorbus torminalis* (L.) Crantz) Conservation in Poland. European botanic gardens together towards the implementation of plant conservation strategies. *Monographs of Botanical Gardens.* Edited by Rybczyński J.J., Puchalski J.T. Vol I: 69-73.

The study contains information on the status of wild service tree genetic resources in Poland and methods of the species conservation. Characteristics of biology of the species and the recognition of the state of genetic variation in Europe on the basis of DNA and protein markers has been concluded. Characteristics of forms the basis of determining methods for the conservation of genetic resources of the species both *in-situ* and *ex-situ*.

The study presents main threats to wild service tree, where competition for light with other species is one of them. As it was indicated, the main effective form of protection of species may be fencing of small areas in forests, where there is a natural regeneration, in order to protect against grazing by animals, but which allowing for the control of competition with other plant species.

Wild service tree is an economically valuable raw material in the furniture industry in the countries of southern and western Europe. In Poland, it is fully protected species.

4.2. **Sułkowska, M.**, 2012. Utilization of genetic approaches for effective conservation of endangered species *ConGRESS* project, regional workshop, Zvolen, January 25– 27, *Folia Forestalia Polonica, series A, Forestry*. Vol. 54 (2), 140–142.

There were shown assumptions of open for forest managers the platform - ConGRESS (Conservation Genetic Resources for Effective Species Survival), established within Consortium project of 7th European Framework.

ConGRESS platform provides information on the biodiversity of plant and animal organisms and methods of their protection, including problems of their genetic diversity. Transfer of theoretical information on species conservation practice is the rank of executive here module, by testing different scenarios of decision-making under given conditions.

The study stressed needs to maintain stability of the gene pool of forest ecosystems, as a key condition for the preservation of their adaptability to react for rapid environmental changes. The first stage of activities in order to protect species, ought to be knowledge of genetic structure of the object. For this purpose, a variety of markers for assessment of qualitative and quantitative traits are utilised. Markers should be both, independent of environmental impact or development stage of the organism, as well as be characterized by predicted pattern of inheritance and enable tracking of coding and non-coding fragments of the genome.

In the last part of the elaboration it was noted that often the stage of cognitive of genetic variability of the population is neglected, while improper conservative actions may cause the destruction of the gene pool of the object under protection.

E. Handbooks, scripts.

1. Cycle of problems - Methodology of genetic research

1.1. **Sułkowska, M.**, Nowakowska, J., Matras, J. 2004: Zachowanie różnorodności biologicznej i edukacja ekologiczna – wyzwania w zjednoczonej Europie. *Leśne Prace Badawcze*, 2004(4): 205–207

The priority contemporary forest policy is subject of the protection of endangered and dominant forest tree species in their natural environment. On the effect of changing climatic and anthropological factors (industrial pollution, fragmentation of forest area), that affect the depletion of the gene pool of forest tree species, the preservation of genetic variation is a key element in the protection of biodiversity and the sustainable development of forests. The study presents activities relating to the protection of genetic resources, whose objectives is to promote continuity and sustainability of forest species in natural habitat of their occurrence (e.g. by establishing reserves and seed bases in the context of conservation *in situ*) and by maintaining *ex-situ* outside the natural range of the occurrence of species (e.g. in the form of archives and collections of clones stored in a forest gene bank).

1.2. **Sułkowska, M.** 2006: Genetyczna zmienność populacji buka zwyczajnego w Polsce. *In*: Elementy genetyki i hodowli selekcyjnej drzew leśnych. Opracowanie zbiorowe, J. Sabora. Centrum Informacyjne Lasów Państwowych. Pp. 223-229.

Chapter of the book is a lecture, presented within the framework of cyclical Postgraduate Studies in Genetics and Selection of Forest Trees of the Agricultural University in Krakow, since 1998. In Part IV of the Handbook on: „Zmienność wewnątrzgatunkowa drzew leśnych (Intraspecific variability of forest trees)", addressed mainly to postgraduate part-time students - foresters - practitioners, the genetic variability of the Polish populations of beech on the background of provenances of neighboring countries was discussed. The level of variation and genetic diversity of 26 populations was estimated, using proteins isoenzyme markers. Research methodology paying attention to: representative collection of plant material, isolation of the proteins and the preparation of solutions and gels to conduct protein resolution in the particular fractions were analyzed, in the further stage were described in detail.

In conclusion, it was emphasized, that the Polish populations were characterized by a similar level of genetic variability as compared to provenances from Slovakia, the Czech Republic and Moravia, Ukraine and Romania.

1.3. Ghowsi, K., Ghowsi H., Kapnissi-Christodoulou, C.P., Piasecki, T., Azouz, A.B., Paull, B., Macka, M., Brabazon, D., Lamy ,E., Costa, A.R., Antunes, C.M., Vitorino, R., Amado, R., Zhou Y., Simonsen, V., Pighin, D.G., González-Arenzana, L., López, R., Santamaría, P., López-Alfaro, I., **Sulkowska, M.K.**, Chacur, M. G.M., Itenge, T.O., Munin, F.S., de Aquino-Silva, M.R., Schwantes, M.L.B, de Almeida-Val, V.M.F., Schwantes, A.R., Sato, Y., 2012. Electrophoresis. InTech. Edited by Ghowsi K., ISBN 978-953-51-0846-7. Stron 246.

