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**Rozród żubra, *Bison bonasus* (L.), w warunkach  
rezerwatowych**

**Размножение зубра, *Bison bonasus* (L.), в заповедниках**

**Reproduction of the European Bison, *Bison bonasus* (L.),  
in Reserves**

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[Pl. XIX—XXII, 25 tables, 2 figs.]

INTRODUCTION<sup>1, 2</sup>

When studying the physiology of the European bison, it is particularly important to approach the problems involved from a historical and developmental standpoint. The bison that lived a thousand years ago and the bison of today all belong to the species *Bison bonasus* (L.), but this does not mean that essential differences between them are to be excluded. More than a hundred representatives of the species *Bison bonasus* (L.) are still living now, but to claim that this population is genuinely representative of the species would hardly be justified. The study of definite physiological functions — even if such a study involved all the European bison now in existence — does not make it legitimate to generalize the results and to apply them to the entire spe-

<sup>1</sup> The introduction is neither exhaustive nor detailed; it deals merely with problems that have a bearing on the rest of the paper and on the whole question of reproduction in the European bison.

<sup>2</sup> This paper was submitted to the Council of the Faculty of Veterinary Medicine of the College of Agriculture in March, 1956.



cies. Also, the several hundred European bison that lived before the First World War at Białowieża could not have been a population representative of a species that once inhabited vast areas of Europe and Asia.

For these reasons, the data concerning the reproduction of the European bison cannot be considered without reference to the generally known history of the species.

#### Historical outline

The genus *Bison* SMITH, 1827, became separated from its other relatives (*Poephagus* GRAY, 1843, *Bos* LINN., 1758) probably in the upper Miocene (SOKOLOV, 1953). Compared with other *Bovinae*, the distinguishing feature of the genus was its better adaptation to the cold climate. Between the Pliocene and the Lower Pleistocene, the evolutionary tendency of the genus *Bison* SMITH, among other things, was towards an increase in bulk of body and size of horns. Subsequently, during the Middle Pleistocene, particularly after the last glaciation, bulk of body and size of horns began to diminish (GROMOVA, 1935 a, b; SKINNER, KAISEN, 1947). About the middle of the Pleistocene the ancestors of the European bison and those of the American bison became separated. The separation between the Caucasian and the Białowieża bison probably occurred during the last glaciation (SOKOLOV, 1953).

The European bison now living, *Bison bonasus* (L.), are believed to descend from the longhorned bison, *Bison priscus* (BOJ.) (GROMOVA, 1935 a). In the longhorned bison sexual dimorphism was much less pronounced than in the European bison or the American bison of today (GROMOVA, 1935 a). Beginning with the last glaciation, sexual selection might have become the dominant factor owing to the extinction of the large carnivores (SEVERCOV, 1951) and to a less abundant food supply<sup>1</sup>.

Historical data (KARCOV, 1903; SZTOLCMAN, 1923—1924, 1927; BAŠKIROV, 1939 a, b) indicate that information relating to the biology of the European bison in the natural state concerns a species already deprived of its specific biotope and space. More detailed data relating to the biology of the European bison date from the XIX century when the animals existed in small numbers and in two areas only: in the Caucasus and at Białowieża, being artificially kept up at the latter habitat.

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<sup>1</sup> Reduction in size and extinction concern not only the European bison, but also other large herbivorous animals. We may mention the diluvial aurochs, *Bos trochoceros* MEYER, which were larger than the alluvial aurochs, *Bos primigenius* BOJ., and the mammoths, *Mammuthus trogontherii* (POHLING), *Mammuthus jeffersoni* OSBORN, *Mammuthus primigenius* (BLUMENBACH) (GROMOVA, 1935 a; OSBORN, 1936—1942; ŁUKASZEWICZ, 1952; LEITHNER, 1927).

### Reproduction of the American bison, *Bison bison* (L.)

The ancestors of the American bison were larger and had long horns, like *Bison priscus* (BOJ.). In the course of evolution, the American bison tended to become smaller, as did the European bison (SKINNER, KAISEN, 1947). Data relating to the reproduction of the American bison before its virtual extermination, concern chiefly the plains variety, *Bison bison bison* (L.). Observations of reproduction in herds subject to protection concern bison of mixed varieties (GARRETSON, 1938; ROE, 1951).

Before the beginning of wholesale extermination, i. e. before the middle of the XIX century, bison lived in large herds numbering several thousand — even more than ten thousand heads<sup>1</sup> (HORNADAY, 1887; ALLEN, 1876; GARRETSON, 1938; ROE, 1951).

According to most data, in seasons other than that of mating, bison were seen in large herds composed of males only and in equally large ones composed of females with young (CASTANEDA, 1540—1542; PIKE, 1806; Narrative of Jaramillo, 1540—1542; quoted after ROE, 1951). According to other data, bulls as well as cows were present in the herds. Only very old bulls are said to have been found — as an exception — travelling alone at the side or behind the herd (GARRETSON, 1938).

Fights between the bulls were fairly rare and took the form rather of brief bouts than of desperate struggles for life or death. In fenced parks, on restricted areas, deadly contests are frequent. The fight is essentially one of pushing, without a dash, and only when one of the adversaries „slips” does the other one deal him the death blow. Very old bulls are said to take no part in the mating season (GARRETSON, 1938; SETON, 1927).

It is said that copulation has never been observed in free-living bison, consequently, it is suggested that it took place mostly at night (GARRETSON, 1938). In the rutting season the bulls made characteristic noises — a kind of bellowing (LEWIS, CLARK, 1922; SETON, 1910; GARRETSON, 1938; ROE, 1951).

The mating season has been observed to take place in different months: this may be explained by the extent of the area the bison inhabited (ROE, 1951). Mostly, however, August and September (SETON, 1910) or September (LACOMBE, 1874) were quoted<sup>2</sup>. In the north, in the wood variety, the mating season was noted in July and August (HEWITT, 1921).

Pregnancy was said to last between 9 and 9 1/2 months (GARRETSON, 1938; ROE, 1951). This information is not reliable though, because it is not based on actual observation. The calves were delivered

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<sup>1</sup> Some authors even report several hundred thousand.

<sup>2</sup> In some American Indian dialects, the month of September was named after the mating season of bison (LACOMBE, 1874).

from April to June (GARRETSON, 1938): this can also be explained by the size of the territories the bison inhabited.

The animals were as a rule uniparous: reports of twins are exceptions (GARRETSON, 1938; ROE, 1951). The fur of the young is much brighter than of the adults. Lactation lasted probably from 3 to 4 months (LONG, 1820; after ROE, 1951). The calves followed the cows about one year, usually till the subsequent calving (GARRETSON, 1938). Free living cows are said to have calved at the age of two years (ROE, 1951). At an age between 7 and 8 years, the bison were fully grown (GARRETSON, 1938), and are said to have lived for 25 to 30 years — the bulls, however, reached even 50 years. Bred by an amateur, two cows calved even after they were 28 years old (GARRETSON, 1938).

Information relating to the instinct impelling the animals to defend their young ones is somewhat contradictory (ROE, 1951). Occasionally, the calves were fiercely defended not only by the cows but also by the bulls (GARRETSON, 1938). The development of the instinct probably depended on a variety of environmental factors (HEDIGER, 1940).

In the natural state most of the cows probably calved every year (ROE, 1951). In herds under protection the annual number of calves was about  $\frac{1}{3}$  the total number of cows; the average annual increase was about 18 per cent. Over 26 years there was an eleven-fold increase in the total number of bison (1903 — 1644 heads; 1929 — 18494 heads; Ann. Rep. Am. Bis. Soc., 1905—1930; GARRETSON, 1938; ROE, 1951).

Attempts to domesticate the bison were numerous. Calves trapped very early and fed by domestic cows are easily tamed; not so the older animals. Calves, even when captured at a very young age and trained, for instance to the yoke, become unreliable and dangerous with age, and are even apt to kill their caretaker (GARRETSON, 1938; ROE, 1951).

#### **Reproduction of the Caucasian bison, *Bison bonasus caucasicus* SATUNIN**

It may be assumed that the relatively free existence of the Caucasian bison began to be restricted at least since the rising of the Circassians against the Russian Tsar, that is, since the so called Caucasian War (about 1832—1864). However, the territory inhabited by the Caucasian bison had been diminishing gradually since much earlier times. The number of bison had reduced from 1864 to 1917 to about one quarter — from about 2000 to about 500 (FILATOV, 1912; BAŠKIROV, 1939 a).

The Caucasian bison lived principally in small herds made up of only a few animals. The herd included the cow and her calves. Young bulls, aged three or four years, were chased away in the rut season by the older bull which took charge of the herd. Cows at the age of three

or four years did not always leave their „parent herd” after being covered and frequently remained with it together with their calves.

Save in the mating season, the bulls lived in separate groups of two three or four. Old bulls occasionally left the herd and lived alone; they became the so called singles (FILATOV, 1912).

According to earlier observations, the mating season began towards the end of August and lasted about three weeks (VINOGRADOV, 1870). It follows from more recent data relating to the calving period that the mating season lasted at least one month and a half (BAŠKIROV, 1939 a).

It is not known whether the bulls joined the herd in the mating season or whether the cows — without their calves — left the herd and joined the bulls. Fights between bulls are known to have taken place but more detailed data concerning their frequency and course are not available. In the course of the mating season, one bull was found to accompany from two to six cows (BAŠKIROV, 1939 a).

It may be that owing to a shortage of suitable territory the duration of the mating season was prolonged (BAŠKIROV, 1939 a).

Pregnancy was reckoned to last 9 months in the Caucasian bison. Calving time was in May (VINOGRADOV, 1870); also the end of April (DINNIK, 1910) and the beginning of June are mentioned (DINNIK, 1884, 1899, 1901).

The Caucasian bison was principally uniparous. Twins are mentioned only twice in the entire literature (BAŠKIROV, 1939 a; PFIZENMAYER, 1929; ŠAPOŠNIKOV, 1928). BAŠKIROV (1939 a) suggested that there were more bull-calves than heifers born in the Caucasus. This assumption is based on a few incidentally captured bull-calves and is of little importance. Cows about to calve left the herd and rejoined it after several days (BAŠKIROV, 1939 a).

The cows of the Caucasian bison did not defend their calves when these were being caught, reports BAŠKIROV (1939 a); instead they would frequently take to flight rather than defend their young. This behaviour is quite unlike that reported for Białowieża bison and those bred in captivity. Since there are no details concerning the trapping of calves in the Caucasus, the problem cannot be assumed to be settled.

After being captured, the newly born calf is said by BAŠKIROV to have drunk daily about four litres of domestic cow milk, which quantity is said to have proved insufficient.

BAŠKIROV, (1939 a, b) believes that in the European bison fertilization depends upon cessation of lactation. Hence, he draws the conclusion that the cows of the Caucasian bison could not produce young more often than once in two or even three years. These conclusions do not appear to be justified since lactating cows do conceive.

The cows (PFIZENMAYER, 1929) and the bulls (BAŠKIROV, 1939 a) of the Caucasian bison are said to have reached puberty at the age of three or four years. The young bulls, however, were unable to service

the cows since they were chased away during rut by the older bulls. Complete physical development was attained by bulls and cows at the age of 6 or 7 years (BAŠKIROV, 1939 a). Information relating to puberty and maturity is neither exact nor based on direct observation. It is assumed on the whole that bulls take longer than cows to become fully developed physically. There are no data available to show how long the Caucasian bison was capable of reproduction.

There was a correlation between food factors and reproduction: Natural salines were visited by bison most frequently in spring and autumn. This is accounted for by the fact that in these seasons (spring — calving, lactation; autumn — breeding) the animals required greater amounts of minerals.

In the Caucasus attempts are said to have been made to cover domestic cows with bison. Such attempts are reported to have led to abortions, complicated parturitions or deaths of new-born calves (BAŠKIROV, 1939 a).

#### **Reproduction of the Białowieża bison, *Bison bonasus bonasus* (L.)**

The area inhabited by the Białowieża or lowland bison was decreasing gradually from early times (TACITUS; HUSSOVIANUS, 1523; VOLOVIČ, 1867; BRINCKEN, 1828, 1829; JAROCKI, 1830; SIEMIRADZKI, 1885; KARCOV, 1903; SZALAY, 1916—1917; SZTOLCMAN, 1923—1924, 1927; WRÓBLEWSKI, 1927; CALKIN, 1951). Roughly between 1865 and 1914, feeding conditions were at Białowieża particularly unfavourable for bison. Supplementary feeding was improperly carried out. This had a particularly notable effect on cows and calves (WRÓBLEWSKI, 1927; ŻABIŃSKI, 1949), probably owing not only to quantitative and qualitative inadequacies of the food, but also to disturbances in the annual feeding cycle.

Earlier authors [GILBERT, 1781; BRINCKEN, 1829; DOLMATOFF (DOLMATOW) 1848, 1849] reported that in the past, when bison were more numerous, the herds grew to a number of 40 or even 50. In the days of KARCOV (1903), the herds at Białowieża consisted of not more than 15—18 animals. Larger numbers were seen only in winter near the feeding sites. In spring the animals divided again into the original herds, it is said. The composition of the Białowieża herds is supposed to have been fairly constant. Bulls at the age of 10 left their „family” and lived singly, in couples or in threes with other older bulls. The remaining animals (cows, calves, and young bulls) stayed together. The herds are said usually to have had a leader, as a rule some old cow (KARCOV, 1903).

BRINCKEN (1829), DOLMATOFF (DOLMATOW) (1848, 1849) and GLIŃSKI (1899) report that the beginning of September is the regular breeding season — less frequently it is the end of August; calving takes place

in May, occasionally in June. According to KARCOV (1903) the beginning of the breeding season starts about the end of July and lasts till the beginning of September, depending upon the weather and the age of the animals; the warmer the summer, the sooner begins the breeding season, says the author. He also reports that older animals mate sooner than younger ones<sup>1</sup>. He claims that in the past calving occurred chiefly in May and April, but that cows happened to calve also in late autumn. WRÓBLEWSKI (1927) believes that with artificial supplementary winter feeding of the animals, calving becomes more frequent in various periods — towards the end of winter or towards the end of summer. This became manifest with particular clarity in the bison kept in the game reserve, where they are said to have received particularly ample additional food (WRÓBLEWSKI, 1927)

KARCOV (1903) reports that in some cows oestrus lasts up to two weeks. This cannot be exact as it relates to animals living in the Białowieża Forest and on the grounds of the former game reserve; it might have arisen, for instance, from a repetition of the oestrus in a given cow after about two weeks.

In the rutting season, the solivagant bulls approach the herds and not infrequently fierce, though rarely mortal, fights ensue. Bulls equal in strength usually part after a few bouts. Weaker bulls take to flight as a rule; they are killed only when they try to oppose a stronger adversary and do not manage to escape in time. Death may be the issue also when one of the contestants „slips” and presents the other animal with an opportunity of dealing a mortal blow (KARCOV, 1903; WRÓBLEWSKI, 1927). In the breeding season, the bulls frequently break, without any evident necessity, trees about 10 cm thick (WRÓBLEWSKI, 1927) and attack people (KARCOV, 1903).

During oestrus, a bull approaching a cow stretches his neck and „strongly wrinkles his nose”. Coitus lasts briefly and is repeated frequently (WRÓBLEWSKI, 1927). When covered by an old, heavy bull, young cows are said to have sometimes suffered mortal injury of the vertebral column and spinal cord (KARCOV, 1903).

Pregnancy is said to last 9 months (BRINCKEN, 1929; KARCOV, 1903; WRÓBLEWSKI, 1927). The condition of a gravid cow can be recognized by its external appearance (WRÓBLEWSKI, 1927)<sup>2</sup>. Cows that are about to calve leave the herd and return to it usually after 5 or 6 days (KARCOV, 1903). Parturition is said to proceed easily and normally in a standing position. There were also observed abnormal deliveries in which help was impossible, however, since the cow fled on sighting

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<sup>1</sup> This is quite likely since, as a rule, there is a similar relationship between mating time and age in some other ruminants (e. g. deer, WALDO, WISŁOCKI, 1951).

