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ANATOMICAL CHARACTERISTICS ON 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 anatomical structure and radiography of the sesamoid bones of the proximal phalanges of cattle digits were studied on osteological material and radiograms of 18 cows and 5 bulls. On the basis of detailed anatomical description, a list of new anatomical names for important anatomical formations was proposed in order to complete the anatomical nomenclature and to provide better orientation on the bones as well as a more precise description of the different bones and determine their origin from the respective digits and/or the left or right thoracic or pelvic limbs.

Thus the axial sesamoid bones of the proximal phalanges of the digit can be distinguished from the abaxial ones. Also the abaxial sesamoid bones of the proximal phalanges of the third and fourth digits can be differentiated as well as their origin from the thoracic or pelvic limb.

On the basis of outer characteristics, we can safely differentiate the axial sesamoid bones of the proximal phalanges of the digits of the thoracic limb and the pelvic limb. Whether the axial sesamoid bones of the proximal phalanges of the digits pertain to the third or fourth digit on the thoracic or pelvic limb and to the left or right limb, it can be determined indirectly from the topographic interrelations of the anatomical formations described in the present study, but only under condition that we know one of the data looked for which is relative to the origin of the bones.

On the basis of the typical shape and location of shadows we can differentiate in the radiograms shadows of the axial sesamoid bones of the proximal phalanges of the digits from those of the abaxial ones. By uneven intensity of the shadow in the radiograms in the dorsoplantar or dorsopalmar projection we can differentiate the abaxial sesamoid bones of the proximal phalanx of the fourth digit and that of the third digit.

Cattle, digits, ossa sesamoidea phalangis proximalis, anatomical characteristics.

According to Preuss (1970), the sesamoid bones appear to have resulted from the pressure of the skeletal muscle tendons on the wall of the synovial formations and consequently they have a close functional connection to them. The ossification centres of these small bones appear either in late gestation or in the postnatal period (Küpfer and Schinz 1923; Vokken 1950; Lindsay 1969). The anatomical structure of these bones is not always known and the osteologic treatment of skeletons and judgement of the archeologic findings bring about difficulties in their differentiation and precise specification. This is especially true of the ossa sesamoidea phalangis proximalis. Basic data on morphology of these bones in cattle were found in classical and more recent textbooks dealing with the veterinary anatomy (Ellenberger and Baum 1943, Sisson and Grossman 1947, Barone 1966, Akaevskiy 1968, Getty 1975, Nickel et al. 1977). Martin and Schauder (1934) and Kolda (1936) reported that both axial sesamoid bones of the proximal phalanges of the third and fourth digits are bigger than the peripheral sesamoid bones. On the

contrary Vokken et al. (1961) reported that both sesamoid bones are smaller and rounder. Koch (1970) proposed "Sehnebeine", tendon bones, or "Gleichbeine", perhaps bones filling unevennesses under the tendons, as synonyms for the ossa sesamoidea phalangis proximalis. No special reports dealing with anatomy of the sesamoid bones of the proximal phalanges in cattle in greater details are available. A more detailed study of the sequence in appearance and development of ossification centres of these bones in fetuses and newborn animals was reported by Červený (1983). He found that the ossification centres of the sesamoid bones of the proximal phalanges of the digits showed uneveness in their development, for there was a regular sequence in their appearance in the eighth and ninth month of the intrauterine life and in normally developed calves all these ossification centres are already present.

The literary data on the structure of the sesamoid bones of the proximal phalanges in cattle do not provide any details and are often contradictory. Thus it is not possible, on their basis, to differentiate and locate these bones on the skeleton and determine their origin from the respective digits of the limbs. Therefore we have attempted to provide more detailed description of the anatomical characteristics and specificity of the sesamoid bones of the proximal phalanges of the digits in adult cattle in order to enrich the anatomical knowledge in this respect and to specify their characteristics.

Materials and Methods

In the present study we examined all limbs of 23 animals of the Red-Spotted Cattle (5 bulls and 18 cows). The age of the animals ranged between 2 and 12 years. The distal parts dissected from all of the four limbs (autopodia) were cleaned and radiographed in the dorsopalmar (dorsoplantar) projection. The left-side limbs were also radiographed in the lateromedial projection and the right-side limbs in the mediolateral projection. The radiograms were made at the Radiographic Department of the University of Veterinary Science using the 4-valve MEGA-META X-ray apparatus. The autopodia were then treated by hot maceration. For this purpose we used a 20-litre pressure vessel with thermometer, pressure gauge and a safety valve. Maceration of the material from animals up to 6 years of age lasted 7—8 hours at 238 °C and 490.33 kPa, from the older animals up to 9 hours. The values presented should be respected especially in younger animals, for surpassing the above mentioned values would result in damage to compactness of bones. After

Table 1

Sample No.	Age years	Body mass kg	Sex
1	2	496	♂
2	2	420	♂
3	5	760	♂
4	7	780	♂
5	3	530	♂
6	3	577	♀
7	3	430	♀
8	3	481	♀
9	4	630	♀
10	4	654	♀
11	4	712	♀
12	4	428	♀
13	4	515	♀
14	5	485	♀
15	5	530	♀
16	5	567	♀
17	6	610	♀
18	7	523	♀
19	8	567	♀
20	9	530	♀
21	9	550	♀
22	10	575	♀
23	12	585	♀

maceration we removed the soft tissue residues, washed the bones properly in warm water and subsequently immersed them into 5 % hydrogen peroxide to bleach for 3 days. The whitened bones were left dry at the room temperature and then anatomically studied. The inner macrostructure of the sesamoid bones of the proximal phalanges of the digits was studied on sagittal and transverse bone sections. The radiograms were evaluated on the L-110 light panel with thoroughly dispersed light. Details about the experimental material are presented in Table 1.

Results

Anatomical description

The ossa sesamoidea phalangis proximalis in cattle (Fig. 1. A, B, C, D) are represented by small regularly shaped bones arranged in pairs for each digit. With respect to the limb axis (in cattle between the third and fourth digit) we can differentiate the axial

