

Teeth Eruption in the European Bison

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Time of eruption, replacement, and teeth complete crown formation was studied in 79 European bison. Deciduous teeth erupt during the first 3 months, and are completely formed by the 6th month of life. Molars erupt between the 6th and 43rd month, and attain their full height during the following 5—13 months. Deciduous premolars are replaced during the 27—44th months, as are incisors from the 22—40th months and canines from the 38—44th month. The results are compared with data from species closely related to the European bison — the American bison and domestic cattle.

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I. INTRODUCTION

Ageing of European bison is of both theoretical and practical importance, and can be achieved most rapidly and relatively accurately by the state of the teeth. There are only short notes on this subject (Owen, 1848; Wilkus, 1957; Flerov, 1965, 1979), while there is a complete lack of data on age changes in teeth. Wasilewski (1967) referred to this problem in his paper comparing incisors wear in the European bison bred in reserves and those under natural conditions.

The present study relates to the periods of eruption and replacement of teeth and complete formation of their crowns. The process of teeth wear in the European bison will form the subject of a separate publication.

II. MATERIAL AND METHODS

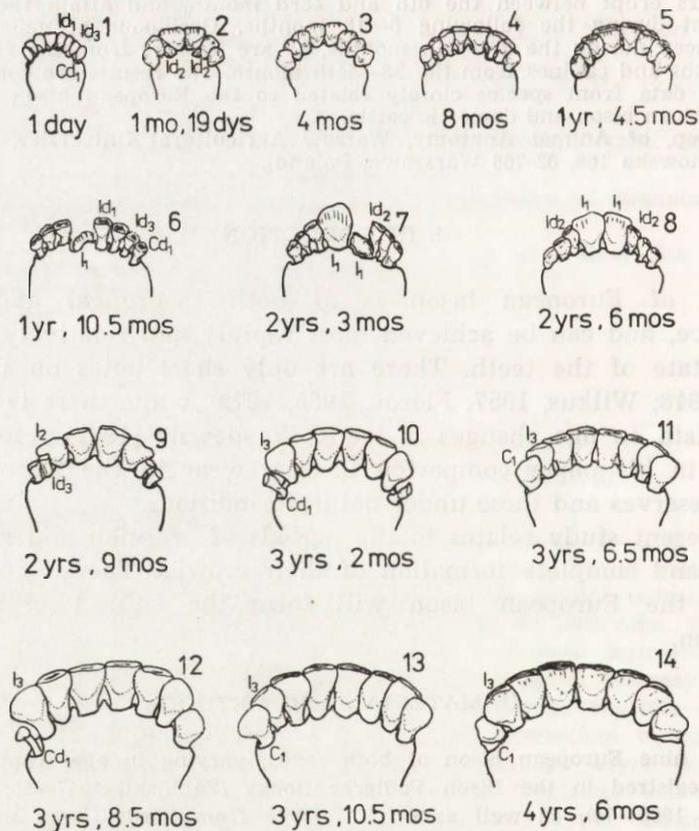
Seventy nine European bison of both sexes, varying in age from one day to 7 years, registred in the Bison Pedigree Books (Żabiński, 1947—65; Żabiński & Raczyński, 1965—74), as well as on 37 calves from herds living under natural conditions. The calves' age varying from 1 month to 1 year, their age being approximately defined by the breeders. The total number of animals examined was therefore 116 (63♂♂ and 53♀♀). Part of the well-documented material (n=21) came from the Mammals Research Institute, Polish Academy of Sciences in Białowieża, while the greater part was kept in the collections of the Department of Animal Anatomy of Warsaw Agricultural University.

A record was kept of the state of the teeth in every European bison examined,

paying attention to fully-grown and erupting teeth, their appearance and the first signs of wear on the occlusal surface. Observations were also made of the replacement of deciduous teeth and growth of enamel folds on molars.