<sup>2</sup> KARCOV claims that a gravid cow cannot be recognized by her appearance, which, however, is not correct.

man in spite of its severe condition. Abortions are fairly frequent. Twins have also been recorded. The cow probably eats the afterbirth after calving (WRÓBLEWSKI, 1927)<sup>1</sup>.

KARCOV (1903) claims that, characteristically for the Białowieża bison, bull-calves are born in much greater numbers than heifers. This claim is, however, unestablished since records of births and deaths were inexact in his times.

The calf stands up immediately after being born<sup>2</sup>. BRINCKEN (1929) and WRZEŚNIEWSKI (1876) report that the calf sucks the mother till autumn, i. e. about 5 months. JAROCKI (1830) says that calves suck up to one year, whereas, after KARCOV (1903), they sometimes do so even longer — mostly till the next calving, occasionally two years. WRÓBLEWSKI (1927) puts the duration of lactation at two years. If a cow gives birth to another calf in the meantime, she feeds both calves (WRÓBLEWSKI, 1927). All these data may be true. In earlier times lactation probably lasted shorter since the natural annual feeding cycle was less disturbed and suitable food for the calves and adult bison was more abundant<sup>3</sup>.

Very young animals are easily tamed when captured, unlike older ones [DOLMATOFF (DOLMATOW) 1848, 1849; KARCOV, 1903]. All the calves captured took domestic cow milk in large quantities.

Most authors report that the cow defends her calf very fiercely. Old bulls usually behave indifferently towards the calves. However, when a calf comes to close it may at any time receive a blow if it does not manage to dodge in time (KARCOV, 1903; WRÓBLEWSKI, 1927).

The cows are said to reach sexual maturity in the third or fourth year of life and full physical development at the age of 6 or 7 years (KARCOV, 1903; WRÓBLEWSKI, 1927). Late maturation may be the result of exceptionally adverse and difficult feeding conditions endured by calves from generation to generation (WRÓBLEWSKI, 1927). Bulls are capable of service at the same age as cows, but, unable to compete with older and stronger bulls, they do not take part in reproduction until they are 6 years old (KARCOV, 1903).

According to the latter author, bulls may live till 50, and cows, some 10 years less. WRÓBLEWSKI (1927) believes these data to be exaggerated and puts the longevity of bulls at 35 years and that of cows at

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<sup>1</sup> The cow of the American bison also eats the afterbirth (HEDIGER, 1940).

<sup>2</sup> Reports by some authors that for several (three) days a newly born calf was unable to stand up must have arisen from incidental observations of pathological cases.

<sup>3</sup> Later food became scarce because the predatory animals of the Białowieża Forest were exterminated: the red and the fallow deer multiplied and the grazing of domestic animals became very extensive (SIEMIRADZKI, 1885; WRÓBLEWSKI, 1927; ŻABIŃSKI, 1949).



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less. However, it is difficult to guess the source of this information since WRÓBLEWSKI claims that the age of bison cannot be judged by the dentition or horns, owing to absence of pertinent data. Consequently, the data referred to must be considered to be of little value.

In old age the bulls are said to become solivagant; they are very strong, spiteful, and even aggressive in character (WRÓBLEWSKI, 1927). Old cows also leave the herd and die very soon; occasionally they join the bulls. At a post mortem, WRÓBLEWSKI found complete atrophy of ovaries in a well nourished cow which shortly before had kept company with three bulls<sup>1</sup>.

The stock of bison at Białowieża as subject to census since 1802 is in no way indicative of the reproductive ability of the animals. Data concerning the number and cause of deaths are wanting. The cows are said to have calved every two or three years, which is attributed to poor feeding conditions (KARCOV, 1903; WRÓBLEWSKI, 1927; ŻABIŃSKI, 1949).

The composition of the herds is probably different from what it had been in natural conditions. Firstly, poor feeding conditions, particularly since 1865, have had an adverse effect first and foremost on cows and calves. Secondly, poaching most certainly played a role different from that of natural elimination (SIEMIRADZKI, 1885; KARCOV, 1903; WRÓBLEWSKI, 1927).

It may be said, in general, that since very long ago the lowland European bison was being consistently dislodged from its natural habitat's conditions. In this connection also the quantitative and qualitative composition of the herds has changed. The natural food suitable for the animal was short, particularly since 1865. Supplementary feed for the animals was incorrect not only in quantity and quality, but also in that it did not agree with the natural annual cycle. Supplementary feed was given most intensively in late autumn and beginning of winter.

It may be assumed that change in the length of the mating season and prolonged lactation are attributable chiefly to food factors (see: discussion of results).

#### Crossbreeds

Most of the literature relating to hybrids of the European and the American bison, has been collected by GRAY (1954). Further relevant data are to be found in the publications by KARCOV (1903), ZABŁOCKI (1939), BAŠKIROV (1939 b), IVANOV (1950), LOGAN, SYLVESTRE (1950) and by MOHR (1952).

1. European bison × American bison. The hybrids are fertile. There is weight heterosis (ANTONIUS, 1933; IVANOV, 1950).

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<sup>1</sup> The histological structure of ovaries and testes of the European bison has been described (KULAGIN, 1928, 1932).

2. European bison  $\times$  domestic cattle. According to some authors (GRAY, 1954) the bulls are sterile and the cows occasionally fertile, while others (KARCOV, 1903) say that both bulls and cows are fertile. Pathological abnormalities connected with reproduction are frequent.

3. American bison  $\times$  domestic cattle. Hybrids are more easy to obtain when bison cows are used in cross breeding. In the alternative case, i. e. when a domestic cow is serviced by a bison bull, pathological abnormalities occur frequently. Bulls  $F_1$  are, as a rule, sterile and the cows, on the whole, fertile, irrespective of whether a domestic bull or a bison bull was used. Pregnancy (domestic bull  $\times$  bison cow) lasts 264 days (GRAY, 1954). There is weight heterosis (IVANOV, 1950 a, b).

4. American bison  $\times$  yak, *Poephagus grunniens* (L.). The hybrid bulls are sterile and the cows are reduced in fertility (GRAY, 1954).

5. American bison  $\times$  zebu, *Bos taurus indicus* (L.). The female crosses are fertile.

6. American bison  $\times$  zebu  $\times$  gayal, *Bibos frontalis* (LAMBERT). A cow obtained from the zebu  $\times$  gayal cross was covered by a bison and proved fertile (BARTLETT, 1884).

7. European bison  $\times$  (American bison  $\times$  domestic cattle). The hybrids are fertile (ZABŁOCKI, 1939; BAŠKIROV, 1939 b). In some, there is eminent weight heterosis, the position of the horns in relation to the skull being in such cases like the longhorned bison's, *Bison priscus* BOJ. (MOHR, 1952).

Notwithstanding a number of publications and occasionally very ample experimental material, the problem of hybrids of the European and the American bison with other species is still very little studied. Investigations in this field are of great importance not only in theoretical but also in practical respects.

## OWN INVESTIGATIONS AND COMPARISONS

### Material and methods

In principle the observations involved two breeding reserves: Niepolonice and Białowieża. In addition, some data have been collected in other reserves: Pszczyna, Gorce, Smardzewice, and also in the zoological gardens at Warszawa, Płock and Wrocław. Data found in the records of the particular reserves and used in this paper were carefully checked<sup>1, 2</sup>.

<sup>1</sup> The author is very much indebted to Prof. Dr. J. J. KARPISKI, former Director of the Białowieża National Park, and to Mr. S. KOŁPOWSKI, forester, in charge of the Niepolonice Reserve.

<sup>2</sup> The author was for over two years veterinarian-in-charge of the European bison and elk reserves in Poland.

Use has also been made of the pedigree books of the European bison (Das Zuchtbuch, 1932, Pedigree books of the European bison). The specimens recorded therein till 1924 were not picked at random nor are they, consequently, representative of a population. They were mostly captured with a purpose and, therefore, cannot be used in some calculations. Furthermore, we have no clue as to the reason why some calves died soon after they were born; abortion, premature delivery, or other causes might have been involved. This was also taken into account, and these calves have not been considered in the calculation of the calving seasons.

#### Mating season

Data relating to the mating season of European bison bred in reserves can be obtained either from observation of oestrus in cows and servicing or from evidence of births (which are the result of successful servicing). Below, we shall deal with data obtained only from evidence of births. Although the duration of pregnancy in the European bison is subject to some variation (see pertinent section), nevertheless, births make it possible to determine the time when ovulation and successful servicing actually took place. Manifestation of oestrus and its recurrence will be dealt with in another section.

The incidence of births in particular months, as shown by the pedigree books of the European bison till 1936, is recorded in table I. Under the Roman numerals, denoting months, the pedigree numbers of the bison born in that month are given. The table does not include such births as were followed by death since these may represent abortions.

Of the total number of 187 births, 69 took place in May [Table I]. This is more than  $\frac{1}{3}$ ; May is the month in which most of the births occur. June comes next, and then the births gradually decrease in frequency till September. A certain increase is noted in October and November. Subsequently the number of births falls gradually to a minimum in February and March, to rise slightly again in April.

Table II shows in the same manner the incidence of births according to pedigree books since 1937. Essentially the pi-

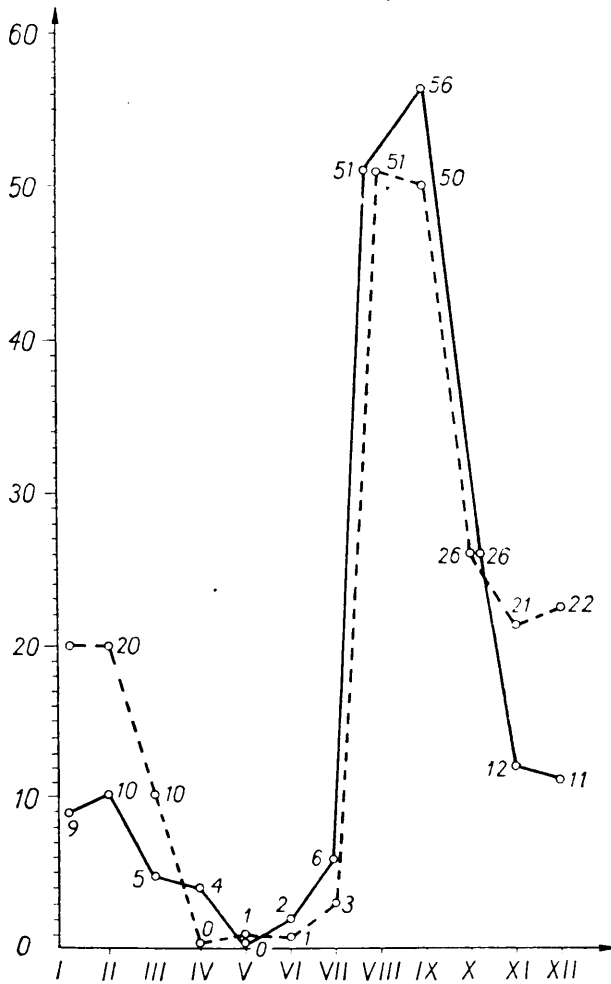


Fig. 1. Incidence of effective matings as compiled approximately on evidence of births. — before Jan. 1, 1937, - - - after Jan. 1, 1937.

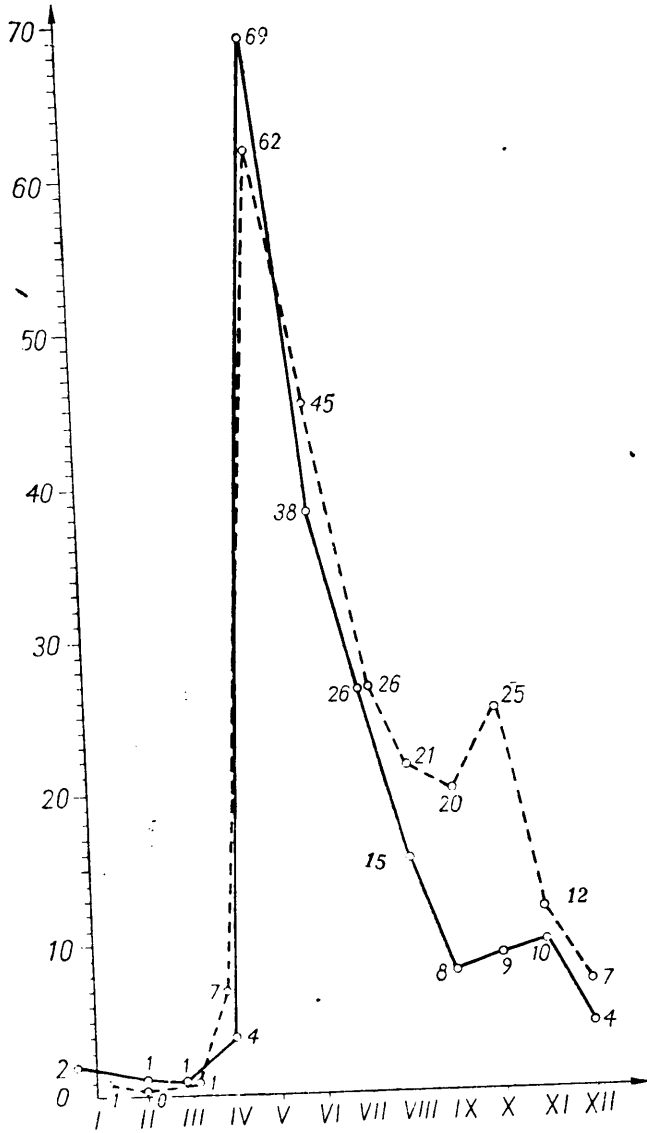


Fig. 2. Incidence of births in European bison in the various months.  
 — before Jan. 1, 1937, - - - after Jan. 1, 1937.

cture is similar; however, the „calving season” in May is here less pronounced and the extension of births to the following months, more distinct. Of 227 births only 62 occurred in May.

The data recorded in tables I and II suggest that May, and possibly June, ought to be the months of calving under „natural conditions”. The births occurring in subsequent months seem to indicate that the oestruses from which they resulted had been delayed, or repeated owing to failure of fertilization. It is characteristic that the number of births is higher in the later months and not in the earlier ones; in April, March, February and January the number of births is at a minimum. As can be seen from the above, the mating season is extended in reserves to the winter months [Table III]. Interesting is the fact that the number of births rises in autumn. The cause of this remains obscure for the time being.

The incidence of successful matings in particular months is recorded in tables III and IV. The theoretical day of fertilization has been defined for each cow by assuming the average duration of pregnancy to be 265 days. These data depict, of course, only a general trend. As can be seen, the greatest number of successful matings occurs in August and September. Tables V and VI record successful matings in the months of August and September in such a way that both of the two months have been split into halves. As follows from the data recorded in these two tables, successful matings were most numerous in the second half of August. In the first half of September the number is slightly less.

Comparison of data given in tables I and II, and III and IV, suggests that prolonged breeding of the European bison in artificial conditions and intensive feeding throughout the whole year tend to abolish a clearly defined mating season, stretching it, instead, over almost the entire year. This is shown more distinctly by table II and IV than by table I and III. A characteristic feature of this tendency is the extension of the mating season into the winter months<sup>1</sup>. It is pos-

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<sup>1</sup> The season of successful matings is in a way equivalent to the former mating season during which were the matings successful. But it is not the same as the occurrence of oestrus.



sible that this is a transitional stage in the direction of the condition that exists in domestic cattle where oestrus occurs throughout the entire year, probably as a result of domestication.

Incidence of births in particular months throughout the entire period covered by the records of the pedigree books (1891—1950) was as follows:

January	3	July	54
February	1	August	36
March	2	September	28
April	11	October	34
May	131	November	22
June	83	December	11

As can be seen, a certain rise may also be noted for October in a tabulation of the entire material.