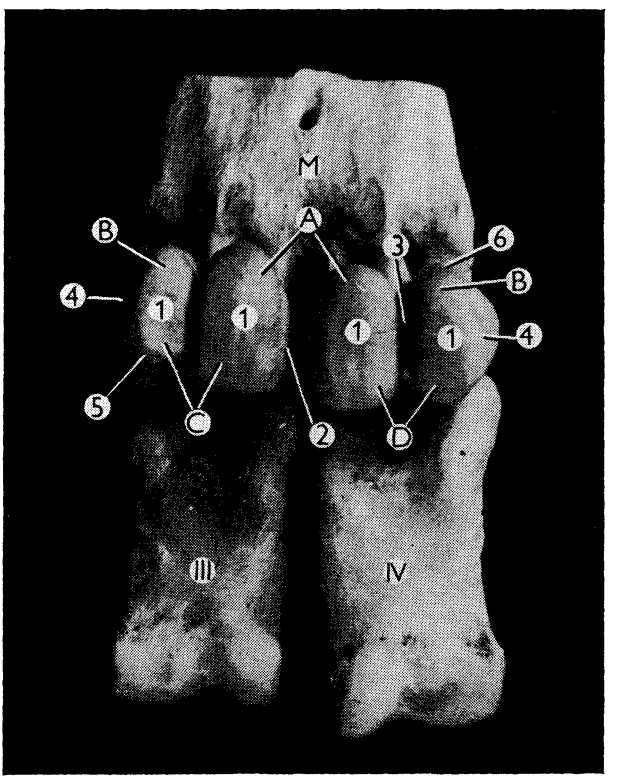

Fig. 1

Ossa sesamoidea phalangis proximalis of the right thoracic limb in the palmar aspect in situ. M — os metacarpale III et IV; III — phalanx proximalis of the third digit, IV — phalanx proximalis of the fourth digit, A — ossa sesamoidea axialia, B — ossa sesamoidea abaxialia, C — ossa sesamoidea phalangis proximalis of the third digit, D — ossa sesamoidea phalangis proximalis of the fourth digit, 1 — facies flexoria, 2 — facies interdigitalis, 3 — facies contactus, 4 — facies externa, 5 — facies distalis, 6 — facies m. interossei.

sesamoid bones of the proximal phalanges of the third or fourth digit and the abaxial sesamoid bones of the proximal phalanx of the third and/or fourth digit. There is a striking difference in shape between the axial sesamoid bones of the proximal phalanges and of the abaxial ones. The axial sesamoid bones are quadrangular-prism--shaped, the abaxial sesamoid bones resembling a triangular prism. The following surfaces can be distinguished on the sesamoid bones of the proximal phalanges: articular surface - facies articularis - for articulation with the metapodium; facies flexoria supporting the m. flexor digitorum superficialis and the m. flexor digitorum profundus; interosseous muscle surface - facies m. interossei - for attachment of the middle branch of the m. interosseus; distal surface - facies distalis - for attachment of the sesamoid ligaments located distally of the sesamoid bone; it articulates with the phalanx proximalis of the respective digit; contact surface - facies contactus - for attachment of the sesamoid ligaments interconnecting the pairs of sesamoid bones of the proximal phalanx of the respective digit; interdigital surface - facies interdigitalis - on the axial sesamoid bones of the proximal phalanges of the digits, and a corresponding outer surface - facies externa - on the abaxial sesamoid bones of the proximal phalanges of the digits, also for attachment of the sesamoid ligaments connecting the above mentioned sesamoid bones to the metapodium and/or for attachment of the ligaments interconnecting the axial sesamoid bones of the proximal phalanges of the third and fourth digits.

Facies articularis (Fig. 2.1) represents a dorsally located smooth surface covered with articular cartilage. It is a proximodistal elongated oval in shape on the axial sesamoid bones and is triangular-shaped on the abaxial sesamoid bones. A clear sagittal crest divides it into a smaller section adjacent to the digit axis and a bigger section diverted from the axis of the digit. The bigger section of the articular surface has a strightly dorsal direction and articulates with the trochlea of the metapodium. The smaller section is attached in an oblique direction to the sagittal crest of the trochlea of the metapodium.

Facies flexoria (Fig. 1.1) is a smooth convex surface. It is rather rectangular in shape on the axial sesamoid bones and is diverted in the palmar or plantar direction, being slightly convex in the same direction. It is elongated-oval-shaped on the abaxial sesamoid bones and is adjacent to the digit axis and also slightly convex. On the abaxial sesamoid bones of the proximal phalanges of all digits and on the axial sesamoid bones of the proximal phalanges of the digits in the thoracic limbs, the facies flexoria passes into a marked tuberculum proximale (Fig. 2.5). On the axial sesamoid bones of the proximal phalanges of the digits in the pelvic limbs, this tuberculum appears less developed and sometimes flattened.

Facies m. interossei (Fig. 2.3) is the proximal end of the bone. It is an uneven rough surface dorsally confined by the top of the articular surface and, in the palmar or plantar direction, by the proximal tuberculum of the facies flexoria. To its sides, the surface is slipping into grooves on the facies contactus and facies interdigitalis or facies externa. The slope is less steep on the axial and more steep on the abaxial sesamoid bones of the proximal phalanx of the digit.

Facies distalis (Fig. 3.1) is located on the distal end of the bone. It is pentagonal in shape and rough. On the abaxial sesamoid bones it is bigger and elongated in the dorsopalmar (dorsoplantar) direction. At the dorsal edge of this surface, a small semilunar-shaped articular surface can be found, which is adjacent to the respective articular surface of the base of the proximal phalanx of the digit. On the axial sesamoid bones of the proximal phalanx of the digits, this surface is much smaller than

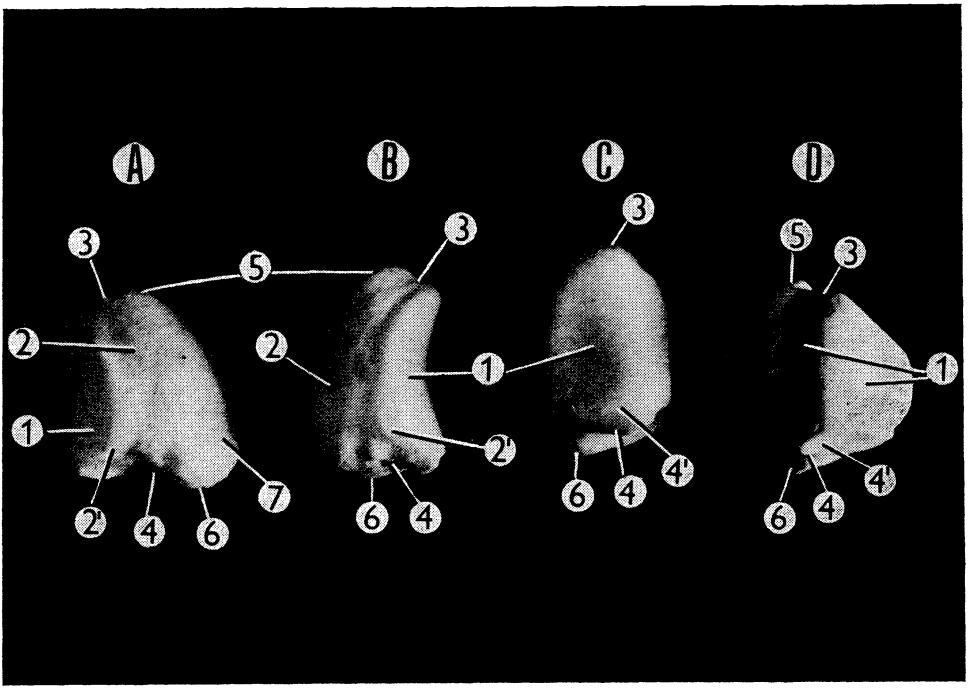

Fig. 2

Ossa sesamoidea phalangis proximalis of the right thoracic limb of cattle, anatomical description. A — os sesamoideum phalangis proximalis abaxiale of the fourth digit, B — os sesamoideum phalangis proximalis axiale of the fourth digit, C — os sesamoideum phalangis proximalis axiale of the third digit, D — os sesamoideum phalangis proximalis abaxiale of the third digit, 1 — facies articularis, 2 — facies contactus with an articular surface (2), 3 — facies m. interossei, 4 — facies distalis with an articular surface (4'), 5 — tuberculum proximale, 6 — tuberculum distale, 7 — facies flexoria.

on the abaxial bones. In the palmar and/or plantar direction the tuberculum distale (Fig. 3.1) can be seen on the facies distalis. A clear fossa can be seen in between the auricular surface of the distal surface and tuberculum distale, with foramina nutricium in the deeper part adjacent to the facies contactus.

