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OSSIFICATION AND DEVELOPMENT OF THE OSSA SESAMOIDEA PHALANGIS PROXIMALIS IN CATTLE (Bos primigenius f. taurus Linné 1758)

Č. ČERVENÝ

Department of Anatomy, Histology and Embryology, University of Veterinary Science, 612 42 Brno

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Abstract

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The sequence of appearance and development of ossification centres of the ossa sesamoidea phalangis proximalis in 22 bovine fetuses and newborn Bohemian Pied calves were investigated using the method of clearing and differential staining of specimens and radiography.

The ossification centres of the ossa sesamoidea phalangis proximalis in cattle appeared at the end of month 8 and during month 9 of intrauterine life in a regular sequence. First the ossification centre of the axial sesamoid of the proximal phalanx of the fourth digit appeared, followed by that of the axial sesamoid of the proximal phalanx of the third digit, and that of the abaxial sesamoid of the proximal phalanx of the fourth digit. Finally, the ossification centre of the abaxial sesamoid of the proximal phalanx of the third digit appeared. The ossification centres in this sequence appeared first in the pelvic limbs.

In full-term newborn calves, all ossification centres were present, however, their development was uneven in consequence of the above-mentioned time sequence in their appearance. The degree of maturation of the ossification centres may be estimated according to the ossification onset and changes in the shapes of the individual centres found in radiograms of fetuses and newborn calves.

Cattle, digits, ossification centre, prenatal and postnatal development.

During our study of development of the cattle acropodium skeleton in the early postnatal period we observed that the development of the ossification centres of the ossa sesamoidea phalangis proximalis of the third and fourth digits was markedly uneven. Similar finding was reported by Schaeffer (1934) on ossification of the ossa sesamoidea phalangis proximalis in the dog. However, differences in the shape and size of these bones in adult cattle are not conspicuous enough to explain the uneven development of the ossification centres of the sesamoids of the proximal phalanges of the digits. According to Preuss (1970), the ossa sesamoidea in the mammalian skeleton had developed in consequence of tendon pressure on the walls of synovial formations. The size differences in development of the ossification centres have not even been reported in papers dealing with ossification of the ossa sesamoidea phalangis proximalis in cattle (Küpfer and Schintz 1923; Rojas 1943; Vokken 1950; Fedrigo 1957; Lindsay 1969). Development of these centres was established by Lindsay (1969) who used histological methods and alizarin-stained and cleared specimens from fetuses 238 days old. However, she did not report on the sequence in which the individual bones appeared.

The radiographic studies of the limb skeleton development carried out by several authors have revealed ossification centres of the ossa sesamoidea phalangis proximalis shortly before birth (Küpfer and Schinz 1923; Fedrigo 1957), and, according to Vokken (1950), even as late as 10 days after birth. Barone (1966) stated that the ossa sesamoidea phalangis proximalis in cattle ossify one month before birth. None of these authors reported on differences in sizes of the individual

ossification centres at a particular stage of development of an animal or the sequence of ossification in individual sesamoids of both digits in cattle limbs. These details were reported in the studies of ossification of the sesamoids of the proximal phalanges of the digits by Pomriaskinski – Kobozieff and Kobozieff (1954) in the dog, and by Bressou et al. (1957, 1959a, 1959b) in the dog and cat. According to these authors, the ossification centres in the ossa sesamoidea phalangis proximalis in the dog and cat do not appear until after birth, within the interval of days 64–70. According to Pomriaskinski – Kobozieff and Kobozieff (1954) and Bressou et al. (1957), the first centres to appear in both the thoracic and pelvic limbs of the dog are those of the sesamoids of the proximal phalanges of the third digit, then of the fourth digit followed by those of the remaining digits. When studying the development of pelvic limb skeleton in the dog, Bressou et al. (1957) found that the ossification centres of the outer sesamoids of the proximal phalanges appeared earlier than those of the inner sesamoids so that they were larger and radiographically clearer. The authors stated that in the cat the ossification centres of the ossa sesamoidea phalangis proximalis in the thoracic limb appear first in the second and third digits, and, in the pelvic limb, in the third and fourth digits. Rajtová (1966, 1967) observed that in the guinea pig the ossification centres of the ossa sesamoidea phalangis proximalis in both the thoracic and pelvic limbs appear on day 60 of intrauterine life, i. e. close to birth. They first appear in the second and third digits in the cartilaginous anlagen in the medial sesamoids and in the fourth and fifth digits in the cartilaginous anlagen for lateral sesamoids. The author also described a delayed appearance of ossification in the ossa sesamoidea phalangis proximalis in retarded guinea pigs. According to Borovanský et al. (1967), consistent findings in man are only the ossa sesamoidea pedis on the plantar side of the head of the most developed first metatarsus. Their appearance is variable at other sites: they are found more frequently near the fifth and second digits and less frequently near the third and fourth digits. In man these bones do not ossify until the age of about 12 years.

Although in cattle the ossification centres of the ossa sesamoidea phalangis proximalis appear as early as during the intrauterine life, they develop in the early postnatal period. Their stage of development as well as that of other ossification centres in the skeleton that appear or develop postnatally are radiographically detectable and may be used as an indicator of skeletal development of the animal. The aim of the present study was therefore to investigate in greater detail the course of ossification of the ossa sesamoidea phalangis proximalis in cattle both in prenatal and early postnatal life so as to contribute to knowledge of cattle skeleton development and to complete the data for estimation of their skeleton maturity.

Materials and Methods

Cartilaginous anlagen and the ossification centres of the sesamoids of the proximal phalanges of the digits in the thoracic and pelvic limbs in 15 bovine fetuses and 7 newborn Bohemian Pied calves were studied radiographically. Further, differential staining with alizarin combined with clearing according to Hood and Neill (1948) was employed.

The radiograms were made in the palmadorsal (plantadorsal), dorsopalmar and mediolateral projections using a 4-valved Mega-meta X-ray apparatus at the University of Veterinary Science, Brno, and a portable X-ray apparatus in calf barns.

For differential staining of the ossification centres the whole cartilaginous anlagen of all four sesamoids were cut out, and the bases of the abaxial sesamoids of the fourth digit were labelled. The samples were preserved in 4 % formalin for 2 days, changed into 75 % ethylalcohol denatured with 2 % petrol for seven days. The specimens were then processed according to Hood and Neill (1948), and perfectly cleared in pure glycerol with a grain of thymol against moulds for about two months. The samples were examined using a binocular magnifier (x 3) on a table illuminated with a 500 W light source. The age, body mass, sex and processing methods used in the individual animals are given in Table 1.

