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RADIOGRAPH OF OSSA SESAMOIDEA PHALANGIS PROXIMALIS IN CATTLE IN POSTNATAL ONTOGENESIS

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Abstract

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Studied and described was the radiograph of sesamoid bones of proximal phalanges on thoracic and pelvic limbs in 23 individuals of adult cattle aged 2 to 15 years and in 29 individuals of juvenile cattle from birth to 20 months of age.

In the dorsopalmar (-plantar of palma-(planta-)) dorsal projection the shadows of axial sesamoid bones differed from those of the abaxial ones. Even the radiograph of these bones differed conspicuously in the course of development. On the basis of typical changes in shape and relative size of shadows of ossification centres of the sesamoid bones of proximal phalanges of the digits the degree of development of these bones with respect to age can be evaluated and the stage of individual's skeleton development differentiated in the postnatal period from radiographs. In five-month old calves the RTG-picture of the sesamoid bones of proximal phalanges of the digits was, as to the shape, the same as that of adult cattle.

In the lateromedial or mediolateral projections the shadows of individual sesamoid bones of proximal phalanges of digits on the limb almost entirely overlapped. Their RTG-picture and topographic relations to the metapodium also changed during development.

On the basis of shape changes in ossification centres of ossa sesamoidea phalangis proximalis of cattle we have drawn the attention to further possible exact criterion for evaluation of the skeleton during the postnatal development in mammals.

Cattle, radiography, ossa sesamoidea phalangis proximalis, development.

The radiographic method is very advantageous even for the evaluation of the development and maturity of the individual's skeleton. After Morgan (1972) the degree of maturity of the

skeleton is indicative of both the condition and the health of an animal. In cattle, which is in fact nidifugous animal, born with well developed skeleton and relatively well developed ossification centres, it will be not enough, when evaluating the skeleton maturity of an individual in postnatal period, to enumerate only the occurrence of ossification centres and to state the disappearance of epiphysodiaphyseal growth cartilages. It is necessary to focus our attention to the investigation of secondary ossification centres and ossification centres of sesamoid bones and to differentiate their shape in relation to the age of an individual. Used to advantage for X-ray examination are the distal sections of limbs, where the ossification centres of ossa sesamoidea phalangis proximalis develop in postnatal period and the ossification centres of ossa sesamoidea phalangis distalis are founded.

The ossa sesamoidea phalangis proximalis are, as against in man (Borovanský et al. 1967), regular parts of the cattle autopodium centres and are founded already in intrauterine period of development in cattle (Küpfer and Schinz 1923; Rojas 1943; Vokken 1950; Fedrigo 1957; Lindsay 1969). The development of ossification centres of ossa sesamoidea phalangis proximalis in cattle and sequence of their appearance were described by Červený (1983). By determining the sequence of appearance of individual centres he explained also the typical regular inequality in size of the ossification centres of the axial and abaxial sesamoid bones of proximal phalanges of digits belonging to respective digits on the limb.

The veterinary radiographic literature - monographs (Carlson 1967; Morgan 1972) and also special publications (Burt et al. 1968; Funk 1966) engaged in radiography of the skeleton of cattle do not go till now into the study and description of the RTG-picture of the sesamoid bones of proximal phalanges of digits in the course of their development. That is why we decided to study the series of radiograms of the autopodium during ontogenesis of cattle from birth up to the adult age and to determine the typical changes in the shape of RTG pattern of sesamoid bones of proximal phalanges of digits in cattle during the postnatal development.

Materials and Methods

The radiographic examination was performed in 52 animals of the Bohemian Pied cattle. Out of them 23 animals were the adults aged 2 to 15 years (See Tab. 1) and 21 animals of juvenile cattle (Tab. 2). The radiograms were made on a four-valve X-ray apparatus "Mega-Meta 125" at the Department of Surgery, University of Veterinary Science in Brno and then with the aid of portable X-ray apparatus "Chirax". Some animals were radiographed repeatedly in two-week and 1-month intervals directly in the stable and some radiograms were provided in one shot on sacrifying the animal. The thoracic and pelvic limbs, the left and the right ones, were always radiographed in resting recumbent position, without a load. Altogether 262 radiographs of distal ends of the metapodium and digits of cattle in dorsopalmar (-plantar) or palma-(planta) dorsal (134 radiographs), mediolateral, lateromedial

(104 radiographs) and in oblique (dorsomedial) projections (24 radiographs) were examined with respect to the age of animals from birth up to 15 years and were studied and described with the aid of L-110 X-ray examination panel providing four intensities of homogeneously dispersed light.

Table 1
Survey on processed material of adult cattle

Sample Number	Age (years)	Body mass kg	Sex
1	2	496	o
2	2	420	o
3	5	760	o
4	7	780	o
5	3	530	o
6	3	577	o
7	3	430	o
8	3	481	o
9	4	630	o
10	4	654	o
11	4	712	o
12	4	428	o
13	4	515	o
14	5	485	o
15	5	530	o
16	5	567	o
17	6	610	o
18	7	623	o
19	8	567	o
20	9	530	o
21	9	550	o
22	10	575	o
23	15	585	o

Results

In dorsopalmar (dorsoplantar) or palmadorsal (plantodorsal) projections the ossa sesamoidea phalangis proximalis in adult cattle are depicted on radiographs of thoracal and pelvic limbs each separately. They are bounded with conspicuous outlines on the shadows of epiphyses of the metapodium and partially only on the shadows of proximal phalanges of the digits, thereby obscuring the detailed outlining of their structure. Their homogeneous shadows are depicted on the radiographs closely proximately over the articular space of the metacarpal-phalangeal (metatarsal-phalangeal) joint lined-up one beside the other in horizontal plane. By their shape they differ somewhat each other and represent generally irregular ovals with