Facies contactus (Fig. 2.2) is located on the side adjacent to the axis of the digit to which the sesamoid bone pertains. It is an uneven rectangular surface passing into a shallow longitudinal groove in the proximodistal direction, which is more pronounced on the abaxial sesamoid bones. A small semilunar articular surface can be found near the dorsodistal top of the facies contactus, which articulates with a similar surface of the neighbouring sesamoid bone from the pair which pertains to the respective digit (Fig. 3.4). Several foramina nutricium are limiting the articular surface at the palmar or plantar edge.

Facies interdigitalis, an interdigital surface (Fig. 1.2), in cattle can be found only on the axial sesamoid bones of the proximal phalanges of the digits. It is an uneven rough surface adjacent to the interdigital space, i.e. to the axis of the limb. It is in the

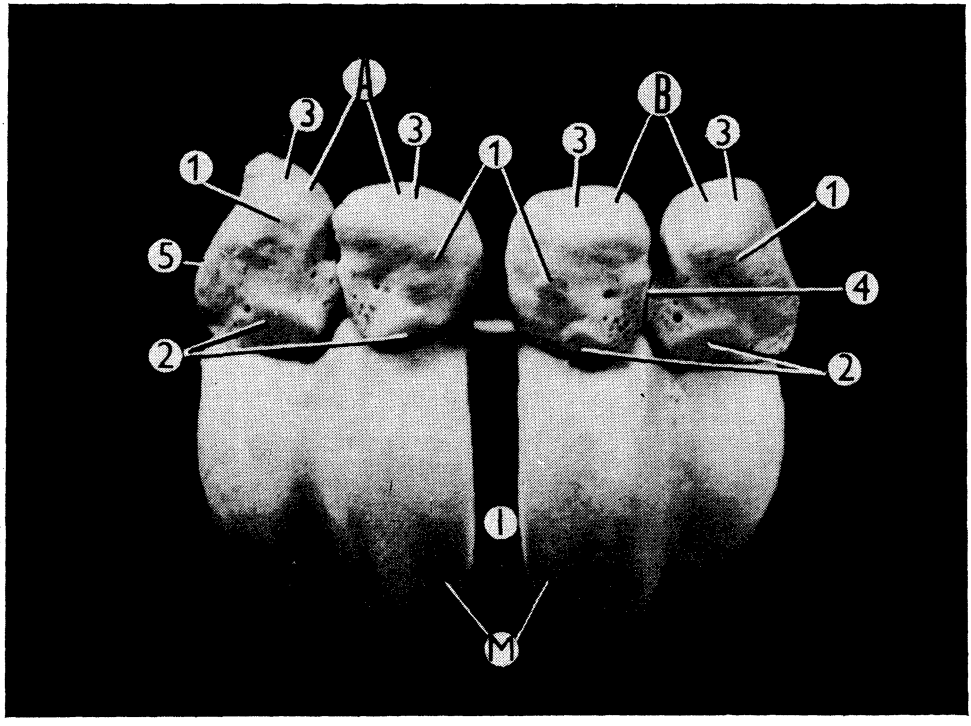

Fig. 3

Ossa sesamoidea phalangis proximalis of the right thoracic limb of cattle, view of the facies distalis. M — metacarpus III et IV (trochlea); I — incisura intertrochlearis, A — ossa sesamoidea phalangis proximalis of the third digit, B — ossa sesamoidea phalangis proximalis of the fourth digit, 1 — tuberculum distale on the facies distalis, 2 — articular surface for articulation of the sesamoid bones with the proximal phalanx, 3 — facies flexoria, 4 — articulation of a pair of sesamoid bones by means of articular surfaces on the facies contactus, 5 — tuberculum externum on the facies externa.

shape of a rectangle. The dorsodistal part of this surface is convex, rough and uneven. The palmo/planto/proximal part of the interdigital surface passes into a shallow groove which, in the dorsoproximal direction, opens into the sloping facies m. interossei.

Facies externa, an outer surface (Fig. 1.4), in cattle can be found on both abaxial sesamoid bones of the proximal phalanges of the digits of the limb because of occurrence of two fully developed digits on the limb. It is located out of the longitudinal axis of the limb and out of the axis of the respective digit. It is in the shape of an irregular quadrangle, quite big in size, the distal border being longer than proximal. The dorsodistal part of this surface passes into a marked tuberculum - tuberculum externum (Fig. 3.5). The remaining part of the surface forms a shallow groove which, in the proximal part, passes into a fossa which is deeper and more pronounced on the abaxial sesamoid bones of the digits of the thoracic limb. Moreover several larger foramina nutritium for blood supply to the bones can be seen on the bottom of the fossa.

