

The changes of founders' number and their contribution to the European bison population during 80 years of species' restitution

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Abstract The aim of this paper is to clarify the genetic structure of European bison *Bison bonasus* after species bottleneck. When in 1924 the restitution process has been started there were only 54 individuals (29 males and 25 females) with proven genetic purity. The pedigree of this group was analyzed and it was stated that 28 animals with unknown parents can be counted as species founders. This large group of founders can be divided into two parts; one consisted of 17 individuals carefully diagnosed by Slatis (1960) and 11 others not represented in current European bison population. The contribution of those lost ancestors at the beginning of restitution was equal to 26,9%. Large part of those losses was due to termination of European bison breeding at Woburn of unknown reason. The analysis explained also tremendous changes in founder's contribution since the beginning of E. bison restitution.

Key words: European bison, founders' number, founders' contribution, pedigree analysis

Introduction

The International Society of European Bison Protection was created in 1923, and one of its most important tasks was to make inventory of all individuals still being alive in few reserves and zoological gardens of Europe. The inventory showed only 54 (29,25) alive European bison with proven genetic purity. Those individuals, as well as their known ancestors, were included in the first edition of European Bison Pedigree Book (Groeben 1932). The detailed pedigree analysis was done first by Slatis (1960) and in his study the animals alive in the mid 50-thies were considered. Slatis found that all European bison are descendants of 17 ancestors but some of those ancestors were represented only through one progeny, so the author decided to use 12 unique genotypes and named them founders of current population (on Dec. 31, 1954). In all future analysis this set of 12 founders was used (Olech 1989; 1999, Bielousova 1993, Krasinski 1994 Pucek *at al.* 2004) and up to now all of them are represented in present population of the species. Simple facts, that the lowest population number of E. bison was 54 individuals, and that contemporary European bison gene pool originates from only 12 founders, are very often mixed up, and seems to be unclear even for people working on species genetics.

The aim of this paper was to present the list of all 54 European bison alive at the end of the year 1924, and to identify all possible founders at that time. Also it was important to compare the structure of gene pool at the beginning of the restitution process with that of current population.

Material and Methods

The material for analysis was all available information about animals registered in the first edition of Pedigree Book. The most important source of data was the first part of Pedigree Book published in 1932 by Groeben, with handwritten comments and amendments done by Erna Mohr. All data were discussed and checked with European Bison Pedigree Book editor (Raczyński, pers. comm.), and were used to construct the list of all 54 animals alive at the end of 1924. Later the pedigree of this group was carefully analyzed to find all ancestors with unknown parents, later they are named founders. There was assumed that founders without information about their parents are not related, because the relationship cannot be measured. We are sure that some founders are related, like for example founders from Pszczyna, but there is impossible to calculate the level of this relation. The contribution of all founders within the initial group was calculated and compared with results obtained in other studies – at the end of year 1954 (Slatis 1960) and more current – at the end of 2000 (Pucek *et al.* 2004).

Results and Discussion

The complete verified list of all 54 (29 males and 25 females) European bison registered as alive at the end of year 1924 is presented in Table 1. There is possible to find all details about individuals, like given names, date of birth, breeder and owner in the moment of analysis. Large group of animals (10) was kept by Herzog v. Bedford in Woburn and another such group (10) by v. Beyme in Germany. In Zoos of Stockholm, Berlin, Antwerp, Copenhagen, Frankfurt, Hamburg, London and St. Petersburg all together 19 animals were kept. Remaining individuals were kept in smaller, privately owned herds.

After tracking down to the founders, the pedigree of the group presented in Table 1 was found, that 28 animals could be counted as founders. Seventeen of them were identified and their contribution explained 30 years later by Slatis (1960) but genes of the remaining (11 founders) existed only at the beginning of restitution. The full list of founders is presented in Table 2, with the contribution of every founder into the gene pool at the end of years 1924, 1954 and 2000. Actually the species is divided into two genetic lines: one – pure lowland subspecies named Lowland (LB), and second with inclusion of genes of the male No 100 Kaukasus, the only one representing the Caucasian subspecies. The second line name is Lowland-Caucasian (LC).