Chapter:

Sulkowska, M.K. 2012. Isoenzyme analyses tools used long time in forest science.*W: Electrophoresis. InTech. Edited by Kiumars Ghowsi, ISBN 978-953-51-0846-7* 1. Str.: 157-172.

The characteristics and use of enzymatic proteins as markers of genetic variation was presented. These proteins represent various structural forms of a specific conformation, differing in the value of electric charge, but do not differ practically in functions of catalyse of chemical reactions (i.e. isoenzymes). The formation of these proteins in nature is explained by genetic mutations that lead to the multiplication of genes responsible for their expression. The presence of various forms of genes (allozymes) can be easily identified in the electrophoretic separation of proteins. Utilized in the analysis isoenzyme proteins represent the direct products of genes responsible for their production. In practice, proteins whose inheritance is predictable and consistent with Mendelian rules are analysed.

The studies describe both advantages and methodological problems associated with the use of isoenzyme proteins as genetic markers. Also, direct examples of utilisation of above mentioned markers in forest methodology of research were given. It were also presents the substantive grounds for statistical analysis of results of research and were introduced computer software packages, that are used in this field.

The results were summarized for two species selected as a models, representing a variation of a clinal (geographic) - Scots pine and European beech, which is a species that is known as creating

habitat ecotypes. In addition, the possibility of using isozyme studies in artificial populations of forest tree of seed orchards for the identification and assessment of individuals mating systems, for production of improved seed material were presented.

At the current state of development of molecular analysis techniques, protein markers, which were characterised in the elaboration represent still a cheaper alternative to study genetic pool and an assessment of the species "migration routes", after the period of glaciation.

1.4. Nowakowska, J.A., **Sułkowska, M.K.** 2015. Capillary Electrophoresis as Useful Tool in Analysis of *Fagus sylvatica* L. Population Genetic Dynamics. *W* Field Effect Electroosmosis - A Novel Phenomenon in Electrokinetics and its Applications in Capillary Electrophoresis. Edited by Ghowsi K., ISBN 978-953-51-2025-4. 108 pages, Publisher: InTech, DOI: 10.5772/59197.

The characteristics and method for utillisation of capillary electrophoresis technique in molecular studies of DNA fragments was shown in the paper. The technique enables effective analysis of multiple samples simultaneously.

The paper presents results own studies of chloroplast DNA analysis for six beech populations (described in Part C, point 3b of this document - **Sułkowska M.,** Nowakowska J. 2011) and new results concerning nuclear DNA variation based on microsatellite analyzes carried out in sequencer CEQ™ 8000 Genetic Analysis System (Beckman Coulter, Fullerton, CA). The presented capillary electrophoresis technique were used following chloroplast (ccmp4, ccmp7 and ccmp10) and nuclear DNA markers (FS1-03, FS1-25, FCM5, mcf5, mcf11) for six beech population and their progeny. In addition, it was explained the procedure of elaboration the results of research based on the detailed analysis of distinguished in the paper forms identified alleles - DNA fragments.

As it was indicated in the paper, evaluation of the genetic structure of the DNA fragments of samples should always be preceded by an qualitative and quantitative analysis of intended to further identify DNA, following its isolation from the cells of the organism. The study also indicated were indicated statistical tools and software packages: CEQ System software (Beckman Coulter sequencer), GeneMapper®, GeneMapper® ID-X Softwares (Abi-Prism sequencer). The basic measure of variability and diversity of genetic parameters, including, inter alia, heterozygosity (observed and expected), the average and effective number of alleles per locus and the genetic distance of the analysed objects, as well as statistical programs, which provide posibilities of analysis of these parameters - GENEPOP, GenALEx, ARLEQUIN, SPAGeDi and POPGENE have also been discussed in the elaboration.

1.5. **Sułkowska, M.**, Nowakowska, J. 2007: Nowoczesne osiągnięcia proteomiki i jej praktyczne zastosowania w diagnostyce procesów chorobotwórczych *Leśne Prace Badawcze* 2007(2): 116–117.

Scientific report presented in the issue of *Leśne Prace Badawcze* is related to new field of science - proteomics research dealing with the structure of proteins, their functions and relationships between the action of these proteins in a living organism. The concept of proteomics was first used in 1995 to identify all the proteins in cell lines, tissue or whole organisms (proteome).

Further shown the steps of proteomic studies, the first of which was concerned the initial separation of the protein mixture with the use of, inter alia, the process of electrophoresis on the gel carrier,

and the next step involved the identification of proteins by mass spectrometry and X-ray crystallography, for the comparative evaluation of the structure of proteins in the databases. During the step of analysis of proteins are also used immunological methods and quantitative measurements. It was emphasized the fact that in proteomics technique are often utilised methods relating to the bioinformatics and testing of endogenous and environmental factors, which determine the modification of proteins in the cellular processes.

The methods of using proteomics, in practice forest management, eg. concerning selection of trees infected by pathogenic strain of fungus, when symptoms were not visible yet, also were discussed.

2. Cykl prac – Problematyka roślin genetycznie modyfikowanych

2.1. Nowakowska, J., **Sułkowska, M.**, Oszako T. 2014. Environmental risk assessment of Genetically Modified Plants (GMO) – challenges and approaches. 2014, *Folia Forestalia Polonica, series A- Forestry*, Vol. 56(3): 113-115. PL ISSN 0071-6677. DOI: 10.2478/ffp-2014-00011.