In the past the mating season probably lasted during September and the second half of August. Owing to supplementary feeding which, though irregular, was started long ago, and on the other hand owing maybe also to generally poor feeding conditions, the mating season became extended into the winter months. Towards the end of the XIX century the animals regularly starved owing to the quality, and frequently also the quantity of the available food; besides, even abundant feeding with oats, hay and beets may not be suitable for bison. Underfeeding might have led to the failure of the cows to conceive at the proper time; supplementary feeding throughout the entire year must have upset the annual feeding cycle. These two seemingly conflicting causes (undernourishment and all-year feeding) are likely to have played a similar role in the course of the taming of domestic cattle<sup>1</sup>. In this connection it will be interesting to note in the future the period of births among bison confined to reserves and among those released from them<sup>2</sup>.

The monthly incidence of births in the particular reserves is given in tables VII, VIII and IX. Letters xxx denote

<sup>1</sup> Though oestrus occurs in domestic cattle throughout the entire year it, nevertheless, is in some months more pronounced (LESBOUYRIES, 1949).

<sup>2</sup> ŽABIŃSKI, 1954.

specimens born in 1951; vvv, those born in 1952; and zzz, those in 1953. The data recorded are too scanty to warrant any conclusions. A striking feature, however, is the second peak of births in autumn, at both Białowieża and Niepołomice. Furthermore, it appears that at Białowieża the mating season is more distinct than at Niepołomice. This is quite likely to be in fact so, since at Niepołomice the enclosures are smaller, and therefore, the bison have less natural food: thus their supplementary feeding is somewhat more intensive.

Table VIII, for the Pszczyna reserve shows the most notable changes in the mating season. If we leave out the specimens born after 1950 (marked xxx, vvv and zzz), October will show the largest number of births. The prevalence of autumnal births becomes particularly striking if we consider all specimens up to and including No. 578. At any rate, the tendency of the calving season, i. e. also of the mating season, to extend over subsequent months is most pronounced at the Pszczyna reserve, where also the second peak of births (October) is most distinct. This can hardly be attributable to climatic effects, since climatic conditions at Białowieża and Niepołomice are also quite different, whereas the tables VII and IX are alike. Here, probably the food factors (prolonged breeding under different conditions) have played their part, as well as inbreeding which became particularly manifest in the Pszczyna line.

In view of the data referred to in the above section, the reports of some earlier authors who claimed that European bisons calve in April and May appear to be dubitable. In „natural conditions” there could be only a few births in April.

#### Course of oestrus

The oestrus does not differ in its manifestations in the particular reserves. Observations were confined chiefly to Białowieża and Niepołomice and were conducted in the years 1950, 1952 and 1953.

Usually the beginning of the oestrus in cows becomes noticeable when the bull begins — as the wardens have it — „to assist”, i. e. to pay his attentions to the cow. The bull

stays near the cow, approaches her again and again, licks her sides and neck, and also smells and licks her external genitalia [Pl. XIX, XX, fig. 1, 2 and 3]. Occasionally, the bull bellows in very low notes and stretches his neck and head. The bellowing of the bull is similar, for instance, to that of a cow which is separated from her calf, but, lower. It is uncertain whether the bull makes that noise also on occasions other than oestrus in cows. At times, the bull even starts as if to mount the cow, but she usually runs away [Pl. XX, fig. 4]. Sometimes the vulva may be seen to open up somewhat and the clitoris, to show. The initial symptoms of oestrus in cows are not characteristic. Occasionally, in the absence of a bull, a cow may mount other cows. This is also considered a manifestation of oestrus.

This state of affairs usually lasts some time (it varies very much in duration, on the average one day) after which the cow stands for service. The mating is frequently seen to occur near the feeding sites. Its progress varies with the bull. „Pumeks” for instance, which I have frequently seen during mating, covers the cow very briefly; usually one swift thrust, the penis not being fully protruded at the moment of mounting, accomplishes service. On the other hand for example, „Puzon”, an older and heavier bull, had often difficulties with intromission. He frequently stuck his penis against the flanks of the cow and consequently, the sexual act lasted somewhat longer. „Plisch”, „Puzon’s” father, copulated in a similar manner. It happened frequently that ejaculation of the semen (or maybe merely ejaculation from the accessory glands) occurred owing to the rubbing of the penis against the cow’s flanks. It is interesting that „Plisch” and „Puzon” covered in a similar manner; also „Borusse” and „Puk” the grandfather and father of „Pumeks” respectively (and „Pumeks”) were alike in their manner of service and introduced the penis swiftly and easily. Data relating to the service habits of „Borusse” and „Puk” have been supplied by the staff of the reserve.

A bull may copulate several times in the course of one day of a given rutting season. For instance, on August 24, 1953, „Pumeks” copulated three times (the first time at 8:30 hs.;

the second, at 15:30 hs.; and the third, at 16:30 hs.). As is shown in table XII, the highest noted number of matings was four in a single day. It is possible, however, that it may even be much higher. It ought to be understood that observations at the Niepołomice reserve involve enclosures of more than 10 ha (24,7 acres) and that, consequently, not everything can be observed. This holds even truer for Białowieża where the largest enclosure is more than 60 ha (148,2 acres). During the rutting season, bulls do not lose their appetites, though they take perhaps less food (supplementary fodder, like hay, etc.) than normally.

After a time (this time varies, but is usually about one day) the symptoms of oestrus subside and the bull ceases „to pay his attentions” to the cow. Nevertheless, so called „servicing symptoms”<sup>1</sup> may be noted in a cow for still some time. These symptoms consist of a characteristic position of the pelvis, the sacral portion of the spine, and the hind legs. The sacral part of the spine and the pelvis are slightly elevated as compared to the normal position. The wardens term it „straddling”. Occasionally a drop of thick mucus, resembling sperm, may be seen on the external genitalia of the cow.

Duration of oestrus and its particular stages vary considerably. In theory, the oestrus lasts about two days (including the premonitory period, service period, and symptoms after service). However, as may be seen from the tables X, XI and XII, even the first period alone („paying attentions”) lasts longer sometimes. On the other hand, the oestrus is occasionally so brief that mating is assumed to have taken place at night, since servicing symptom were noted in the morning. The particular stages of the oestrus also vary in duration. Sometimes the stage of „paying attentions” lasts very briefly, and sometimes it extends over several days. The same applies to the service stage and to symptoms after service. In general, it may be said that the premonitory stage is the

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<sup>1</sup> From the standpoint of physiology, „servicing symptoms” ought not to be reckoned among stages of oestrus. Since, however, they immediately follow the latter and are helpful in recognizing it, they are here referred to in conjunction.

longest one. The stage in which the cow stands for service lasts usually about one day. Symptoms after service range in duration from several hours to one day.

In table X, the word „manipulation” is added to the records relating to the performance of „Puszek” in 1951. This means that the bull — three years old at that time (born May 20, 1948) — had difficulties with service, which difficulties are said to have arisen from his then still small size. „Manipulation” consisted of attempts to coax the cow to stand in a depression (thereby being lower than the bull) so as to make copulation easier. This „manipulation” was quite important for him because the reserve at Gorce extends over a fairly steep slope, which could make service difficult.

Nothing certain can be said about fights during the rutting season because at Niepołomice, as well as at Białowieża, there was only one bull to a herd. Under these conditions a fight would have been almost certain to ensue if a strange bull had been added to the herd. Within the confinements of a small enclosure such a fight would be bound to end in severe injuries, or even the death of the weaker animal. However, when a bull grows up from birth or early youth in a herd, he usually leaves the field to an older bull, maybe because of conditioned reflexes. For instance, in the Białowieża herd, there was no fight in the lifetime of the bull „Plisch”, although the herd comprised even 5-year old bulls (e. g., „Poganin”). Similarly, in „Poganin’s” herd, „Plisch” being dead, there was in 1953 the bull „Polel” (born May 18, 1949) which always gave way to the older one, although the latter had one of his horns broken close to the skull.

At Pszczyna, „Pluvius II” ruled for a long time even though there were fully grown bulls superior in size in the herd — for instance, „Platzmajor” and „Plotkarz”.

Among the bison in all the reserves there is a habit by which one can tell the ruling animal of the herd; namely, at feeding time, when the warden puts the fodder (e. g. oats or beetroots) into the troughs, the bison take up positions in order of their strength: the strongest bull stands at the first trough, the second strongest at the next, and so on down to the weakest one. When the first one finishes his portion, he passes to the

next trough, chasing away his neighbour, and finishes the rest. When this trough is empty, he passes to the next one, and so on. The chased away neighbour takes recompense by chasing away the next and still weaker one, etc.

In the Pszczyna reserve „Pluvius II” (born September 15, 1940) ruled the herd till the end of the rutting season in 1952. He covered all cows in the breeding season although the herd comprised the bulls „Platzmajor” (born October 10, 1942) and „Plotkarz” (born May 28, 1947). However, as the wardens say, after the rut a rivalry ensued between „Plotkarz” and „Pluvius”, and the end of it was that „Plotkarz” took over the first trough. This fight, however, having taken place in the large Pszczyna reserve enclosure (about 700 ha = 1,730 acres) ended without a death. After some time, the weaker contestant fled. A similar fight occurred in 1953 between „Plotkarz” and „Pleban” (born August 21, 1948), and here, too, the fight ended without either of the bulls coming to harm. On the other hand, the fight would be bound to have a fatal issue at the Niepołomice reserve, for instance, where every bull has a separate herd and the enclosures are not large. „Puzon” and „Pumeks” were separated by a double fence and an interval of a few metres, and yet one had the impression that each of the bulls senses the presence of the other and the heat period of the cows in the adjacent enclosure. They frequently indicate this by digging up the ground with their hoofs, by breaking trees, etc. The final issue of a fight between them would be easy to foresee — death of the weaker animal, as was the case in 1935 at Białowieża in the fight between „Borusse” and „Björnsen”<sup>1</sup>.

Scent is almost certain to be the first and foremost factor that causes a bull to take interest in a given cow. The smell of a cow's genitalia must be assumed in all likelihood to undergo a change during the heat period.

#### Protrusion of the penis during defecation

European bison always protrude their penes to some extent during defecation. This occurs at all times of the year, and

<sup>1</sup> Bull fights ought to be distinguished from „bouts for fun” [Pl. XXI, fig. 5 and 6].

I noted it both at Niepołomice and at Białowieża. When defecating, the bison — bulls and cows alike — characteristically arches his back and takes a peculiar squatting position (almost like a dog's). The hind legs are slightly bent and brought forward, the hind quarters are much lower than usual, and the back is arched. It may be that in this position the sigmoid flexure of the penis becomes straightened out. In August, 1953, I saw „Putyfar” (born May 16, 1951) from the Niepołomice reserve protrude his penis while defecating, but to a lesser extent than mature bulls. Bull-calves do not protrude their penes when defecating<sup>1, 2</sup>.

At any rate, the protrusion of the penis during defecation ought not to be associated with rut, since the two phenomena are in no way related. The animals protrude their penes throughout the year during defecation.

#### Recurrence of oestrus<sup>3</sup>

Heat periods of cows at the Niepołomice reserve are recorded in table XI. The data served for defining the intervals between heat periods when heat recurred. Relevant data are recorded in table XIII; the sign „+” added to a date means that copulation was probably successful since parturition followed in due time. Average intervals between heat periods,

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<sup>1</sup> In calves of domestic cattle the folds of the prepuce are fused.

<sup>2</sup> Mr. S. KOŁPOWSKI, in charge of the Niepołomice reserve, and the wardens there claim that protrusion of the penis during defecation is a sign of sexual maturity. There may be a good deal of truth in this; for the time being, there is too little material to be certain that it is so in fact.

<sup>3</sup> Recurrence of heat in polyoestrous animals with so called spontaneous ovulation depends, as is known, on multiple factors. The effects of copulation, nervous system, presence of a male, season of the year, food factors, exercise, etc. must all be accounted for. The length of the oestrus cycle represents an average obtained from ample material. For the domestic cow, for instance, the length of the oestrus cycle is 21 days. However, in the same cow and under similar conditions, heat periods may occur at 11, 15 and 30 day intervals or the like. Variations are here very considerable (ASDELL, 1946; LESBOUYRIES, 1949; MILOVANOV, 1951, and others),

when heat recurred, as calculated for particular cows are recorded in table XIV.

Analogical data relating to cows from the Białowieża reserve are recorded in tables XV and XVI. In table XV, intervals considered uncertain for various reasons are marked „?”; those not underlined are almost certain. This has been necessitated by the fact that the enclosures of the Białowieża reserve are fairly large and, therefore, observation of servicing being not always possible, one has to rely occasionally only on symptoms of oestrus or servicing. Under the conditions referred to, some of the data (particularly those from Białowieża) must be accepted as merely indicative of the general trend. Table XVI gives average „certain” intervals; average values calculated from all intervals (certain and somewhat uncertain ones) are given in brackets.

Not infrequently there is a want of data showing whether, when, and for how long a cow was separated from a bull — as occasionally happened for a prolonged period of time. Therefore, we ought to disregard some of the very long intervals. It follows from the above that the data recorded in tables XIII, XIV, XV and XVI are not exact; nevertheless, they do warrant some conclusions.

Thus, we may say that a cow of the European bison that has been covered, but not fertilized, usually experiences another heat period. Oestrus usually repeats itself at intervals of a number of days (usually between 10 and 70; more often between 20 and 30).

HEAPE (1901) and ASDELL (1946) claim that unserviced cows of the American bison experience heat periods every three weeks throughout the entire year. However, it is rather difficult to assume that bison have a more regular oestrus cycle than domestic cattle, especially if we consider that the geographical distribution of the species *Bison bison* (L.) was and is fairly wide even now. The truth seems to be merely that in the American bison usually the interval between heat periods is about three weeks and that oestrus may appear throughout the entire year.



The underlined statement which may possibly be true of the American bison, holds also in principle for the European bison, as may be seen from this section.

#### Oestrus after calving<sup>1</sup>

Data relating to the length of the interval between calving and the subsequent heat period in the European bison are recorded in table XX. The date of the heat period during which the cow has become pregnant is marked „+”. As can be seen from table XX, the shortest interval between parturition and the next heat experienced by the cow was 22 days. This happened in the case of „Puma” at the Niepolomice reserve, in 1949. „Puma” calved on November 3, 1949, was covered again on November 25, 1949, and calved again in 269 days on August 30, 1950. [Table XI].

The next shortest intervals are those of 25 days for „Beste” at Białowieża, and of 31 and 32 days for two other cows; in all three cases, however, copulation failed to result in pregnancy. Ineffective covering is not a rare thing among European bison.

Intervals averaging between 40 and 80 days are most frequently met with. Not all the data recorded in table XX are reliable. Information showing whether and for how long a given cow had been separated from the herd — such cases were frequent and often lasted quite some time — is wanting. Nevertheless, it is legitimate to draw the following conclusions.

Oestrus and successful mating (ovulation and fertilization) can take place in European bison 22 days after calving. Usually it takes place later — often from 40 to 80 days.

Under suitable conditions the cow of the European bison may calve every year. It may be assumed that in earlier, more

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<sup>1</sup> As yet the interval between parturition and the next oestrus has not been clearly defined even with regard to domestic cows. The data quoted by various authors are very discordant: they range from 21 to 108 days. Most authors quote average figures between 35 and 60 days (LESBOUYRIES, 1949). Resumption of heat periods after parturition most likely depends on numerous factors which are not sufficiently accounted for in the quotations of means. The more important factors are likely to be: season of the year, living conditions, food factors, climate, lactation, race, and presence of a bull.

„natural”, and more „primitive” conditions with a restricted breeding season and assuming gestation lasting 265 days, oestrus was almost certain to occur about 100 days after parturition. On reserves the breeding season is somewhat delayed. The conclusions referred to above, however, indicate that the delay is not due to the intervals between parturition and heat being longer in reserve animals, as these intervals appear rather to be curtailed on reserves. Consequently, it may be assumed that, for some reason or other, copulation during the first heat period of a given year fails to result in fertilization and thus leads to an increased recurrence of oestrus.