Table 2
Survey on processed material of juvenile cattle

Sample No.	Body mass kg	Sex	RTG repeatedly at the age of Neonate	Weeks 2	Months 1	2	3	4	5	RTG once at the age
1	50	♀	-	-	-	-	-	-	-	neonate
2	44	♂	-	-	-	-	-	-	-	neonate
3	46	♂	-	-	-	-	-	-	-	neonate
4	47	♂	-	-	-	-	-	-	-	neonate
5	56	♀	-	-	-	-	-	-	-	2 weeks
6	62	♂	-	-	-	-	-	-	-	2 weeks
7	45	♂	-	-	-	-	-	-	-	2 weeks
8	42-111*	♂	+	+	+	+	+	+	-	
9	48-86 *	♀	+	+	+	+	+	-	-	
10	52-85 *	♀	+	+	+	+	+	-	-	
11	45-85 *	♂	+	+	+	+	+	-	-	
12	45-103*	♂	+	+	+	+	+	+	-	
13	47-50 *	♂	+	+	+	-	-	-	-	
14	50-52 *	♂	+	+	-	-	-	-	-	
15	54-56 *	♂	+	+	+	-	-	-	-	
16	54-57 *	♂	+	+	+	+	-	-	-	
17	47-71 *	♀	-	+	+	+	+	-	-	
18	40-60 *	♀	-	+	+	+	+	-	-	
19	51-72 *	♀	-	+	+	+	+	-	-	
20	57-73 *	♀	-	+	+	+	+	-	-	
21	55-76 *	♂	-	+	+	+	+	-	-	
22	63	♂	-	-	-	-	-	-	-	2 weeks
23	64	♀	-	-	-	-	-	-	-	1 month
24	96	♂	-	-	-	-	-	-	-	5 months
25	101	♀	-	-	-	-	-	-	-	6 months
26	165	♀	-	-	-	-	-	-	-	8 months
27	240	♂	-	-	-	-	-	-	-	14 months
28	260	♂	-	-	-	-	-	-	-	16 months
29	330	♂	-	-	-	-	-	-	-	20 months

* Body mass of calves at the time of the first and last RTG

wider basis and with proximal narrowing extending into rounded apex. The shadows of both axial sesamoid bones of proximal phalanges are rather cubic in shape with rounded apex. The shadows of both abaxial sesamoid bones of proximal phalanges are more conical. The projections of shadows of both abaxial sesamoid bones of proximal phalanges of the third and fourth digit often extended, in the limb without load, slightly distally from the space of metacarpophalangeal (metatarsophalangeal) joint. This shadow from the abaxial sesamoid bone of proximal phalanx interferes more conspicuously distally and still more frequently and clearly on the thoracal limb. Depicted here is the shadow of distal end of the flexor area and tuberculum distale. The shadow of the abaxial sesamoid bone of proximal phalanx of the fourth digit is deep in axial, approximately three quarters, since it is intensified by

the shadow of trochlea of the fourth digit metapodium. In the abaxial remaining part the shadow of this sesamoid bone is reduced, inconspicuous, since, in this part, the sesamoid bone is not underlaid by the trochlea of the fourth metapodium. The abaxial edge of this trochlea forms a sharp boundary of unevenly deep parts of shadow of the sesamoid bone of the fourth digit proximal phalanx. In substantially lesser scale the less deep part of shadow can be followed at a thorough study of the radiogram even on the RTG-picture of the abaxial sesamoid bone of the third digit proximal phalanx. At oblique dorsopalmar or dorsoplantar projection these less deep sections of the shadow of abaxial sesamoid bones of proximal phalanges can be found in opposite size ratio. The radiolucid spaces between individual pairs of the sesamoid bones of proximal phalanges of respective digits is depicted in the form of 1 - 2 mm narrow space extending along the symmetrical contours of shadows of the neighbouring sesamoid bones both in proximal and in distal directions. Proximally, this radiolucid area passes into the drawing of trabecula of respective epiphysis of the metapodium and, distally, it is bounded with a conspicuous radiolucency of the space of the metacarpal-phalangeal (metatarsal-phalangeal) joint and by the shadow of the base of respective digit proximal phalanx. Between both axial sesamoid bones of proximal phalanges is about 1/2 cm wide deep radiolucency of the intertrochleal nick of the metapodium, into which, from one or both sides, as dependent on the position of digits during radiographing, small, not too deep elongated shadows project. Depicted here on the radiographs are the contours of interdigital areas and associated structures of axial sesamoid bones of proximal phalanges.

In the mediolateral and/or lateromedial projection the ossa sesamoidea phalangis proximalis of adult cattle are seen in the radiograms of distal parts of limbs as a uniform, very intensive shadow localized palmarly or plantarly from the metapodium distal end. They take the height from the lowest spot of radiolucency of the metacarpo-phalangeal (metatarsophalangeal) joint articular space proximally up to about 3/4 epiphyses length. The epiphyses are, contrary to diaphysis, clearly bounded by radiolucid epiphysodiaphyseal growth cartilage and/or, in later age, by the shadow of epiphysodiaphyseal junction. The edges of shadow of the sesamoid bones posses unsharp contour, since individual sesamoid bones are depicted in those places where they do not overlap entirely during projection. These shadows are here less intensive. The shadow of the sesamoid bones of the third and fourth digit proximal phalanges takes, in lateromedial or mediolateral projection, the shape of annular sector with rounded apexes, dorsal concave and palmar (plantar) convex base. In oblique dorsomedial projection, due to incomplete superposition of shadows of individual sesamoid bones of proximal phalanges, less intensive shadows of individual sesamoid bones of the third and fourth proximal phalanges appear partially overshadowed in the line one behind the other.

In healthy well-developed newborn calves, in dorsopalmar (plantar), and/or in palma-(planta)-dorsal projection all the four sesamoid bones of proximal phalanges of digits on the thoracic and pelvic limbs are represented inconspicuously by contrast shadows

