Birth and mortality rate of European Bison (*Bison bonasus bonasus* L1758) population

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Abstract

A survey of the birth and mortality of European Bison (*Bison bonasus bonasus* L1758) conducted from 2000 to 2018 in two nurseries showed that the females in the first study group had the first mating at an average age of 42.54 months, with an interval from 23 to 84.5 months. The average age of the first mated females in the second study group was 31.67 months, with an interval from 39.5 to 66.93 months. The average time between calving for the first group females was 9.95 months, with an interval from 0.5 to 28.5 months. The calving interval for the second group was 8.53 months with variation from 1 to 32 months. The first group had a maximum of seven calves, while the maximum in the second group was 13.A total of 33 calves were born in the first group during the study period, 16 males (48.48%) and 17 females (51.51%), while 40 calves were born in the second group,16 males (40.0%) and 24 females (60.0%).The mortality rate in the first group ranged between 14.3 and 30.0%, with a mortality rate of males of 20 to 60% and for females of 16.66 to 50%. In the second group, the mortality rate was from 9.09 to 23.08%, for males 33.33% and from 11.11 to 25.0% for females. The results indicate that future studies should address greater attention to birth and mortality rates.

Key words: *European Bison; birth rate; mortality rate*

Introduction

When examining the European fauna, a particular animal is conspicuous – the heaviest land mammal in Europe. This is a European bison (*Bison bison bonasus* L. 1758). Today it is known as "Białowieża" bison. It was namedafter the Białowieża Forest where the largest populations were found, where they were maintained and developed. Today, the majority of this vast territory falls within Belarus (Belovezhskaya Pushcha), and the smaller part belongs to Poland (Białowieża). European bison have also always lived in the area of the Caucasus Mountains, and in certain other European areas. This animal has an unusual exterior, and

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distinctive physiological characteristics, and has survived the long period since the Ice Age.

The scientific study of European bison began in 1758, when Swedish naturalist Carl von Linné (Lat. Carolus Linnaeus - 1707-1778), mentioned this animal in his scientific work *Systems of Nature* (*Systema Naturae*, 1735). Linnaeus did not study or describe the Caucasian type of European bison, instead naming it *Bison bonasus*, combining the two names given by Pliny and Aristotle. The word *bison*is of Greek origin and means "animal that resembles an ox".

The European Bison belongs to the family *Bovidae*, subfamily *Bovinae*, genus *Bison*. The basic physiological traits and reproductive cycle are quite similar to cattle (*Bos taurus*).There are very little data about European bison birth and mortality rates in the available literature. Mizin (2006) also refers to the lack of data on these subjects.

Trepet (2008) studied the European bison population in Caucasus between 2001 and 2006, and found that there were more females than males. Kalugin (1968, cited in Trepet, 2008) stated that the population consisted of 65.7% females. This was also described by other authors, and a similar gender ratio was presented in both free-living and semi free-living groups.

The high ratio of females makes sense as a means for procreation maintenance, since procreation can only be reached by plenitude of birth, thus more female calves get born. One male can inseminate multiple females, so the number of males can be less than the number of females.

Krasinski and Račinski (1969) (cited in Mizin, 2006), reported that female European bison in nurseries in Poland and free-living groups in Białowieża (Poland) reached their first calving at 4 years, and possibly even older. Males reach maturity by the age of 3-4 years.

Trepet (2008) claimed that in the period 1960 to 1989, adult females accounted for 46 to 58.8% of the population, with a gender ratio of 1:1.2 in favour of females. Females keep the reproduction cycle for many years, even up to the age of 20 years, though the best fertility is observed between the ages of 4 to 13 years (Korochkin, 1971, cited in Mizin, 2006).

According to Tereshkin (1966), a cross-bred (European bison x American bison) has its first calving under 3 years old. When full mature males and females mate, calving can occur every year. According to the European Bison Pedigree Book (EBPB), purebred and cross-bred bison can calve every year. There are data in the literature about calving once every two or three years, though these data are not quite accurate.

Gravidity in the Caucasus region was 261–283 days, whereas in Białowieża Forest (Poland) it was 257–272 days (Krasinski and Krasinska, 2004, Nemcev, 2003, cit. Mizin, 2006). As a rule, female give birth to only one calf at a time. According to Wolf 1987 (cited in Rezač, 2017), a twin birth was registered in 1945 in Poland (Psczene), but both offspring died the same day.