It was discussed controversial issues of deliberate release of genetically modified organisms into environment, on the example of 89 scientific debate the European Food Safety Authority (EFSA) GMO Panel on 9-10 April 2014. The debate was focused on large-scale use in world soybean and rape and the assessment of the risk of introducing these organisms into the environment and manage their use simultaneously in aspects of their impact on human and animal health.

2.2. **Sułkowska, M.**, Nowakowska, J., Oszako, T. 2014. Możliwości integrowanej ochrony roślin przed szkodnikami. *Leśne Prace Badawcze* 75(4): 429-430.

The problem of uncontrolled gradation of pests / pathogens of foreign origin which to a new habitat were introduced accidentally by man was also presented. Generally, such organisms as it was noted, usually do not have natural enemies in the environment and their elimination have to usually performed through the use of chemical agents that are beyond the poisoning of the environment also could require incurring of large financial costs.

Next, there were discussed actions on opportunities to improve integrated pest control undertaken on an international scale. In the studies it was drawn attention to the possible induction of resistance, the preservation functional diversity of species and opportunities to reduce feeding of insects, described as a model *Rhagoletis cerasi* (European cherry fly), *R. cingulata*, *Drosophila suzukii* (spotted wing drosophila).

In protection, as it was noted, the genetically modified organisms (GMOs) may be innovative solution. Such organisms can play important role the future in forestry, with the prudence principle, the introduction into the environment, if it occurs, and after analyzing the risks. The procedure for placing on the market of such organisms is very complex, and their possible presence in nature raises a lot of social controversy.

F. Participation in research projects

„Populacyjna zmienność buka zwyczajnego (*Fagus sylvatica* L.) w Polsce (wzrost i rozwój populacji w okresie młodnika), dotyczącym badań proweniencyjnych 45 polskich populacji buka" – funded by General Directorate of Forest State, No. of topic: BLP-304 (start 1992. and continued until 2010).

„Fizjologiczne i biochemiczne aspekty długoterminowego przechowywania generatywnych i wegetatywnych organów i tkanek drzew leśnych", – funded by the World Bank, 1994 – 1997.

Concerted Action „European Network for evaluation of the genetic resources of beech for appropriate use in sustainable forestry management" – funded by the third Framework Programme, the Concerted Action, 1995-1998.

Continued as:

COST E52 „Evaluation of Beech Resources for Sustainable Forestry" – Cost Action, 2006 –2010.

Zmienność genetyczna wybranych cech morfologicznych i przyrostowych buka zwyczajnego (*Fagus sylvatica* L.) polskich pochodzeń – project statutory of Forest Research Institute, No. topic: 12/24/01, financed by the Committee for Scientific Research, 1996-1999.

Centre of Excellence **"Proforest: Protection of forest resources in Central Europe"** – funded by Sixth Framework Programme, No. topic: QLK1-CT-2002-30315/ PROFOREST, 2003-2006.

Genetyczne uwarunkowania zmienności ekotypowej buka zwyczajnego (*Fagus sylvatica* L.) – funded by General Directorate of Forest State, No. of topic: BLP-248, 2003-2007.

Zmienność gatunków lasotwórczych na granicy ich naturalnego występowania w Polsce w świetle prawdopodobnych zmian klimatycznych oraz konsekwencje tych zmian dla gospodarki leśnej (etap I – buk zwyczajny *Fagus sylvatica* L.), ocena zmienności genetycznej i charakterystyki hodowlanej gatunku na granicy zasięgu; funded by General Directorate of Forest State, No. of topic: BLP 266, 2004 – 2008.

Network of Excellence **"Global change and Ecosystems EVOLution of TREEs as drivers of terrestrial biodiversity – EVOLTREE. Biodiversity and ecosystems. Genomics for terrestrial biodiversity and ecosystem research"** – funded by Sixth Framework Programme, 2006 –2010.

„TREEBREEDEX: of tree improvement for competitive, multifunctional and sustainable European forestry" – funded by Sixth Framework Programme, 2006 –2010.

"Opracowanie i wdrożenie do praktyki leśnej metod identyfikacji wczesnej oceny leśnego materiału rozmnożeniowego w oparciu o markery molekularne" – financed by the Committee for Scientific Research, No. of topic: 671235, 2007 – 2009.

„Zróżnicowanie genetyczne czereśni ptasiej (*Cerasus avium* Moench) i jarząbu brekinii (*Sorbus torminalis* (L.) Crantz) w Polsce oraz możliwości ich plantacyjnej uprawy w celu uzyskania wysokowartościowego surowca drzewnego" – funded by General Directorate of Forest State, No. of topic: BLP 334, 2008 – 2012.

„Weryfikacja istniejących zasięgów występowania głównych lasotwórczych gatunków drzew w Polsce na podstawie nowych badań"; funded by General Directorate of Forest State, No. of topic: BLP 358, 2011– 2014).

„Charakterystyka genetyczna polskich populacji świerka z podzasięgu południowego (Hercyńsko-Karpackiego) na podstawie analiz DNA" – funded by General Directorate of Forest State, No. of topic: BLP 407, 2014-2017.