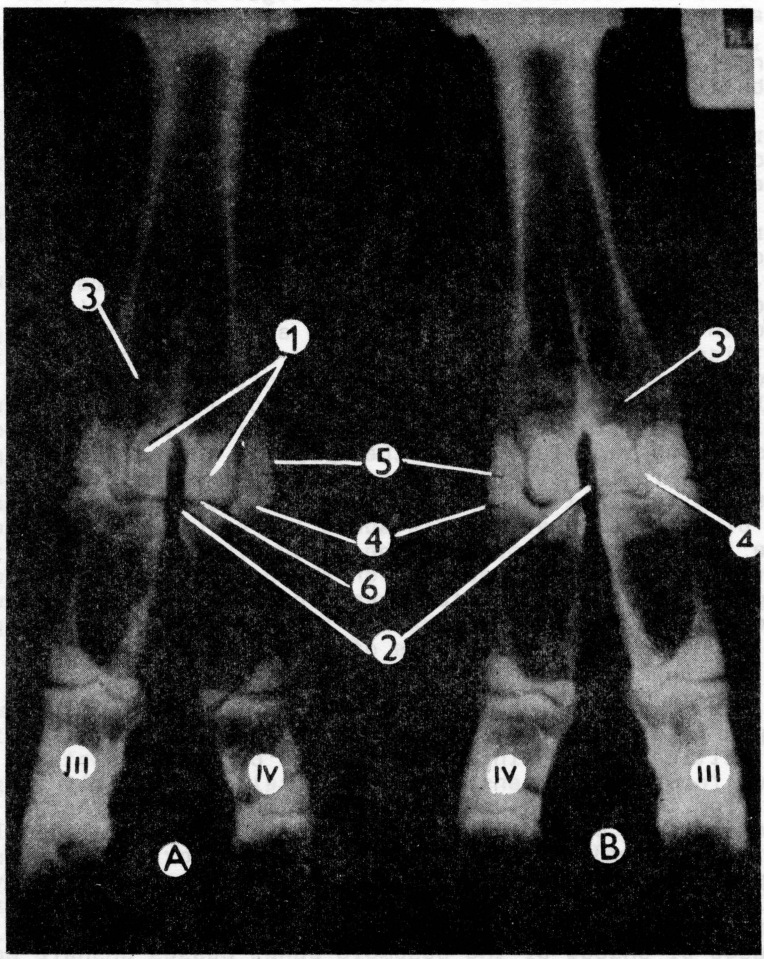

Fig. 1. Radiographof the autopodium of the left (A) and right (B) thoracal limb of 9-year old cow in dorsopalmar projection.

III - third digit, IV - fourth digit, 1 - shadows of axial sesamoid bones of proximal phalanges of the third and fourth digit, 2 - shadow of overlapping interdigital area of the axial sesamoid bone extending into the wide radiolucency remaining after incisura intertrochlearis of metapodium, 3 - epiphysodiaphyseal junction (residua), 4 - shadow of distal end of flexor area and distal tubercle of the abaxial sesamoid bone, 5 - inconspicuous shadow after tuberculum externum and parts of the abaxial sesamoid bones of proximal phalanx of fourth digit adjacent to facies externa, 6 - radiolucency of articular space of articulatio metacarpophalangea.

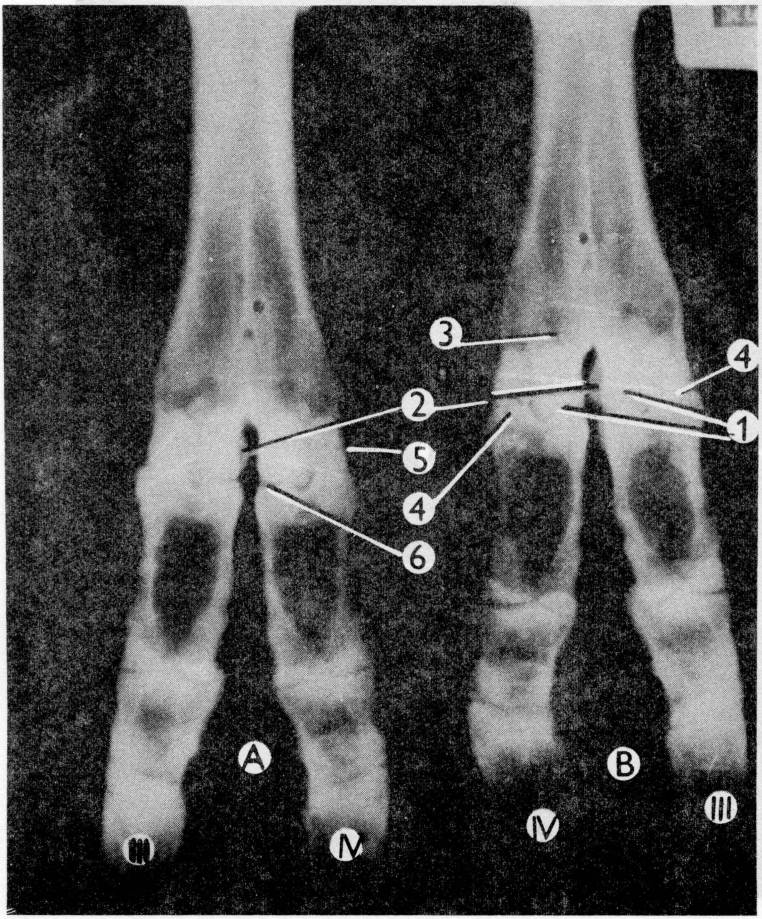

Fig. 2. Radiograph of the autopodium of the left (A) and right (B) pelvic limb of 9-year old cow in dorsoplantar projection.

III - third digit, IV - fourth digit, 1 - shadows of axial sesamoid bones of proximal phalanges of the third and fourth digit, 2 - shadow of overlapping interdigital area of the axial sesamoid bone extending to the wide radiolucency after incisura intertrochlearis of metapodium, 3 - epiphysodiaphyseal junction (residua), 4 - shadow of distal end of flexor area and distal tubercle of the abaxial sesamoid bone, 5 - inexpressive shadow after tuberculum externum and parts of the abaxial sesamoid bones of proximal phalanx of the fourth digit adjacent to facies externa, 6 - clearing up of the articular space of articulatio metacarpophalangea.

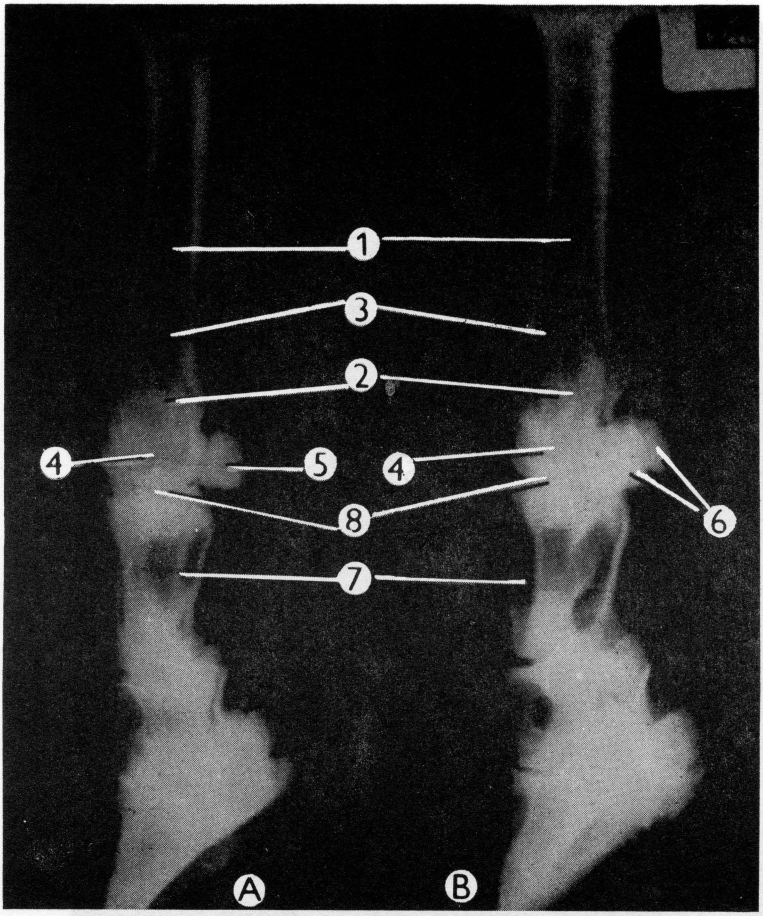

Fig. 3. Radiograph of autopodium of the left thoracal limb in direct lateromedial projection (A) and radiogram of the right thoracal limb in oblique mediolateral projection (B) of 9-year old cow.