III. RESULTS

Deciduous dentition in the European bison consists of 3 pairs of incisors (Id_1 , Id_2 , Id_3), a pairs of canines (Cd_1) and 3 pairs of premolars (Pd_2 , Pd_3 , Pd_4) in the mandible and 3 pairs of premolars (Pd^2 , Pd^3 , Pd^4) in the maxilla. This dental complement increases else by permanent dentition — 6 molars (M_1 , M_2 , M_3) in the mandible and the same number in the maxilla (M^1 , M^2 , M^3).



Figs. 1—14. Incisors and canines in European bison of different age. Lingual surface view (age by figure).

Eruption of deciduous teeth. European bison calves are usually born with all incisors (Id_1 — Id_3) and canines (Cd_1) (Fig. 1). Sometimes (1 case in 5) Id_2 and Cd_1 are observed to be absent in newborn calves and then

the surface of Id_1 and Id_3 are contact, while Id_2 and Cd_1 grow later. Poorer development of Id_2 was observed in several other animals up to the age of 6 months, and in one young European bison (1.5 months) it was nearly invisible from the lingual side (Fig. 2). In the age group from 2 to 9 days all incisors and canines were observed to have grown. During the initial period of life these teeth are diagonally situated and the flat crowns overlap each other like roof tiles (Figs. 1—3), later to take up their correct positions in year-old individuals.

Table 1

Age at which deciduous teeth erupt in European bison.

Name of tooth	Age in months	N	Name of tooth	Age in months	N
Id_1	before birth	12	Pd_2	1—1.5	15
Id_2	before or after birth	13	Pd_3	before birth	12
Id_3	before birth	12	Pd_4	before birth	12
Cd_1	before or after birth	11	cranial lobe	before birth	10
			medial lobe	before birth	4
			caudal lobe	1—1.5	12
			Pd^2	before birth	12
			Pd^3	before birth	12
			Pd^4	before birth	12
			cranial lobe	before birth	12
			caudal lobe	2—3	5

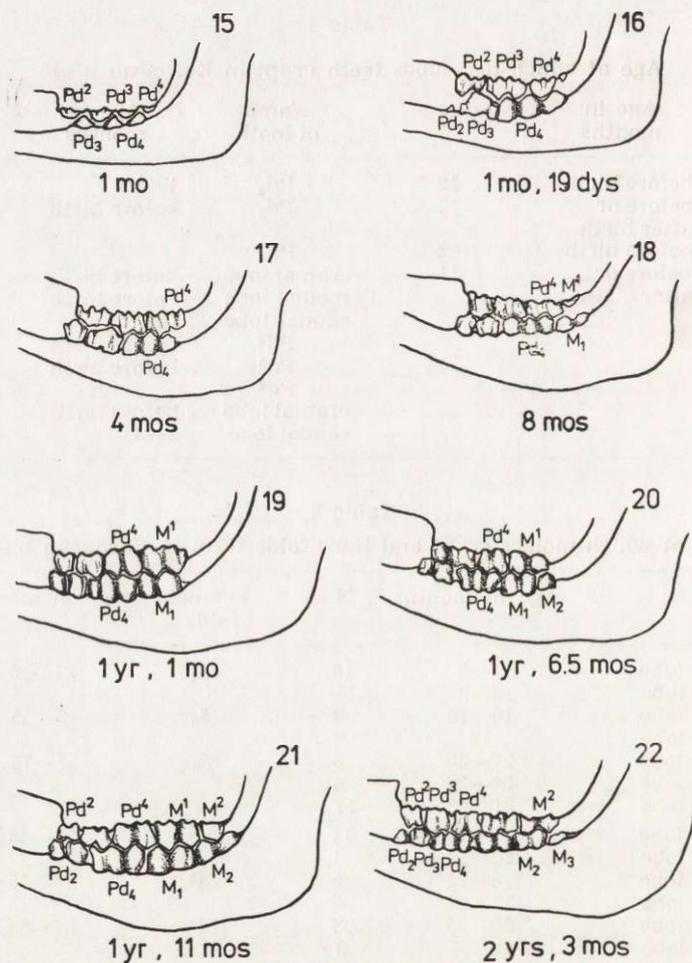
Table 2

Age at which molars erupt and their folds form in European bison.