G. Lectures presented at scientific conferences

17 September 1994, **Sułkowska, M.** 1995: Growth of beech seedlings (*Fagus sylvatica* L.) in provenance trials in Poland. *Proceedings from the 5th Beech Symposium of the IUFRO Project Group P1.10–00, 19 – 24 September 1994, Mogenstrup, Denmark, edited by Soren F. Madsen, Danish Forest and Landscape Institute, Forskningsserien* **11**: 69–82. Monograph, reviewed

4 October 1995,. **Sułkowska, M.** 1995: Ecological and growth characterisation of beech (*Fagus sylvatica* L.) populations in Poland. *"6 Beech Symposium"Lviv*, Ukraine, 1-8.10.1995. p. 15

6 July 2004, **Sułkowska, M.** 2004: Genetic and ecotype differentiation of *Fagus sylvatica* L. in Poland. Proceedings of the conference "Biodiversity conservation and ecological education – challenges in the United Europe" Cieszyn, 5–8.07.2004. p. 22

30 September 2004, **Sułkowska, M.** 2004: Zróżnicowanie ekotypowe populacji buka zwyczajnego *Fagus sylvatica* L. w Polsce. Międzynarodowa konferencja nt. „Rola lasu w zachowaniu w zachowaniu różnorodności biologicznej" Poznań–Puszczykowo, 29–31.09.2004. pp. 56–57

4 September 2007, **Sułkowska M.**, Charkot, S., Bieniek, B., Przybylski, P. 2007: Markery izoenzymatyczne i DNA w ocenie zmienności i zróżnicowania genetycznego wybranych populacji buka w Polsce. Botanika w Polsce – sukcesy, problemy perspektywy. Streszczenia referatów i plakatów. 54 Polish Botanical Society. Szczecin 3-8 September 2007. p. 45

3 July 2007, **Sułkowska, M.** 2007: Wild service tree (*Sorbus torminalis* (L.) Crantz) important, disappeared and endangered species in Poland. *Biuletyn Ogrodów Botanicznych, Muzeów i Zbiorów.* 2007. Vol. 16A. p. 29

28 February 2008, **Sułkowska, M**. 2008: Genetic variation of European beech in response to soil differentiation. Workshop on Plasticity and Adaptation in Forest Trees. Madrid, 27th – 29th February 2008. p. 14

5 March 2009, **Sułkowska, M.**, - „Genetyczna zmienność populacji buka w Polsce (izoenzymy)". Studium podyplomowe Genetyki i Selekcji Drzew Leśnych. Rok akademicki 2008/2009.

24 May 2009, **Sułkowska, M**., Wojda, T. 2009: Isoenzyme variability in Polish and Latvian silver birch (*Betula pendula* Roth) provenances. Eurasian Forests – Polish Forests. Materials of the IX International Conference of Young Scientists, dedicated to 145 anniversary from the date of prof. I.K. Paczoski`s birth. Poznań –Kórnik-Kostrzyca, 24-30, May 2009. pp: 162-167

29 May 2009, Wojda, T., **Sułkowska, M.** 2009: Fenologiczna i genetyczna zmienność wybranych proweniencji brzozy brodawkowatej (*Betula pendula* Roth) a regionalizacja leśnego materiału rozmnożeniowego. Konferencja Naukowa „Rozwój hodowli lasu wspólnym osiągnięciem nauki i praktyki leśnej". Poznań – Zielonka – Łopuchówko 27-29 maja 2009. Przegląd Leśniczego nr 5/2009 (215/XIX): 21

8 April 2010, **Sułkowska, M.** – „Międzypokoleniowe zróżnicowanie genetyczne populacji buka zwyczajnego w Polsce" – seminarium : „Badania genetyczne drzew leśnych na poziomie molekularnym", Forest Research Institute. This seminar was widely discussed in forest journals: Trybuna Leśnika no. 5/2010, Głos Lasu no. 5/2010 and Las Polski no. 15-16/2010

4 May 2010, Robson, T.M., Gömöry, D., Rasztovits, E., Mertens, P. Liesebach, M., Zitová, M., Ionita, L., Bozic, G., **Sulkowska, M.**, Alia, R., Forstreuter, M., von Wühlisch, G. 2010. Influence of provenance origin and site of growth on the timing of leaf flush in beech saplings. W: Genetic Resources of European Beech (*Fagus sylvatica* L.) for Sustainable Forestry 4-6 May 2010, Burgos, Spain. Book of Abstracts. p. 47

5 May 2010, **Sulkowska, M.** 2010. Ecotype variation of European beech in Poland on the basis of soil differentiation. W: Genetic Resources of European Beech (*Fagus sylvatica* L.) for Sustainable Forestry 4-6 May 2010, Burgos, Spain. Book of Abstracts. p. 55

13 May 2010, **Sułkowska, M.**, Nowakowska J. 2010. Genetic structure of European beech of mother and progeny stands in Poland on the basis of DNA chloroplast markers. International Conference "Forestry: Bridge to the Future" 13 - 15 May 2010, Park Hotel Moskva, Sofia, Bulgaria. Book of Abstracts. p. 124

10 June 2010, von Wühlisch, G., Alexandrof, A., Alia, R., Bozic, G., Dococousso, A., Fennessy, J., Forstreuter, M., Frydl, J., Geburek, T., Raffaello, G., Gömöry, D., Hansen, J.K., Huber, G., Ivankovic, M., Ionita, L., Liesebach, M., Matyas, C., Mertens, P., Muhs J.H., Parnuta, G., Paule, L., Rasztovits, E., Robson, T.M., Stener, L-G., **Sulkowska, M.**, Urban, O., Vettori, C., de Vries S.M.G., Wesoly, W. 2010. Evaluation of Genetic Resources of European Beech (*Fagus sylvatica* L.) by International Provenance Trials. W: Forest ecosystem genomics and adaptation. San Lorenzo de El Escorial (Madrid), Spain 9-11 June, 2010. Book of Abstracts. p. 90

22 June 2010 r. **Sułkowska, M.** – „Characteristics of genetic diversity and differentiation of progeny and mother stands of European beech in Poland" What do large genetic field experimental networks across Europe bring to the scientific community? Sękocin Stary (Poland), June 22–24, 2010.