Table 1. The list of European bison alive at the end of year 1924 (source: European Bison Pedigree Book)

Sex	Ped. No	Pedigree name (common name)	Birth date	Father No	Mother No	Breeder	Owner
M	13	BERNADOTTE (ODIN)	3.07.1908	7	8	ZOO Berlin	Zoo Stockholm
F	16	PLAVIA (MUSCHE)	1906	?	?	Pless/Pszczyna	Zoo Berlin
M	17	PLANTAGENET	28.07.1911	7	16	Zoo Berlin	Zoo Antwerpen
M	19	BEGAS (FRANZ)	20.06.1914	15	16	Zoo Berlin	Zoo Berlin
F	20	BEATRICE (SARAH)	21.07.1915	15	16	Zoo Berlin	Zoo Kopenhagen (?)
F	21	BERMUDA (LISBETH)	10.06.1917	15	16	Zoo Berlin	Zoo Berlin
M	23	BELISAR	6.05.1921	19	16	Zoo Berlin	v. Beyme
M	24	BEN	7.03.1923	19	16	Zoo Berlin	Zoo Berlin (?)
F	25	BETTINA	17.06.1922	19	21	Zoo Berlin	Graf Arnim
M	26	BELA	11.05.1924	19	21	Viena	Graf Arnim
M	30	PLINIUS (MATYI)	18.05.1910	27	28	Zoo Leipzig	Visegrad
F	37	PLANKE	6.05.1915	32	33	Zoo Frankfurt	Zoo Frankfurt
M	38	PLŪSKOW (GERMAR)	27.08.1916	32	33	Zoo Frankfurt	Zoo Hamburg
F	42	PLANTA (FRICKA)	ca. 1904	?	?	Pless/Pszczyna	Pless/Pszczyna
M	45	PLEBEJER (WODAN)	ca.1917	?	?	Pless/Pszczyna	Pless/Pszczyna
F	46	PLACIDA (SILESIA)	1918	?	?	Pless/Pszczyna	v. Beyme
M	47	PLATON (THOR)	1919	?	?	Pless/Pszczyna	Pless/Pszczyna
F	49	PLAKETTE (GERDA)	25.10.1924	45	42	Pless/Pszczyna	Pless/Pszczyna
F	61	BIRULA (MENSCHAJA)	1908?	?	?	Białowieża	Askania Nova
M	64	PEPO	?			Gatschina	Zoo Petersburg
M	65	PETER (WASKA)	1913	?	?	Zoo Petersburg	Zoo Petersburg
M	72	WOLF	1912	68	71	v. Bedford	v. Bedford
F	74	WOLGA (Nr 1)	05.1909	68	71(?)	v. Bedford	v. Bedford
F	77	GABY	?	?	?	Gatschina	v. Bedford
M	78	GAGARIN	29.12.1914	76	77	Zoo London	Zoo London
F	81	WOBURNA	09.1920	78	75	v. Bedford	v. Bedford
M	82	WOBURN	28.05.1921	78	74	v. Bedford	v. Bedford
F	83	WONNE	05.1923	79	74	v. Bedford	v. Bedford
M	84	WOGUN	12.05.1924	72	81	v. Bedford	v. Bedford
M	87	BILL (TOR)	06.1913	85	86	Zoo Budapest	Zoo Stockholm
F	89	BILMA (FREIA)	1913	?	?	Białowieża	Zoo Stockholm

Table 1. Continued

Sex	Ped. No	Pedigree name (common name)	Birth date	Father No	Mother No	Breeder	Owner
F	90	BILLA (YLVA)	25.05.1918	87	89	Zoo Stockholm	Zoo Stockholm
F	93	BISERTA (TORA)	25.10.1924	87	90	Zoo Stockholm	Zoo Stockholm
F	94	BISKRA (IDUN)	9.10.1922	87	90	Zoo Stockholm	Zoo Stockholm
F	96	GATSCHINA (GRETEN)	1911	?	?	Białowieża	v. Beyme
M	100	KAUKASUS	1907	?	?	Kaukaz	Graf Arnim
M	101	HAGEN (MUFFEL)	23.09.1911	100	95	Hagenbeck	v. Beyme
M	104	HGESTOLZ (DONAR)	10.11.1918	100	95	Hagenbeck	Zoo Frankfurt
M	105	HAGEDORN	7.12.1920	100	95	Hagenbeck	F.E. Blaauw
F	106	FRIGGA (KAUKA)	31.08.1921	100	35	Zoo Frankfurt	Graf Arnim
M	108	GOGOL	.05.1924	106	22	F.E. Blaauw	F.E. Blaauw
F	109	SCHARBINA	20.05.1918	101	36	v. Beyme	v. Beyme
M	111	SCHALĴAPIN	6.11.1919	101	96	v. Beyme	v. Beyme
M	113	SCHATTEN (ĴENŃ)	20.08.1922	101	96	v. Beyme	Zoo Berlin (?)
M	114	SCHARLATAN	01.06.1924	101	96	v. Beyme	v. Beyme
F	116	SCHANZE (BELMA)	12.07.1922	101	109	v. Beyme	v. Beyme
M	117	SCHALL	25.09.1923	101	109	v. Beyme	v. Beyme
F	118	SCHARADE (GEORGINA)	08.10.1924	101	109	v. Beyme	v. Beyme
M	119	SCHALK (AUGUST)	13.07.1922	101	46	v. Beyme	Zoo Berlin
F	120	SCHALMEI (ĴULIA)	07.07.1924	101	46	v. Beyme	Zoo Berlin
F	124	BIENE (K2)	5.05.1910	123	122	Schönbrunn	Schönbrunn
F	125	BILLION (K3)	13.05.1915	123	124	Schönbrunn	Schönbrunn
M	126	BIRON (B4)	19.07.1915	123	122	Schönbrunn	Schönbrunn
M	127	BIBERPELZ (B5)	11.04.1920	123	124	Schönbrunn	Schönbrunn