It may be seen from table XX that when calving takes place in May, the first oestrus after parturition occurs after an interval of more than 100 days. Shorter intervals, on the other hand, are met with usually when parturition takes place later in the year.

It would appear from the above that the timing of the first heat period of a given year should be relatively consistent. It follows from table XX that the first oestrus after parturition occurs usually in August — September (72 per cent of 50 cases). This would infer that the oestrus, the beginning of the breeding season, is much more constant in timing than the calving season. The „scattering of births” should be, rather, the result of the failure to become pregnant during the first heat period of the year; this failure leads to a recurrence of oestrus. To what extent this assumption is correct remains an open question.

BAŠKIROV (1939 a) claims that the oestrus after parturition is associated with the cessation of lactation in the European bison. He quotes a case — involving, however, a half-breed American bison cow — in which the calf was very soon separated from its mother whereupon the cow was successfully covered (12 days after parturition) by an European bison. BAŠKIROV's claim is contradicted by the fact that lactating cows of the European bison also can become gravid. There are no further data available concerning any possible correlation between the separation of a cow from the calf and the occurrence of oestrus after parturition.

### Duration of pregnancy<sup>1</sup>

The data recorded in tables X, XI and XII have been used in the calculation of the duration of pregnancy in European bison. The calculations are based on the interval between the last mating and delivery. Most reliable are the data obtained from Niepołomice, since the enclosures in the latter reserve are relatively small. In the enclosures of the Białowieża reserve and, especially, of the Gorce reserve (one of the enclosures is several hundred ha in area) some of the matings might have gone unnoticed. Consequently, the longer duration of some pregnancies (especially in cows from Gorce) is uncertain.

In 1947, „Poziomka” was in all probability successfully fertilized on September 12 or 13, but symptoms of oestrus (the bull „paying his attentions”) were noticed three times in October [Table XII]. Similarly in 1949, „Poganka” was successfully fertilized probably on October 15; symptoms of oestrus, though („paying of attentions”) were again noticed on December 3. This may lend a basis for the statement that cows of the European bison occasionally show symptoms of heat even after fertilization.

It follows from calculations [Table XXI] that the average duration of pregnancy is 265 days for bison at Niepołomice and Białowieża, and 272 for the bison at Gorce. The average for all European bison is 265 days. Pregnancy was shortest in „Purchawka” (in 1952–1953) and longest in

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<sup>1</sup> Some of the large ruminants show the following average duration of pregnancy:

Yak, *Poephagus grunniens* (L.) — 258 days (DENISOV, 1938).

Domestic cattle, *Bos taurus* L. — 282 days (varies between 274 and 291 days).

Ayreshire, *B. taurus* L. — 277,84 days,

Jersey, *B. taurus* L. — 277,94 days,

Holstein, *B. taurus* L. — 278,15 days,

Red Polish, *B. taurus* L. — 285 days,

Bernese, *B. taurus* L. — 290,1 days.

Zebu, *Bos taurus indicus* L. — 205 days.

American bison, *Bison bison* (L.) — 9 months (BROWN, 1936).

Buffalo, *Bubalus bubalis* (L.) — 305–332 days (ASDELL, 1946).

„Poganka” (in 1949—1950); they were 256 and 283 days respectively.

Of the 52 pregnancies considered, 29 lasted between 260 and 269 days, 13 were longer than 269 days, and 10 shorter than 260 days. These data warrant the conclusion that pregnancy in European bison usually lasts between 260 and 270 days — averaging about 265 days.

The nine months (272 days) quoted by most authors appears to be an approximation which is slightly too high.

In the material involved, no distinct correlation was found to exist between duration of pregnancy and sex of the calf or the season of the year.

#### Sex of the calves born

Numerous authors claim (КАРЦОВ, 1903; БАШКИРОВ, 1939 a, b; WRÓBLEWSKI, 1927) that European bison produce more bull-calves than heifers.

The sex of all European bison has been tabulated from the pedigree books and shown in table XXII. Data relating to the period before 1925 do not cover all living and born bison and frequently quote the sex of animals captured for some special purpose and are, therefore, not relevant. However, till 1925 the sex ratio was 59 bulls to 60 cows. The sex ratio of bisons born between 1925 and 1950 was 179 bulls to 182 cows. The sex ratio of bison born after 1950 (according to still unofficial and maybe incomplete data kindly supplied by the editor of the pedigree books) is 33 bulls to 38 cows. Thus, taking into account all data, the over-all sex ratio would be 271 bulls to 280 cows. This means even a slight surplus of females — a contradiction to the data quoted in literature.

At Pszczyna, between 1865 and 1926, there were born 116 cows and 100 bulls (MEYER, 1927; CZUDEK, 1930 a, b; MOHR, 1952). These figures cannot be added to the previous ones since a part of the former is accounted for in the latter.

This shows that the belief that European bison bulls are born in larger numbers than their cows is entirely incorrect.

The sex ratio of calves born in particular months — according to prewar and postwar pedigree books, and their combination — has been shown in tables XVII, XVIII and XIX.

This ration, which is obtained from the comparison of small figures, is about 50:50. Only in October do heifers predominate fairly distinctly. In truth, the figures considered are rather small, but they, nevertheless, deserve some attention since October is also the month of the second „peak” of births in the annual cycle (see section on mating season).

No correlation whatever could be found to exist between the sex of the calf and the age of the parents (the age of the bull and that of the cow were considered both separately and together)<sup>1</sup>.

For some bison the progeny was of predominantly one sex. Here we may refer to the cows „Beste”, „Biscaya”, „Plakette” and the bull „Borusse”. Table XXIII gives the pedigree of the bull „Puk” and shows the sex of his and his ancestors’ progeny. Of course, no conclusions can be drawn from a single tabulation of this kind. However, it is worth while to pay some attention to this problem in the course of further investigations on bison. The pedigree record for „Plisch”, showing also the sex of his own progeny and of that of his ancestors, is shown in table XXIV.

#### Sexual maturity

„Borusse” serviced cows with good effect at a little over 29 months (ŽABIŃSKI, 1949). „Wouwerman” did so at nearly 15 months (MOHR, 1952)<sup>2</sup>. „Pumeks” fertilized a cow success-

<sup>1</sup> Particularly bison with a more numerous progeny were considered (No. No. of pedigree books: 7, 15, 16, 42, 45, 21, 25, 49, 85, 86, 87, 89, 96, 100, 101, 113, 145, 158, 161, 163, 228, 229, 524).

<sup>2</sup> „Wouwerman” was born on May 31, 1930 and on May 20, 1932, a cow he covered delivered a bull-calf at Woburn. The mother (Kreuzungszuchtregister No. 55) was of predominantly European bison blood, about  $\frac{21}{32}$ . Length of pregnancy in crossbreeds is unknown. The mother being of predominantly European bison blood, gestation may be assumed to have lasted between 260 and 280 days. Hence, copulation probably occurred between August 13 and September 2, 1931; „Wouwerman” was 15 months old on August 31, 1931. On June 11, 1932, a cow (Kreuzungszuchtregister No. 56) covered by „Wouwerman” delivered a heifer; the mother’s percentage of European bison blood was the same as in No. 55. Hence, „Wouwerman” successfully fertilized another cow at an age of not quite 16 months.

fully at a little over 21 months<sup>1</sup>. Subsequent performances of both „Borusse” and „Pumeks” have shown that early mating does not seem to have an adverse effect on a bull’s development („Pumeks” is the grandson of „Borusse”).

Occasionally the view is expressed that bulls ought not to be used for servicing before three years of age. Considering the data referred to above, this view is open to question. There is no importance attached to the problem in actual breeding practice since bulls are always available in excess, and the need almost never arises for using young animals for reproduction.

The cow „Beresina” delivered a bull-calf when she was just over 32 months old. „Borgia” gave birth to a bull-calf at nearly 36 months (МОНР, 1952), so did „Springerin” at just over 36,5 months and „Pumianka” at about 36,5 months. This shows that cows of the European bison can calve at three years, and even earlier<sup>2</sup>.

Breeders of European bison fairly widely share the view that cows ought not to be covered before they are three years old. To what extent this view is correct cannot be ascertained until the over-all fertility of cows covered in the second and third year of life respectively has been compared. The data so far available are still too scanty to make such a comparison.

Weaned and separated from the mother, European bisons at one or two years are on the whole hardly dangerous to man [Pl. XXII, fig. 7]. When mature and beginning to reproduce, they are almost invariably dangerous, even to the feeders. This may be associated with sexual maturity.

Unfortunately, there are no detailed data concerning the weight of bison in particular age groups. Judging by the eye, bulls develop (gain weight) at least until the eighth year of life. With cows the period is shorter: from four to five years.

When „Plisch” and „Puzon” died, their skulls were ex-

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<sup>1</sup> „Pumeks” was born on May 16, 1949. In February, 1951, he covered „Pumianka” who gave birth to „Pumik” on November 9, 1951. Assuming gestation lasts 265 days, fertilization must have occurred about February 19, 1951.

<sup>2</sup> In all the cases referred to above, with the exception of „Wouwerman’s” second mating, the offspring of young bulls were males.

mined craniometrically<sup>1</sup>. The animals were without question some of the largest specimens bred in reserves: they were very large and were believed to weigh more than 1,000 kg. Craniometrically though, they did not differ very much from the other bulls bred in reserves — the differences in size being confined, rather, to the long bones (JUŚKO, 1953).

The craniometrical data obtained from „Plisch” and „Puzon” were compared with those of bison that lived in the poor conditions of the second half of the XIX century at Białowieża. The skulls of „Plisch” and „Puzon” proved to be distinctly smaller than those of their ancestors living some 50 to 80 years ago, whose skulls were supplied in those days to various museums. Data relating to the weight of bison that lived before 1914 at Białowieża are few (SZTOLCMAŃ, 1927; KARCOV, 1903). These weights in kilograms can be reckoned with some degree of exactness from the former weight units, but the precision of the method of weighing used in those days is rather doubtful<sup>2</sup>. The weight of bison before 1914 was calculated to be between 600 and 800 kg: the largest bull killed by August II in 1732 was said to weigh about 960 kg. The heaviest bison bull killed by Johann Sigismund of Brandenburg in 1595 was said to weigh about 970 kg (BUJACK, 1839).

It is not clear why the skulls of the heaviest bison in the reserves are smaller than those of bison that lived before 1914. This problem may possibly be cleared up by systematically weighing bison living in reserves.

The data obtained supply no evidence for conjectures as to the sexual or physical maturity of European bison that lived at large.

#### Longevity of the European bison

In calculating the average age reached by bison in reserves and zoos only those animals have been considered that had lived at least 5 years. Such animals have been taken into

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<sup>1</sup> The craniometrical examinations were made possible by the kindness of Mr. K. ŚWIEŻYŃSKI, Veterinary Surgeon, Adjunct at the Department of Animal Anatomy, College of Agriculture, Warsaw.

<sup>2</sup> The weight was frequently taken after gutting, skinning etc.

account irrespective of whether they died of old age or acute or chronic disease, or whether they were shot to death, etc. The purpose was to determine average longevity with due consideration to all the conditions hitherto prevailing (which included a variety of incidents — among them circumstances such as wars, transfers, etc.).

The ages of particular bison, according to pedigree books, are recorded in table XXV.

Average longevity under the conditions referred to above, is for bulls 12 years ( $797:67 = 11.869$ ), and for cows 13 years ( $851:66 = 12.894$ ).

Of the 67 bulls taken into account, three lived over 20 years („Plebejer”, „Hagen”, „Schalk”), which makes up 4.5 (4.478) per cent. The oldest bull died at an age of 23.

Of 66 cows, 11 lived more than 20 years, and four, more than 25 years, which makes up 16.5 (16.667) per cent and 6.5 (6.667) per cent respectively. The four oldest cows lived for 26 years („Plavia”, „Beatrice”, „Bilma”, „Frigge”).

The data referred to above do not warrant the conclusion that cows generally live longer than bulls. Bulls were more often shot, and recently they were even used for experiments (JACZEWSKI and ŚWIEŻYŃSKI, 1955). However, earlier claims that bulls lived as a rule longer than cows ought to be treated with some reservation. The data referred to before hardly supply any evidence for conjectures about the longevity of bison living „at large” before 1914. Some pointers relating to the problem may be supplied in the future by surveying animals released at Białowieża.

#### Increase in particular herds

The total number of bisons in 1924 and subsequent years was as follows:

December 1, 1924	—	66 animals,
January 1, 1947	—	93 animals,
January 1, 1949	—	119 animals,
January 1, 1951	—	143 animals.

In the course of 27 years (1924—1951) the bison multiplied about 2,5 times.

In the particular herds the number of bison was as follows:



## Pszczyna (MEYER, 1927; CZUDEK, 1929 a, b):

- 1865 — 4 animals,
- 1883 — 14 animals (in 1880 1 bull imported),
- 1893 — 17 animals (5 cows imported from Białowieża),
- 1899 — 22 animals (in 1900 1 bull imported),
- 1906 — 33 animals,
- 1908 — 26 animals (in 1909 1 bull imported),
- 1913 — 56 animals,
- 1918 — 74 animals.

Between 1865 and 1891, the bison were fenced in on an area of 600 ha (1,482 acres). The incidence of heat is reported to have been very irregular and calvings occurred not infrequently in winter. In 1891, the bison were transferred to a site of 10,000 ha (24,711 acres). Reports say that thereupon the incidence of heat became regular and occurred in September-October).

- 1923 — 3 animals (1 ♀, 2 ♂ — ŻABIŃSKI, 1949),
- 1945 — 32 animals,

## Białowieża:

- 1930 — 3 animals,
- 1936 — 11 animals (1 bull imported from Pszczyna, in 1935, 2 cows exported to Sweden),
- 1944 — 27 animals.

As can be seen from the data referred to above<sup>1</sup>, the bison reproduced very well sometimes. Actually, in reserves the increase could be still better if it were not for the mistakes and errors made in tending and breeding which mistakes are, after all, inevitable considering the initial lack of experience on the part of the management. Furthermore, the poor increase of bison (1924—1951) is explained by the losses suffered during the last war (1939—1944)<sup>2</sup>.

Thus it may be said that neither the unfavourable conditions prevailing in reserves (i. e. conditions different from those required by bison) nor inbreeding were able to affect adver-

<sup>1</sup> Obviously the data only show the general trend. It seems to serve no useful purpose to repeat details relating to conditions, shooting, diseases, etc. (MEYER, 1927; CZUDEK, 1930).

<sup>2</sup> When this paper was already prepared for publication a new part of the pedigree books of the European bison was issued. According to it, the world census on January 1, 1953 was 184 European bison. In Poland on January 1, 1957, there were 95 bison. The poor increase was caused by the foot and mouth disease in 1953 and 1954. At that time, 42 European bison were lost.

sely the reproductive capacity of the European bison. Under suitable conditions they may reproduce as successfully as the American bison.

This provides yet another proof that it is wrong to assume that the species *Bison bonasus* (L.) is doomed from itself. It is only the external conditions that are responsible for their extinction. Restitution of the European bison can succeed only when, using a proper knowledge of their biology, the animals are given suitable living conditions.

The decreasing size of the European bison<sup>1</sup> (CALKIN, 1951) is by no means evidence of their degeneration. Numerous animals undergo in the course of evolution a reduction or increase in size, and such phenomena are not necessarily associated with their extinction. Furthermore, it is not unlikely that unsuitable feed — which no doubt applies to reserves and zoos — is responsible for the reduction of size. This problem may be elucidated by investigations concerned with digestion and metabolism of the European bison.

#### DISCUSSION OF RESULTS

Extension of the mating season, as well as other disturbances in the physiology of reproduction of the European bison, is likely to be attributable essentially to food factors.

There are data that indicate disturbances in the digestive processes (GILL, 1954) and metabolism (PILARSKI, 1956, JACZEWSKI and ŚWIEŻYŃSKI, 1955) of the European bison.