27 October 2010 r. **Sulkowska, M.** – „Genetic and ecotype characterization of European beech (*Fagus sylvatica* L.) in Poland". International Scientific Symposium. Fagus 2010. „Is there future for beech – Changes, Impacts and Answers". October 27th-28th Varaždin, Croatia. pp. 29-31

7 September 2010, Nowakowska J., **Sułkowska, M.**, Szczygieł, K. – „Laboratory of Molecular Genetics at the Institute (DNA analysis, isoenzymes, in vitro". The 5th FIELD GENETICISTS NETWORK Meeting POLAND, Warszawa, September 6-10, 2010.

27 October 2010, **Sułkowska, M.,** – „Genetic and ecotype characterization of European beech (*Fagus sylvatica* L.) in Poland" – International Scientific Symposium. Fagus 2010. „Is there future for beech – Changes, Impacts and Answers". October 27th-28th Varaždin, Croatia.

27 January 2012 r. **Sułkowska, M.**, - „Genetic diversity studies and ex-situ conservation methods of *Sorbus torminalis* L. (Crantz.) in Poland". The utilization of genetic approaches for effective conservation of endangered species *ConGRESS project*, regional workshop, Zvolen, January 25– 27, 2012. Technical University Zvolen, *ConGRESS project*.

1 June 2012, **Sułkowska, M.**, – "Zmienność genetyczna jarzębu brekinii (*Sorbus torminalis* (L.) Crantz) w Polsce i proponowane metody zachowania jego zasobów genowych. Forest Research Institute.

31 January 2013, Nowakowska, J., Łukaszewicz, J., Paluch, R., Tereba, A., Pawlak, B., **Sułkowska, M.**, Zajączkowski, P., Borys, M., Konecka, A., Michalska, A., Zawadzka, A., Jakubowski, G., Kopryk, W., Krajewski, S., Bieniek, J. 2013. Struktura genetyczna głównych gatunków lasotwórczych w Polsce na tle współczesnych granic zasięgów ich występowania. *Forest Reproductive Material Office*, Warszawa, 31.01.2013 r.

6 June 2013, **Sułkowska M.** – "Zróżnicowanie genetyczne jarzębu brekinii na podstawie badań DNA". Seminarium IBL, Czereśnia ptasia i jarząb brekinia w Polsce – Występowanie, zróżnicowanie genetyczne oraz możliwości uprawy plantacyjnej, Forest Research Institute, Sękocin St. **Lecture ordered**

26 June 2013, **Sułkowska M.**, Bednorz L., Bieniek J. - „ Zmienność genetyczna jarzębu brekinii (*Sorbus torminalis* (L.) Crantz) w Polsce i proponowane metody zachowania jego zasobów genowych". 56 Zjazd Polskiego Towarzystwa Botanicznego, Interdyscyplinarne i aplikacyjne znaczenie nauk botanicznych, Olsztyn-Kortowo. Polish Botanical Society, Congress. 24-30 June 2013. **International Conference**

26 June 2013, Nowakowska, J., Aniśko, E., Borys, M., Bieniek, J., Kantorowicz, W., Klisz, M., Kowalczyk, J., Matras, J., Michalska, A., Przyborowski, J., Przybylski, P., Rakowski, K., Szyp-Borowska, I., **Sułkowska, M.**, Szczygieł, K., Zawadzka, A., Zawadzki, M. - „ Zmienność genetyczna polskich populacji sosny zwyczajnej (*Pinus sylvestris* L.) na podstawie markerów mitochondrialnego DNA, 2013 r., 56. Polish Botanical Sosiety Congress. **24-30 June 2013. International Conference**

8 April 2014, **Sułkowska M.** – „Wstępna ocena zmienności rodowo-proweniencyjnej wybranych pochodzeń jarzębu brekinii i czereśni ptasiej w Polsce". Seminar, Forest Research Institute; Sękocin St. – 8.04.2014

12 June 2014 r. Wojda T., **Sułkowska, M.**, - „Ocena zróżnicowania jarzęba brekinii *Sorbus torminalis* (L.) Crantz. na powierzchniach proweniencyjno-rodowych w Nadleśnictwie Syców i Jamy." Scientific and Educational Seminar: Rozmnażanie cisa pospolitego jako element ochrony i restytucji gatunków drzew leśnych w jednostkach Lasów Państwowych, Stary Sącz – Nawojowa,11-13.VI.2014. Regional Directorate of Forest State Kraków, Forest department, Agricultural Uniwersity, Kraków. **Lecture ordered**

17 April 2015, Nowakowska, J., **Sułkowska, M.**, Tereba, A. – „Struktura genetyczna świerka, modrzewia, jodły, buka i dębu bezszypułkowego w Polsce". Konferencja naukowa nt. Weryfikacja istniejących zasięgów występowania głównych lasotwórczych gatunków drzew na podstawie nowych badań. Forest Research Institute; Sękocin St. – 8.04.2014 r.