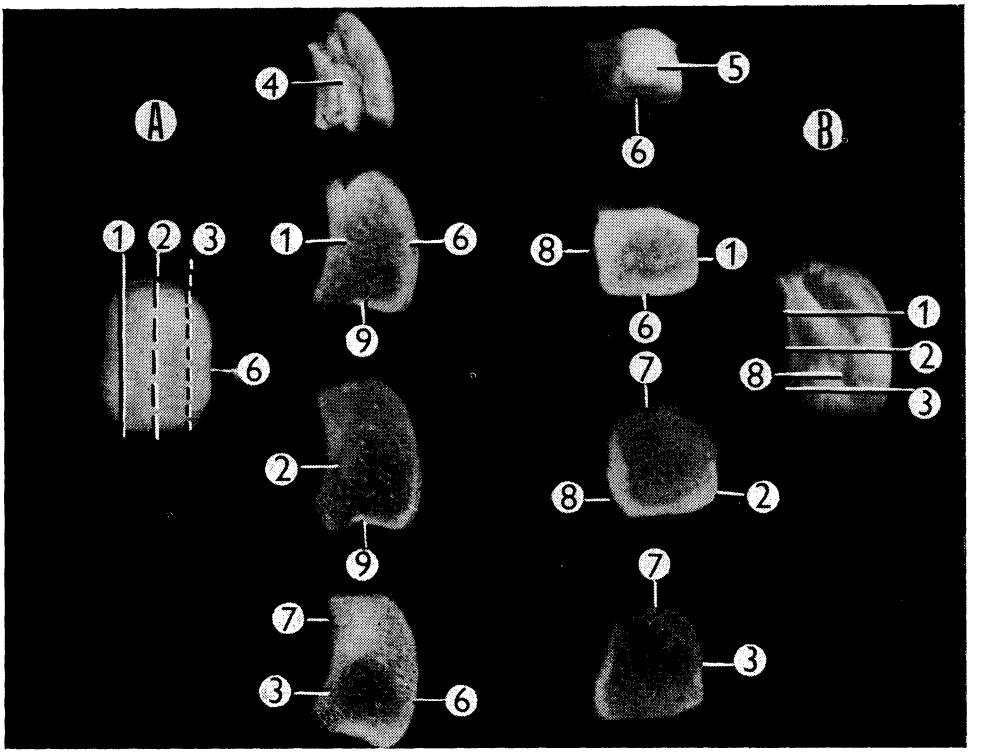

Fig. 4

Inner structure of the sesamoid bones of the proximal phalanges of cattle digits (arrangement of the spongy and compact bone). A — sagittal sections on three indicated planes of the axial sesamoid bone of the proximal phalanx of the third digit of the right pelvic limb, B — transverse sections made on three planes of the axial sesamoid bone of the proximal phalanx of the fourth digit of the right pelvic limb. 1, 2, 3 — indicated section planes and section surfaces, 4 — facies contactus, 5 — facies pelvic limb. 1, 2, 3 — indicated cutting planes and cutting surfaces, 4 — facies contactus, 5 — facies m. interossei, 6 — facies flexoria, 7 — facies articularis, 8 — facies interdigitalis, 9 — facies distalis.

The inner structure

The sesamoid bones of the proximal phalanges of the digits do not show a uniform medullary cavity. Their centres are filled with a fine porous spongy bone which is externally limited by compacta of uneven thickness.

On the axial sesamoid bones of the proximal phalanges of the digits, the thickest compacta layer is located in the dorsoproximal part of the facies articularis (Fig. 4. A-7) and throughout the facies interdigitalis (Fig. 4.8-8). Another thick layer of the compact bone can be seen at the level of the tuberculum proximale and the tuberculum distale. A thinner and macroscopically almost indistinct compacta layer can be seen on the facies distalis at the level of the deeper part of the surface, where a fossa is produced, and in the adjacent distal parts of the contact surface (facies contactus) and the articular surface (facies articularis).

A similar situation can be seen on the abaxial sesamoid bones of the proximal phalanges of the digits except that the compacta is even more developed between the articular surface and the facies externa, so that the tuberculum externum of this surface is fully filled with compact bone. The compacta layer in this area is the least developed again near the facies distalis and the adjacent parts of the articular surface.

Radiography

In the dorsopalmar (dorsoplantar) or palmodorsal (plantodorsal) projection, the ossa sesamoidea phalangis proximalis of adult cattle appear separated in the thoracic and pelvic limbs. They are demarcated by clear lines on the shadows of the metapo-

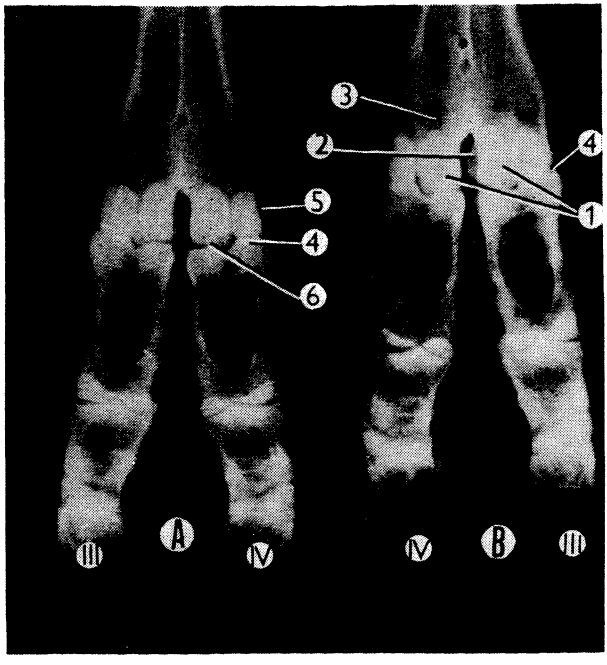

Fig. 5

Radiogram of autopodium from the left (A) and right (B) thoracic limb of a 9 year old cow in the dorsopalmar projection. III — third digit, IV — fourth digit, 1 — shadows of the axial sesamoid bones of proximal phalanges of the third and fourth digits, 2 — shadow of the interdigital surface of the axial sesamoid bone penetrating into the clearing from the incisura intertrochlearis of the metapodium, 3 — epiphysodiaphyseal symphysis (residues), 4 — shadow of the distal end of the facies flexoria and distal tuberculum of the abaxial sesamoid bone overlapping the cleared articular space of the metacarpophalangeal (metatarsophalangeal) joint and penetrating as far as the proximal apex of the base of the proximal phalanx of the digit, 5 — faint shadow from the the proximal apex of the base of the proximal phalanx of the digit, 5 — a faint shadow from the tuberculum externum and from parts of the abaxial sesamoid bone of the proximal phalanx of the fourth digit that are adjacent to the facies externa (the above mentioned parts of the sesamoid bones are abaxially overhanging the abaxial edge of the trochlea of the fourth metacarpus or metatarsus), 6 — clearing from the articular space of the articulatio metacarpophalangea (metatarsophalangea).

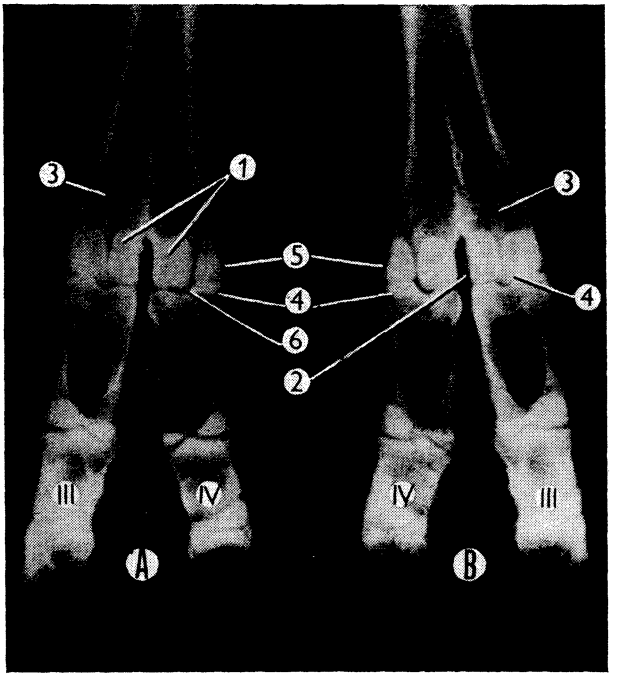

Fig. 6

Radiogram of the autopodium from the left (A) and right (B) pelvic limb of a 9 years old cow in the dorsoplantar projection. For legend see Fig. 5.