In the 19th century, a European bison female free-living in Białowieża Forest had her first calving at the age of 6 years (Usov, 1865, Kulagin, 1919, cited in Korobko and Kurnosov, 1979). In zoos, the feeding is much better than in the wild, and females can reach sexual maturity by 2 years and 3 months old (Zablotsky, 1957, cited in Korobko and Kurnosov, 1979). Living in a reserve environment, females had their first calving at the age of 3 years, and more often at 4 years old. When they have enough food of good quality, they can calve every year (Zablotsky 1957, cited in Korobko and Kurnosov, 1979).

Parusel (1996) studied the basic results of reproduction in a nursery in

Poland from 1924 to 1990. He observed that females born in the nursery remained there all their lives. There were 30 females. The average duration of the reproduction period was 5.53 years, with a variation interval from 1 to 15 years. The first calving was at an average age of 3.59 years, with an interval from 3 to 6 years: 17 females calved first at the age of 3 years (58.62%), 8 females at 4 years (27.59%), 3 females at 5 years (10.34%), and only 1 female had the first calving at an age of 6 years (3.45%). The author stated that each female had an average of 4.5 calves, and this ranged between 1 to 15 calves. Regarding the ratio of newborn calves (n=135), 71 were males (52.59%) and 64 were females (47.41%).

The period between calving was 1.3 to 2.5 years (Krasinski et al., 1994, cited in WWF Moscow, 2002). Females can calve every year, depending on the diet (Mizin, 2006). The average period between calving is 24.4 months (Krasinski and Račinski, 1969, cited in Mizin, 2006).

Kartsov (1903) reported that there were 8 females in the Pless Principality from 1865 to 1903. During this 37-year period, they gave 63 calves: 36 males (57.14%) and 27 females (42.86%). The author did not provide the age of first calving, but stated only that calving most often began at the age of 3 to 4 years old, depending on development stage and health condition.

Regarding mortality, there is very little data available in the literature. Sipko et al. (1999, cited in WWF Moscow, 2002) reported an 11 to 44% mortality of calves under the age of 1 year, with an average of 25%. Adult mortality is 4.0% (Pucek et al., 1996, cited in WWF Moscow, 2002). According to Kartsov (1903), the mortality in Białowieża Forest was 7.95%.

When examining European bison mortality in the period from 1937 to 1954 from records in the European Bison Pedigree Book (EBPB), Urošević et al. (2020) found that 43.28% of male calves died on the same day they were born, 28.36% calves died at less than 2 months old, and 28.36% at less than 1 year. As for female calves, 15.38% died the day of birth, 50.77% died during first 2 months and 33.85% at an age under 1 year old.

Zablotsky (1939) studied European bison breeding in the Askania Nova Nature Reserve in Ukraine in the period 1902–1938.He reported a catastrophic total mortality rate of 95.24%. This was a small herd, with only six adult animals. During the 37-years survey, 13 calves were born, and all died. Actual research was held to verify these data.

Materials and methods

The data for the research were taken from the official books (European Bison Pedigree Book), in the period from 2000to 2018. The research results from two nurseries in Germany were analysed and compared, one in Erbach-Eulbacher (park 400 ha), that lies between Würzburgand Vielbrunn, and one in Bavaria (forest 250 ha). Animals are free to move around inside the fenced territory, so they are semi-free living.

The first group (Erbach-Eulbacher Park) contained 11 animals, all born there, and the second group (Bavaria forest) had 8 animals. The following parameters were evaluated: age at the first mating and statistical significance of the age at the first mating were compared. Frequency distribution and calving per group, period between calving per group, calf numbers per group and gender. The data were processed by Statistical Package for the Social Sciences (SPSS) programme for Windows Release 17.0.0.

Results

The table below shows the total number of animals by gender in both nurseries.