25 June 2015, **Sułkowska, M.**, Nowakowska, J., Tereba, A., - "Utilisation of molecular studies in the conservation of genetic resources of selected forest tree species". Genetic Resources Conservation – Scientific And Social Challenges. 25-June-2015. Karpacz (Poland). **Lecture ordered.**

Many lectures of promoting research at the Forest Research Institute 1994- 2015

As well as:

2012-2014, the organization of the Festival of Science in the month - September:

Family Picnic "Secrets of forests"

Sułkowska, M. „Geography and biology in environment" lecture

Sułkowska, M. „Identifying species of trees" workshops for children and adults

H. Synthetic summary of scientific achievements

1. Number of publications and scientific reports in total: 86
2. Number of publications after obtaining the degree of doctor: 55
3. The number of publications in journals from JCR list: 11
4. The number of publications in journals from JCR list after obtaining the degree of doctor: 3
   The number of remaining publications: 75
   before obtaining the degree of doctor: 23
   after obtaining the degree of doctor: 52
   including popularised papers: 15
5. Number of individual publications: 33
6. Number of individual publications in journals from JCR list: 6
7. Number of publications with co-authors – two authors: 31
8. Number of publications with co-authors – two authors in journals from JCR list: 4
9. Number of publications with co-authors – three or more authors: 22
10. Number of publications with co-authors – three or more authors in journals from JCR list: 1
11. **The total score for all publications (according to the MNiSW of 31 December 2014): 457**
    The total score MNiSW according to the scoring by year of publication: 195
    The total score with regard to monographs and chapters in monographs: 305
12. **The total score for publications after obtaining the degree of doctor (according to the MNiSW of 31 December 2014): 274**

The total score MNiSW according to the scoring year of publication after obtaining the degree of doctor: 244

13. **The total score for publications from JCR list (according to the MNiSW of 31 December 2014): 190**

14. **The total score for publications from JCR list (according to the MNiSW of 31 December 2014) after obtaining the degree of doctor: 45**
15. Impact factor for all publications (according to the MNiSW of 31 December 2014): 5,715
    Impact Factor according to the scoring by year of publication after obtaining the degree of doctor: 0,631
    before obtaining the degree of doctor: 0,261
    after obtaining the degree of doctor: 0,370
16. The total number of citations (according to Web of Science of 25 July 2015): 12
17. Number of citations without auto-citations (according to Web of Science of 25 July 2015): 11
18. Indeks Hirsha (according to Web of Science of 25 July 2015): 1

I. Synthetic summary of the achievements of teaching, popularisation and summary of cooperation with institutions, organizations and scientific societies

1. Participation in scientifc conferences

1.1. **Sułkowska, M. 2004:** Genetic and ecotype differentiation of *Fagus sylvatica* L. in Poland. Proceedings of the conference "Biodiversity conservation and ecological education – challenges in the United Europe" Cieszyn, 5–8.07.2004. p. 22

1.2. **Sułkowska, M. 2004:** Zróżnicowanie ekotypowe populacji buka zwyczajnego *Fagus sylvatica* L. w Polsce. Międzynarodowa konferencja nt. „Rola lasu w zachowaniu w zachowaniu różnorodności biologicznej" Poznań–Puszczykowo, 29–31.09.2004: 56–57

1.3. **Sułkowska, M,** Charkot, S., Bieniek B., Przybylski, P. 2007: Markery izoenzymatyczne i DNA w ocenie zmienności i zróżnicowania genetycznego wybranych populacji buka w Polsce. Botanika w Polsce – sukcesy, problemy perspektywy. Streszczenia referatów i plakatów. 54 Zjazd Polskiego Towarzystwa Botanicznego. Szczecin 3-8 września 2007.p. 45

1.4. **Sułkowska, M.** 2007: Wild service tree (*Sorbus torminalis* (L.) Crantz) important, disappeared and endangered species in Poland. Biuletyn Ogrodów Botanicznych, Muzeów i Zbiorów 2007 Vol. 16A. p. 29

1.5. **Sułkowska, M.** 2008: Genetic variation of European beech in response to soil differentiation. Workshop on Plasticity and Adaptation in Forest Trees. Madrid, 27th – 29th February 2008. p. 14

1.6. **Sułkowska, M.,** Wojda, T. 2009: Isoenzyme variability in Polish and Latvian silver birch (*Betula pendula* Roth) provenances. Eurasian Forests – Polish Forests. Materials of the IX International Conference of Young Scientists, dedicated to 145 anniversary from the date of prof. I.K. Paczoski`s birth (24-30, May 2009): 162-167

1.7. Wojda, T., **Sułkowska, M.** 2009: Fenologiczna i genetyczna zmienność wybranych proweniencji brzozy brodawkowatej (*Betula pendula* Roth) a regionalizacja leśnego materiału rozmnożeniowego. Konferencja Naukowa „Rozwój hodowli lasu wspólnym osiągnięciem nauki i praktyki leśnej" . Poznań – Zielonka – Łopuchówko 27-29 maja 2009. Przegląd Leśniczego nr 5/2009 (215/XIX): 21