dium epiphyses and only in part on the shadows of the proximal phalanges of the digits, which results in an obscure picture of their structure. Their homogenous shadows can be found in the radiograms proximally over the articular space of the metacarpophalangeal (metatarsophalargeal) joint arranged in the horizontal level. They are slightly different in shape, being generally in the shape of irregular ovals with a wider base and proximally narrowing into a round apex. The shadows of both axial sesamoid bones of the proximal phalanges of the digits are rather cubic in shape with a round apex. The shadows of the abaxial sesamoid bones of the proximal phalanges of the digits are rather conical in shape. The projected shadows of both abaxial sesamoid bones of the proximal phalanges of the third and fourth digit in the unloaded limb penetrate slightly distal of the space of the metacarpophalangeal (metatarsophalangeal) joint. More distal penetration shows the shadow of the abaxial sesamoid bone of the proximal phalanx of the fourth digit; more frequently and clearly in the thoracic limb. Here we can observe the shadow of the distal end of the facies flexoria and the tuberculum distale. The shadow of the abaxial sesamoid bone of the proximal joint of the fourth digit is found deep in the axial four fifths approximately, for there is a contribution of the shadow of the metapodium trochlea of the fourth digit. In the remaining abaxial part, the shadow of this sesamoid bone is faint, for the sesamoid bone in this part is not laying on the trochlea of the fourth metapodium. The abaxial edge of this trochlea forms a sharp border of the section of unequally deep shadows of the se-

samoid bone of the proximal phalanx of the fourth digit (Fig. 5.5). To much less extent it is possible to observe a section of faint shadow also in the radiograms of the abaxial sesamoid bones of the proximal phalanx of the third digit. In an oblique dorsopalmar or dorsoplantar projection, these sections of the less deep shadows of the abaxial sesamoid bones of the proximal phalanges of the digits may show a reverse surface area ratio. The clearing of the spaces between the different pairs of the sesamoid bones of the proximal phalanges of the respective digits is represented by a 1-2 mm space diverging along the symmetrical lines of the shadows of the neighbouring sesamoid bones of the proximal phalanges in the proximal and distal direction. In the proximal direction, this clearing passes into the picture of the osseous trabeculae of the respective epiphysis of the metapodium and distally it is limited by a markedly cleared space of the metacarpophalangeal (metatarsophalangeal) joint and by the shadow of the base of the proximal phalanx of the respective digit. Between the two sesamoid bones of the proximal phalanges of the digits we can see in the radiograms an approximately 0.5 cm wide very clear band representing the intertrocheal cutting of the metapodium in which small, not very deep elongated shadows are projected

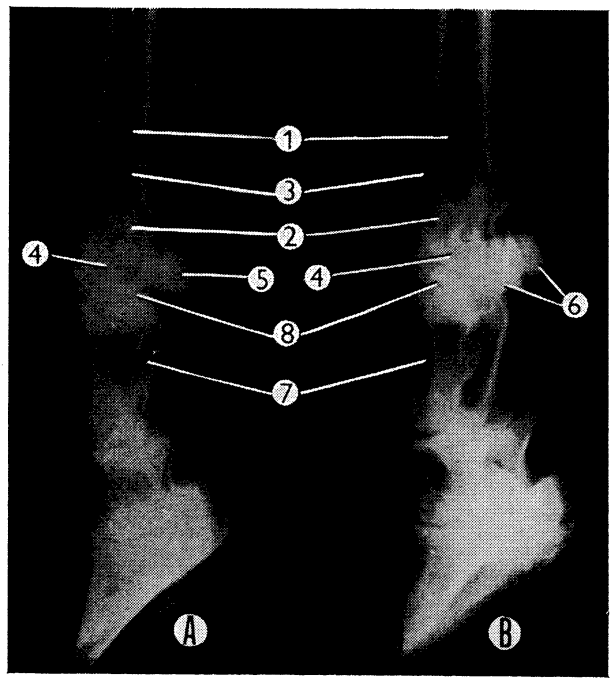

Fig. 7

Radiogram of the autopodium from the left thoracic limb in the direct lateromedial projection (A) and radiogram of the right thoracic limb in the oblique mediolateral projection (B), from a 9 years old cow. 1 — shadow from the os metacarpale III et IV; 2 — epiphysodiaphyseal symphysis, 3 — clearing from the canalis metatarsalis distalis, 4 — trochlea metatarsi, 5 — superposed shadows of all of the 4 sesamoid bones of the proximal phalanges of a digit in the direct lateromedial projection, 6 — distribution of partly superposed shadows of the sesamoid bones of the proximal phalanges of digits in the oblique direction, 7 — phalanx proximalis, 8 — articulationes metacarpophalangeae (clearing from the articular surface).

in the unilateral or bilateral aspect, in dependence of the position of the digits during radiography. Lines of the interdigital surfaces and their adjacent structures of the axial sesamoid bones of the proximal phalanges of the digits can be seen in the radiograms.

In the mediolateral and/or lateromedial projection we can see in the radiograms of the distal parts of the limbs the ossa sesamoidea phalangis proximalis of adult cattle which are represented as a uniform very deep shadow located palmar or plantar of the distal end of the metapodium. Their heights ranged from the lowest point of the clearing from the articular space of the metacarpophalangeal (metatarsophalangeal) joint to approximately three quarters of the epiphyseal length. The epiphyses, in contrast to diaphyses, are clearly limited by remainders of the epiphysodiaphyseal symphysis. The limits of the shadows are an unsharp line, for the sesamoid bones are projected in sites where the overlapping is not complete. The shadows appear less deep here. The shadows of the sesamoid bones of the proximal phalanges of the third and fourth digits in the lateromedial and mediolateral projection are represented by a sector of annulus with round apices, dorsal concave and palmar (plantar) convex base (Fig. 7.5). In an oblique projection, owing to an incomplete superposition of shadows of the different sesamoid bones of the proximal phalanges of the digit, we can observe less deep shadows of the different sesamoid bones of the proximal phalanges of the third and fourth digits, which are partly overlapping one another (Fig. 7.6).

Characteristics

The shapes and sizes of the surfaces described of the sesamoid bones of the proximal phalanges of the third or or fourth digit and the tubercula, rough areas, fossae or articular surfaces observed on these surfaces were so much regular that on the basis of a detailed study of the outer macromorphology of these small bones we could define characteristics for their differentiation.

It is quite easy to distinguish the abaxial sesamoid bones of the proximal phalanges of the digits in the thoracic and pelvic limbs from the axial ones, for the shape differences between these bones are clearly pronounced. The axial sesamoid bones of the proximal phalanges of the digits are in the shape of a quadrangular prism, the abaxial sesamoid bones of the proximal phalanges of the digits are triangular-prism-shaped. Even the different surfaces, the tubercula and rough areas on these bones show different shapes, and these characteristics permit us to differentiate the small sesamoid bones of the proximal phalanges of the digits one from the other.