Table 1. Number of animals by gender for the duration of the survey period (EBPB)

№	Year	First group		∑n	Second group		∑n
		Male	Female		male	female	
1	2000	2	7	9	3	5	8
2	2001	3	5	8	3	4	7
3	2002	5	4	9	3	6	9
4	2003	4	5	9	4	7	11
5	2004	4	5	9	4	6	10
6	2005	2	5	7	2	7	9
7	2006	2	6	8	3	9	12
8	2007	5	6	11	2	9	11
9	2008	5	6	11	4	10	14
10	2009	3	2	5	6	9	15
11	2010	4	4	8	4	4	8
12	2011	2	6	8	3	6	9
13	2012	3	7	10	3	5	8
14	2013	5	6	11	5	5	10
15	2014	4	5	9	5	6	11
16	2015	5	5	10	3	6	9
17	2016	3	6	9	1	9	10
18	2017	5	7	12	2	6	8
19	2018	4	9	13	2	8	10

Table 2. Descriptive statistics of the first mating

	N	Minimum	Maximum	Mean		Std. Deviation
				Statistic	Std. Error	
Group 1	11	23.00	84.50	42.54	6.34	21.03
Group 2	8	39.50	119.00	66.93	11.19	31.67

The average age for the first mating in group 1 was 42.54 months, while in the second group it was 66.93 months (Table 2). In group 1, the animals had the first mating at an age of 23 months, and in the second at an age of 84.5 months. The earliest mating in group 2 was at the age of 39.5 months old, and the latest one at an age of 119.00 months. T-test was applied to calculate the statistical value of the age at the first mating of these two groups, and the differences in the age at first mating did not differ significant between the groups. (Table 3).

Table 3. T-test of statistical significance at first mating

	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Group_1	6.710	10	0.000	42.54545	28.4171	56.6738
Group_2	5.977	7	0.001	66.93750	40.4573	93.4177

With regard to the number of calvings in these two groups, in group 1, four females calved only once (36.4%), two females calved twice (18.2%), and one female each calved 3 (9.1%), 4 (9.1%), 5 (9.1%), 6 (9.1%) or 7 (9.1%) times. (Table 4; Figure 1).

Table 4. Frequency distribution in group 1

Numberof calvings		Frequency	Percent
Valid	1	4	36.4
	2	2	18.2
	3	1	9.1
	4	1	9.1
	5	1	9.1
	6	1	9.1
	7	1	9.1
	Total	11	100.0

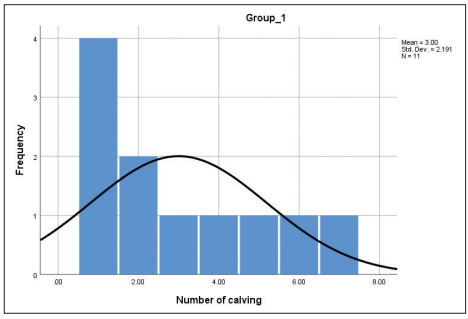

Figure 1. Frequency distribution of the number of calvings in group 1

Table 5. Frequency distribution in group 2

Number of calving		Frequency	Percent
Valid	1	2	25.0
	2	1	12.5
	3	1	12.5
	5	1	12.5
	7	2	25.0
	13	1	12.5
	Total	8	100.0

In group 2, two females each calved once (25.0%) and 7 times (25.0), while one female each calved 2 (12.5%), 3 (12.5%), 5 (12.5%), or 13 (12.5%) times. (Table 5; Figure 2).

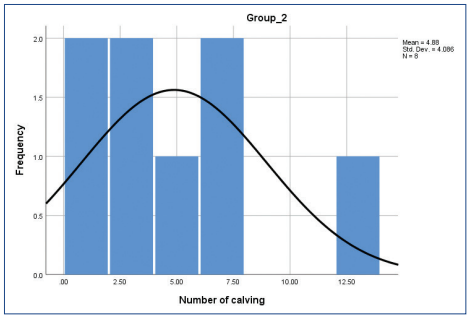

Figure 2. Frequency distribution of the number of calvings in group 2

Descriptive statistics of the number of calvings in both groups is given in the table below. The mean number of calving in the group 1 was 3.00 with a standard deviation 2.19, while in group 2 it was 4.87 with a standard deviation of 4.08. (Table 6).

Table 6. Descriptive statistic values

	Group 1	Group 2
N	11	8
Mean	3.00	4.87
Std. Error of Mean	0.66	1.44
Std. Deviation	2.19	4.08
Minimum	1	1
Maximum	7	13

The mean value of the time interval between calvings in group 1 was 9.95 months with a standard deviation of 9.05. The shortest interval between calving was 0.5 months and the longest was 28.5 months. The mean value of the time interval between calving in group 2 was 8.53 months with a standard deviation of 7.58. The shortest interval was one month and the longest was 32 months. (Table 7).