1 - shadow from os metacarpale III et IV, 2 - epiphysodiaphyseal junction, 3 - radiolucency remaining from can. metacarpalis distalis, 4 - trochlea metacarpi, 5 - superposed shadows of all four sesamoid bones of proximal phalanges in direct lateromedial projection, 6 - distributed and partially overlaid shadows of the sesamoid bones of proximal phalanges in oblique projection, 7 - phalanx proximalis, 8 - articulatio metacarpophalangea (radiolucency of the articular space).

of four ossification centres in cartilagineous bases of these bones. The shadows of these ossification centres differ clearly by the shape and size, and also by the location with respect to radiolucency of metacarpal (metatarsal) articular space of metacarpo-(metatarso)phalangeal joint. The shadows of axial sesamoid bones of the proximal phalanges of the third and fourth digit take the shape of proximodistal elongated oval with narrower proximal apex without perceptible difference in size. The shadows of ossification centres for both abaxial bones are round so as they appear in foetuses and are of unequal size. Smaller is the shadow of the ossification centre of abaxial sesamoid bone of the proximal phalanx of the third digit. The ossification centres of all four sesamoid bones are depicted on radiographs in dorsoplamar (plantar) projection in horizontal plane one beside the other on the shadows of distal epiphyses. The proximodistal diameter of shadows in axial sesamoid bones of proximal phalanges exceeds 1 cm while being about 0.75 cm in abaxial sesamoid bones.

In two-week-old calves the ossification centres of the sesamoid bones of proximal phalanges go on developing as to the size and shape. On radiograms in dorsopalmar (plantar) or palma--(planta-)dorsal projection the shadows of these centres take an elongated shape, in particular on pelvic limbs. The shadow of ossification centre founded as the latest for abaxial sesamoid bone of proximal phalanx is usually still round or slightly elongated and is somewhat smaller than other ossification centres of the sesamoid bones of proximal phalanges of the respective limb.

In the next developmental stages the proximal ends of oval shadows of the ossification centres of the sesamoid bones, third and fourth digit appear sharper and extend in width. The spaces between sesamoid bones are being reduced. These shadows are localized in horizontal line, namely, still more conspicuously over the radiolucent metacarpo-(metatarso) articular space of the phalangeal joint. The shadows of axial sesamoid bone are conspicuously longer, not distinguishable from each other according to their shapes, shadows of the abaxial bones are reminiscent of a triangle with the apex inverted proximally. In one-month old calves the proximal apexes of ossification centres of the sesamoid bones extend up to the level of the centre of proximodistal length of metapodia epiphyses. In three-month old calves, this centre is reached by proximal apexes of shadows of ossification centres of the abaxial sesamoid bones and the shadows of ossification centres of the axial sesamoid bones even exceed it somewhat in proximal direction. At the ages starting with the fifth month, the RTG-picture of the sesamoid bones of proximal phalanges does not generally differ in shape from the conditions seen in adult cattle. In adulthood only general enlargement of shadows on individual sesamoid bones can be observed even in the relation to the size of epiphyses and trochleas of the metapodia.

In mediolateral and/or lateromedial projection, in radiograms of newborn calves, the ossification centres for ossa sesamoidea phalangis proximalis depicted in the form of one, proximodistally, somewhat elongated deep oval shadow, localized behind the shadow of epiphyses of the metapodium, distally from the centre of proximal axis of these epiphyses. In other

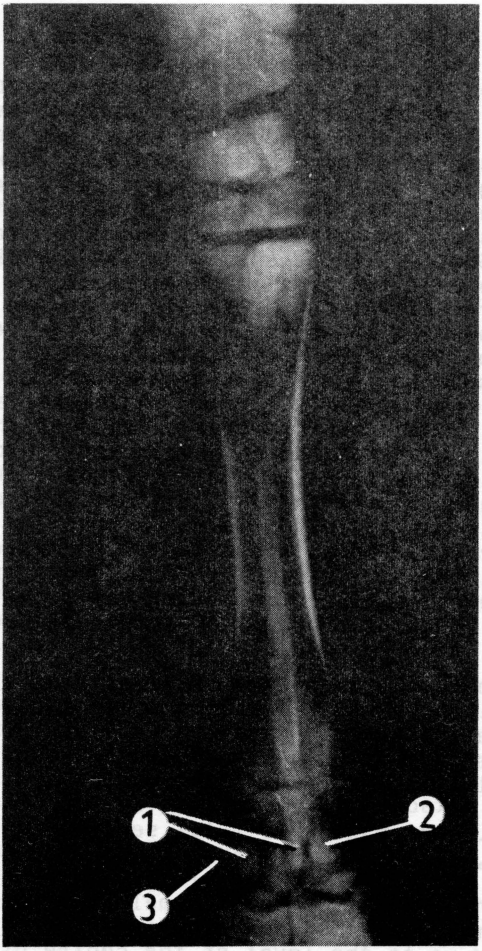

Fig. 4. Radiograph of the metapodium of the right thoracal limb of newborn calf in palmadorsal projection.
1 - elongated shadows of ossification centre for axial ossa sesamoidea phalangis proximalis, 2 - shadow of ossification centres for abaxial sesamoid bone of proximal phalanx of fourth digit is still round, 3 - shadow of ossification centres of abaxial sesamoid bone of proximal phalanx of third digit is smallest.

age stages, due to the gradual development of the sesamoid bones of proximal phalanges of the third and fourth digit, above all the shape and size of shadows of ossification centres of these bones and their localization change with respect to the radiolucency of the articular space of metacarpo(metatarso) phalangeal joint. In the radiograms, the shadows of these bones