Molars	Age in months	N	Enamel folds	Age in months	N
M_1 cranial lobe	6—7	16	M_1	21—25	3
caudal lobe	8—9	11			
M_2 cranial lobe	16—18	3	M_2	43—45	4
caudal lobe	18	2			
M_3 cranial lobe	27—30	3	M_3	53—78	6
medial lobe	30—36	4			
caudal lobe	31—43	11			
M^1 cranial lobe	8—9	11	M^1	31—43	5
caudal lobe	10—12	3			
M^2 cranial lobe	18—25	6	M^2	45—46	2
caudal lobe	23—27	4			
M^3 cranial lobe	30—35	3	M^3	53—84	8
caudal lobe	31—35	3			

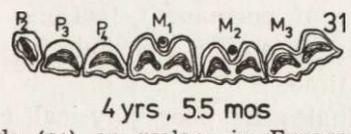
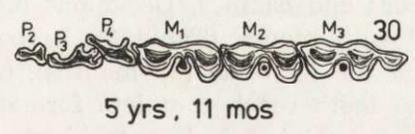
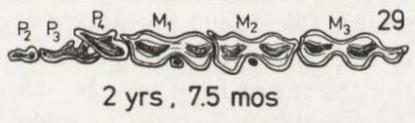
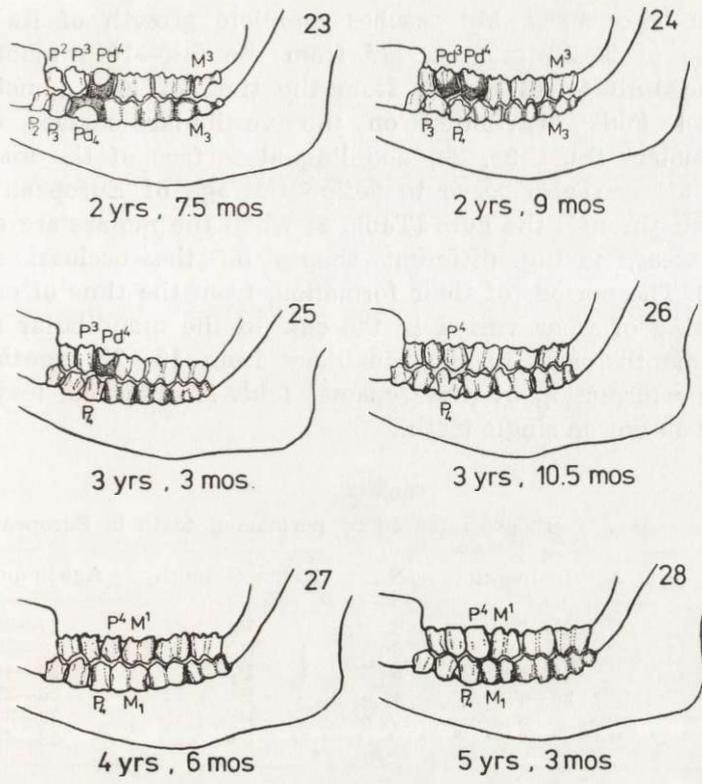
Medial premolar cusps are already formed in animals one to several days old, apart from Pd_2 and the caudal lobe of Pd_4 , which appear above the gum slightly later (Table 1). The lateral cusps of upper premolars of European bison of the same age are cut, with the exception

of the caudal lobe of Pd⁴. In older individuals the teeth grow in turn as follows: the caudal lobe of Pd₄, Pd₂ and finally the caudal lobe of Pd⁴, as the last (Table 1, Fig. 16). It was found that in month-old bison Pd⁴ grows diagonally, so that its cusps wedge the cranial lobe between cusps of Pd³. Nearly complete deciduous premolars are encountered in 4-month old calves, their surfaces being subject to wear, with the exception of caudal lobe of Pd⁴ (Fig. 17) the final formation of the crown of which takes place in individuals 6 months old.