The outer characteristics enable to differentiate the abaxial sesamoid bones of the proximal phalanges of the digits from the thoracic and pelvic limbs. On the facies externa of the sesamoid bones from the thoracic limb, on the third as well, as the fourth digit, a groove can be seen under the outer edge of the facies flexoria which contains an elongated fossa with several noticeable nutrient foramina (Fig. 8. A-3). This fossa is substantially shallower on the pelvic limb (Fig. 8.B-4), or there is a groove without such concentration of so clear nutrient foramina, or these foramina are absent (Fig. 8. B 2).

Other anatomical characteristics can be utilized for determinatnio whether an abaxial sesamoid bone of the proximal phalanx of the digits pertains to the third or fourth digit. First, it is the different shape of the palmar or plantar-located outer edge of the facies flexoria. On the abaxial sesamoid bones of the proximal phalanges of the third digits, this edge is sharper and thinner whole length with a marked overhang towards the facies externa. The facies flexoria is smaller and thinner on the sesamoid bones

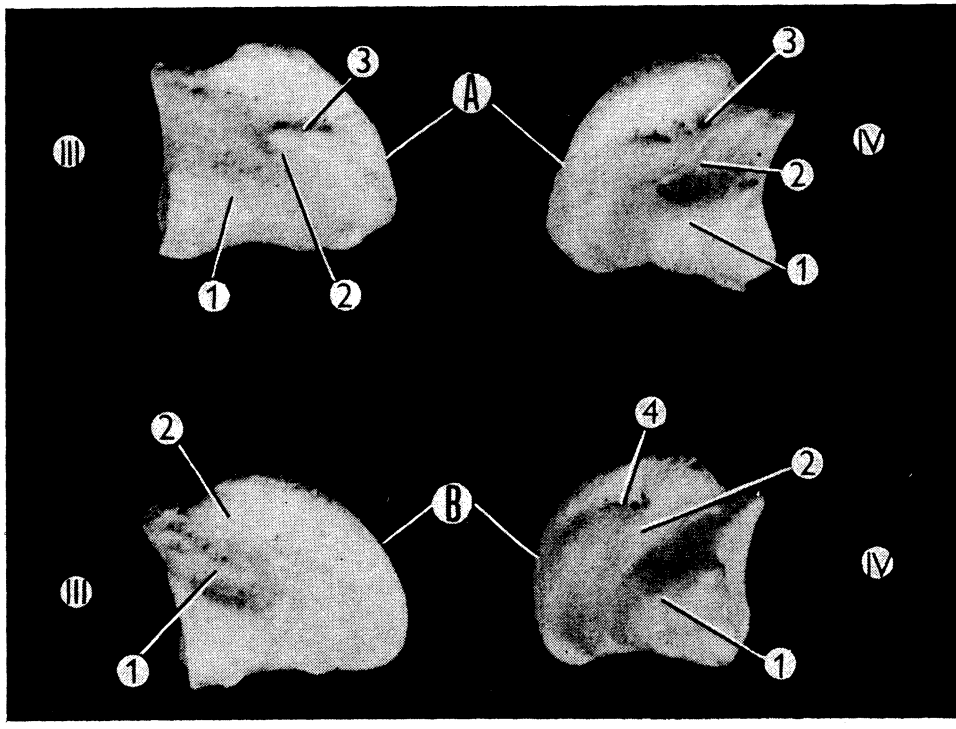

Fig. 8

Differentiation of the abaxial sesamoid bones of the proximal phalanges of digits from the thoracic limb and the pelvic limb of cattle. A — abaxial sesamoid bones of the proximal phalanges of digits from the right thoracic limb, B — abaxial sesamoid bones of the proximal phalanges of digits from the right pelvic limb, III — bones from third digits, IV — bones from fourth digits, 1 — tuberculum externum on the facies externa, 2 — a groove on the facies externa, 3 — an elongated fossa with marked nutrient foramina on the abaxial sesamoid bones of the proximal phalanges of the digits from the thoracic limb, 4 — a shallow fossa or 2 — only a groove on the facies externa of the abaxial sesamoid bones of the third and fourth digits of the pelvic limb.

of the fourth digit (Fig. 9.1). With some experience in determination of these small bones the investigator can easily distinguish the thinner and smaller abaxial sesamoid bone of the proximal phalanx of the third digit from the wider and bigger abaxial sesamoid bone of the proximal phalanx of the fourth digit. Another characteristic is the dorsopalmar or dorsoplantar size of the proximally situated facies m. interossei. In the dorsopalmar or dorsoplantar aspect, this surface is longer on the abaxial sesamoid bones of the proximal phalanges of the third digits than on the sesamoid bones of the proximal phalanges of the fourth digit (Fig. 10.1).

To determine whether abaxial sesamoid bones of the proximal phalanges of the digits pertain to the left or right limb is not possible before we have determined to which digit in the limb they pertain. For determination of their origin from a digit in the limb we can utilize the position of the crest on the facies articularis as well as

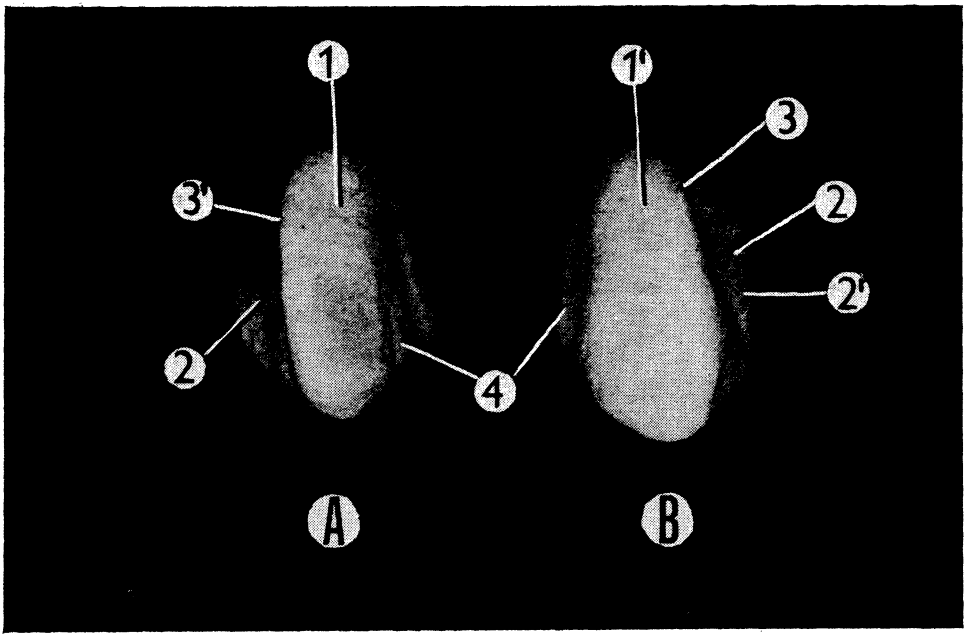

Fig. 9

Differentiation of the abaxial sesamoid bones of the proximal phalanges of the third or fourth digit of the outer edge of the facies flexoria and the shape of the facies flexoria. A — os sesamoideum phalangis proximalis abaxiale of the third digit from the right thoracic limb, B — os sesamoideum phalangis proximalis abaxiale of the fourth digit from the right thoracic limb, 1 — the facies flexoria is smaller and narrower, 1′ - the facies flexoria is larger and wider, 2 — facies externa, 2′ — tuberculum externum, 3 — outer edge of the facies flexoria, 3′ — the outer edge of the facies flexoria on the abaxial sesamoid bone of the proximal phalanx of the third digit is sharper and narrower, 4 — facies contactus.