Results

Ossification centres in the cleared and differentially alizarin-stained specimens

No ossification centres of the ossa sesamoidea in the cartilaginous anlagen of these bones in earliest developmental stages under study (i. e. 231 and 234 days of gestational age) were found. However, the cartilaginous anlagen of the sesamoids

showed a slight red-brown staining with alizarin, indicating a colour differentiation from the tendons of the interosseous muscles (Fig. 1). The stained cartilaginous anlagen for the abaxial sesamoids of the proximal phalanx of the third and fourth digits were pentagon-shaped, distally wide and proximally tip-pointed. The cartilaginous anlagen of the two axial sesamoids are pentagon-shaped, too, but they were more elongated, longer and narrower. The contours of the cleared and stained cartilaginous anlagen of the proximal phalanx sesamoids in both the thoracic and pelvic limbs resembled contours of these bones in radiograms of adult cattle.

In older fetuses (245 and 258-days old), the ossification centres were detected only in some of the cartilaginous anlagen for the ossa sesamoidea phalangis proximalis. The centres in sesamoids of the pelvic limbs seemed to develop earlier than those of the thoracic limbs (Fig. 3), e. g. the largest ossification centres were detected in the cartilaginous anlagen for the axial ossa sesamoidea phalangis proximalis of the fourth digits in pelvic limbs. However, no ossification centres were found in anlagen for the abaxial ossa sesamoidea phalangis proximalis of the third digits in the pelvic and thoracic limbs. The sequence of ossification onset in the cartilaginous anlagen for ossa sesamoidea phalangis proximalis is the same for both thoracic and pelvic limbs. Ossification started first in the cartilaginous anlage for the axial sesamoid of the proximal phalanx of the fourth digit, then in the axial sesamoid of the proximal phalanx of the third digit, followed by its onset in the abaxial sesamoid of the fourth digit (Fig. 2 and 3). The last ossification centres to appear were those of the abaxial sesamoids of the proximal phalanx of the third digit as evident also from the findings in older fetuses.

In 269-days-old fetuses ossification centres were visible in sesamoids of the proximal phalanges of the digits in the cartilaginous anlagen of both axial and abaxial sesamoids of the fourth digit in the pelvic and thoracic limbs and in the anlagen

Table 1

Characteristics of the experimental material

Specimen No.	Age (days of i. u. life)	Body mass (kg)	Sex	Processing method		Note
				X-ray	Differential staining with alizarin	
1	231	20	♂	+	+	
2	234	21	♂	+	+	
3	245	28	♂	+	+	
4	248	27	♀	+	−	
5	256	29	♀	+	−	
6	256	32	♂	+	−	
7	258	31	♂	+	+	
8	262	36	♀	+	−	
9	269	36	♂	+	+	
10	270	33	♀	+	−	
11	274	42	♂	+	+	
12	275	35	♀	+	+	twins
13	275	31	♀	+	+	twins
14	277	38	♀	+	−	
15	281	39	♂	+	−	
16	neonate	50	♂	+	−	
17	neonate	52	♂	+	−	
18	neonate	45	♀	+	−	
19	neonate	47	♂	+	−	
20	neonate	45	♀	+	−	
21	neonate	50	♀	+	−	
22	neonate	42	♂	+	+	

for the axial sesamoids of the third digits in all limbs. The ossification centres for the abaxial sesamoid of the proximal phalanges of the third digit in the pelvic limbs are present, too, but they are the smallest (Fig. 4). A minute ossification centre may also be seen in the cartilaginous anlage for the abaxial os sesamoideum phalangis proximalis of the third digit in the right thoracic limb (Fig. 5). However, in the contralateral limb, ossification of this sesamoid had not started yet. The outlines of all ossification centres at this fetal age showed differences in their sizes and more advanced development as compared to the younger fetuses. Uneven development of the ossification centres follows from the recorded sequence of ossification, and its earlier onset in the cartilaginous anlagen for the sesamoids of the proximal phalanges of the digits in the pelvic limbs.

At the end of gestation (day 274), all ossification centres of the ossa sesamoidea phalangis proximalis in both the pelvic and thoracic limbs were present. The development of these centres was also uneven: the smallest ones were those for the abaxial ossa sesamoidea phalangis proximalis of the third digits and the most developed ones were the centres for the axial sesamoids of the proximal phalanges of the fourth and third digits. Ossification centres for the ossa sesamoidea phalangis proximalis in pelvic limbs were more developed. The centres for the two axial bones were proximally slightly elongated, those for abaxial bones were round (Fig. 6).

In the present study we also examined twin fetuses aged 275 days. The cleared and alizarin-stained specimens revealed a marked variability in development of ossification centres of the ossa sesamoidea phalangis proximalis including also more advanced ossification in the pelvic limbs (Fig. 7 and 8). In fetus No. 12 (Fig. 7), a more advanced development of the ossification centres was observed as compared to its twin fetus (No. 13; Fig. 8). Especially prominent was the advance in ossification of the centres for the abaxial ossa sesamoidea phalangis proximalis of the third digit. Both twins presented a delay in development of the ossification centres under study as compared to the 274-day-old fetus, especially apparent in the ossification centres for the abaxial sesamoids of the proximal phalanx of the third digits.

Radiographic findings

Radiograms of the distal limbs of the fetal and newborn calves revealed shadows of different sizes indicative of the present ossification centres of the ossa sesamoidea phalangis proximalis. These findings confirmed the identity of the ossification centres demonstrated in the cleared and differentially stained specimens. The uneven development of these centres visible in all radiograms, the sequence of their appearance and changes in their shapes confirm and illustrate the above-mentioned time sequence in development of these bones as described in the cleared and alizarin-stained specimens. The ossification centres for the axial sesamoids of the proximal phalanx of the fourth digit were the first to develop whereas those for the abaxial sesamoids of the proximal phalanges of the third digits were the most retarded ones. In all animals under study, the ossification centres of the sesamoids of the proximal phalanges developed earlier in pelvic than in thoracic limbs.

In youngest fetuses, the ossification centres of the sesamoids of the proximal phalanges of the digits presented little contrast and partly fused with the shadows of metapodial epiphyses in radiograms in the palmadorsal (plantadorsal) projections. The shadows of these centres were clear in radiograms in the mediolateral projection. However, in a projection perpendicular to the sagittal plane of the

limb, they overlapped one another (Fig. 10-2) entirely. A slightly oblique direction of the X-rays presented the shadows of the ossification centres for ossa sesamoidea phalangis proximalis in close proximity or slightly overlapped (Fig. 10-3). In radiograms of older fetuses the ossification centres were clearer and easier to identify in the palmadorsal (plantadorsal) projection. In radiograms of 9-month-old fetuses the shadows of the ossification centres for the two axial sesamoids of the proximal phalanges were larger, and before birth they assumed elongated oval shapes (Fig. 12). Shadows of the ossification centres for the two abaxial sesamoid were round-shaped and uneven, the centre for the abaxial sesamoid of the third digit being smaller. This difference was more pronounced in the thoracic limbs. In radiograms of newborn calves the ossification centres of the individual sesamoids were uneven as yet, and the shadows of the axial centres were elongated and oval (Fig. 13). The shadows of the ossification centres for the two abaxial sesamoids were mostly still round, the shadow of the centre for the abaxial sesamoid of the proximal phalanx of the third digit being smaller.