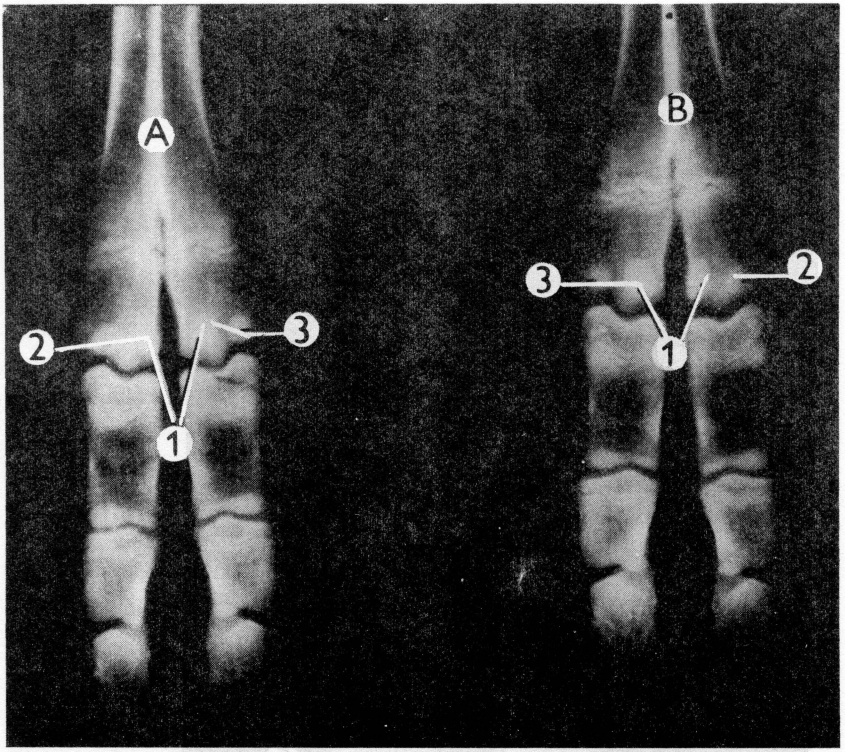

Fig. 5. Radiograph of distal sections of the left (A) and right (B) pelvic limb of 2-week old calf in plantadorsal projection.

1 - elongated shadows of ossification centres of axial ossa sesamoidea phalangis proximalis, 2 - shadow of ossification centre of the abaxial sesamoid bone of proximal phalanx of the fourth digit is still round, 3 - shadow of ossification centre of the abaxial sesamoid bone of proximal phalanx of the third digit is smallest.

gradually elongate and reach, by their distal end, up to the radiolucent articular space of metacarpo-(metatarso) phalangeal joint. In calves aged six months the development even in proximal direction is already conspicuous, so the proximal apex of sesamoid bones of proximal phalanges of the third and fourth digit go up to two thirds of length of the metapodia epiphyses and, in 14-month old individuals, these relations are the same as found in adult cattle. The typical shape of shadows of these sesamoid bones of proximal phalanges, as found in lateromedial and mediolateral projections in adult individuals can be traced already in the radiograms of five-month old calves.

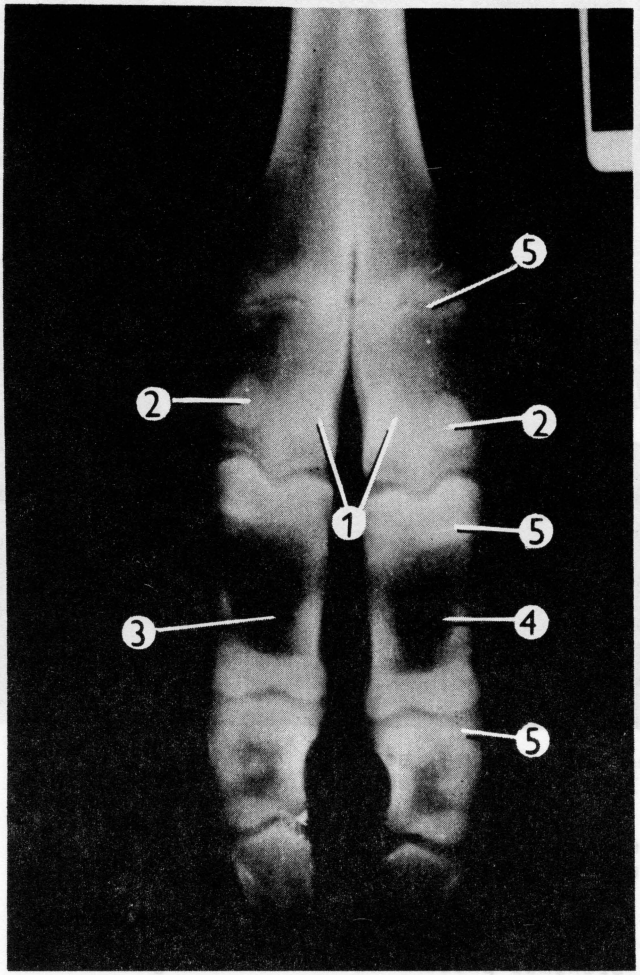

Fig. 6. Radiograph of distal section of the right pelvic limb of 1-month old calf in plantadorsal projection.

1 - shadows of ossification centres of the axial sesamoid bones of proximal phalanges of the fourth digit are conspicuously elongated and proximally pointed, 2 - shadows of ossification centres of both the abaxial sesamoid bones are also elongate and proximally point, 3 - phalanx proximalis of the third digit, 4 - phalanx proximalis of the fourth digit, 5 - epiphysodiaphyseal growth zones of metapodium and of proximal and central phalanx of the digit.