1.8. **Sułkowska, M.,** Wojda, T. 2014: Znaczenie rodowych powierzchni doświadczalnych w ochronie ex situ jarzębu brekinii (*Sorbus torminalis* L. Crantz XLIII Zjazd Polskich Ogrodów Botanicznych i Ogólnopolska Konferencja p.t. „Różnorodność biologiczna Polski a Światowy

Strategiczny Plan dla Bioróżnorodności 2011-2020 – nowe wyzwania i zadania dla ogrodów botanicznych oraz banków genów", Powsin, 30.VI.-4.VII.2014 r.). p. 41

1.9. Przybylski, P., **Sułkowska, M.,** Szyp-Borowska, I. 2014: The verification of the correctness of clone grafts planting in seeds orchard of Scots Pine (*Pinus sylvestris* L.) in Norh-eastern Poland. „Forest Tree Breeding" IUFRO Conference Praha (Czechy) 24-31.VIII.2014 r. p. 50.

1.10. **Sułkowska, M.K.**, Nowakowska, J.A, Tereba, A. 2015. Utilisation of molecular studies in the conservation of genetic resources of selected forest tree species. Genetic Resources Conservation – Scientific And Social Challenges. 25-June-2015. Karpacz (Poland). p. 51-52

2. Participation in organizing committees of scientific conferencesOrganisation of Workshop for Proforest (Centre of Excellence) – "Analysis of microsatelite sequences in Scots pine", Sękocin St. 24-27.08.2004 – Secretary

2.2. Organisation of meeting for group COST E52 "Evaluation of the Genetic Resources of Beech for Sustainable Forestry" Joint Working Groups and Management Committee Meeting. Rzeszów-Jasionka. 06-10.2008 r. – Main Organiser

2.3. Workshop conference: Metody identyfikacji leśnego materiału rozmnożeniowego w oparciu o markery molekularne DNA. Sękocin Stary IBL - 27. 11. 2009 – Co-organiser

2.4. International scientific Conference What do large genetic field experimental networks across Europe bring to the scientific community? Sękocin Stary (Poland), June 22–24, 2010 – Co-organiser

2.5. Scientific Sesions of Warsaw Department of Polish Botanical Society since October 2006 up to now – with different functions: Secretary of Department, vice-head of DepartmentCongresses of Polish Botanical Society: September 2010 - Warsaw - Chief Organizer, June 2013 - Olsztyn – Protocol sekretaryReviews in journals from JCR database

3.1. Efficient plantlet regeneration and flow cytometry analysis of nuclear DNA content in brinjal (*Solanum melongena* L.) var. Mattu and Perampalli Gulla - unique varieties in Udupi, Karnataka. India. *Acta Physiologiae Plantarum.* 2012.

3.2. In vitro propagation of the medicinal plant *Solanum nigrum* in liquid media and evaluation of its antioxidant property. *Acta Physiologiae Plantarum.* 2013.

Reviews in journals other than JCR database

1. Review of dissertation: made for the Belarusian Academy of Sciences, Institut Počvovedenia i Agrochemii NAN Balarusi: dissertation – Viktorii Leonidownej Andreewy nt. Ocenka počzvenno-resursnovo potencjala tipov zemel Balarusi na primere Berezinskovo biosfernovo zapowiednika i Nacionalnovo parka „Braslavskie ozera" – PhD defense 10 April 2006.

2. Book review: **Sułkowska, M. 2007**: Zachowanie i zarządzanie leśnymi zasobami genowymi w Europie [Thomas Gburek & Jozef Turok editors. Conservation and Management of Forest Genetic Resources in Europe. Arbora Publisher, 2005]. *Leśne Prace Badawcze* 2007(3): 147-148.

3. Review of dissertation: **Sułkowska, M. 2008**: Zmienność genetyczna polskich wybranych populacji sosny zwyczajnej (Pinus sylvestris L.) na podstawie analiz polimorfizmu DNA [J. A.

Nowakowska. Prace Instytutu Badawczego Leśnictwa, Rozprawy i Monografie, Sękocin, 2007]. *Leśne Prace Badawcze* Vol. **69**(1): 77-78

4. Opinion for the General Directorate for Environmental Protection, Department of Nature Conservation, concerning the restitution of wild service tree on territory of West Poland, Forest Arboretum in Syców. April 2009.

Reviews - qualified to publish articles as section editor (genetics) at the Leśne Prace Badawcze Journal (Forestry Research Institute), reviews for papers of *Folia Forestalia Polonica Series A – Forestry*

2011 r.

1. The effect of Light on seedlings increment in regeneration gaps in pure beech Forests (Case Study: Iran- Mazandaran - Liresar Forest). *Folia Forestalia Polonica, Series A – Forestry*
2. The effect of forest treefall gap on humus forms in mixed *Fagus orientalis* Lipsky (Oriental Beech) forest. *Folia Forestalia Polonica, Series A – Forestry*
3. Polimorfizm izoenzymów i wzrost wybranych pochodzeń świerka pospolitego [*Picea abies* (L.) Karst.] doświadczenia IPTNS-IUFRO 1964/68 w Krynicy. *Prace Instytutu Badawczego Leśnictwa*
4. Wzrost szczepów lipy drobnolistnej (*Tilia cordata* Mill.) na plantacji nasiennej w Nadleśnictwie Susz. *Prace Instytutu Badawczego Leśnictwa*
5. Markery RAPD sprzężone z genami cech ilościowych sosny zwyczajnej (*Pinus sylvestris* L.). *Prace Instytutu Badawczego Leśnictwa*
6. Wartość hodowlana wyselekcjonowanych rodów modrzewia europejskiego (*Larix decidua* Mill.) z pochodzenia sudeckiego na przykładzie powierzchni doświadczalnej w Zwierzyńcu Lubelskim. *Prace Instytutu Badawczego Leśnictwa*
7. Analiza wybranych cech jodły pospolitej (*Abies alba* Mill.) na powierzchni proweniencyjnej w Rogowie. *Prace Instytutu Badawczego Leśnictwa*

2012 r.