Discussion

The authors reporting on skeletal ossification in cattle (Küpfer and Schinz 1923; Rojas 1943; Vokken 1950; Fedrigo 1957; Lindsay 1969) have summarized data on the appearance of the ossification centres of the ossa sesamoidea phalangis proximalis paying no attention to interrelationships between the onset of ossification in the cartilaginous anlagen of the sesamoids of the proximal phalanges of the individual digits. They may have missed these details because of the width of the problems they studied. If Lindsay (1969) detected the ossification centres for the ossa sesamoidea phalangis proximalis in 8-month-old bovine fetuses, she certainly did not so for all four bones in the limb. Consequently, she did not report in which cartilaginous anlagen of the sesamoids of the proximal phalanges the ossification centres were found. Though Schaeffer (1934), Pomriaskinski-Kobozieff and Kobozieff (1954), Bressou et al. (1957, 1959a, 1959b) and Rajtová (1966, 1967) noticed the time sequence in ossification onset in the ossa sesamoidea phalangis proximalis, they did not comment on this findings.

The sequence of appearance of the ossification centres in the cartilaginous anlagen fot the individual sesamoids of the proximal phalanges of the digits could best be studied in the cleared and differentially-stained specimens. Thus also the different developmental stages of the ossification centres for the individual bones may well be seen along with the regular sequence in their appearance, identical in the thoracic and pelvic limbs, and based on observation of bones of fetuses of various ages.

Both the cleared specimens and radiograms showed that the ossification centres in the pelvic limbs appeared earlier than those in the thoracic limbs. However, the sequence of their appearance was identical. This developmental pattern possibly anticipates the higher functional load exerted on the sesamoids of the proximal phalanges of the digits and higher pressure on the articular capsule of the pelvic limbs in cattle. Our explanation is based on the conclusions drawn from comparative studies of animal skeleton ossification by Vokken (1949) who attributed the species differences in the onset of the process, especially ossification of the secondary centres, to a certain specific functional adaptation of the skeleton

in the course of phylogenetic evolution. Such interpretation follows also from the conclusions of Preuss (1970). In his opinion, the sesamoids had developed as a result of pressures on the walls of the joint capsules. Our findings are consistent with this interpretation. In cattle, the heaviest functional load is apparently on the plantar part of the joint capsule of the articulatio metatarsophalangea in the axial part of the limb, especially on the fourth digit. In carnivorous animals (dogs and cats) (Pomriaskinski-Kobozieff et al. 1954; Bressou et al. 1957, 1959a, 1959b), is the sequence of ossification onset different due to differences in the anatomical structure and different functional loads on the limbs as compared to cattle. Similar explanation may be given for the specific course in the sequence of appearance of the ossification centres for the sesamoids of the proximal phalanges of the digits in the thoracic limb of guinea pigs (Rajtová 1966). Considering the fact that there are only three digits on the pelvic limb of the guinea pig, the differences between the sequence of ossification onset in their thoracic and pelvic limbs are not surprising (Rajtová 1967). Preuss' (1970) explanation of the origin of sesamoids in mammals and our conclusions concerning the specific sequence in appearance of the ossification centres in these bones in that part of the limb which had received the higher functional load in the course of the phylogenetic evolution are also supported by regular occurrence of sesamoids of the proximal phalanges of the toe in man near the most developed and most loaded first metatarsus and first toe.

The differences in the time course of appearance of the ossification centres in the cartilaginous anlagen of the ossa sesamoidea phalangis proximalis in cattle as reported by several authors (Vokken 1950; Lindsay 1969 and others) may also result from the different methods employed in the study of this problem. A lower quality of radiograms may prevent the investigator from detecting the

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Fig. 1. Alizarin-stained and cleared cartilaginous anlagen for the ossa sesamoidea phalangis proximalis in the right pelvic limb of a bovine fetus aged 234 days. 1 — cartilaginous anlagen for the ossa sesamoidea phalangis proximalis of the fourth digit, 2 — cartilaginous anlagen for the ossa sesamoidea phalangis proximalis of the third digit, 3 — mm. interossei (insertion).

Fig. 2. Gradual appearance of the ossification centres in the cartilaginous anlagen for the ossa sesamoidea phalangis proximalis of the right thoracic limb of a bovine fetus aged 258 days. Palmar view. 1 — ossification centre of the axial sesamoid of proximal phalanx of the fourth digit, 2 — ossification centre for the axial sesamoid of proximal phalanx of the third digit, a little smaller, 3 — outlines of the appearing centre for the abaxial sesamoid of proximal phalanx of the fourth digit, 4 — ossification centre for the abaxial sesamoid of proximal phalanx of the third digit in the cartilaginous anlage has not yet appeared.

Fig. 3. Cleared cartilaginous anlagen for the ossa sesamoidea phalangis proximalis and alizarin-stained ossification centres for the individual sesamoids in all four limbs at different stages of their development in a bovine fetus aged 245 days. Palmar and plantar view. 1 — ossification centre for the axial sesamoids of proximal phalanx of the fourth digit in the pelvic limb, 1′ — similar centre in the thoracic limb, 2 — ossification centre for the axial sesamoid of proximal phalanx of the third digit in the pelvic limb and 2′ — thoracic limbs, 3 — ossification centre for the abaxial sesamoid of the proximal phalanx of the fourth digit in the pelvic limb, 3′ — incipient ossification in the cartilaginous anlagen for the abaxial ossa sesamoidea phalangis proximalis of the fourth digit in the thoracic limb, 4 — cartilaginous anlagen for the abaxial sesamoids of proximal phalanx of the third digit in the thoracic and pelvic limbs.

Fig. 4. Ossification centres for the ossa sesamoidea phalangis proximalis in the left pelvic limb of a bovine fetus aged 269 days. The centres are present in anlagen. The least developed centre is that of the abaxial os sesamoideum phalangis proximalis of the third digit. Plantar view. 1 — ossification centres for the ossa sesamoidea phalangis proximalis of the fourth digit, 2 — centre for the ossa sesamoidea phalangis proximalis of the third digit.