the previously described topographic characteristics of the different osseous surfaces with small articular surfaces, fossae and tubercula located on them. Also the smaller articular surfaces on the facies articularis situated on the abaxial sesamoid bones of the proximal phalanges of the digits, on the side adjacent to the axis of the digit and thereby, to the facies contactus, can be utilized for orientation. In addition to it, also the facies contactus of these sesamoid bones and a small sickle-shaped or oval-shaped articular surface can be used (Fig. 2. A.2′).

The axial sesamoid bones of the proximal phalanges of the digits from the thoracic or pelvic limb can be differentiated according to the different shape of the tuberculum proximale. On the axial sesamoid bones of the proximal phalanges of the digits from the thoracic limb the tuberculum proximale is overhanging the facies m. interossei and mostly reaches more proximally than the proximal apex of the facies flexoria from which it can be separated by a clear groove. On the axial sesamoid bones of the proximal phalanges of the digits in the pelvic limb, the tuberculum proximale is lower and rounder and thus the facies flexoria is passing into the facies m. interossei as a low edge (Fig. 11.4).

Another characteristic which can be employed for differentiation of the sesamoid

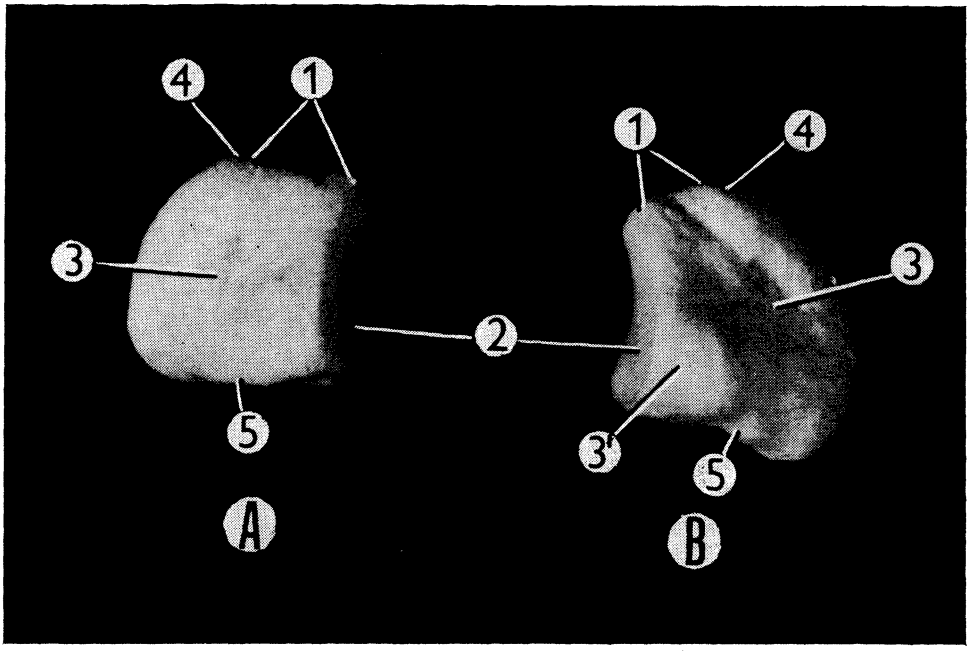

Fig. 10

Differentiation of the abaxial sesamoid bones of the proximal phalanges of the third and fourth digits on the basis of different dorsopalmar or dorsoplantar dimension on the facies m. interossei. A — os sesamoideum phalangis proximalis abaxiale of the third digit from the left pelvic limb, B — os sesamoideum phalangis proximalis abaxiale of the fourth digit from the left pelvic limb, 1 — different dorsopalmar dimension of the facies m. interossei, 2 — facies articularis, 3 — facies externa, 3′ — tuberculum externum, 4 — tuberculum proximale, 5 — facies distalis.

bones of the proximal phalanges of the thoracic and pelvic limbs can be derived from the length/width relation in the facies flexoria (Fig. 12.1). The axial sesamoid bones of the proximal phalanges of the digits of the pelvic limb show shorter facies flexoria in the proximodistal direction than those of the thoracic limb where the facies flexoria is longer in both the proximal and distal directions.

It is impossible to decide, on the basis of anatomical characteristics, whether the axial sesamoid bones of the proximal phalanges of the digits pertain to the third or fourth digit, unless we know that the bones are from the right-side or left-side limb. If we can decide, on the basis of characteristics on the abaxial sesamoid bones of the proximal phalanges of the digit, that a set of sesamoid bones belong to the left or right limb, or if the origin of these bones is known, the previously described anatomical formations and their topographic relations can be employed for orientation and determination whether the axial sesamoid bones pertain to the third or fourth digit in the limb. However if their origin from a digit is known, it can be determined in the same way whether they belong to the left or right limb. For that we employ again above all the topographic relations on the facies articularis. The smaller part of the