Figs. 15—28. Premolars and molars in European bison of different age. Vestibular surface view (age by figure). Figures concluded on p. 115.

Eruption of molars. Molars erupt over a relatively long period of the animal's life, from the 6th to 43rd month (Table 2, Figs. 18—23),



Figs. 29—31. Enamel folds (pe) on molars in European bison of different age. Occlusal surface view. A — lingual surface, B — vestibular surface: Fig. 31. Upper tooth row, Figs. 29, 30. Lower tooth row.

identically in both sexes. M_1^1 reaches complete growth of its crown over a period of 5—12 months, M_2^2 from the 5th—10th month and M_3^3 from the 10th to 13 month from the time of gum penetrating.

The enamel folds distributed on the vestibular surface of the mandibular molars (Figs. 29, 30) and lingual surface of the maxillary molars (Fig. 31) can also serve to define the age of European bison. These folds cut through the gum (Table 2) when the molars are already starting to wear, taking different shapes on the occlusal surface (Figs. 29—31). The periods of their formation, from the time of eruption to the beginning of wear varies, in the case of the mandibular molars, from 8—10 months, and in the maxillary from 15—23 months. Occasionally poor formation of these enamel folds is observed, less often, they are total absent on single teeth.

Table 3

Age at which deciduous teeth are replaced by permanent teeth in European bison.

Name of tooth	Age in months	N	Name of tooth	Age in months	N
I_1	22—26	6	P_2	27—28	3
I_2	30—31	6	P_3	28—29	2
I_3	35—40	5	P_4	37—40	5
C_1	38—44	4	P^2	28—29	3
			P^3	30—34	3
			P^4	38—44	3

Replacement of premolars. Deciduous premolars are replaced between the 27th and 44th month (Table 3). This process takes place earlier in the mandible than in the maxilla (Figs. 24, 25), differences being slight (up to 1 month) in females, where as in males there is a distinct delay in replacement of the maxillary teeth of 2 to 4 months (particularly Pd^4).

Replacement of incisors and canines. Deciduous incisors are replaced between the 22nd and 40th month (Table 3). In both sexes the first to be replaced is Id_1 on the left side (22 months), then the right side (26 months). Both these teeth reach complete formation of the crowns in the same order. The remaining incisors on both sides are replaced simultaneously, first Id_2 and then Id_3 . Replacement of deciduous incisors occurs from 2 to 5 months earlier in females than in males. Complete formation of the crowns of permanent incisors, after replacement of the deciduous teeth, takes place over a period of 3—6 months, I_3 forming in relatively the shortest time.

Variants. In some females in poor physical condition considerable delay was observed in eruption of incisors and therefore these data have not been included in the tables. Among such animals were female

4953 (27 months) which still had all deciduous incisors; female 3968 (37 months) with I_1 on both sides but only the right I_2 ; and female 3965 (40 months) in which only the first incisors were permanent. In addition these animals retained deciduous canines.

Deciduous canines are replaced between the 38th—44th month of life (Table 3, Figs. 10—13), and the permanent teeth attain complete crown formation in males during the next 3 months. It was impossible to trace crown formation of these teeth in females for lack of such material, but their deciduous forerunners were shed earlier (2 months).

Permanent and deciduous incisors and canines in the European bison immediately after formation of the crowns are positioned diagonally so that they overlap each other by their broad crowns in the same way as roof tiles (Figs. 11—13). As the animal and consequently also the mandible grows, the teeth gradually take up their terminal position. In animals about 7 years old the surfaces are in contact.

IV. DISCUSSION

The data obtained permit ageing of European bison from birth to the 7 years of life (Table 4). The material collected is, for European bison bred in reserves, fairly numerous, although insufficient for exhaustive examination of age changes in teeth.