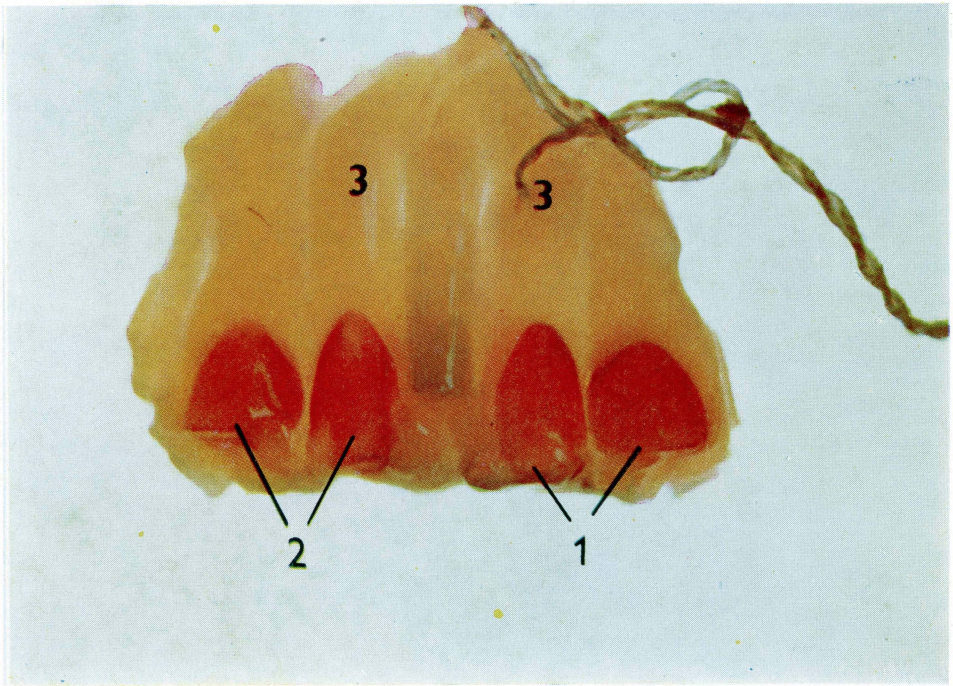
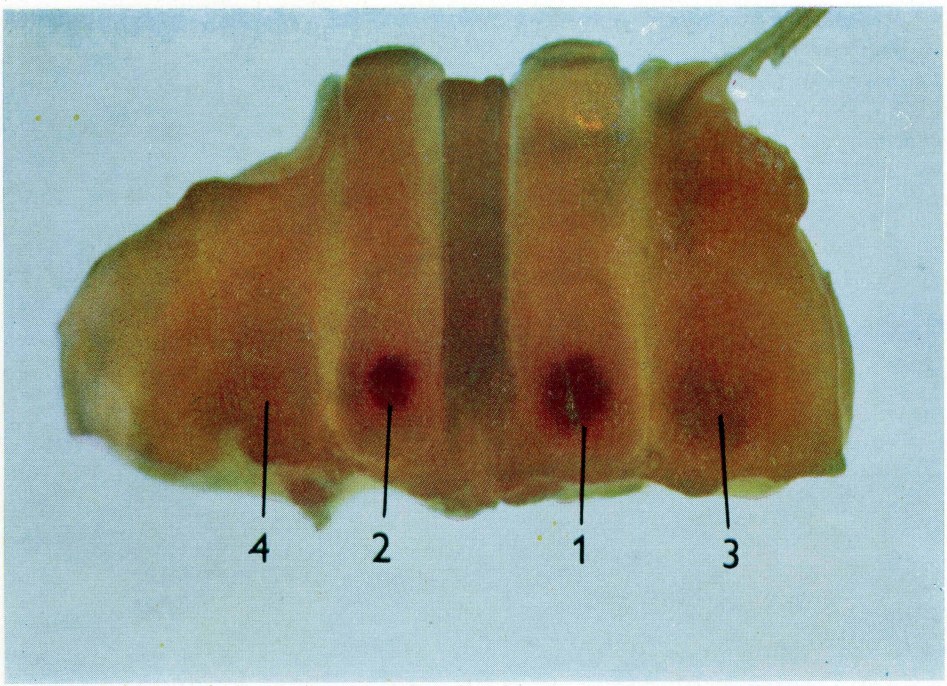


Fig. 1 ▲



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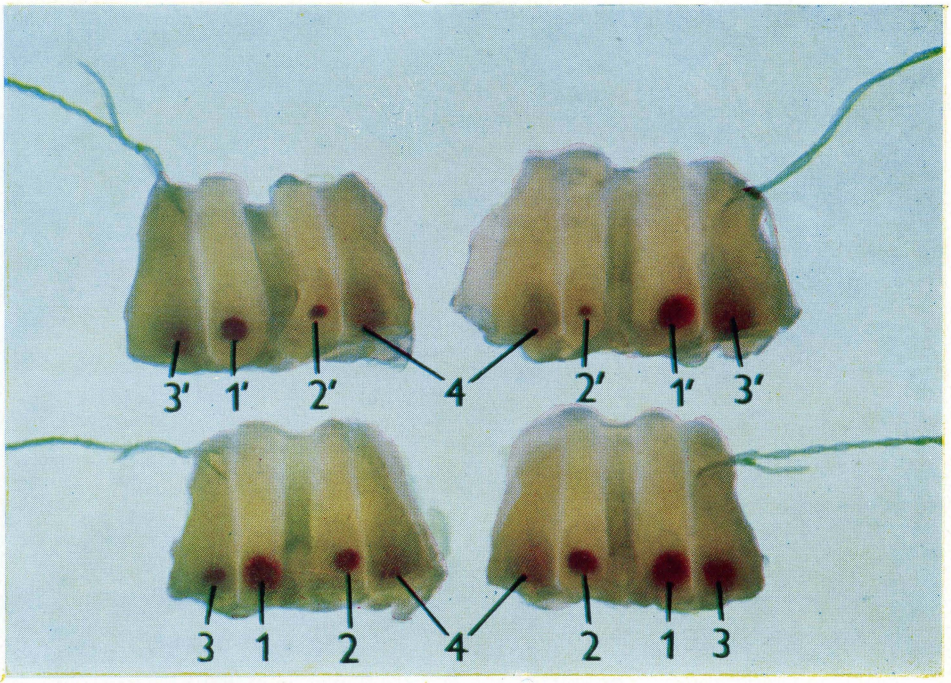

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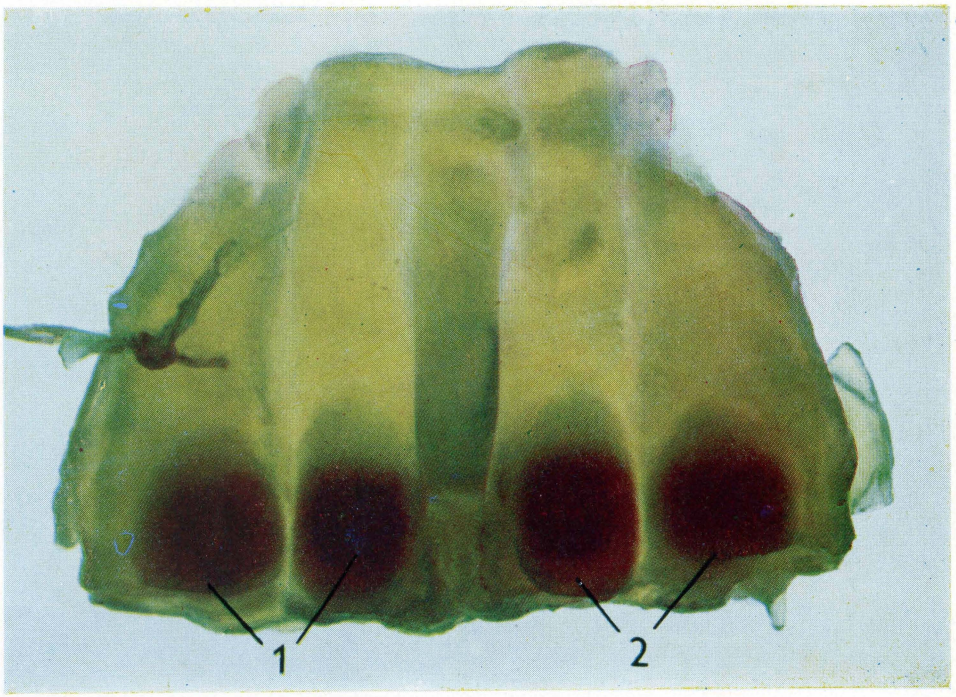