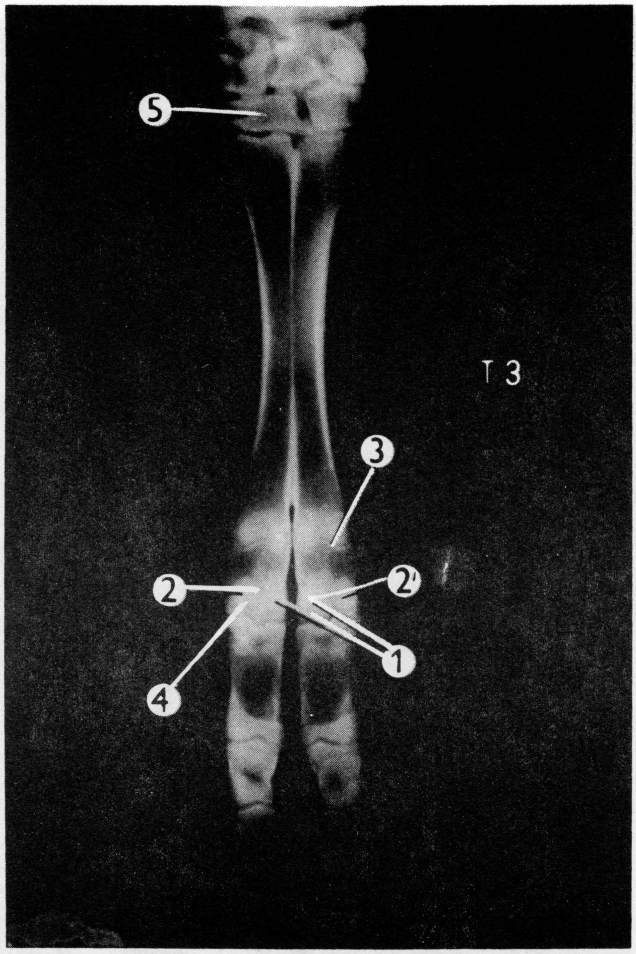

Fig. 7. Radiograph of autopodium of the left thoracic limb of 3-month old calf in dorsopalmar projection.

1 - shadows of ossification centres of the axial sesamoid bones of proximal phalanges, 2 - shadows of ossification centres of the abaxial sesamoid bones of the third and 2' -fourth digit, 3 - epiphysodiaphyseal growth zone of metacarpals, 4 - radiolucent articular space of articulatio metacarpophalangea, 5 - os carpale II et III.

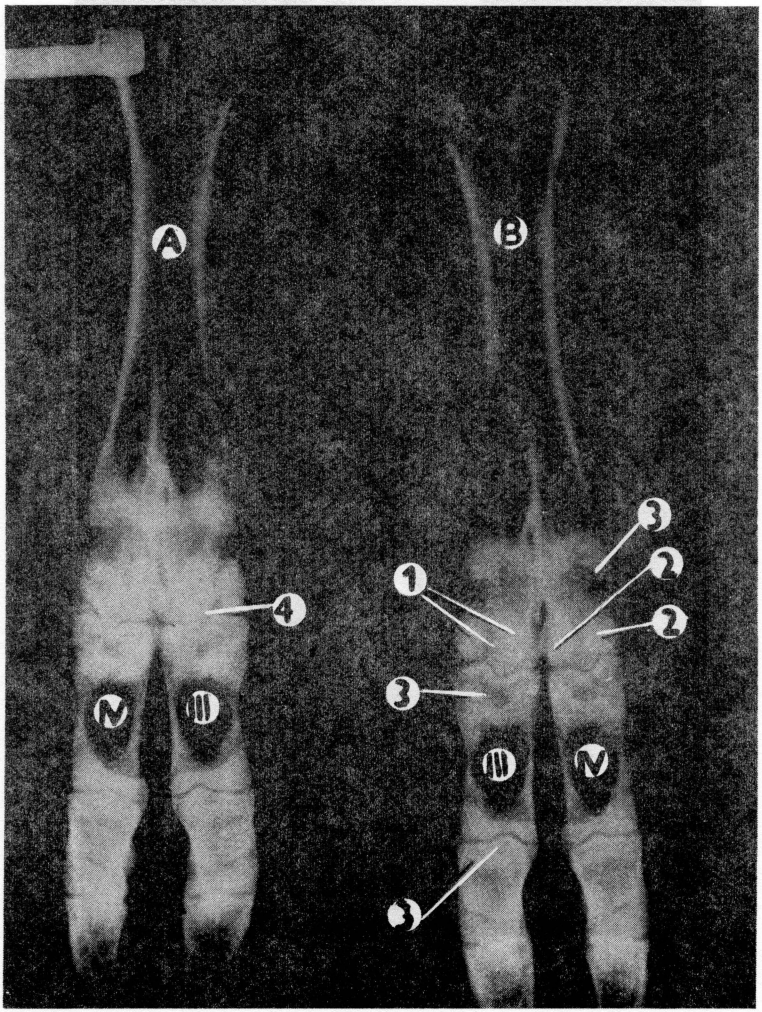

Fig. 8. Radiograph of distal end of the left (A) and right (B) pelvic limb of 6-month old calf in plantadorsal projection.

1 - shadows of the sesamoid bones of proximal phalanx of the third digit, 2 - shadows of the sesamoid bones of proximal phalanx of the fourth digit (the shadows of axial and abaxial sesamoid bones do not differ in shape from the relation found in adult cattle), 3 - epiphysodiaphyseal growth zone of metatarsals and phalanges, 4 - radiolucent articular space of articulatio metatarsophalangea.

In oblique dorsomedial projections these shadows of ossification centres are lined up one beside the other or partially overlap with clearly visible even their various sizes and shapes in the stage of early postnatal development; the round shadows of ossification centres of the abaxial sesamoid bones and elongated oval shadows of ossification centres of axial sesamoid bones of proximal phalanges.

Discussion

On the basis of detailed knowledge of anatomic structure of the sesamoid bones of proximal phalanges of cattle (Červený 1984) and their development (Küpfer and Schinz 1923; Lindsay 1969; Červený 1983 and others) we have studied and described their radiologic pattern in adult cattle. Also described were the changes in radiologic pattern of the sesamoid bones of proximal phalanges relating to the shape and topographic relations to the metapodium and metacarpo-(metatarso) phalangeal joint in the course of postnatal development. So we complete a void in the veterinary radiologic literature (Funk 1966; Carlson 1967; Burt et al. 1968; Morgan 1972). Because the sesamoid bones of proximal phalanges, as reported by Nickel et al. (1977), are a regular element of cattle skeleton and their ossification and sequence of origin of the ossification centres (Červený 1983) and their development and changes in shape have a typical course, we suggest to make use of our data as a basis for the evaluation of the maturity stage of the juvenile cattle skeleton. Similarly, it is possible to study even the changes in shape of the whole series of further secondary ossification centres of the skeleton and make use of them even in this field. Sokolowska - Pituchowa and Goszczyński (1971) suggest to make use of the knowledge of change in shape of ossification centres of the antebrachial bones of the skeleton in the course of development also for the evaluation of skeleton maturity in man. Consequently, another aspect for the evaluation of the skeleton age thus appears. In addition to the traditional finding of the ossification onset both in primary and in secondary ossification centres of individual bones, or in later age, the involution of growth cartilages in epiphysodiaphyseal zones of bone, there are typical changes in shape of ossification centres that sequentially appear with the development and growth of bones.