Our studies confirmed the earlier observations of dental formation given by Wilkus (1957) and Flerov (1979). Calves of the genus *Bison* after Flerov (1979) and also the American bison (Fuller, 1959; Nowakowski, 1965) are most often born with all incisors and canines, as is the case in the majority of European bison. Sometimes, however Id_3 and Cd_1 may erupt on the 2—6th day after birth, and in weaker individuals even later (Flerov, 1979). We also encountered such delay, extending addition to canines, and second incisors. In several older (up to about 6 months) calves greatly delayed growth of Id_2 was observed, sometimes remaining slightly diagonally positioned at one year.

Replacement of incisors and canines of the genus *Bison* from Flerov (1979) are imprecise, since they are defined in whole years, and are therefore difficult to compare with our data.

Eruption of molars in the European bison and replacement of mandibular premolars precedes that in the maxilla. Owen's (1848) data on the teeth of a male European bison aged 2.5 years are similar to our observations in this same age group.

Flerov (1979, Fig. 40) illustrates an erupted Pd_2 and caudal lobe of Pd_4 but we did not find this in our animals, in which these teeth did not erupt until about 1.5 month of life.

There are certain differences in the eruption and replacement of

teeth in the European and American bison. In the first place M_1 erupts in the European bison 3—4 months later than in the American bison. Periods of replacement of incisors and canines are given in complete years for the American bison (Fuller, 1959), and therefore cannot be accurately compared with our data. It may, however, be taken that Id_2 is replaced slightly later in the American bison (in the 3rd year of life) than in the European bison. Eruption and formation of canines

Table 4
Approximate data for defining the age of European bison by their teeth (up to 7 years).

Age in months	Incisors			Canines	Premolars			Molars		
	1	2	3		1	2	3	1	2	3
1—9 days	Id	(Id)	Id	(Cd)	Pd	Pd	Pd,cr	O	O	O
					O	Pd	Pd,cr,m	O	O	O
1—1.5	Id	Id	Id	Cd	Pd	Pd	Pd,cr	O	O	O
					(Pd)	Pd	Pd,cr,m,ca	O	O	O
4—5	Id	Id	Id	Cd	Pd	Pd	Pd,a	O	O	O
					Pd	Pd	Pd	O	O	O
6—7	Id	Id	Id	Cd	Pd	Pd	Pd	O	O	O
					Pd	Pd	Pd	$M_{1,cr}$	O	O
8—9	Id	Id	Id	Cd	Pd	Pd	Pd	$M_{1,cr}$	O	O
					Pd	Pd	Pd	M	O	O
12—18	Id	Id	Id	Cd	Pd	Pd	Pd	M	O	O
					Pd	Pd	Pd	M	$M_{1,cr}$	O
18—24	(I)	Id	Id	Cd	Pd	Pd	Pd	M	$M_{1,cr}$	O
					Pd	Pd	Pd	M	$M_{1,ca}$	O
24—30	Id	Id	Id	Cd	(P)	Pd	Pd	M	M	O
					P	Pd	Pd	M	M	$M_{1,cr}$
30—36	I	(I)	Id	Cd	P	(P)	Pd	M	M	$M_{1,a}$
					P	P	Pd	M	M	$M_{1,a}$
36—42	I	I	(I)	Cd	P	P	(P)	M	M	M
					P	P	(P)	M	M	M
42—48	I	I	I	C	P	P	(P)	M	M	M
					P	P	P	M	M	M
48—60	I	I	I	C	P	P	$P_{1,a}$	M	M	M
					P	P	P	M	M	M
60—72	I	I	I	C	P	P	P	M	M	M
					P	P	P	M	M	M

Symbol in brackets indicates that sometimes the tooth is missing (above the gum), cr — cranial lobe cuts gum, m — medial lobe cuts gum (applies to Pd_4 and M_3), ca — caudal lobe cuts gum, a — crown incompletely formed, O — unerupted tooth.

takes place about 9—11 months earlier in the American bison, while Pd_4 is replaced in this animal about 2—5 months later than in the European bison (Nowakowski, 1965).

There are several differences in eruption and replacement of teeth between the European bison and domestic cattle. Newborn calves of early maturing cattle have all their deciduous teeth already erupted, and in those maturing at a medium age Id_3 erupts during the first week of life; in those maturing late, Id_3 and Cd_1 not until the second week (Ackerknecht, 1943; Schummer & Nickel, 1960, Habermehl, 1975). According to Brown *et al.* (1960) incisors in cattle erupt before or immediately after birth, and canines from the 14th to 42nd day.