Table 7. Descriptive statistics of the time interval between calving

	N	Minimum	Maximum	Mean		Std. Deviation
				Statistic	Std. Error	
Group 1	11	0.50	28.50	9.95	1.92	9.05
Group 2	8	1.00	32.00	8.53	1.36	7.58

Table 8. Number of calves born per group

Group 1		Group 2	
Male	Female	Male	Female
16 (48.48%)	17 (51.51%)	16 (40.0%)	24 (60.0%)
∑ 33		∑ 40	

In group 1, a total of 33 calves were born, 16 males and 17 females. In group 2, 40 calves were born, 16 males and 24 females. (Table 8).

Mortality in both groups is presented in Tables 9 and 10. There were no deaths in the group1 in the year 2000, but 3 females died in 2001 and 2 females in 2002, though there were no male deaths in these years. A male and female each died in 2003 and 2005, with deaths recorded in 2004 and 2006. A female died in 2007, with no deaths in 2008. Two females died in 2009, with no deaths in 2010. Two males died in 2011, with no deaths in 2012. A male and two females died in 2013. Three males died in each of the years from 2014 to 2018 (in 2016).

Table 9. Bison mortality in group 1 (EBPB)

No	Year	Number		Died		%m	%f	Total (%)
		Male	Female	Male	Female			
1	2000	1	4	-	-	-	-	-
2	2001	2	7	-	3	-	42.86	33.33
3	2002	5	6	-	2	-	33.33	18.18
4	2003	5	6	1	1	20.0	16.66	18.18
5	2004	4	5	-	-	-	-	-
6	2005	4	5	1	1	25.0	20.0	22.22
7	2006	3	4	-	-	-	-	-
8	2007	3	4	-	1	-	25.0	14.28
9	2008	5	6	-	-	-	-	-
10	2009	3	4	-	2	-	50.0	28.57
11	2010	4	4	-	-	-	-	-
12	2011	4	4	2	-	50.0	-	25.00
13	2012	3	6	-	-	-	-	-
14	2013	3	7	1	2	33.33	28.57	30.00
15	2014	5	5	-	-	-	-	-
16	2015	5	5	-	-	-	-	-
17	2016	5	5	3	-	60.0	-	30.00
18	2017	5	7	-	-	-	-	-
19	2018	5	7	-	-	-	-	-

Table 10. Bison mortality in group 2 (EBPB)

No	Year	Number		Died		%m	%f	Total (%)
		Male	Female	Male	Female			
1	2000	1	6	-	-	-	-	-
2	2001	3	6	-	1	-	16.67	11.11
3	2002	3	4	-	1	-	25.00	14.28
4	2003	3	9	-	-	-	-	-
5	2004	4	5	-	-	-	-	-
6	2005	4	6	-	-	-	-	-
7	2006	2	6	-	-	-	-	-
8	2007	3	10	1	2	33.33	20.00	23.08
9	2008	2	9	-	2	-	11.11	9.09
10	2009	4	8	-	-	-	-	-
11	2010	6	9	-	1	-	11.11	6.67
12	2011	2	4	-	-	-	-	-
13	2012	3	6	1	-	33.33	-	11.11
14	2013	5	5	-	-	-	-	-
15	2014	5	5	-	-	-	-	-
16	2015	3	6	-	-	-	-	-
17	2016	1	6	-	-	-	-	-
18	2017	1	9	-	1	-	11.11	10.00
19	2018	3	6	1	-	33.33	-	11.11

In the period from 2000 to 2006, two females died in group 2 (2001 and 2002). One male and two females died in 2007, two females died in 2008. From 2009 to 2018 there were four deaths: a female in 2010, a male in 2012, a female in 2017 and a male in 2018.

Discussion

Regarding the age of the females in group 1, females in this study had their first calving at an earlier age than reported by Krasinski and Račinski (cited in Mizin, 2006), (Usov, 1865; Kulagin, 1919; cited in Korobko and Kurnosov, 1979). Females in group 1 had their first calf at an average age of 3.55 years, while the females in group 2 had an average age of 2.64 years.

These results are in accordance with the data of Tereshkin (1966) for cross-bred females (European bison x American bison), and also correspond with the information about the age of first calving by Zablotsky 1957, cited in Korobko and Kurnosov, 1979). Our results are almost identical to those described by Parusel (1996).