Unnatural feeding conditions are likely to represent the main factor responsible for changes in the physiology of reproduction of the European bison. The main constituents of food given to bison in reserves are oats (undigested grains of oats are fairly numerous in the faeces of bison), beetroots, hay and a small addition of twigs. Furthermore, the animals have no natural salines available to them, only artificial ones. This is food the animal cannot freely choose.

It would be very difficult, of course, to draw up today even a general list of plants the European bison fed on in natural conditions, since, in the stricter sense, the freedom of the

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<sup>1</sup> Cf. p. 334.

animal was substantially limited already long ago (at least since 1803). Even if we assume that the forest space they lived on in those days was so large that they were able to find in its flora all food factors indispensable for them, we must bear in mind that these conditions came to an end exactly 37 years ago, when the last cow was killed at Białowieża in the season 1920—1921. At any rate, we may say now — though this assumption calls for future experimental proof — that a considerable part must have been played in the diet of free living bison by buds and young shoots of trees and shrubs in spring, and by berries, mushrooms and the like elements of the undergrowth in summer and autumn. The corresponding proteins, and possibly other supplementary or even only related substances, can hardly be expected to be found in satisfactory amounts in oats, beetroots or meadow hay, that is in the forage fed to bison annually for nearly 100 years (all the animals now living descend from those sent by the tzars as gifts to the West in the years 1860—1880). This space of time is no doubt sufficiently long (approximately 15 generations) to allow certain differences in feeding to affect the biological rhythm of the animals. The lack, or rather perhaps, the shortage of some exogeneous food components may be responsible for peculiar dietary inadequacies (occasionally made up for with delay) and may thus contribute to the fact that cows fail to conceive in proper time and the oestrus cycle is repeated. It might be assumed that the first oestrus cycles of the year are not always adequate in all respects and, therefore, do not always result in pregnancy. Hence, occasionally, the cow becomes in calf only after the cycle has been repeated at least once.

Furthermore, the monotonous diet throughout the entire year must have upset the annual metabolic cycle which is in temperate zones a physiological phenomenon peculiar to wild herbivorous animals. In reserves, the European bison has access to concentrates all through the year; a grown animal receives daily about 5 or 6 kg of oast, beetroots, and hay ad libitum. Thus, while the European bison under natural conditions experienced every winter a hunger period (lasting probably about two months), the feeding conditions in reser-

ves resemble those in which domesticated animals live. This state of affairs makes the animals independent of the seasons and causes them to reproduce throughout the entire year, though the peak of reproduction, i. e. the highest ratio of fertilization, coincides with the time of the former mating period.

Consequently, it may be supposed that the two apparently conflicting factors, i. e. unsuitable quality of the food on the one hand and monotonous diet throughout the year, with simultaneous excess of some kinds of feed on the other, have caused the rhythm of reproduction of the European bison to undergo the changes referred to above.

As to other large free-living ruminants of the temperate zones (PETERSON, 1955; MURIE, 1951), their diet is known to be subject to considerable annual variation; particular species are also well known to differ greatly in the choice of plants they feed on, irrespective of the fact that they may live in the same territory. Thus, for instance, the elk feeds on different plants than the moose, and if one plant or another is found to be included in the diet of both animals the proportion it accounts for in the over-all food intake differs between the species, even when they live in the same area. The food given to the European bison in reserves leaves the animals essentially without an opportunity to choose the species of plants they need in the given season. That the European bison actually do suffer such inadequacies may be illustrated if only by the fact that animals released from the reserve took with a remarkable appetite to „bark” ash trees. These problems however, may be elucidated only by detailed research on the digestion and feeding of the animals.

The fact that the first breeding season of the year occurs fairly regularly in the second half of August and in September, may also be taken as evidence of the regulating effect of light. This factor, however, very much like the climatic factors, cannot be responsible for the changes referred to above, since for all practical purposes both have changed very little in the course of recent centuries.

The effect of lactation needs to be studied in more detail. We do know that lactating cows become pregnant. It may be,

however, that „shortage” of suitable feeding stuff for calves in reserves prolongs intensive lactation with which may be associated a delay in the period of successful fertilization.

It may also be that other essential factors affecting reproduction are herd life, competition between bulls, elimination by predatory animals, and the like, but sound scientific data relating to the above are not available.

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## STRESZCZENIE

Na początku pracy omówiono ważniejsze dane z literatury dotyczące rozrodu w rodzaju *Bison* H. SMITH, 1827; wspomniano dane z filogenezy mogące mieć związek z rozrodem. Przytoczono najważniejsze dane dotyczące rozrodu bizona w stanie dzikim i po restytucji. Rzucają one wiele światła na sprawę rozrodu żubra i wykazują dość często istotne podobieństwa (po uwzględnieniu warunków lokalnych).

Omówiono krytycznie piśmiennictwo dotyczące rozrodu żubra kaukaskiego i białowieskiego. Między innymi poddano krytyce utarty pogląd, że rodzi się więcej żubrów samców niż samic, oraz rozpowszechnione dawniej wyobrażenia dotyczące przyczyn niskiej płodności żubrów.

W Białowieży żubr utrzymał się dzięki specjalnej opiece. Opieka ta oraz szereg czynników i warunków miejscowych spowodowały zmiany i wypaczenia w biologii tego zwierzęcia. Dawniejsze obserwacje podają u żubra na ogół dość ściśle określony sezon wycieleń i sezon godowy. Stopniowe zmiany w warunkach bytowania spowodowały „rozregulowanie się” tych sezonów. Istotną przyczynę tego stanowią prawdopodobnie warunki żywieniowe.

Omówiono ważniejsze dane dotyczące krzyżówek żubra i bizona.

Główną część pracy opiera się na danych z ksiąg rodowodowych żubra oraz na własnych obserwacjach, przeprowadzanych we wszystkich rezerwatach żubrów w Polsce, a także w niektórych ogrodach zoologicznych.

Na podstawie dat wycieleń podanych w księgach rodowodowych wywnioskowano, że żubr w chwili obecnej, jeśli chodzi o rozród, stanowi pewne przejście między dzikimi przeżuwaczami, które mają w umiarkowanym klimacie dość ściśle ograniczony sezon godowy i sezon wycieleń, a zwierzętami domowymi, u których przeważnie sezon godowy rozciąga się na cały rok. Szczególnie dotyczy to dość blisko spokrewnionego z żubrem bydła domowego.

Analiza występowania rui u żubrów wskazuje, że zachodzi ona najczęściej w końcu sierpnia i we wrześniu, często jednak nie dochodzi do zapłodnienia. Ruja wówczas powtarza się. Jakkolwiek największa liczba porodów przypada na maj, to jednak rozciągają się one na wszystkie następne miesiące w zmniejszającej się liczbie. To stopniowe zacieranie się granic sezonu wycieleń wynika także z porównania danych rodowodowych do r. 1936 włącznie z późniejszymi. Porównanie dat wycieleń w różnych rezerwatach, wykazuje największe rozciągnięcie sezonu godowego w czasie w rezerwacie Pszczyńskim.

Opisano szczegółowo przebieg rui u żubrów w rezerwatach. Rywalizacja byków w tym czasie, może przebiegać bardzo drastycznie na terenie małych zagród, natomiast na rozleglejszym terenie byk słabszy zwykle ustępuje silniejszemu i ucieka.

Zaobserwowano, że dojrzałe płciowo byki wysuwają prącie w czasie defekacji.

Ruja, o ile nie nastąpiło zapłodnienie, powtarza się co kilkanaście do kilkudziesięciu dni; zwykle co dwadzieścia kilka dni.

Ruja, owulacja i zapłodnienie może wystąpić u żubrzyce w 22 dni po porodzie; zwykle jednak następuje później (po kilkudziesięciu, 40—80, dniach). Na ogół odstęp ten bywa dłuższy, jeśli poród nastąpił w maju, natomiast krótszy, gdy poród odbył się w miesiącach późniejszych. Wyjątkowo można zaobserwować u żubrzyce występowanie objawów rujo-nych po pokryciu.

Ciąża trwa zwykle u żubrów od 260 do 270 dni; przeciętnie 265 dni.

Zestawienie płci żubrów urodzonych we wszystkich rezerwatach i ogrodach zoologicznych wykazuje niezbitcie, że u żubrów rodzi się 50% samic i 50% samców.

Oдноśnie dojrzałości płciowej samców dane z ksiąg rodowodowych świadczą, że byk może pokryć skutecznie w wieku 15 miesięcy. Te same dane dla samic świadczą, że żubrzyce były pokrywane ze skutkiem w wieku około 24—28 miesięcy. Pełny rozwój fizyczny byki osiągają w wieku około 8 lat; krowy w około 4—5 lat.

Najdłuższy wiek byka wynosi, na podstawie ksiąg rodowodowych, 23 lata, krowy 26 lat; średni wiek byka 12 lat, a krowy 13. Dane te nie pozwalają na wyciągnięcie wniosku, że byki żyją krócej, ponieważ samce nie były często otaczane taką troskliwością, jak samice.

Na podstawie analizy szybkości wzrostu pogłowia żubrów w różnych rezerwatach, można wyciągnąć wniosek, że ani niekorzystne warunki rezerwatowe, ani chów wsobny nie osłabiły zdolności rozrodczych żubra, który przy odpowiedniej opiece mnoży się nie gorzej od bizona.

Istotną przyczyną, która powoduje zarówno zanikanie sezonu godowego, jak i szereg innych zaburzeń w fizjologii żubra, są przypuszczalnie czynniki żywieniowe. Prawdopodobnie nienaturalne żywienie (owsem, burakami, sianem itp., z niewielkim dodatkiem gałęzi), pasza, której zwierzę nie może sobie samo wybierać, brak naturalnych solanek, oraz brak odpowiednich sezonowych, ilościowych i jakościowych zmian w pokarmie jest istotną przyczyną zmian w fizjologii rozrodu żubra.

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## РЕЗЮМЕ

В начале работы рассмотрены важнейшие данные из литературы относящиеся к размножению рода *Bison* Н. SMITH, 1827; упоминаются тоже данные из филогенеза, которые могут иметь связь с размножением. Приведены самые важные данные касающиеся размножения бизона в диком состоянии и после реституции. Они разъясняют во многом вопросы размножения зубра и обнаруживают довольно часто существенное сходство (учитывая местные условия).

Критически рассмотрено литературу относящуюся к размножению кавказского и бяловежского зубра. Между прочим подвержено критике распространенное мнение, что у зубров рождается больше самцов, чем самок, и встречаемые раньше представления касающиеся причин низкой плодовитости зубров.

В Бяловеже зубр сохранился благодаря специальной охране. Эта охрана, а также ряд факторов и местных условий вызвали перемены и искажения в биологии этого животного. Прежние наблюдения указывают у зубра в общем довольно точно определенный период отелов и период гона. Постепенные перемены в условиях жизни привели к „регулировке” этих периодов. Подлинной причиной этого являются вероятно кормовые условия.

Рассмотрены тоже более важные данные относящиеся к гибридам зубра и бизона.

Главная часть работы основана на данных из племенных книг зубра и на собственных наблюдениях во всех заповедниках зубров в Польше, а также в некоторых зоологических садах.

На основании дат отелов, указанных в племенных книгах, автор приходит к заключению, что размножение зубра в настоящее время составляет известного рода переход между дикими жвачными, у которых в умеренном климате период гона и период отелов довольно точно определены, и домашними животными, у которых по большей части период гона и период отелов растянуты на весь год. Это касается особенно домашнего скога довольно близко родственного зубру.

Анализ наступания течки у зубров показывает, что она происходит чаще всего в конце августа и в сентябре, однако часто не доходит до оплодотворения. Течка тогда повторяется. Хотя самое значительное число отелов бывает в мае, то однако они растягиваются на все последующие месяцы в уменьшающемся количестве. Это постепенное исчезновение границы периода отелов, видно тоже из сравнения данных племенных книг до 1936 г. включительно с более поздними данными. Сравнение дат отелов в разных заповедниках обнаруживает самую большую растянутость периода года в Пщинском заповеднике.

Подробно описан ход течки у зубров в заповедниках. Соревнование самцов может в это время принимать в малых оградах очень острые формы, но на более пространных местах более слабый самец всегда уступает более сильному и уходит.

Отмечено, что полсвзрелые самцы высовывает пенис при дефекации.

Если не произошло оплодотворение, течка повторяется через десять, двадцать, или несколько десятков дней: обыкновенно каждые двадцать с небольшим дней.

Течка, овуляция и оплодотворение могут наступить у самки в 22 дня после родов; обыкновенно однако происходят позже (спустя 40—80 дней). В общем этот промежуток бывает дольше, если роды были в мае, и короче, если они произошли в последующих месяцах. В виде исключения можно наблюдать у самок появление симптомов течки после покрытия.

Беременность продолжается обыкновенно у зубров от 260 до 270 дней; в среднем 265 дней.

Сопоставление пола зубров рожденных во всех заповедниках и зоологических садах доказывает вне всякого сомнения, что у зубров рождается 50% самок и 50% самцов.

Относительно половой зрелости самцов данные из племенных книг доказывают, что самец может покрыть успешно в возрасте 15 месяцев. Те же самые данные для самок свидетельствуют, что самки были успешно покрываемы в возрасте около 24—28 месяцев. До полного физического развития самцы доходят в возрасте около 8 лет; самки около 4—5 лет.

Самый долгий срок жизни самцов, на основании племенных книг, 23 года, самок 26 лет; средний век самцов 12 лет, а самок 13. Из этих данных не следует, что самцы живут короче, так как о самцах часто не заботились с такой старательностью, как о самках.

На основании быстроты роста поголовия зубров в разных заповедниках можно сделать вывод, что ни неподходящие условия заповедников, ни родственное разведение не ослабили плодовитости зубра, который при соответствующим уходе размножается не хуже бизона.

Главной причиной, которая вызывает как исчезание определенного периода гона, так и ряд других расстройств в физиологии зубра, являются по всей вероятности кормовые факторы. Вероятно несоответствующее природным условиям питание (овсом, свеклой, сеном и т. п. с небольшой прибавкой ветвей), корм, которого животное не может само себе выбирать, отсутствие естественных солощов, и отсутствие соответствующих сезонных, количественных и качественных перемен в корме, являются подлинной причиной перемен в физиологии размножения зубра.

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T A B L E S

Table I

Incidence of births in European bison in the particular months, tabulated according to the pedigree books, up till Dec. 31, 1936.

No	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	128 <sup>1</sup>	79	24	52	3	4	13	29	81	49	11	10
2.	181			127	5	12	17	38	101	93	14	78
3.				171	6	19	20	60	117	94	103	105
4.				191	9	21	53	63	163	107	104	147
5.					15	25	92	80	225	118	111	
6.					18	34	115	88	230	144	146	
7.					22	35	116	106	244	145	158	
8.					23	36	119	112	269	231	189	
9.					26	56	120	113		245	213	
10.					30	57	126	157			224	
11.					31	59	143	220				
12.					37	87	174	228				
13.					48	91	175	254				
14.					54	102	182	256				
15.					55	110	187	262				
16.					58	114	192					
17.					82	155	195					
18.					83	166	199					
19.					84	173	206					
20.					90	178	207					
21.					108	193	211					
22.					109	205	218					
23.					124	216	219					
24.					125	217	226					
25.					141	222	236					
26.					142	223	241					
27.					154	229						
28.					156	235						
29.					161	243						
30.					162	255						
31.					164	258						
32.					165	260						
33.					172	261						
34.					176	265						
35.					177	266						
36.					183	267						
37.					184	268						
38.					186	270						
39.					188							
40.					196							
41.					198							
42.					201							
43.					203							
44.					204							
45.					208							
46.					209							
47.					210							
48.					212							
49.					214							
50.					215							
51.					221							
52.					233							
53.					234							
54.					237							
55.					238							
56.					239							
57.					240							
58.					242							
59.					246							
60.					247							
61.					248							
62.					249							
63.					250							
64.					251							
65.					253							
66.					257							
67.					259							
68.					263							
69.					264							

<sup>1</sup> Individual animals denoted by their pedigree numbers.