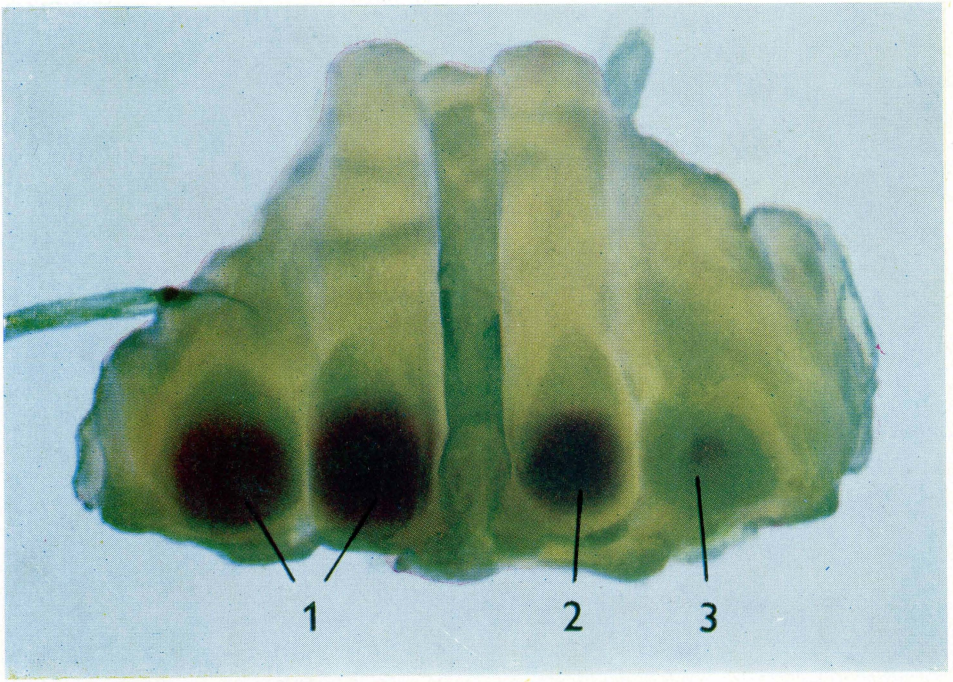

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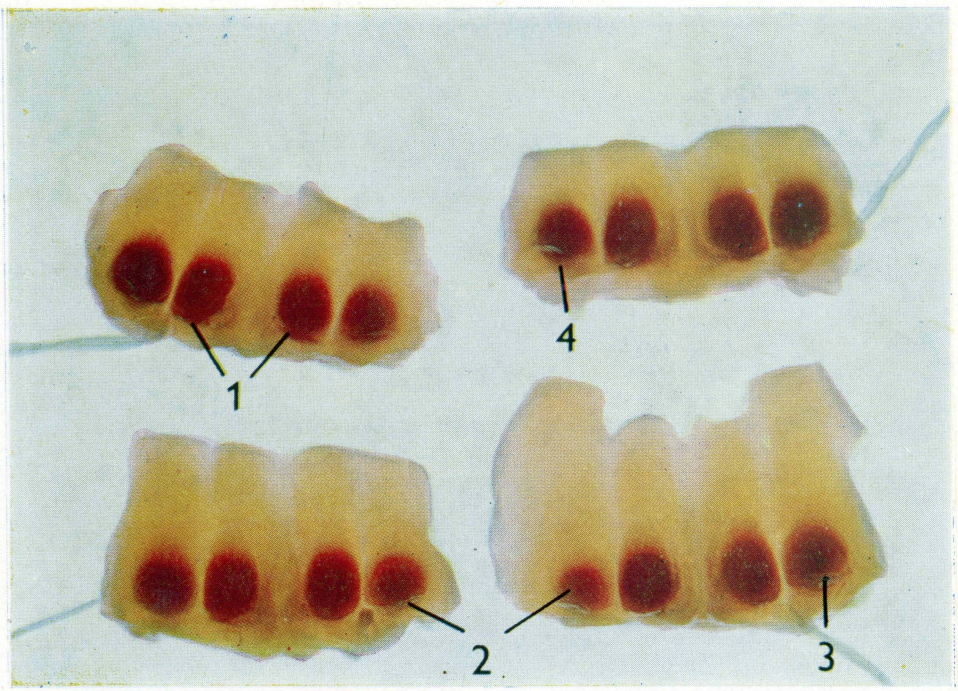