The mean time interval between calving in group 1 was 9.95 months with a standard deviation of 9.05. The shortest time interval was 0.5 months and the longest 28.5 months. The mean time interval between calving in group 2 was 8.53 months with a standard deviation of 7.58, with a range from 1 month to 32 months. As to the mean time interval between calving, our results show that females in both groups had a shorter average time interval between calving than reported elsewhere (Krasinski et al., 1994, cited in WWF Moscow, 2002; Kartsov, 1903). The mean time interval

between calving was considerably shorter than reported by Krasinski and Račinski (1969, cited in Mizin, 2006), and is similar to the data of Mizin (2006).

Our study results support the data from the literature (Kartsov, 1903; Parusel, 1996; Volf, 1987, cited in Rezač, 2017) that a female has only one calf at a time.The study results of group 2 support the literature data (Korochkin, 1971, cited in Mizin, 2006) that females are reproductively active for many years. One female in group 2 calved 13 times.

In this study, the sex ratio of newborn calves was similar to the data in the literature (Kartsov, 1903; Trepet, 2008). Though females were dominant in this study, Parusel (1996) reported a dominance of newborn males. Concerning mortality, our results are difficult to compare with the literature, as there is a lack of these data.

The results presented here showed no deaths in group 1 in 2000. In 2001 and 2002, 3 females died each year, though no males. A male and a female died in 2003 and 2005.In 2007, there was on female death, and two female deaths in 2009. Two males died in 2011, and one male and two females died in 2013. Three males died in 2016. No deaths were recorded in 2004, 2006, 2008, 2010, 2012, 2014, 2015, 2017 or 2018. In group 2, one female died in 2001 and one female in 2002, one male and two females died in 2007, and two females in 2008, one female in 2010, one male in 2012, one female in 2017 and one male in 2018.The numbers of death in this survey results are considerably lower than those given by Zablotsky (1939).

Our results correspond with those reported by Sipko et al. (1999, cited in WWF Moscow, 2002).The survey results of mortality in group 2 were somewhat higher than those published by Kartsov (1903). The total mortality statistics in both groups corresponded with the results given by Urošević et al. (2020).

Conclusions

From the reviewed literature and our survey results, it is clear that this field is not well studies, particularly concerning mortality, though fertility is also lacking in data.

It was observed that fertility and mortality parameters depend on the system of bison breeding. According, the fertility and mortality rates of animals kept in zoos, in semi-free or free living should be studied in greater detail.

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Odnos nataliteta i mortaliteta u populaciji europskog bizona (*Bison bonasus bonasus* L1758)

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Prateći natalitet i mortalitet, u dva stada, u razdoblju 2000.-2018., europskog bizona (*Bison bonasus bonasus* L. 1758) ustvrđeno je da se prvoj oglednoj skupini prvo parenje krava događa, u prosjeku, s uzrastom od 42,54 mjeseca, uz interval variranja od 23 do 84,5 mjeseci. U drugoj oglednoj skupini uzrast ženskih grla pri prvom parenju bila je prosječno, 31,67 mjeseci s intervalom variranja od 39,5 do 66,93 mjeseci. Međutelidbeni interval u ženskih grla u prvoj skupini bio je, prosječno, 9,95 mjeseci s intervalom 0,5-28,5 mjeseci. U drugoj skupini ovaj je interval prosječno iznosio 8,53 mjeseca uz variranje od 1-32 mjeseca. Kada je riječ o broju teljenja ustvrđeno je da je u prvoj skupini, maksimalan broj teljenja bio 7, a u drugoj skupini 13. Kada je riječ o odnosu spolova oteljene teladi u prvoj je skupini za promatrano razdoblje, oteljeno 33 teleta, 16 muških (48,48 %) i 17 ženskih (51,51%). U drugoj skupini oteljeno je 40 - 16 muških (40,0 %) i 24 ženska (60,0 %) teleta. Mortalitet grla, u promatranom razdoblju, u prvoj skupini kretao se od 14,29 % do 30,0 %. Promatrano po spolovima muških grla se kretalo u granicama od 20,0 % do 60,0 %, a u ženskih grla od 16,66 % do 50,0 %. U drugoj promatranoj skupini mortalitet se kretao u granicama od 9,09 % do 23,08 %. Smrtnost muških grla je bila 33,33 %, a ženskih od 11,11 % do 25,0%.Na osnovu analize dobivenih rezultata jasno je da se proučavanju nataliteta i mortaliteta u populaciji europskih bizona mora pristupiti organiziranije i temeljitije.

Ključne riječi: *europski bizon, natalitet, mortalitet*