Table II

Incidence of births in European bison in the particular months, tabulated according to the pedigree books, for the period between Jan. 1, 1937, and Dec. 31, 1950.

No	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	683 <sup>1</sup>		525	549	471	474	479	484	481	486	487	477
2.				580	472	475	499	457	485	503	548	523
3.				624	473	476	501	520	488	504	557	554
4.				673	482	478	519	527	502	521	578	608
5.				776	492	480	571	555	505	522	607	641
6.				805	493	498	572	556	546	547	640	702
7.				806	494	500	600	637	576	573	698	559
8.					496	518	605	657	585	577	701	
9.					506	524	636	658	627	606	772	
10.					507	526	655	660	686	628	777	
11.					517	545	656	680	688	629	778	
12.					528	551	661	699	700	630	780	
13.					529	552	662	723	705	634		
14.					541	570	663	742	724	652		
15.					542	575	665	752	756	664		
16.					543	579	676	768	769	689		
17.					544	581	677	775	770	697		
18.					550	584	685	779	795	708		
19.					574	599	704	792	796	720		
20.					582	610	707	793	808	721		
21.					583	611	716	794		725		
22.					596	613	719			726		
23.					597	626	767			744		
24.					603	638	791			748		
25.					604	639	803			797		
26.					625	666	804					
27.					631	679						
28.					632	695						
29.					653	696						
30.					654	718						
31.					674	727						
32.					675	728						
33.					678	739						
34.					684	740						
35.					687	741						
36.					694	749						
37.					703	751						
38.					714	753						
39.					715	764						
40.					717	766						
41.					735	787						
42.					736	788						
43.					737	789						
44.					738	790						
45.					746	614						
46.					747							
47.					750							
48.					754							
49.					755							
50.					760							
51.					761							
52.					762							
53.					763							
54.					773							
55.					774							
56.					785							
57.					786							
58.					798							
59.					800							
60.					801							
61.					802							
62.					807							

<sup>1</sup> Individual animals denoted by their pedigree numbers.



Table III

Incidence of effective matings in the particular months, compiled approximately according to data given in Table I.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
94 <sup>1</sup>	14	11	10		24	52	3	4	13	17	29
101	49	105	78		79	97	9	5	20	60	38
107	93	147	128			127	18	6	35	63	80
117	103	189	181			153	22	12	53	112	106
118	104	213				171	23	15	56	113	220
144	111				202	26	19	92	115	225	
163	145					30	21	116	143	228	
231	146					31	25	119	157	230	
245	158					37	34	120	211	244	
	224					48	36	126	226	256	
						54	57	174	254	269	
						55	59	175	262		
						58	90	179			
						84	91	182			
						109	102	187			
						124	110	192			
						125	114	195			
						141	142	199			
						151	154	206			
						152	155	207			
						161	156	218			
						172	162	219			
						176	164	236			
						183	165	241			
						184	166	243			
						186	173	265			
						188	177				
						191	178				
						196	185				
						201	193				
						203	194				
						208	197				
						209	198				
						214	204				
						221	205				
						227	210				
						233	212				
						234	215				
						238	216				
						239	217				
						240	222				
						242	223				
						246	229				
						247	235				
						248	237				
						249	250				
						251	255				
						252	258				
						253	259				
						257	260				
						263	261				
							264				
							266				
							267				
							268				
							270				

<sup>1</sup> Pedigree numbers of individual calves which resulted from the particular matings.

Table IV

Incidence of effective matings in the particular months, compiled approximately according to data given in Table II.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
486 <sup>1</sup>	487	477		683	525	549	471	474	476	484	481
488	504	523				673	472	475	479	499	485
503	522	554				776	473	478	501	520	497
521	547	559					492	480	518	527	502
577	548	578					494	482	519	571	505
585	557	608					496	498	581	572	546
606	573	641					506	500	600	656	555
628	607	702					517	507	605	657	556
629	630	724					528	526	611	658	576
634	640	778					541	529	636	659	627
689	652						542	543	639	680	637
697	664						550	544	655	685	660
720	698						580	545	661	699	686
721	701						582	551	662	704	688
725	722						583	552	663	707	700
744	726						596	570	665	723	705
770	748						597	574	676	742	752
796	772						624	575	677	768	756
797	777						625	579	679	779	769
808	780						631	584	716	792	775
							632	599	718	793	794
							653	603	719		795
							654	604	740		
							674	610	749		
							675	613	791		
							678	614	803		
							684	626			
							694	638			
							703	666			
							714	687			
							715	695			
							735	696			
							736	717			
							746	727			
							747	728			
							750	737			
							754	738			
							760	739			
							761	741			
							762	751			
							773	753			
							774	755			
							785	763			
							786	764			
							798	766			
							799	787			
							800	788			
							801	789			
							805	790			
							806	802			
							807				

<sup>1</sup> Pedigree numbers of individual calves which resulted from the particular matings.

Table V

Incidence of effective matings in August and September, compiled approximately according to data given in Table III.

1-15 VIII	16-31 VIII	1-15 IX	16-30 IX
9 <sup>1</sup>	3	4	12
23	18	5	19
37	22	6	21
48	26	15	25
54	30	36	34
124	31	59	91
151	55	90	102
161	58	114	110
183	84	142	155
191	109	154	173
242	125	156	178
251	141	162	185
	152	164	193
	172	165	194
	176	166	210
	184	177	223
	186	197	229
	188	198	235
	196	204	258
	201	205	260
	203	210	261
	208	212	266
	209	215	267
	214	217	268
	221	222	270
	227	237	
	233	250	
	234	255	
	238	259	
	239	264	
	240		
	246		
	247		
	248		
	249		
	252		
	253		
	257		
	263		

Table VI

Incidence of effective matings in August and September, compiled approximately according to data given in Table IV.

1-15 VIII	16-31 VIII	1-15 IX	16-30 IX
580 <sup>1</sup>	471	474	475
624	472	482	478
653	473	507	480
654	492	529	498
674	494	543	500
694	496	544	526
746	506	570	545
754	517	574	551
773	528	575	552
785	541	579	584
786	542	603	599
805	550	604	610
806	582	614	613
	583	626	638
	596	666	696
	597	687	727
	625	695	739
	631	717	753
	632	728	766
	675	737	788
	678	738	789
	684	741	790
	703	751	
	714	755	
	715	763	
	735	764	
	736	787	
	747	802	
	750		
	760		
	761		
	762		
	774		
	798		
	799		
	800		
	801		
	807		

<sup>1</sup> Pedigree numbers of individual calves which resulted from the particular matings.

<sup>1</sup> Pedigree numbers of individual calves which resulted from the particular matings.

Table VII

Incidence of births in the particular months in the reserve of Niepolomice.

No	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.					747 <sup>1</sup>	787	767	723	724	748	772	
2.					760	790	791	793	756		xxx	
3.					761	xxx	vvv	xxx	769		vvv	
4.					763	xxx	vvv	vvv	795			
5.	. . . . .				786	xxx	vvv	zzz				
6.					xxx	xxx	zzz					
7.					xxx	vvv						
8.					vvv	vvv						
9.					zzz	vvv						
10.	. . . . .				zzz	zzz						
11.					zzz							

<sup>1</sup> Individual animals denoted by their pedigree numbers; letters indicate animals which have not yet been given pedigree numbers: xxx — animals born in 1951, vvv — born in 1952, zzz — born in 1953.

Table VIII

Incidence of births in the particular months in the reserve of Pszczyna.

No	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.					574 <sup>1</sup>	575	605	484	485	486	487	523
2.					603	679	655	657	505	503	548	608
3.					604	718	656	658	540	504	578	702
4.					631	739	719	680	576	521	607	xxx
5.					632	741	xxx	699	700	522	701	
6.					653	766	vvv	742	796	547	xxx	
7.					654	789	zzz	768	xxx	577		
8.					678	xxx		775		606		
9.					717					634		
10.	. . . . .				737					720		
11.					785					721		
12.					xxx					744		
13.					vvv					797		
14.					zzz							
15.					zzz							
16.					zzz							
17.					zzz							

<sup>1</sup> Individual animals denoted by their pedigree numbers; letters indicate animals which have not yet been given pedigree numbers: xxx — animals born in 1951, vvv — born in 1952, zzz — born in 1953.

Table IX

Incidence of births in the particular months in the reserve of Bialowieża

No	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.				624 <sup>1</sup>	517	478	479	520	502	573	698	xxx
2.				673	541	500	501	792	627	628		xxx
3.					542	518	519	794	770	629		
4.					543	545	571	zzz		630		
5.					544	570	572	zzz		652		
6.					596	599	600			697		
7.					597	626	676			725		
8.					625	695	677			xxx		
9.					674	696	716					
10.	. . . . .				675	764	vvv					
11.					694	788	vvv					
12.					714	xxx						
13.					715	vvv						
14.					735	zzz						
15.					736							
16.					762							
17.					xxx							
18.					xxx							
19.					xxx							
20.	. . . . .				zzz							
21.					zzz							
22.					zzz							

<sup>1</sup> Individual animals denoted by their pedigree numbers; letters indicate animals which have not yet been given pedigree numbers: xxx — animals born in 1951, vvv — born in 1952, zzz — born in 1953.

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BIBLIOTEKA

**Table X**  
Matings and calvings noted in the reserve of Goree, compiled according to records kept at the reserve.

No	Name of		Date of matings	Date of calving	Duration of pregnancy	Sex of calf	Name of calf
	cow	bull					
<b>1950—1951</b>							
1	„Puma”	„Puk”	16 X 1950 once	3 XI 1950 assist.	22 XI 1950 symptoms of oestrus		
2	„Pupilka”	„Puk”	6 IX 1950				
3	„Pużanka”	„Puk”	26 IX 1950 twice				
<b>1951—1952</b>							
1	„Puma”	„Puszek”	17 VIII 1951 once with manipulation		22 V 1952	279	♀
2	„Pupilka”	„Puszek”	26 VIII 1951 once with manipulation	29 XI 1951			
3	„Pużanka”	„Puszek”	13 VIII 1951 with manipulation		5 V 1952	266	♂
<b>1952—1953</b> (large enclosure)							
1	„Puma”	„Puszek”	17 VIII 1952	2 XI 1952			
2	„Pupilka”	„Puszek”	11 IV 1952	14 VIII 1952 assist.			
3	„Pużanka”	„Puszek”	23 VIII 1952	7 IV 1953			
4	„Pupileczka”	„Puszek”	11 VIII 1952		30 VI 1953		♀
			10 II 1953 assist.		15 VII 1953 died; autopsy revealed preg- nancy of 5 months		„Tatrzan- ka”

Table XI  
Matings and calvings noted in the reserve of Niepołomice, compiled according  
to records kept at the reserve.

N <sup>o</sup>	Name of		Date of matings	Date of calving	Duration of pregnancy	Sex of calf	Name of calf
	cow	bull					
1948—1949							
1	„Puma”	„Puzon”	30 I 1948	24 X 1948	268	♀	„Pumianka”
2	„Pupilka”	„Puk”	24 VIII 1948 1 IX 1948	28 V 1949	269	♀	„Puganka”
3	„Puszcza”	„Puzon”	27 VIII 1948	16 V 1949	262	♂	„Pumeks”
4	„Purta”	„Puzon”	28 VIII 1948 16 IX 1948 10 X 1948 28 X 1948	9 IX 1949		♂	„Purjan”
5	„Pużanka”	„Puk”	6 X 1948 19 X 1948 8 XI 1948	30 VII 1949	264	♂	„Pukar”
6	„Pura”	„Puzon”	2 XI 1948 10 XI 1948	21 VI 1949 aborted after 224 days			
7	„Putka”	„Puzon”	18 VIII 1948	11 V 1949	266	♀	„Puzorka”
1949—1949							
1	„Puma”	„Puk”	6 II 1949	3 XI 1949	270	♀	„Pustynia” died 11 XI 1949
1949—1950							
1	„Puma”	„Puk”	25 XI 1949	30 VIII 1950	268	♀	„Pugorka”
2	„Pupilka”	„Puk”	6 VIII 1949	6 V 1950	273	♀	„Pupileczka”
3	„Puszcza”	„Puzon”	10 IX 1949 4 X 1949	20 VI 1950	259	♀	„Puszczanka”
4	„Purta”	„Puzon”	10 XII 1949 30 XII 1949	18 IX 1950	262	♀	„Purtanka”
5	„Pużanka”	„Puk”	11 IX 1949	2 VI 1950	264	♂	„Pustak”
6	„Pura”	„Puzon”	12 VIII 1949 31 VIII 1949 19 IX 1949 11 X 1949 28 XI 1949 1 II 1950 26 II 1950				
7	„Putka”	„Puzon”	16 IX 1949 27 IX 1949 6 X 1949 29 X 1949	16 VII 1950	260	♀	„Pulka”
1950—1951							
3	„Puszcza”	„Puzon”	9 IX 1950 18 XI 1950	25 VIII 1951	280	♂	„Puszczan”
4	„Purta”	„Puzon”	11 XII 1950 21 I 1951 24 II 1951				
6	„Pura”	„Puzon”	28 VIII 1950	16 V 1951	261	♂	„Putyfar”
7	„Putka”	„Puzon”	17 IX 1950	9 VI 1951	264	♀	„Pudlarka”
8	„Puborka”	„Puzon”	19 VIII 1950	15 V 1951	269	♂	„Putnik”
9	„Pułomka”	„Puzon”	19 IX 1950	23 VI 1951	277	♀	„Pulonka”
10	„Puszyńska”	„Puzon”	30 IX 1950	20 VI 1951	263	♂	„Pudlarz”
11	„Purchawka”	„Puzon”	3 X 1950	24 VI 1951	264	♂	„Puzyk”
12	„Pumianka”	„Pumeks”	beginning of February 1951	9 XI 1951		♂	„Pumik”
1951—1952							
3	„Puszcza”	„Puzon”	7 X 1951 26 X 1951	8 VII 1952	256	♂	„Pułkownik”
4	„Purta”	„Puzon”	13 VIII 1951 1 IX 1951 21 IX 1951 20 X 1951 6 XI 1951	25 VII 1952	262	♀	„Pukajka”
6	„Pura”	„Puzon”	27 VIII 1951	14 V 1952	261	♂	„Purytan”
7	„Putka”	„Puzon”	14 X 1951 12 XI 1951 18 XII 1951 27 XII 1951 3 II 1952	28 XII 1952		♀	„Puzinka”
8	„Puborka”	„Pumeks”	6 XI 1951	24 VII 1952	262	♀	„Pumarka” died 13 VIII 1952
9	„Pułomka”	„Pumeks”	18 IX 1951	11 VI 1952	267	♂	„Puchatek”
10	„Puszyńska”	„Pumeks”	24 XI 1951	28 VIII 1952	278	♀	„Pustułka”
11	„Purchawka”	„Puzon”	18 IX 1951 27 IX 1951	12 VI 1952	259	♀	„Puszysta”
13	„Puzorka”	„Pumeks”	9 IX 1951 29 IX 1951	21 VI 1952	266	♂	„Pudelek”
1952—1953							
3	„Puszcza”	„Puzon”	1 IX 1952 10 IX 1952 29 IX 1952 13 XII 1952 2 I 1953 8 II 1953				
4	„Purta”	„Puzon”	11 X 1952	3 VII 1953	265	♂	„Pustybór”
6	„Pura”	„Puzon”	3 IX 1952	22 V 1953	261	♂	„Pułan”
8	„Puborka”	„Pumeks”	24 VIII 1952 13 IX 1952 3 X 1952	25 VI 1953	265	♀	„Pustelnia”
9	„Pułomka”	„Pumeks”	22 VIII 1952 2 IX 1952	30 V 1953	270	♂	„Pulik”
10	„Puszyńska”	„Pumeks”	7 X 1952 2 XI 1952				
11	„Purchawka”	„Puzon”	9 IX 1952 1 X 1952 19 XI 1952	3 VIII 1953	257	♀	„Puella”
12	„Pumianka”	„Pumeks”	23 VIII 1952	20 V 1953	270	♀	„Puzłotka”
13	„Puzorka”	„Pumeks”	27 VIII 1952				
1953—1954							
6	„Pura”	„Puzon”	28 IX 1953 10 XI 1953				
7	„Putka”	„Puzon”	22 VII 1953				
8	„Puborka”	„Pumeks”	20 XI 1953				
9	„Pułomka”	„Pumeks”	7 IX 1953				
10	„Puszyńska”	„Pumeks”	24 VIII 1953				
11	„Purchawka”	„Puzon”	11 IX 1953 20 XI 1953				
12	„Pumianka”	„Pumeks”	25 XI 1953				
13	„Puzorka”	„Pumeks”	28 VIII 1953 19 X 1953				
14	„Pulka”	„Pumeks”	30 IX 1953				
15	„Purtanka”	„Putyfar”	16 XI 1953				

Table XII  
Matings and calvings noted in the reserve of Białowieża,  
compiled according to records kept at the reserve.