The group of 17 animals considered to be founders was discussed by Slatis (1960), and he stated that three sets of individuals from this list were represented by one descendant, which is regarded as a founder. Such situation was with pairs of founders No 85 and 86 (descendant No 87); No 32 and 33 (descendant No 35); No 122 and 123 (descendant No 147) and group No 1, 2 and 7 represented later through animal No 15. It was decided by Slatis and repeated in all future studies on European bison pedigree that the accepted list of founders consists of 12 animals.

The other part of potential founders was lost over the course of years. The comparison between 1924 and 1954 showed, that genes of 11 potential

Table 2. The list of all possible founders after the bottleneck, and their contribution to the gene pool of the European bison population at the end of years: 1924, 1954 (source: Slatis 1960), and 2000 (source: Pucek *et al.* 2004)

Founders in 1924	Founders of current population	Founder contribution				The animals at the end of 1924 with contribution of founder	Year when last descendant died
		In 1924	In 1954	In 2000			
				LB line	LC line		
85	No 87 ¹	0,050	0,072	0,026	0,090	87, 90, 93, 94	
86							
89		0,042	0,096	0,026	0,117	89, 90, 93, 94	
95		0,081	0,038		0,038	101, 104, 105, 108, 109, 111, 113, 114, 116, 117, 118, 119, 120	
96		0,046	0,063		0,064	96, 111, 113, 114	
122	No 147 ²	0,028	0,009	0,027	0,005	124, 125, 126, 127	
123		0,046					
1	No 15 ³	0,060	0,082	0,027	0,077	18, 20, 21, 23, 24, 25, 26, 108	
2							
7							
7 ⁴		0,019				Nos 13; 17	1926
16		0,106	0,091	0,055	0,082	16, 17, 18, 20, 21, 23, 24, 25, 26, 108	
32	No 35 ⁵	0,070	0,027		0,032	37, 38, 106, 109, 116, 117, 118	
33							
42		0,028	0,188	0,294	0,183	42, 49	
45		0,028	0,264	0,545	0,229	45, 49	
46		0,037	0,009		0,013	46, 119, 120	
100		0,109	0,061		0,071	100, 101, 104, 105, 106, 108, 109, 111, 113, 114, 116, 117, 118, 119, 120	
8		0,009				13 (Berlin)	1926
27		0,009				30 (Leipzig)	1926
28		0,009					
47		0,019				47 (Pszczyna)	1931
61		0,019				61 (Askania)	1931
64		0,019				64 (St.Petersburg)	1925
65		0,019				65 (Gatczyna)	1925
68		0,039				71, 74, 81, 82, 83, 84 (Woburn)	1951
71		0,039					
76		0,025					
77		0,044					

¹ The founders 85 and 86 were represented by the only descendant No 87 from year 1924, and according to Slatis the animal 87 is cited as founder.

² In 1925 was born the only progeny of founders No 122 and 123, so according to Slatis the animal 147 is cited as founder.

³ Three founders, No 1, 2 and 7 were later represented through only one progeny No 15, which is cited as founder.

⁴ In year 1924 there were two descendants of No 7 completely independent of No 15 (see ³), so founder No 7 is listed twice.

⁵ The founders No 32 and 33, later were represented through No 35, their only progeny and according to Slatis No 35 is cited as founder.

founders ceased to exist in later time. Those founders had very large representation in 1924, equaling to 26.9% of total gene pool. In Table 2 given is also the year when the last descendant of every lost founder died. Some of potential founders died one or two years after the first inventory but there were four founders represented by their progenies up to the year 1951. The contribution of founders No 68, 71, 76 and 77 was quite large, equaling to 14.7%. It is a pity that this part of gene pool was not saved until present time. All those animals were kept in Woburn reserve by Herzog v. Bedford. The owner was very much involved in endangered species conservation and has succeeded with Père David's deer (*Elaphurus davidianus*) but probably did not keep the European bison in a high regard (Bostock 2001). For species with so narrow gene pool survival of this group was very important and could save unique genetic variability.