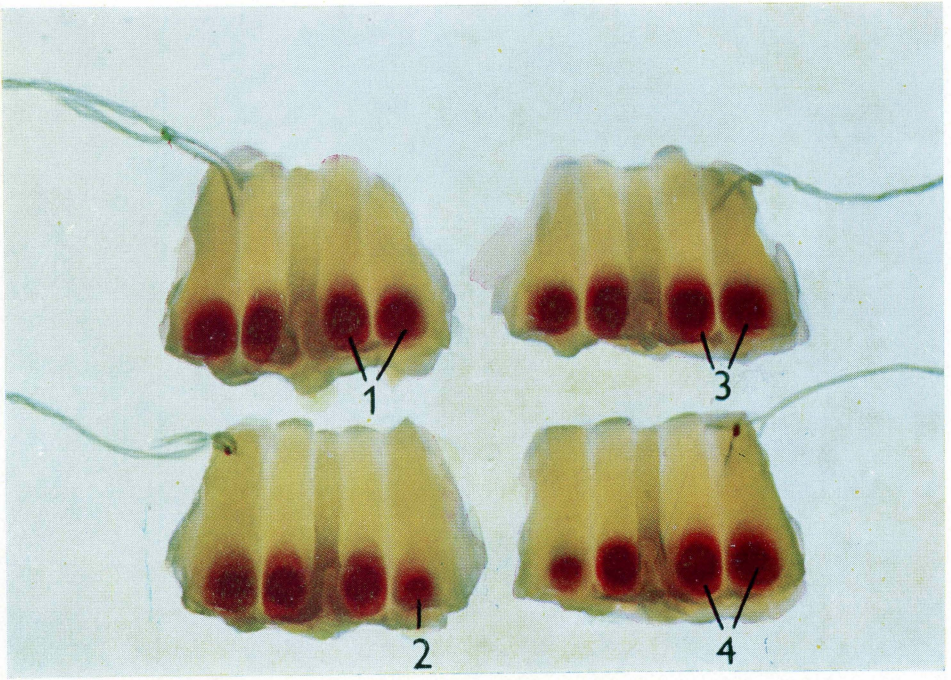

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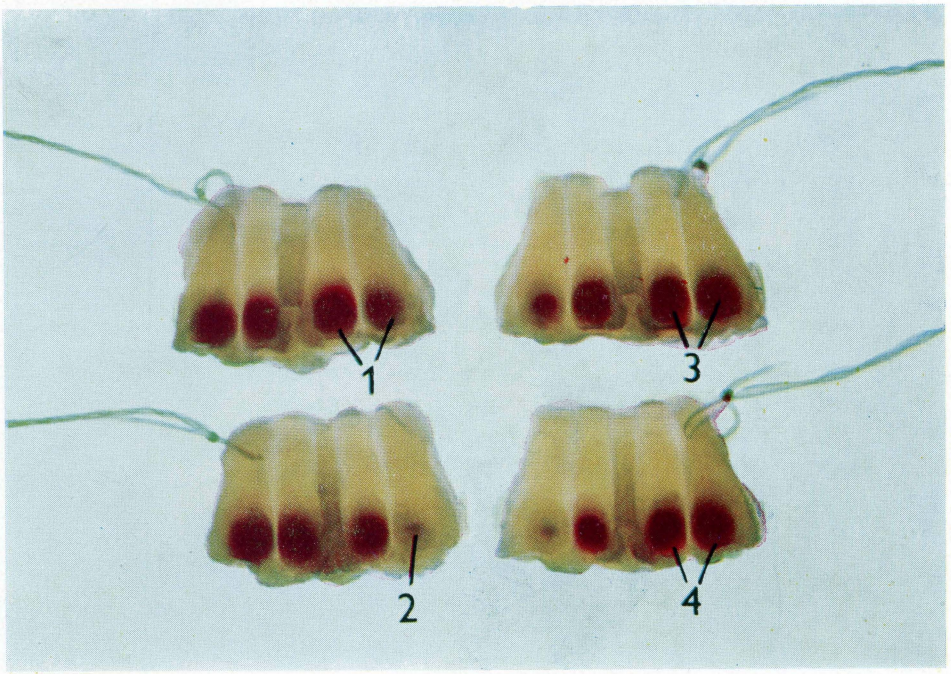

less developed ossification centres if only a radiographic study is performed (Vokken 1950). The earliest ossification stages may certainly be detected by histological examination of the cartilaginous anlagen for the bones and in the cleared and alizarin-stained specimens (Lindsay 1969). A certain time range in appearance of the ossification centres can be accounted for by breed characteristics and individual specific features of skeletal development that are dependent upon many factors, e.g. the fetal body mass, the number of fetuses in litter, effects of environmental temperature on fetal development as shown by Garard et al. (1974) in rats. Our findings in bovine fetuses are also supported by those of Garard et al. (1974) as we found less developed ossification centres in the fetus of lower body mass. Its ossification centres in the abaxial sesamoids of the proximal phalanges of the third digits had just started to form.

The sesamoids in skeleton of nidifugous mammals including cattle arise from the ossification centres in the cartilaginous anlagen for these bones mostly by the end of the intrauterine life or in the early postnatal period. The ossification centres of these minute bones appear with the same regularity as those of the basic parts of the skeleton so that their development may be employed for evaluation of the skeleton maturity. They are easily accessible for radiographic examination and may well be differentiated from other parts of the acropodium skeleton. The regular sequence of appearance of the ossification centres in cattle is clearly demonstrated in our material: invariably the first to appear were those of the axial sesamoids of the fourth digits at the beginning of 9th month of gestational age, the last to appear were those in the cartilaginous anlagen for the abaxial sesamoids of the third digits shortly before birth. The earlier the ossification of the ossa sesamoidea phalangis proximalis started the earlier equal sizes of the bones were observed. Only sporadically an earlier appearance of the homologous ossification centres in either the right or the left limb occurred. In newborn calves, uneven development of these ossification centres is still maintained; it is especially conspicuous in the centre of the abaxial sesamoid of the third digit. Yet more

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Fig. 5. Ossification centres in sesamoids of the proximal phalanges of the digits in the right thoracic lihb of a bovine fetus aged 269 days. At this age, also the ossification centre in the cartilaginous anlage for the abaxial os sesamoideum phalangis proximalis in the third digit begins to form. Palmar view. 1 — ossification centre of the ossa sesamoidea phalangis proximalis of the fourth digit, 2 — ossification centre of the axial sesamoid of proximal phalanx of the third digit, 3 — incipient ossification in the anlage for the abaxial os sesamoideum phalangis proximalis of the third digit.

Fig. 6. Ossification centres in the cartilaginous anlagen for the ossa sesamoidea phalangis proximalis in the limbs of a bovine fetus aged 274 days. Palmar and plantar views. 1 — ossification centres of the axial sesamoids become elongated, 2 — ossification centres in the abaxial sesamoids of the proximal phalanges of the third digits in thoracic limbs are least developed, 3 — ossification centre in the sesamoid of the proximal phalanx of the fourth digit in the right thoracic limb, 4 — ossification centre in the abaxial sesamoid of the proximal phalanx of the third digit in the right pelvic limb.

Fig. 7. Ossification centres in the ossa sesamoidea phalangis proximalis in twin fetuses aged 275 days (fetus No. 12, body mass 35 kg). 1 — ossification centres in the sesamoids of the proximal phalanx of the third digit in the pelvic limb, 2 — ossification centre in the abaxial sesamoid of the proximal phalanx of the third digit in the left thoracic limb, 3 — ossification centres in the ossa sesamoidea phalangis proximalis of the fourth digit in the right pelvic limb, 4 — ossification centres in the ossa sesamoidea phalangis proximalis of the third digit in the right thoracic limb.

Fig. 8. Ossification centres in the ossa sesamoidea phalangis proximalis of twin fetuses aged 275 days (fetus No. 13, body mass 31 kg). Distribution of the ossification centres in the individual sesamoids is the same as in Fig. 7 (for key see Fig. 7).

uneven development of these centres may be regarded as a sign of less mature skeleton. On the contrary, the beginning shape differentiation of the ossification centres in axial and abaxial sesamoids of the proximal phalanges of the digits in fetuses close to birth and in newborn calves is indicative of a more advanced development of both these centres and the skeleton itself.