No	Name of cow	Name of bull	Date of matings	Date of calving	Duration of pregnancy	Sex of calf	Name of calf
1947-1948							
1	„Pupilka”	„Plisch”	31 VII 1947	3 V 1948	277	♂	„Fuchar”
2	„Poganka”	„Plisch”	17 VIII 1947 26 VIII 1947 twice	9 V 1948	257	♀	„Pojata”
3	„Poziomka”	„Plisch”	12, 13 IX 1947 12 X 1947 four times assist.	30 V 1948	260	♂	„Podbipięta”
4	„Beste”	„Plisch”	24 X 1947 29 X 1947 assist.	23 VI 1948	259	♀	„Poświęta”
5	„Polana”	„Plisch”	6, 7 X 1947 8 X 1947 assist.	21 V 1948	260	♀	„Podwika”
3	„Poziomka”	„Połamaniec”	7 VIII 1947 15 VIII 1947 once assist.				
6	„Plarka”	„Plato”	18 VIII 1947 3, 4 IX 1947 assist. twice				
		„Plisch”	3 VIII 1947 5 IX 1947 assist. assist.				
			27 VII 1947 twice				
			23, 24 X 1947 29 X 1947 assist. assist.				
1948-1949							
2	„Poganka”	„Plisch”	20 VIII 1948 24 VIII 1948 assist. twice	1 VI 1949	258	♂	„Pobóg”
3	„Poziomka”	„Plisch”	25 VIII 1948 16 IX 1948 once				
4	„Beste”	„Plisch”	11 VIII 1948 7 IX 1948 assist. assist.	7 X 1949 abortion, placenta hanging out 40 cm		♀	„Popielica”
5	„Polana”	„Plisch”	20 IX 1948 29 IX 1948 assist. assist.	23 IX 1949			
			14 X 1948 10 I 1949 assist. assist.				
7	„Pożoga”	„Plisch”	1 VIII 1948 12 VIII 1948 assist. assist.	18 V 1949	264	♂	„Polel”
8	„Planaria”	„Plato”	16, 17 VIII 1948 27 VIII 1948 twice				
9	„Plesse”	„Plato”	28 VIII 1948 31 VIII 1948 assist. assist.				
		„Pleciuch”	6 X 1948 assist.				
			7 VIII 1948 19, 20 VIII 1948 assist.				
			6, 7 IX 1948 assist.				
			3 VIII 1948 assist.				
			9 X 1948. 18 XI 1948 once				
1949-1950							
2	„Poganka”	„Plisch”	8, 9 VIII 1949 23 VIII 1949 assist.	25 VII 1950	283	♂	„Pogrom”
3	„Poziomka”	„Plisch”	1 IX 1949 22, 23 IX 1949 assist. four times				
5	„Polana”	„Plisch”	14, 15 X 1949 3 XII 1949 assist.	7 VI 1950	261	♀	„Pomsta”
7	„Pożoga”	„Plisch”	5 XI 1949 18 XI 1949 assist.				
8	„Planaria”	„Plato”	19 IX 1949 assist.				
9	„Plarka”	„Plato”	3, 5 IX 1949 assist.	22 II 1949 14 III 1949 28 X 1949 assist.	7 VIII 1950	♂	„Karpacz”
			26 VIII 1949 assist.				
1950-1951							
2	„Poganka”	„Plisch”	21 IX 1950 24 IX 1950 28 X 1950 assist. assist.				
3	„Poziomka”	„Poganim” „Plisch”	2 III 1950 20 III 1950 assist. assist.	1 VI 1951	263	♂	„Polonus”
4	„Beste”	„Plisch”	20 III 1950 11, 12, 13 VIII 1950 assist. assist.	6 V 1951	265	♀	„Poręba”
5	„Polana”	„Plisch”	20, 21 VIII 1950 11 IX 1950 assist. assist.	21 V 1951		♂	„Pomruk”
7	„Pożoga”	„Plisch”	27 VII 1950 14 VIII 1950 assist. assist.	22 V 1951		♂	„Popas”
8	„Planaria”	„Plato”	22 VII 1950 assist.				
10	„Plamka II”	„Poganim”	7 II 1950 assist.	21 XII 1951		♀	„Pozłota”
		„Podbipięta”	7 I 1951 assist.	15 II 1951 assist.			
11	„Pojata”	„Poganim”	17 I 1951 7 II 1951 assist.	23 X 1951	258	♀	„Pogoń”
12	„Poświęta”	„Poganim”	9 I 1951 20 II 1951 13 III 1951 assist. assisting symptoms assist.	25 XII 1951	269	♀	„Polatucha”
			31 III 1951 assist.				
1951-1952							
2	„Poganka”	„Plisch”	7 II 1951 21 III 1951 19 VIII 1951 assist. twice, without effect assist.				
		„Poganim”	22, 23, 24 VIII 1951 6 IX 1951 cows mount each other, Plisch does not mount them assist.				
3	„Poziomka”	„Plisch”	17 IX 1951	15 VII 1952	283	♀	„Poda”
4	„Beste”	„Poganim”	16 IX 1951 6 X 1951	5 VI 1952 days, foetus not recovered			
6	„Plarka”	„Plato”	18 IX 1951 10 X 1951 assist. assist.	12 VII 1952		♀	„Kaba”
7	„Pożoga”	„Poganim”	14 II 1951 17 IX 1951 assist.				
13	„Podwika”	„Poganim”	20 IX 1951 10 X 1951 assist.				
		„Podbipięta”	11 I 1951 assist.	1 VII 1952	258	♀	„Pobudka”
			17 IX 1951				
1952-1953							
4	„Beste”	„Poganim”	9 VIII 1952 29 VIII 1952 assist.	11 VIII 1953		♀	„Pociecha”
5	„Polana”	„Poganim”	19 XI 1952				
6	„Plarka”	„Plato”	8 VIII 1952 28 VIII 1952 assist.				
			11 XI 1952 24 XII 1952 assist.				
10	„Plamka II”	„Poganim”	13, 14 VIII 1952 20 VIII 1952 assist. assist.				
			22 XI 1952 13 XII 1952 assist. assist.				
			10, 11, 13, 14 VIII 1952 assist.	19 VI 1953	260	♂	„Ponury”
			24, 25 VIII 1952 2 X 1952 assist. assist.				
11	„Pojata”	„Podbipięta”	11 VIII 1952	16 V 1953	277	♂	„Podarek”
12	„Poświęta”	„Podbipięta”		15 V 1953		♂	„Postęp”
13	„Podwika”	„Podbipięta”		14 VIII 1953		♀	„Pogodna”
14	„Popielica”	„Podbipięta”		14 V 1953		♂	„Pokój”

Table XIII

Intervals (in days) between heat recurrences in cows of the Niepołomice reserve compiled according to data given in Table XI<sup>1, 2</sup>.

- „Pupilka”: 2\* VIII 1948 – 1 IX 1948 (+) = **7**; („Puk”).
- „Puszcza”: 10 IX 1949 – 4 X 1949 (+) = **24**; 9 IX 1950 – 18 XI 1950 (+) = **70**; 7 X 1951 – 26 X 1951 (+) = **19**; 1 IX 1952 – 10 IX 1952 – 29 IX 1952 – 13 XII 1952 – 2 I 1953 – 8 II 1953 = **9 – 19 – 73 – 20 – 37**; („Puzon”).
- „Purta”: 28 VIII 1948 – 16 IX 1948 – 10 X 1948 – 28 X 1948 = **19 – 24 – 18**; 10 XII 1949 – 30 XII 1949 (+) = **20**; 11 XII 1950 – 21 I 1951 – 24 II 1951 – 13 VIII 1951 – 1 IX 1951 – 21 IX 1951 – 20 X 1951 – 6 XI 1951 (+) = **41 – 34 – 170 – 19 – 20 – 30 – 16**; („Puzon”).
- „Pużanka”: 6 X 1948 – 19 X 1948 – 8 XI 1948 (+) = **13 – 20**; („Puk”).
- „Pura”: 2 XI 1948 – 10 XI 1948 (+) = **8**; 12 VIII 1949 – 31 VIII 1949 – 19 IX 1949 – 11 X 1949 – 28 XI 1949 – 1 II 1950 – 26 II 1950 – 28 VIII 1950 (+) = **19 – 19 – 22 – 48 – 64 – 25**; („Puzon”).
- „Putka”: 16 IX 1949 – 27 IX 1949 – 6 X 1949 – 29 X 1949 = **11 – 9 – 23**; 14 X 1951 – 12 XI 1951 – 18 XII 1951 – 27 XII 1951 – 3 I 1952 = **29 – 36 – 9 – 38**; („Puzon”).
- „Puborka”: 24 VIII 1952 – 13 IX 1952 – 3 X 1952 (+) = **20 – 20**; („Pumeks”).
- „Pułomka”: 22 VIII 1952 – 2 IX 1952 (+) = **11**; („Pumeks”).
- „Puszyńska”: 7 X 1952 – 2 XI 1952 = **26**; („Pumeks”).
- „Purchawka”: 18 IX 1951 – 27 IX 1951 (+) = **9**; 9 IX 1952 – 1 X 1952 – 19 XI 1952 (+) = **21 – 49**; („Puzon”).
- „Puzorka”: 9 IX 1951 – 29 IX 1951 (+) = **20**; („Pumeks”).

<sup>1</sup> The sign (+) denotes that mating was successful.

<sup>2</sup> Intervals established beyond any doubt given in bold print, those less certain – in ordinary print, dubious ones – with an interrogation mark.

Table XIV

Means of intervals (in days) between heat recurrences in cows of the Niepołomice reserve<sup>1</sup>.

„Pupilka”	7	„Purta”	24(37)	„Pura”	30	„Puborka”	20
„Puszcza”	34	„Pużanka”	16	„Putka”	22	„Pułomka”	11
„Puszyńska”	26	„Purchawka”	26	„Puzorka”	20		

<sup>1</sup> Means of intervals established beyond any doubt given without brackets, in brackets means based on all intervals the dubious ones included.



Table XV

Intervals (in days) between heat recurrences in cows of the Białowieża reserve, compiled according to data given in Table XII<sup>1,2</sup>.

- „Poganka”: 17 VIII 1947 – 26 VIII 1947 = **9**; 20 VIII 1948 (?) – 24 VIII 1948, 25 VIII 1948 – 16 IX 1948 (+) = 4 (?) – **22**; 8, 9 VIII 1949 – 23 VIII 1949 – 1 IX 1949 – 22, 23 IX 1949 – 14, 15 X 1949 (+) – 3 XII 1949 (?) = **14** – 8 – **21** – **21** – **39** (?); 21 IX 1950 (?) – 24 IX 1950 – 28 X 1950 = 3 (?) – **34**; 7 II 1951 – 21 III 1951 – 19 VIII 1951 – 22, 23, 24 VIII 1951 – 6 IX 1951 („Plisch”) – 14 X 1951 („Poganiń”) = 42 – 151 – 3 (?) – 13 – 38.
- „Poziomka”: 12, 13 IX 1947 (+) – 12 X 1947 – 24 X 1947 – 29 X 1947 = 29 – 12 – 5; 11 VIII 1948 – 7 IX 1948 – 20 IX 1948 – 29 IX 1948 – 14 X 1948 – 10 I 1949 = **27** – **13** – **9** – **15** – **88**; 5 XI 1949 – 18 XI 1949 = **13** („Plisch”); 2 III 1950 („Poganiń”) – 20 III 1950 („Plisch”, „Poganiń”) – 11, 12, 13 VIII 1950 – 20, 21 VIII 1950 – 11 IX 1950 (+) – 18 – 144 – 7 – 21 („Plisch”).
- „Beste”: 27 VII 1950 – 14 VIII 1950 (+) = **18** („Plisch”); 16 IX 1951 – 6 X 1951 = **20** („Poganiń”); 9 VIII 1952 – 29 VIII 1952 – 19 XI 1952 = **20** – **82** („Poganiń”).
- „Polana”: 7 VIII 1947 – 15 VIII 1947 – 18 VIII 1947 – 3, 4 IX 1947(+) = 8 – 3 (?) – **16**; 1 VIII 1948 – 12 VIII 1948 (?) – 16, 17 VIII 1948 – 27 VIII 1948 = 12 – 4 (?) – 10 („Plisch”); 22 VIII 1951 (?) – 30 VIII 1951 („Plisch”) – 18 IX 1951 – 10 X 1951 = 8 – 19 – **22**; 8 VIII 1952 – 28 VIII 1952 – 11 XI 1952 – 24 XII 1952 = **20** – **75** – **43** („Poganiń”).
- „Plarka”: 27 VII 1947 („Plato”) – 23, 24 X 1947 – 29 X 1947 („Plisch”) = 87 – 5; 14 II 1951 – 17 IX 1951 = 215; 13, 14 VIII 1952 – 20 VIII 1952 – 22 XI 1952 – 13 XII 1952 = 6 – 63 – **21** („Plato”).
- „Pożoga”: 28 VIII 1948 – 31 VIII 1948 – 6 X 1948 = 3 (?) – **36** („Plisch”); 20 IX 1951 – 10 X 1951 = **20** („Poganiń”).
- „Planaria”: 7 VIII 1948 – 19, 20 VIII 1948 – 6, 7 IX 1948 – 22 II 1949 – 14 III 1949 – 28 X 1949 – 7 II 1950 = 12 – 17 – 168 – 20 – 228 – 102 („Plato”).
- „Plesse”: 3 VIII 1948 – 9 X 1948 – 18 XI 1948 = 67 – 39 („Plato”).
- „Plamka II”: 7 I 1951 („Poganiń”) – 15 II 1951 = **39** („Podbipięta”); 10, 11, 13, 14 VIII 1952 – 24, 25 VIII 1952 – 2 X 1952 (+) = **10** – **38** („Poganiń”).
- „Pojata”: 7 I 1951 – 7 II 1951 (+) = **31** („Poganiń”).
- „Poświęta”: 9 I 1951 – 20 II 1951 – 13 III 1951 – 31 III 1951 (+) = 42 – 21 – **18** („Poganiń”).
- „Podwika”: 11 I 1951 („Poganiń”) – 17 IX 1951 (+) = 249? („Podbipięta”).

<sup>1</sup> The sing (+) denotes that mating was successful.

<sup>2</sup> Intervals established beyond any doubt given in bold print, those less certain – in ordinary print, dubious ones – with an interrogation mark.

Table XVI

Means of intervals (in days) between heat recurrences in cows of the Białowieża reserve<sup>1</sup>.

„Poganka”	20 (22)	„Planaria”	16 (91)
„Poziomka”	27 (31)	„Plesse”	(53)
„Beste”	19 (35)	„Plamka II”	29
„Polaná”	29 (20)	„Pojata”	31
„Plarka”	21 (66)	„Poświęta”	27
„Pozoga”	28 (20)	„Podwika”	(249 ?)