When the contribution of 12 founders is compared, it is interesting to notice large changes between years 1924 and 1954. Animals No 42 and 45 in 1924, had together only 5.6% of contribution to the total genetic pool, but later because of a large number of their descendants their representation increased up to 45.2% in 1954 and to almost 84% in current Lowland line (Pucek *et al.* 2004). The opposite happened to the contribution of Kaukasus (No 100), with initial contribution larger than 10%, decreasing to only 6% now.

Conclusions

In the year 1924, the European bison passed through a severe bottleneck but at this moment the genetic structure of species was much better than present. Large part of gene pool was lost in the period of 30 years because of lack of continuation of breeding of 11 possible founders. The representation of lost potential founders was equal to 26.9% of the total gene pool of the species. The most important loss was connected with the end of E. bison breeding at Woburn in 1951, when 4 unique sets of genes disappeared. From all initial 28 founders, 17 are represented in current European bison population.

Such information like "from the group of 54 only 12 reproduced" (Tokarska 2008) or "all 54 animals was descendants of 12" are not true. It is important to emphasise, that at the starting point of species restitution, its gene pool consisted of genes of 28 potential founders out of which 11 were lost but remaining 17 are represented through 12 genotypes. Those 12 animals are called founders in all currently published papers.

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References

- Bielousova I. P. 1993. About modern breeding lines' origin of European bison (*Bison bonasus* L.). In: About possibility of European bison preservation in Russia. Pusztino: 6–30.
- Bostock S.S.C. 2001: Zoos and Animals Rights The ethics of keeping animals. Routledge, New York, pp. 220.
- Groeben G. von der. 1932: Das Zuchtbuch. *Berichte der Internationalen Gesellschaft zur Erhaltung des Wisents* 5, pp50.
- Krasiński Z.A. 1994. Restytucja żubrów w Białowieży w latach 1929–1952. *Parki Nar. i Rez. Przyr.* 13(4): 3–23.
- Olech W. 1989. The participation of ancestral genes in the existing population of European bison. *Acta theriologica.* 34, 29: 397–407.
- Olech W. 1999. The number of ancestors and their contribution to European bison (*Bison bonasus* L.) population. *Annals of WAU, Animal Science* 35: 111–117.
- Pucek Z. (ed), Belousova I.P., Krasińska M., Krasiński Z.A., Olech W. 2004. European bison. Status Survey and Conservation Action Plan., IUCN Gland, Switzerland and Cambridge, UK, pp 55.
- Slatis M.A. 1960. An analysis of inbreeding in the European bison. *Genetics* 45: 275–287.
- Tokarska M. 2008. Czy geny pozwolą żubrowi przetrwać. *Matecznik Białowiecki*, Nr specjalny: 13–15

Zmiany liczby i udziału założycieli w populacji żubra podczas 80 lat restytucji

Streszczenie: Celem pracy było zbadanie struktury genetycznej żubra *Bison bonasus* po przejściu gatunku przez wąskie gardło. W 1924 roku rozpoczął się proces restytucji i inwentaryzacja na koniec tego wykazała jedynie 54 (29 samców i 25 samic) czyste gatunkowo żubry, których lista jest przedstawiona w tabeli. Rodowody tych zwierząt przeanalizowano i stwierdzono, że wszystkie wywodzą się od 28 przodków (osobników o nieznanym rodzicach). Liczna grupa 28 potencjalnych założycieli może być podzielona na dwie części, na tych których potomkowie istnieją obecnie, i na te, których geny zostały stracone. Pierwsza grupa złożona z 17 założycieli była szczegółowo analizowana przez Slatisa (1960) u żubrów żyjących na koniec 1954 roku. W tym momencie stwierdził on istnienie tylko 17 założycieli, z których kilku było reprezentowanych przez tylko jednego potomka uznanego za założyciela. W efekcie Slatis uznał, że pula genowa żubra składa się z 12 osobników i ta liczba jest obecnie podawana we wszelkich publikacjach.

Pozostałe 11 potencjalnych przodków, których potomkowie istnieli w 1924 roku, zostało całkowicie utracone z populacji. Największą stratą najprawdopodobniej jest brak kontynuacji i przepływu genów z hodowli księcia Bedford w Woburn, gdzie w 1951 roku padł ostatni potomek czterech z potencjalnych założycieli. Początek restytucji był okresem bardzo trudnym, nie było łatwo uzyskać potomstwo od wielu osobników. Ale trzeba pamiętać, że pula genowa gatunku 80 lat temu była znacznie bogatsza i w kolejnych latach stracone zostało około 26,9% genów.