Comparison of the developmental stages of ossification centres and the actual age of larger number of animals in age groups allows us to determine a standard for the skeleton age of juvenile animals thereby developing a further criterion for the evaluation of the skeleton differentiation in the postnatal period of development. However, it is necessary to keep in view the possible time dispersion, above all with respect to breed characteristics and, possibly, to the genetic specificity and effects of the environment in the course of intrauterine development, as proved by Gerard et al. (1974) in rats. Just the different shape of ossification centres of axial and abaxial sesamoid bones of proximal phalanges and unequal size and shape of abaxial sesa-

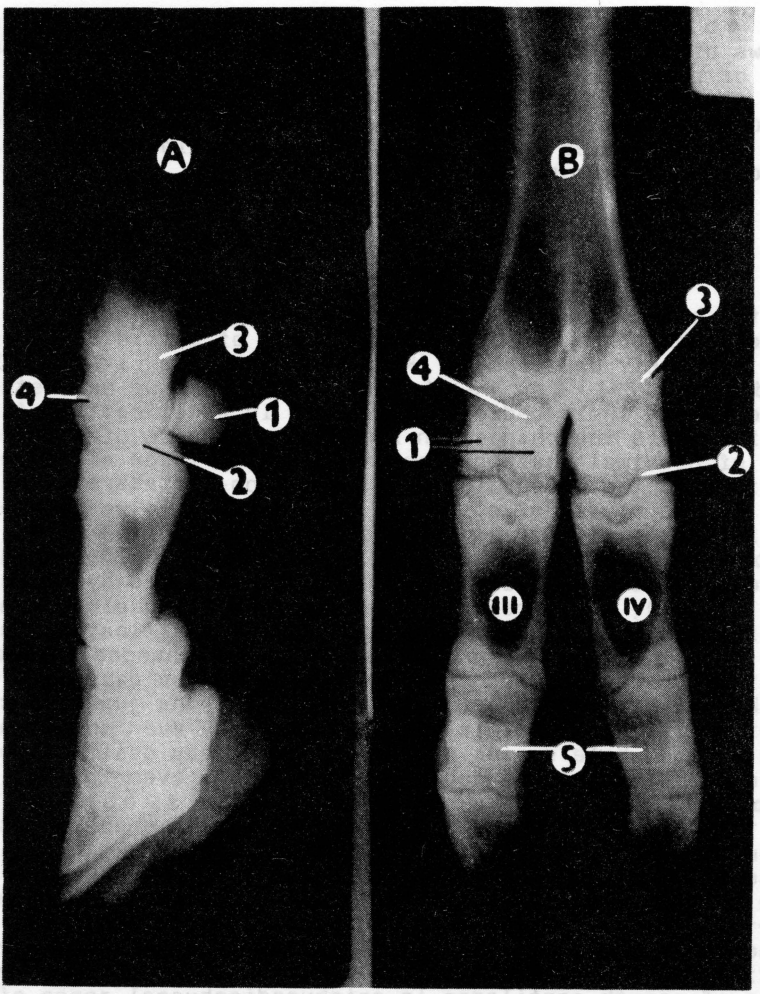

Fig. 9. Radiographof distal end of the left thoracic limb of 14-month old bull in mediolateral (A) and dorsopalmar (B) projections.

1 - shadows of sesamoid bones of proximal phalanx of the third and fourth digit, 2 - radiolucency of articular space of articulatio metacarpophalangea, 3 - epiphysodiaphyseal growth zone of metacarpals , 4 - epiphysis metacarpi III, 5 - shadows of ossa sesamoidea phalangis distalis.

Rentgenový obraz ossa sesamoidea phalangis proximalis skotu v postnatální ontogenesi

Studovali jsme a popsali rentgenový obraz sezamských kostí proximálních článků prstů na hrudních i pánevních končetinách 23 jedinců dospělého skotu ve věku od 2 do 15 let a 29 jedinců juvenilního skotu ve věku od narození až do 20 měsíců.

V dorsopalmární (plantární) či palma (planta) dorsální projekci se tvarově liší stíny axiálních sezamských kostí od abaxiálních. Výrazně se liší i rentgenový obraz těchto kostí v průběhu vývoje. Na základě typických změn tvaru a relativní velikostí stínů osifikačních center sezamských kostí proximálních článků prstů lze v raném postnatálním období na rentgenogramech hodnotit stupeň vývoje těchto kostí vzhledem k věku a posoudit stupeň vývoje skeletu jedince. U pět měsíců starých telat je rentgenový obraz sezamských kostí proximálních článků prstů co do tvaru shodný s obrazem u dospělého skotu.

V lateromediální či mediolaterální projekci se stíny jednotlivých sezamských kostí proximálních článků prstů na končetině téměř zcela převrstvují. Jejich rentgenový obraz a topografické vztahy k metapodiu se též během vývoje mění.

Na základě zjištěných tvarových změn osifikačních center pro ossa sesamoidea phalangis proximalis skotu jsme upozornili na další možné exaktní kriterium pro hodnocení diferenciace skeletu v průběhu postnatálního vývoje u savců.

Рентгеновская картина ossa sesamoidea phalangis proximalis крупного рогатого скота в послеродовом онтогенезе

Дается описание рентгеновской картины ossa sesamoidea phalangis proximalis и их топографических отношений к метаподию и метакарпальной части (metatarso) сустава фаланги грудных и тазовых конечностей взрослого крупного рогатого скота и молодняка чешского пратнистого племени со дня отела до 15 лет.

В дорсопальмарном (плантарном) или пальма-дорсальном проектировании по форме отличаются тени акциальных и абакциальных сесамовидных костей.

Существенно отличается также рентгеновская картина этих костей в ходе развития. На оцнове типичных изменений формы и относительного размера теней центров оссификации сесамовидных костей проксимальных фаланг можно на рентгенограммах в ранний период после отела оценить степень развития данных костей по отношению к возрасту и судить о степени развития скелета животного. Рентгеновская картина сесамовидных костей проксимальных косточек пальцев телят в возрасте пять месяцев совпадает по форме с картиной взрослых животных.

В латеромедиальном или медиолатеральном проектировании тени отдельных сесамовидных костей проксимальных фаланг на конечности почти полностью перекрываются. Их рентгеновская картина и топографические отношения к метаподию в ходе развития также меняются.