8. Genetic structure of selected Norway spruce [*Picea abies* (L.) Karst.] provenances tested in IPTNS-IUFRO 1964/68 experiment in Krynica. *Folia Forestalia Polonica, Series A – Forestry*

2013 r.

9. Growth of Scots pine (*Pinus silvestris* L.) on forest and former agricultural lands in Krynki Forest District *Folia Forestalia Polonica, Series A – Forestry*

10. The effective factors on diversity of natural regeneration and herbaceous vegetation in forest corral area in northern forests of Iran. Forest District *Folia Forestalia Polonica, Series A – Forestry*
11. Diversity of flora in the undergrowth of parks' afforestations, rural plantings and oak-hornbeam forests. Forest District *Folia Forestalia Polonica, Series A – Forestry*
12. *Sorbus hornadensis* Mikoláš (Rosaceae, Pyreae), a new hybridogenous species of *Sorbus hazslinszkyana* agg. from eastern Slovakia, THAISZIA - Journal of Botany

2014 r.

13. Comparative evaluation of development of spruce climatypes in 33-year old provenance trial of Russia. Forest District *Folia Forestalia Polonica, Series A – Forestry*

4. Lectures and workhops with students (hour/ year between xxx-xxx)

Sułkowska M conducted didactic classes in the form of lectures and laboratory exercises on the first and second semester of Postgraduate Studies of Genetics and Selection of Forest Trees in the academic year 1999/2000, 2000/2001, 2005/2006 and 2008/2009.

Lectures:
– Genetic variability of deciduous species populations – 2 hours
– Genetic variability of beech populations in Poland (isoenzyme) – 2 hours
Laboratory exercises:

– DNA analysis of spruce and beech isoenzyme markers – 2 hours

5. Development of series of lectures and exercises in forest tree genetics and genetic diversity

The thematic scope of lectures and exercises in forest tree genetics and genetic diversity assessment methods of spruce using DNA techniques and isozyme analysis has been prepared as lectures and author`s M. Sułkowska and number of hours of teaching has been established at the request of the then Head Study Professor. Janusz Sabor (died) and with the approval of the Faculty of Forestry, H. Kołłątaj University of Agriculture in Kraków.

6. Publications popularising knowledge

6.1. Rybacki, S., **Sułkowska, M.** 1998: Drzewo drzewu nierówne. *Poznajmy Las:* 3: 6-9.
6.2. Rybacki, S., **Sułkowska, M.** 1999: Pokrywa na talerzu. *Poznajmy Las:* 5: 13-15.
6.3. **Sułkowska, M.,** Rybacki, S. 1999: Śpiący las. *Poznajmy Las*: 1: 3-7.
6.4. **Sułkowska M.**, Rybacki S. 1999: Nowa Arka Noego. *Poznajmy Las:* 3: 3-6.
6.5. Rybacki S., **Sułkowska M.** 1999: Chemiczne wojny roślin. *Poznajmy Las:* 4: 4-7.
6.6. **Sułkowska, M.**, Rybacki, S. 1999: Drewniane kalendarze. *Poznajmy Las:* 6: 3-6.
6.7. **Sułkowska, M.** 2000: Monitoring czyli czuwanie. *Poznajmy Las:* 1: 3-6.
6.8. Rybacki, S., **Sułkowska, M.** 2000: Leśne zegary. *Poznajmy Las:* 2: 22-24.
6.9. **Sułkowska, M.**, Rybacki, S. 2000: Kwitnący las. *Poznajmy Las:* 3: 7-9.
6.10. **Sułkowska, M.**, Rybacki, S. 2001: Goście w lesie. *Poznajmy Las:* 1: 10-12.
6.11. **Sułkowska, M.**, Rybacki, S. 2001: W sieci... czyli rzecz o pająkach. *Poznajmy Las:* 3: 18-19.

6.12. **Sułkowska, M.**, Rybacki, S. 2001: Sowy - nocni łowcy. *Poznajmy Las:* 4: 7-9.

6.13. **Sułkowska, M.** 2003: Wiosna w lesie. *Poznajmy Las:* 3: 16-17.

6.14. Skrzyszewska, K., **Sułkowska M.**, 2012. Prof. dr hab. Janusz Sabor (1946-2012) – distinguished geneticist-forester, critical observer, nature and arts lover. *Folia Forestalia Polonica, series A, Forestry.* Vol. 54 (3), 202–204.

6.15. Skrzyszewska, K., **Sułkowska M.**, 2012. Janusz Sabor (1946-2012). Wspomnienie pośmiertne. *Leśne Prace Badawcze*, Vol. 73, 3: 263-265.