<sup>1</sup> Means of intervals established beyond any doubt given without brackets, in brackets means based on all intervals the dubious ones included.

Table XVII

Sex of calves born in the particular months of the year (up to Dec. 31, 1936).

January	— 1 ♀ + 1 ♂	July	— 12 ♀♀ + 14 ♂♂
February	— 1 ♂	August	— 9 ♀♀ + 6 ♂♂
March	— 1 ♂	September	— 3 ♀♀ + 5 ♂♂
April	— 2 ♀♀ + 2 ♂♂	October	— 7 ♀♀ + 2 ♂♂
May	— 36 ♀♀ + 33 ♂♂	November	— 4 ♀♀ + 6 ♂♂
June	— 16 ♀♀ + 22 ♂♂	December	— 1 ♀ + 3 ♂♂

Table XVIII

Sex of calves born in the particular months of the year (in the years 1937—1950).

January	— 1 ♀	July	— 14 ♀♀ + 12 ♂♂
February	—	August	— 10 ♀♀ + 11 ♂♂
March	— 1 ♂	September	— 11 ♀♀ + 9 ♂♂
April	— 4 ♀♀ + 3 ♂♂	October	— 16 ♀♀ + 9 ♂♂
May	— 32 ♀♀ + 30 ♂♂	November	— 6 ♀♀ + 6 ♂♂
June	— 20 ♀♀ + 25 ♂♂	December	— 4 ♀♀ + 3 ♂♂

Table XIX

Sex ratio of calves born in the particular months of the year (summary).

January	— 2 ♀♀ + 1 ♂	July	— 26 ♀♀ + 26 ♂♂
February	— 1 ♂	August	— 19 ♀♀ + 17 ♂♂
March	— 2 ♂♂	September	— 14 ♀♀ + 14 ♂♂
April	— 6 ♀♀ + 5 ♂♂	October	— 23 ♀♀ + 11 ♂♂
May	— 68 ♀♀ + 63 ♂♂	November	— 10 ♀♀ + 12 ♂♂
June	— 36 ♀♀ + 47 ♂♂	December	— 5 ♀♀ + 6 ♂♂

Table XX

First oestrus after parturition (compiled according to data given in Tables XI and XII)<sup>1</sup>.

	Calving	Mating	Interval in days
„Puszcza”	16 V 1949	10 IX 1949 („Puzon”)	117
	20 VI 1950	9 IX 1950 („Puzon”)	81
	25 VIII 1951	7 X 1951 („Puzon”)	43
	8 VII 1952	1 IX 1952 („Puzon”)	53
„Puma”	24 X 1948	6 II 1949 („Puk”) (+)	105
	3 XI 1949	25 XI 1949 („Puk”) (+)	22
	30 VIII 1950	16 X 1950 („Puk”)	47
	22 V 1952	17 VIII 1952 („Puszek”)	87
„Pupilka”	3 V 1948	24 VIII 1948 („Puk”)	113
	28 V 1949	6 VIII 1949 („Puk”) (-)	70
	6 V 1950	6 IX 1950 („Puk”)	123
„Purta”	9 IX 1949	10 XII 1949 („Puzon”)	92
	18 IX 1950	11 XII 1950 („Puzon”)	84
	25 VII 1952	11 X 1952 („Puzon”) (+)	78
„Pużanka”	30 VII 1949	11 IX 1949 („Puk”) (+)	43
	2 VI 1950	26 IX 1950 („Puk”)	116
	5 V 1952	11 VIII 1952 („Puszek”)	98
„Pura”	aborted 21 VI 1949	12 VIII 1949 („Puzon”)	52
	16 V 1951	27 VIII 1951 („Puzon”) (+)	103
	14 V 1952	3 IX 1952 („Puzon”) (+)	112
	22 V 1953	28 IX 1953 („Puzon”)	129
„Putka”	11 V 1949	16 IX 1949 („Puzon”)	128
	16 VII 1950	17 IX 1950 („Puzon”) (+)	63
	9 VI 1951	14 X 1951 („Puzon”)	127
	28 XII 1952	22 VII 1953 („Puzon”)	207
		was alone until May 1953	
„Puborka”	15 V 1951	6 XI 1951 („Pumeks”) (+)	114
	24 VII 1952	24 VIII 1952 („Pumeks”)	31
	25 VI 1953	20 XI 1953 („Pumeks”)	87
„Pułomka”	23 VI 1951	18 IX 1951 („Pumeks”) (+)	87
	11 VI 1952	22 VIII 1952 („Pumeks”)	72
	30 V 1953	7 IX 1953 („Pumeks”)	100
„Puszyńska”	20 VI 1951	24 XI 1951 („Pumeks”) (+)	157
	28 VIII 1952	7 X 1952 („Pumeks”)	40
„Purchawka”	24 VI 1951	18 IX 1951 („Puzon”)	86
	12 VI 1952	9 IX 1952 („Puzon”)	89
	3 VIII 1953	11 IX 1953 („Puzon”)	39
„Pumianka”	9 XI 1951	23 VIII 1952 („Pumeks”)	336
	20 V 1953	25 XI 1953 („Pumeks”)	189
„Puzorka”	21 VI 1952	27 VIII 1952 („Pumeks”)	67
„Poganka”	4 VII 1947	17 VIII 1947 („Plisch”)	44
	9 V 1948	20 VIII 1948 („Plisch”)	103
	1 VI 1949	8 VIII 1949 („Plisch”)	68
	25 VII 1950	21 IX 1950 („Plisch”)	58
„Poziomka”	30 V 1948	11 VIII 1948 („Plisch”)	73
	aborted 7 X 1949	5 XI 1949 („Plisch”)	29
	1 VI 1951	17 IX 1951 („Plisch”)	109
„Beste”	6 V 1951	16 IX 1951 („Poganin”)	103
	15 VII 1952	9 VIII 1952 („Poganin”)	25
„Polana”	20 V 1947	7 VIII 1947 („Plisch”)	79
	21 V 1948	1 VIII 1948 („Plisch”)	72
	18 V 1949	19 IX 1949 („Plisch”)	124
	21 V 1951	22 VIII 1951	93
	aborted 5 VI 1952	8 VIII 1952 („Poganin”)	64
„Plarka”	12 VII 1952	13 VIII 1952 („Plato”)	32
„Pozoga”	22 V 1951	20 IX 1951 („Poganin”)	121

<sup>1</sup> The sign (+) denotes that mating was successful.

Table XXI

Average duration of pregnancy.

Niepołomice:	8 762 : 33 = 265.5151 days,
Białowieża:	4 512 : 17 = 265.4117 days,
Gorce:	545 : 2 = 272.5 days.

In all three reserves together:

$$13\ 819 : 52 = 265.75 = 265 \text{ days.}$$

(The figure has been rounded to 265 as pregnancies of supposed longer duration might have been the result of matings that escaped notice; this applies in particular to the Gorce reserve).

Table XXII

Sex ratio of European bison born (compiled according to the pedigree books).

Born before Jan. 1, 1925: 60 ♀♀, 59 ♂♂

Born	♀	♂		♀	♂
			in 1937:	9	9
in 1925:	4	5	in 1938:	9	7
in 1926:	4	4	in 1939:	7	6
in 1927:	4	2	in 1940:	7	10
in 1928:	6	3	in 1941:	9	9
in 1929:	2	5	in 1942:	4	11
in 1930:	4	7	in 1943:	8	10
in 1931:	3	9	in 1944:	8	6
in 1932:	7	6	in 1945:	8	9
in 1933:	4	5	in 1946:	7	7
in 1934:	3	6	in 1947:	11	5
in 1935:	8	3	in 1948:	14	8
in 1936:	9	5	in 1949:	9	12
			in 1950:	14	10
	<hr/> 58	<hr/> 60		<hr/> 124	<hr/> 119

Total in the years 1925 to 1950: 182 ♀♀, 179 ♂♂

Born	♀	♂
in 1951:	11	15
in 1952:	16	7
in 1953:	11	11
	<hr/> 38	<hr/> 33

Over-all figures: 280 ♀♀, 271 ♂♂  
which makes 49,18 per cent of males and 50,82 per cent of females.

Table XXIII

The pedigree of „Puk” (228) showing the sex ratio in his and his ancestors' progeny.

♂ Hagen × ♀ Gatschina (5♀♀ 8♂♂)		♂ Begas × ♀ Bermuda (2♀♀ 1♂)		♂ Bieberstein × ♀ Bildung (1♂)		♀ Bildung × ♂ Bildung (1♀ 1♂)		? × ?
♂ Schatten (2♀♀ 3♂♂)	×	♀ Bettina (3♀♀ 4♂♂)		♂ Bill (5♀♀ 1♂)	×	♀ Bilma (4♀♀ 4♂♂)		
		♂ Borusse (12♀♀ 6♂♂)	×			♀ Biscaya (9♀♀ 2♂♂)		
♂ Puk (4♀♀ 2♂♂)								

Table XXIV

The pedigree of „Plisch” (229) showing the sex ratio in his and his ancestors' progeny.

♂ Plebejer × ♀ Planta (5♀♀ 4♂♂)		♀ Planta × ♂ Plebejer (1♀ 2♂♂)		♂ Plebejer × ♀ Planta (5♀♀ 4♂♂)		♀ Planta × ♂ Plebejer (1♀ 2♂♂)
♂ Platen (2 ♂♂)	×			♀ Plakette (5♀♀ 10♂♂)		
♂ Plisch (22♀♀ 24♂♂)						

Table XXV

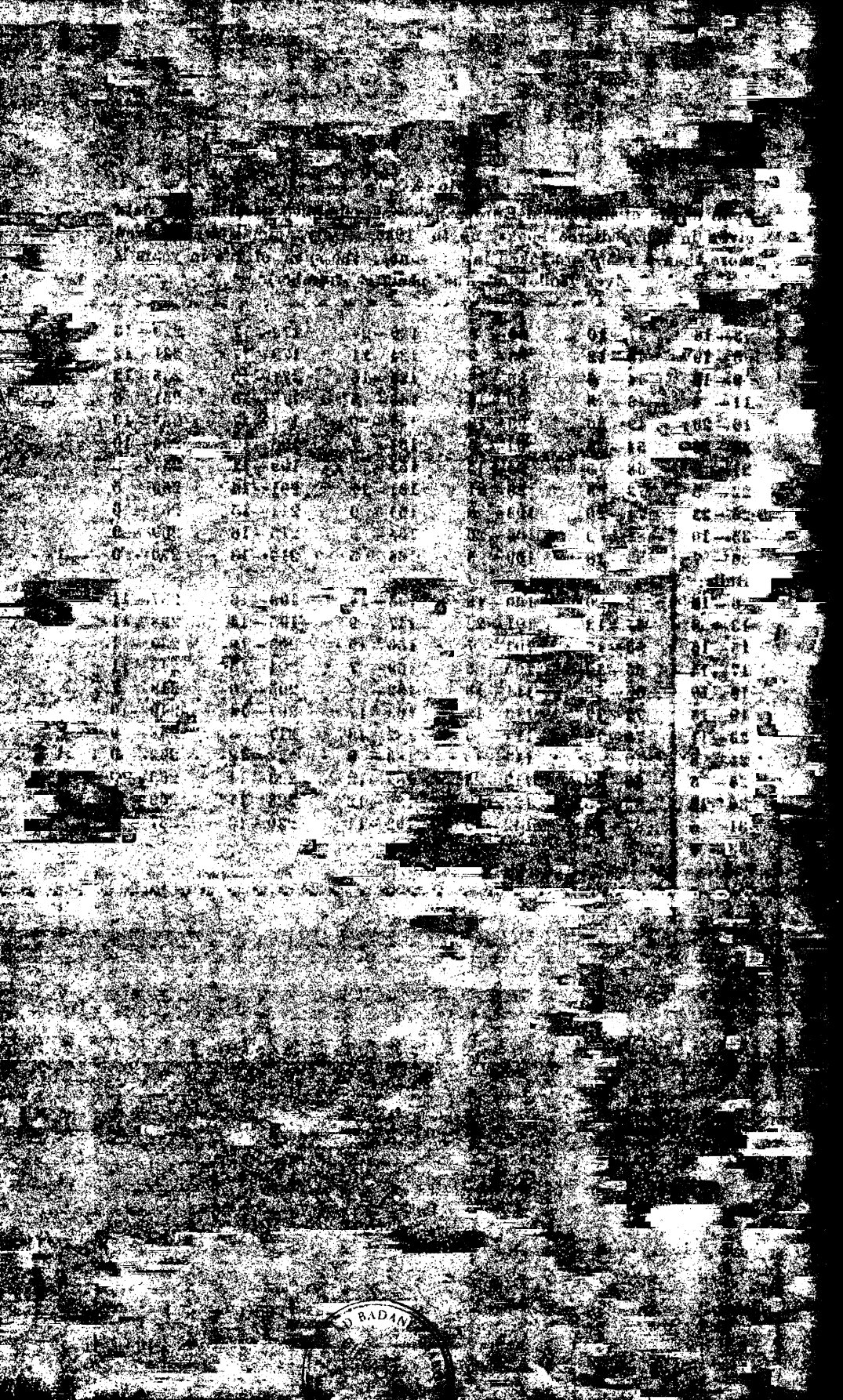
Span of life of individual European bisons, compiled according to data given in the pedigree books up to 1936. (Only animals which lived more than 5 years are taken into account; the span of life in years is given following the pedigree number).

Cows:

3-16	37-10	86- 9	120-24	172-17	220-16
5-19	43-12	88- 9	124-21	173-17	231-12
9-16	44- 6	89-26	125-16	177-10	235-12
11- 8	46- 8	90-13	143- 5	178-16	251- 5
16-26	49-20	93-19	145-20	187- 7	253-10
20-26	54- 5	94- 5	154- 7	196-17	254-10
21- 9	58-15	95-15	155- 7	199-11	257- 8
22- 5	73- 5	96-21	161-17	201-14	259- 5
25-23	74-20	103- 8	164- 6	211-15	262- 6
35-10	81- 9	106-26	165- 6	215-16	269- 9
36- 7	83-18	109- 8	166- 5	219-18	270- 9

Bulls:

6-15	45-20	100-18	146-14	193-16	237-11
13- 8	47-12	101-22	147- 9	195-14	238-11
15-16	55-17	104- 7	156-19	203-18	239-11
17-14	65-12	105- 6	158- 7	204-14	243-11
18-10	66- 8	111-18	162- 7	205- 6	248- 7
19-18	72-17	113-10	163-17	207-14	249-10
23-11	78-12	114- 6	182-16	217- 8	258- 9
24- 8	79- 7	117-10	186- 6	222-12	263- 9
26- 5	82-16	119-23	184-12	223-14	265- 9
30-16	85- 5	127- 9	189-12	228-17	266- 9
31- 5	87-16	142- 9	192-11	230-13	267- 9
38- 9					



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PLATES



Plate XIX

Fig. 1. Aug. 27, 1953, „Pumeks” sniffs at the external genital organs of „Puzorka”, note the position of „Puzorka’s” hind legs.

Fig. 2. Aug. 27, 1953, beginning of heat in „Puzorka”, „Pumeks” licks her.



Auctor phot.  
*Zb. Jaczewski*

Plate XX

Fig. 3. Aug. 27, 1953, „Pumeks” licks the back of „Puzorka”.

Fig. 4. Sept. 30, 1950, „Puzon” and „Puszynka” in rut.



Auctor phot.  
*Zb. Jacewski*

Plate XXI

Fig. 5. Febr. 6, 1953, „Pustak” and „Puszek”.

Fig. 6. Febr. 6, 1953, „Pustak” and „Puszek”.



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Auctor phot.  
*Zb. Jaczewski*

Plate XXII

Fig. 7. Sept. 28, 1953, a herd of young European bison (the bull „Putyfar” born May 16, 1951) does not attack men.



Auctor phot.  
*Zb. Jaczewski*



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