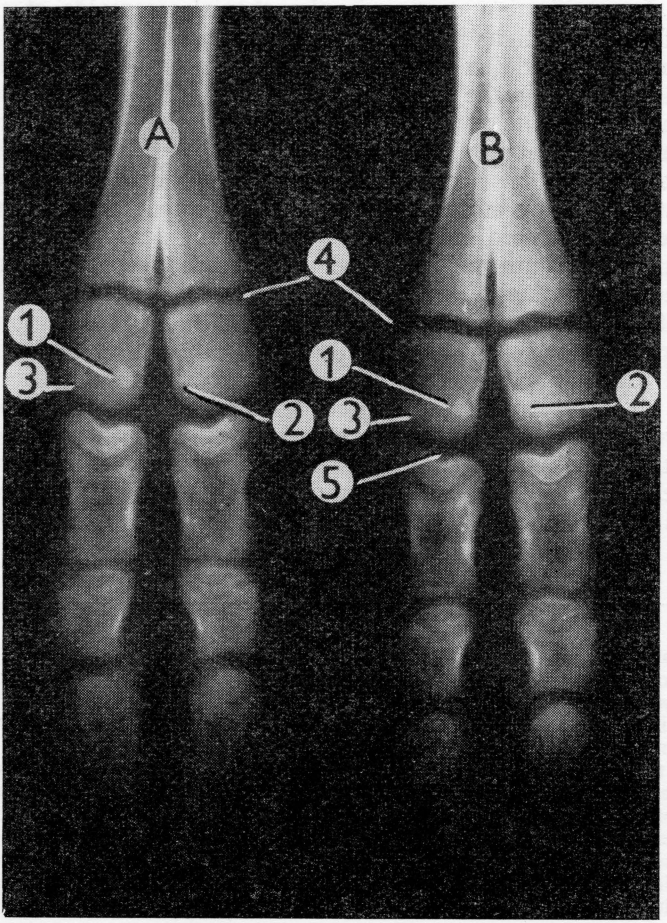


Fig. 9. Radiogram of the left thoracic (A) and left pelvic (B) autopodium of a bovine fetus aged 256 days. Palmadorsal and plantadorsal projection. 1 — shadow of the ossification centre in the sesamoid of the proximal phalanx of the fourth digit, 2 — shadow of the centre for the axial sesamoid of the proximal phalanx of the third digit, 3 — shadow of the centre for the abaxial sesamoid of the proximal phalanx of the fourth digit, 4 — clear zone in the epiphysodiaphyseal cartilage of the metapodium, 5 — clear zone of the articular space in the articulatio metatarsophalangea.

Osifikace a vývoj ossa sesamoidea phalangis proximalis u skotu (Bos primigenius f. taurus Linné 1758)

Studovali jsme posloupnost vzniku a rozvoj osifikačních center pro ossa sesamoidea phalangis proximalis u fetů a novorozenců skotu plemene červenostrakatého. Pozorování jsme provedli na 22 jedincích ve věku od 231 dnů i. u. života až do věkového stadia novorozených telat, a to metodou projasněných a alizarinem diferenčně barvených preparátů a pomocí rentgenu.

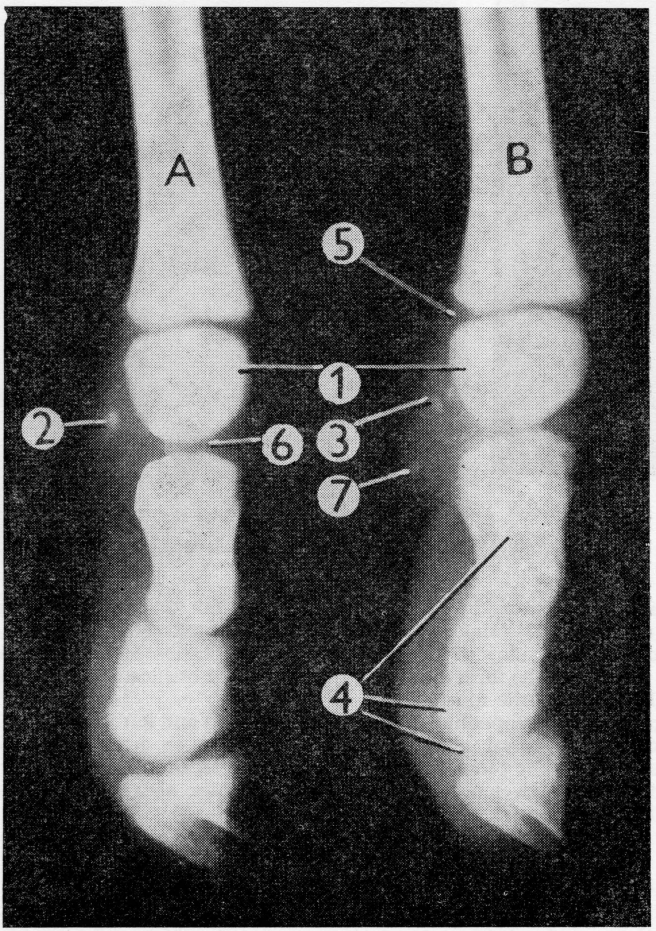
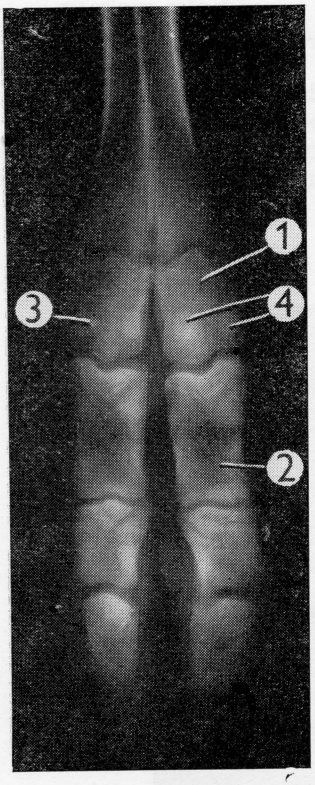


Fig. 10. Radiogram of the left pelvic limb acropodium in the mediolateral projection (A) and right pelvic acropodium in the mediolaterodorsal (oblique) projection (B) of a bovine fetus aged 256 days. 1 — shadows of the metapodium epiphyses, 2 — shadows of the sesamoids of the proximal phalanges of the digits overlapping one another, 3 — shadows of the sesamoids in the oblique projection, 4 — shadows of the individual digit phalanges, 5 — clear zone of the epiphysodiaphyseal cartilage, 6 — clear zone of the articular fissure of the articulatio metatarsophalangea, 7 — shadow of the ossification centre of the rudimentary digit phalanx.