На основе установленных изменений формы центров оссификации в ossa sesamoidea phalangis proximalis крупного рогатого скота мы обратили внимание на следующий возможный точный оценки дифференциации скелета в ьоде постнатального розвития млекопитающих.

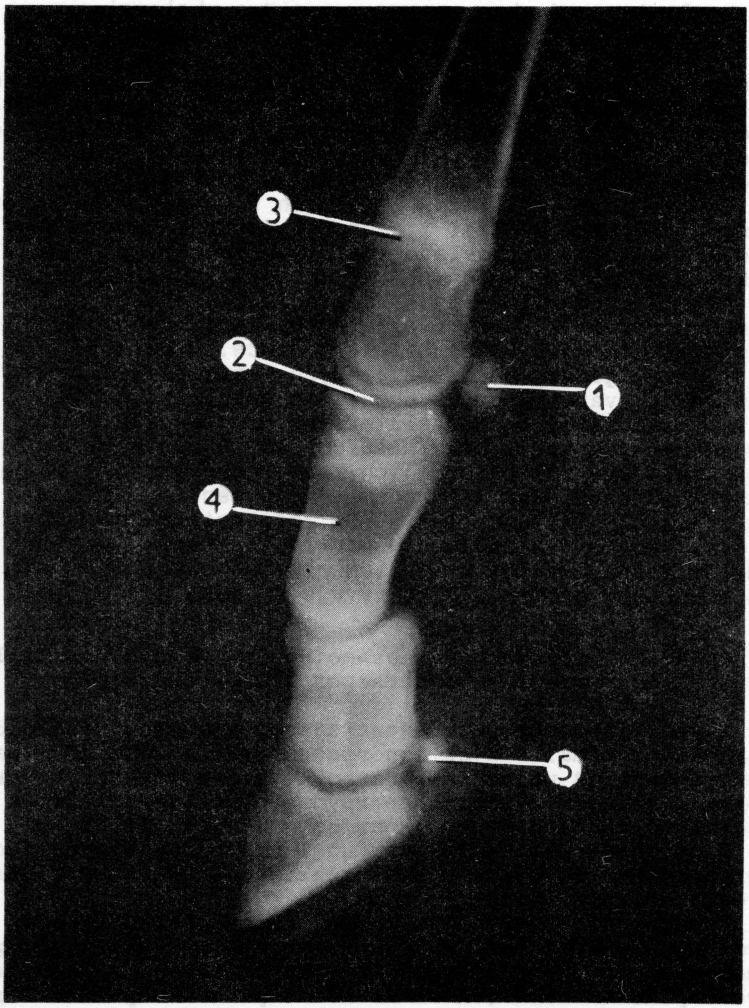

Fig. 10. Radiograph of acropodium of the left pelvic limb of 2-month old calf in mediolateral projection.

1 - shadows of ossification centres of ossa sesamoidea phalangis proximalis, 2 - radiolucent articular space of articulatio metatarsophalangea, 3 - epiphysodiaphyseal growth zone of metacarpuses, 4 - phalanx proximalis, 5 - shadow after ossification centres of ossa sesamoidea phalangis distalis.

moid bones of proximal phalanges in early postnatal period of development are a determining sign of the maturity stage of the skeleton, since in older and insufficiently developed individuals, the signs of earlier developmental stage of these bones and vice versa can occur.

References

BOROVANSKÝ, L. - HROMADA, J. - KOS, J. - ZRZAVÝ, J. - ŽLÁBEK, K.: Soustavná anatomie člověka /I. díl/. SZN, Praha 1967, 590 pp.

BURT, J. K. - MYERS, V. S. - HILLMAN, D. J. - GETTY, R.: The radiographic locations of epiphyseal lines in bovine limbs. Am. J. Vet. Med. Ass., 152, 1968, 168-174.

CARLSON, W. D.: Veterinary radiology. Lea and Febiger, Philadelphia, 1967, 666 pp.

ČERVENÝ, Č.: The development and ossification of the ossa sesamoidea phalangis proximalis in the cattle /Bos primigenius f. taurus Linné 1958/. Acta vet. Brno, 52, 1983, 27-38.

ČERVENÝ, Č.: Anatomical characteristics of the ossa sesamoidea phalangis proximalis in cattle (Bos primigenius f. taurus Linné 1758). Acta Vet. Brno, 54, 1985, 3-22.

FEDRIGO, G.: Studio radiografico sui nuclei ossificazione di feti bovini. Nuova veterinaria, 33, 1957, 45-55.

FUNK, K.: Röntgenanatomische Untersuchungen am Karpalskelett des Rindes. Thesis, Tierärztliche Hochschule Hannover, 1966, 41 pp.

GARARD, C. - HARRISON, C. A. - WEINER, S.: Genotypic differences in the ossification of 12-dya-old mice. J. Anat., 117, 1974, 531-539.

HABELL, R. R. - BARRETT, R. B. - DIESEM, C. D. - ROENIGK, W. J.: Nomenclature for radiologic anatomy. Am. J. Vet. Med. Ass., 142, 1963, 38-41.

KUPFER, M. - SCHINZ, N. R.: Beitrag zur Kenntniss der Skelettbildung bei domestizierten Säugetieren auf Grund Roentgenologischer Untersuchungen. Denksch. d. Schweiz. Naturf. Ges., 59, 1923, 1-133.

LINDSAY, F. E. F.: Observations on the loci of ossification in the prenatal and neonatal bovine skeleton. I. Appendicular skeleton. Brit. Vet. J., 125, 1969, 101-111.

MORGAN, J. P.: Radiology in veterinary orthopedic. Lea and Febiger, Philadelphia, 1972, 406 pp.

NICKEL, R. - SCHUMMER, A. - SEIFERLE, E.: Lehrbuch der Anatomie der Haustiere. Band I. Bewegungsapparat Paul Parey, Berlin und Hamburg 1977, 539 pp.

ROJAS, M.: Estudio radiologico del desarrollo esqueletico del ternero. Rev. de Med. Vet., 12, 1943, 74-100.

SOKOLOWSKA-PITUCHOVA, J. - GOSZCZYŃSKI, M.: Morfologia jader kostnienia blizszych nasad obou kośći przedramienia w obrazie radiologicznym. Folia morph. /Warsz./, 30, 1971, 237-241.

VOKKEN, G. G.: Kostnyj skelet tulovišča i konečnostej plodov, novoroždennych i molodnjaka krupnogo rogatogo skota. Sb. nauč. trudov Leningr. inst. usoverš. vet. vračej, 5, 1950, 89-103.