Replacement of deciduous incisors by permanent ones occurs relatively late in European bison and is most similar to that in late-maturing breeds of cattle (Schönberg, 1928; Martin & Schauder, 1938; Klimow & Akajewski, 1960; Voken *et al.*, 1961; Clair, 1975). Some authors however (Schummer & Nickel, 1960; Brown *et al.*, 1960) give earlier dates for canines formation in cattle, data similar to those we observed in European bison. According to Krysiak (1983) canines in cattle erupt decidedly later than incisors, where as in the European bison canines erupted at almost the same time as incisors (Table 3).

Eruption of some deciduous premolars (Pd_2 , caudal lobe of Pd_4) in the European bison takes place over a relatively protracted time, up to 2 months, where as in domestic calves this process lasts only 2 (Duerst, 1926) or 3 weeks (Schummer & Nickel, 1960).

Lower premolars in the European bison are replaced at almost the same time as in breeds of late-maturing cattle or even later, except for Pd_4 , which is replaced about 4 months earlier in cattle. Deciduous premolars in the maxilla of European bison are replaced even later, exceeding data for late-maturing cattle (Habermehl, 1961) — Pd^2 by 1 month, Pd^3 by 3 months, and Pd^4 by as much as 10 months. Eruption of molars (upper and lower) in cattle (all references cited), despite considerable differentiation of breeds, takes place in identical time periods, although, according to Sokolov & Rašek (1961), in the majority of ungulates the mandibular teeth appear slightly earlier than in the maxilla. Eruption times of mandibular molars in the European bison generally agree with data for late-maturing cattle, while maxillary molars (apart from M^3) erupt from 2–3 months later than in domestic cattle (Jones & Clair, 1957).

It therefore may be assumed that the majority of teeth, except canines, erupt and are replaced in the European bison in the same way as in breeds of late-maturing cattle. This seems logical since European bison begin reproduction and attain complete physical development relatively late (Wróblewski, 1927; Krasiński & Raczyński, 1967).

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WYRASTANIE I WYMIANA ZĘBÓW U ŻUBRA

Streszczenie

Obserwacje przeprowadzono na 116 żubrach obu płci, od 1 dnia do 7 lat, w większości zarejestrowanych w księgach rodowodowych, a więc o dokładnie znanym wieku.

Zęby mleczne przebijają dziąsła w okresie pierwszych 3 miesięcy (Tabela 1, Ryc. 1, 2 i 15—16), zaś całkowite formowanie ich koron odbywa się do 6 miesiąca życia (Ryc. 17, 18). W następnej kolejności wycinają się trzonowce: M_1^1 między 6 a 12, M_2^2 — 16 a 27 i M_3^3 — 27 a 43 miesiącem (Tabela 2, Ryc. 18—23), zaś całkowity wzrost koron każdego zęba trzonowego trwa 5 do 13 miesięcy. Wymiana przedtrzonowców zachodzi między 27 a 44 miesiącem (Tabela 3, Ryc. 22—26). Siekacze mleczne wymieniają się na stałe: I_1 na przełomie 2 i 3 roku, I_2 — w wieku 2,5 lat, I_3 w pierwszej połowie 4 roku, kły zaś około połowy 4 roku życia zwierzęcia (Tabela 3, Ryc. 6—13). Od momentu pozbycia się zębów mlecznych stałe siekacze i kły wykształcają zupełnie swe korony w przeciągu 3—6 miesięcy. Zęby trzonowe wyrastają w jednakowym czasie, natomiast wymiana przedtrzonowców, siekaczy i kłów następuje o 2—5 miesięcy wcześniej u samicy niż u samców. Proces wyrastania i wymiany zębów pozwala na stosunkowo dokładne określanie wieku do 7 roku życia zwierzęcia (Tabela 4).