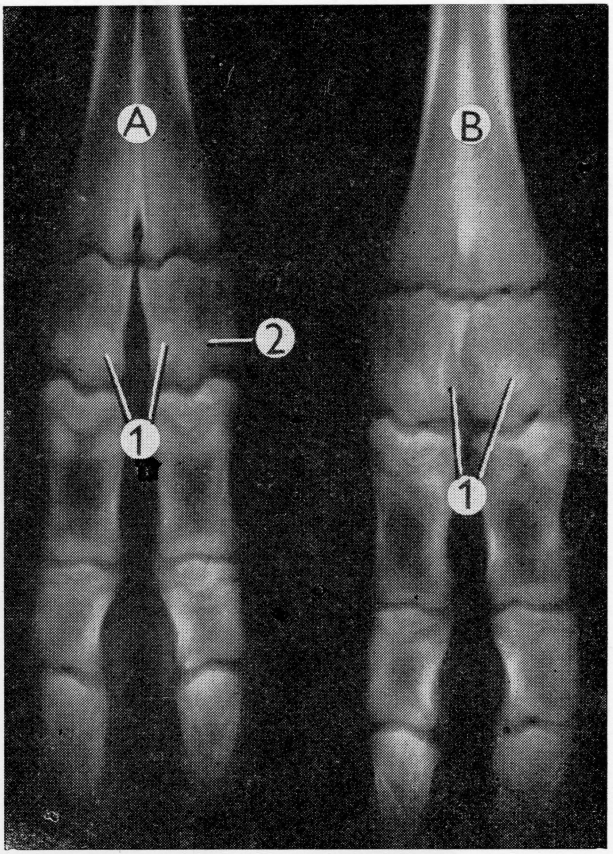


Fig. 11 **Fig. 12**

Fig. 11. Radiogram of the autopodium of the right thoracic limb (A) of a bovine fetus aged 277 days in palmadorsal projection. 1 — shadow of the metapodium epiphyses, 2 — shadow of the proximal phalanx of the digit, 3 — shadow of the least developed ossification centre for the abaxial sesamoid of the proximal phalanx of the third digit, 4 — shadows of the ossification centres for the sesamoids of the proximal phalanx of the fourth digit.
Fig. 12. Radiogram of the autopodium of the left thoracic (A) and left pelvic (B) limbs of a bovine fetus aged 281 days. Palmadorsal (plantadorsal) projection. 1 — shadows of the ossification centres for the axial sesamoids of the proximal phalanges of the third and fourth digits are oval in shape, 2 — shadow of the least developed ossification centre for the abaxial sesamoid of the proximal phalanx of the third digit in the thoracic limb.

Osifikační centra pro ossa sesamoidea phalangis proximalis se u skotu zakládají koncem osmého a v devátém měsíci intrauterinního života v pravidelném pořadí. Nejprve se zakládá osifikační centrum pro axiální sezamskou kost proximálního článku čtvrtého prstu, dále pro axiální sezamskou kost proximálního článku třetího prstu a abaxiální sezamskou kost proximálního článku čtvrtého prstu. Nakonec se zakládá osifikační centrum pro abaxiální sezamskou kost proximálního článku třetího prstu. Tato osifikační centra vznikají v uvedeném sledu s předstihem na pánevních končetinách.

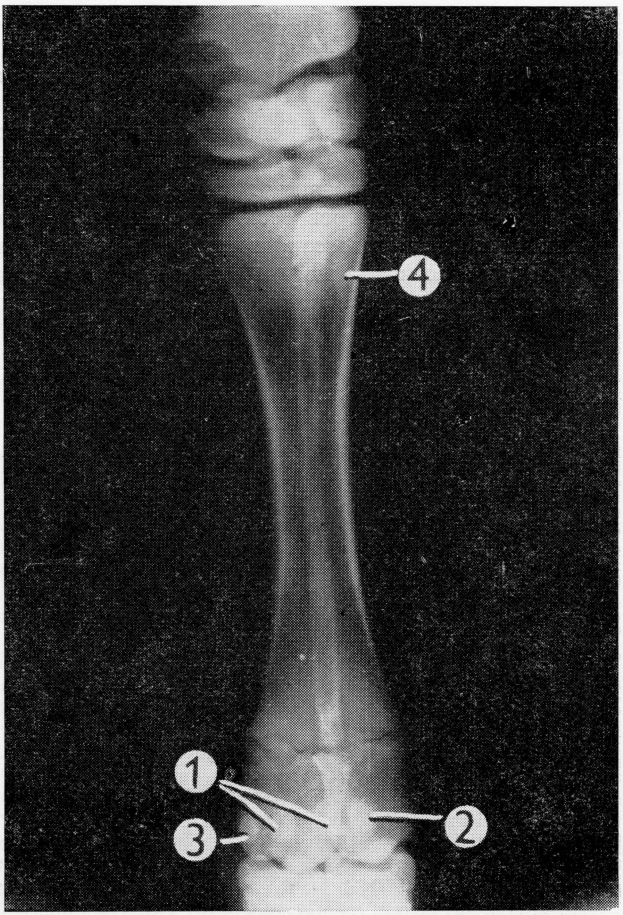


Fig. 13. Radiogram of the right thoracic metapodium of a newborn calf im palmadorsal projection. 1 — elongated shadows of the ossification centres for the axial ossa sesamoidea phalangis proximalis, 2 — shadow of the abaxial sesamoid of the proximal phalanx of the fourth digit still round, 3 — shadow of the abaxial sesamoid of the proximal phalanx of the third digit is the smallest 4 — os metacarpale V.

U normálně vyspělých novorozených telat jsou již všechna osifikační centra pro ossa sesamoidea phalangis proximalis založena a je dosud zachována nerovnoměrnost v jejich rozvoji související s posloupností vzniku těchto osifikačních center. Na základě zjištěného sledu v nástupu osifikace a zjištěných tvarových změn studovaných osifikačních center na rentgenogramech fetů a novorozenců skotu lze posoudit stupeň zralosti těchto osifikačních center.

К оссификации и развитию **ossa sesamoidea phalangis proximalis** у крупного рогатого скота **(Bos primigenius f. taurus Linné 1758)**

Проводились исследования последовательности возникновения и развития центров оссификации для ossa sesamoidea phalangis proximalis у зародышей и новорожденного крупного рогатого скота пестро-красного племени. Наблюдения проводились на 22 животных в возрасте 231 день внутриутробной жизни — до возрастной стадии новорожденных телят методом просветленных, ализарином дифференциально окрашиваемых препаратов и с помощью рентгеновского исследования.

Центры оссификации для ossa sesamoidea phalangis proximalis у крупного рогатого скота образуются в конце восьмого и девятого месяцев внутриутробной жизни в регулярном порядке. Сперва основывается центр оссификации для аксиальной сезамовой кости основной фаланги четвертого пальца, далее, для аксиальной сезамовой кости проксимальной фаланги третьего пальца и абаксиальной сезамовой кости проксимальной фаланги четвертого

пальца. Наконец оссификационный центр возникает для абаксиальной сезамовой кости основной фаланги третьего пальца. Данные центры оссификации возникают в приведенной последовательности с опережением на тазовых конечностях.

У нормально развитых новорожденных телят все центры оссификации для ossa sesamoidea phalangis proximalis основаны, до сих пор наблюдается неравномерность их развития, связанная с последовательностью возникновения упомянутых центров оссификации. На основе установленной последовательности проявления оссификации и выявленных изменений формы изучаемых центров оссификации на рентгенограммах зародышей и новорожденного крупного рогатого скота можно оценить степень зрелости данных центров оссификации.

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