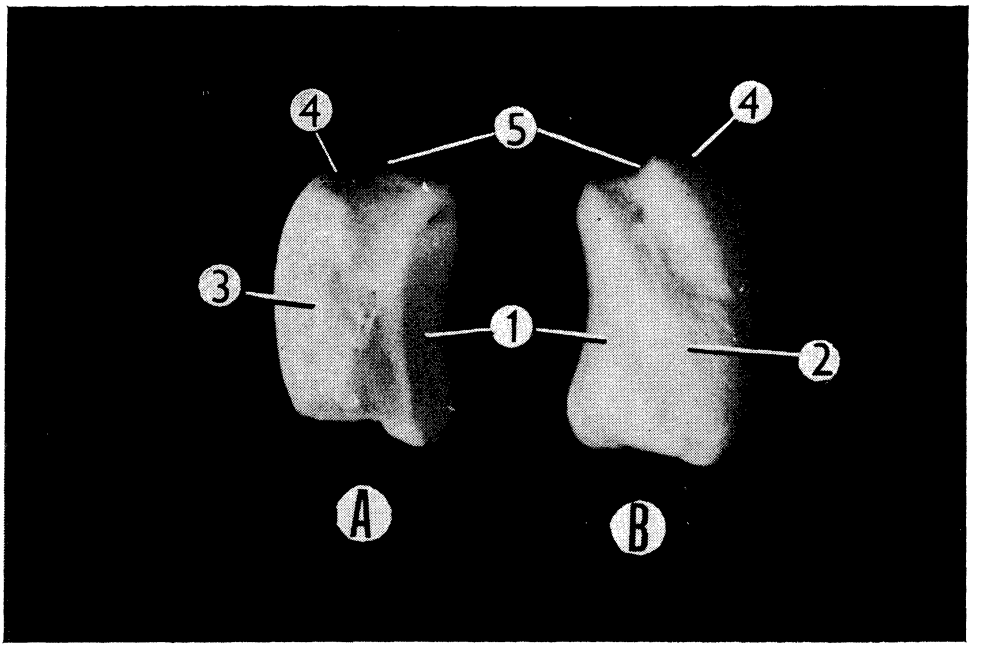

Fig. 11

Differentiation of the axial sesamoid bones of the proximal phalanges of the digits from the thoracic and pelvic limbs on the basis of formation of the tuberculum proximale. A — os sesamoideum phalangis proximalis axiale of the third digit from the right pelvic limb, B — os sesamoideum phalangis proximalis axiale of the third digit of the left thoracic limb, 1 — facies articularis, 2 — facies interdigitalis, 3 — facies contactus, 4 — tuberculum proximale (on the axial sesamoid bones of the proximal phalanges of the digits from the pelvic limb (A) the tuberculum proximale is lower), 5 — facies m. interossei.

articular surface divided by the sagittal crest is situated on the axial sesamoid bones of the proximal phalanges of the third and fourth digits, again on the side adjacent to the axis of the digit. On the same adjacent side, a small articular surface for articulation with the abaxial sesamoid bone of the proximal phalanx of the same digit can be observed on the facies contactus. It must be taken into account that a similar but much smaller articular surface can be sporadically found even on the interdigital surface of these bones. Also the marked fossa with nutrient foramina on the facies distalis, located near the contact edge of this surface and the facies contactus, i.e. adjacent to the axis of the digit, can be used for determination of the origin of the sesamoid bones of the proximal phalanges of the digits.

The axial and abaxial sesamoid bones can reliably be differentiated in radiograms from their shape and location only in the dorsopalmar (dorsoplantar) and/or palmadorsal (plantodorsal) projection. Because of different widths of the shadows recorded in the radiograms of the abaxial sesamoid bones of the proximal phalanges of the digits, a narrower shadow of the abaxial sesamoid bone of the proximal phalanx of the fourth digit, which is abaxially limited by a less deep shadow of the outer surface of

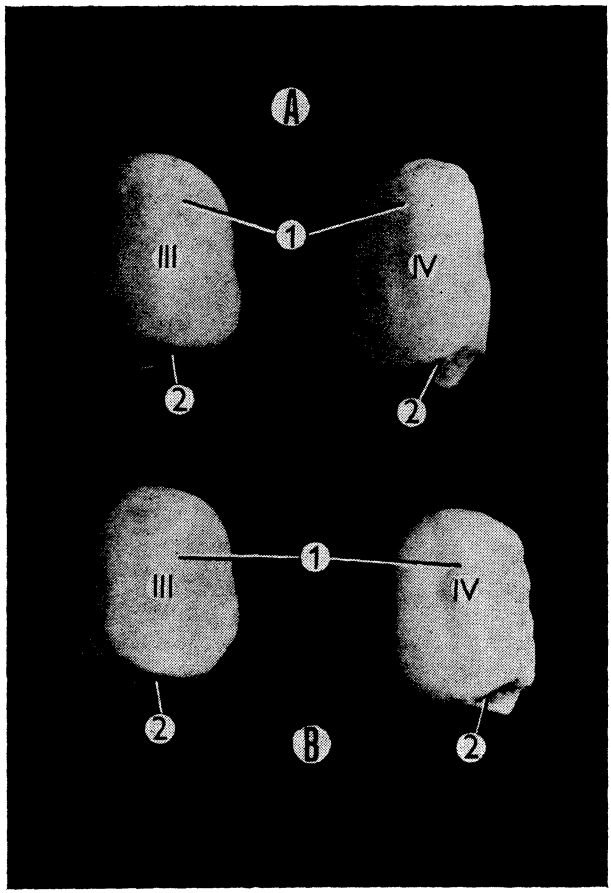

Fig. 12

Differentiation of the axial sesamoid bones of the proximal phalanges of the digits from the thoracic and pelvic limbs. A — axial sesamoid bones of the proximal phalanges of the third (III) and fourth (IV) digits from the right thoracic limb, B — axial sesamoid bones of the proximal phalanges of the third (III) and fourth (IV) digits from the right pelvic limb, 1 — facies flexoria (in the pelvic limb, the facies flexoria of the axial sesamoid bones of the proximal phalanges show smaller proximo-distal dimension than those in the thoracic limb), 2 — facies distalis.

this bone which is abaxially overlapping the shadow of the trochlea of the fourth metacarpus or metatarsus, can be determined in the radiograms in this projection (Fig. 5.5). The radiograms in the lateromedial or mediolateral projection and those in the oblique projection can provide a picture of topographic relations of a set of sesamoid bones to the surrounding bones and joints of the autopodium.

Discussion

The anatomical descriptions of the sesamoid bones of the proximal phalanges of the digit as presented by the available literature are quite brief. Although there are marked differences in the shapes of these bones, as shown by our findings obtained from study of a set of macerated bones and by the radiograms, their description has been lacking in special papers or classical textbooks (Ellenberger and Baum 1943; Sisson and Grossman 1947), nor is it available in more recent textbooks of veterinary anatomy (Barone 1966; Akaevskiy 1968; Getty 1972; Nickel et al. 1977) and textbooks on Radiology (Carlson 1967; Morgan 1972). The contradictory data on sizes of these bones as reported by Martin and Schauder (1934) and Kolda (1936) on one hand and by Vokken et al. (1961) on the other indicate that their knowledge of these small bones was not sufficient. In the present report we have attempted to describe the outer shape and the inner macrostructure of these bones, which represent a regular component of the skeleton, and on the basis of detailed analysis and description of their shape and comparison of these bones we have determined typical anatomical characteristics which permit to differentiate the different sesamoid bones of the proximal phalanges of the digits and to determine their origin from the limb, digit and even determine their origin from the right or left limb.

The detailed description of all of the surfaces of the sesamoid bones studied required introduction of new anatomical names because the veterinary anatomical nomenclature Nomina Anatomica Veterinaria (1983) does not go into such details. To differentiate the bones from a pair pertaining to the same digit we have used the name »axial sesamoid bone of the proximal phalanx of the digit« which had been used by Martin and Schauder (1934) and Kolda (1936). We have introduced the name »abaxial sesamoid bone of the proximal phalanx of the digit« to describe the other bone from the pair of the sesamoid bones pertaining to the same digit which is situated at a greater distance from the axis of the limb. The name considers the position of the bones with respect to the axis of the limb, which is in agreement with the proposition to designate the direction in the limbs where the functional axis passes between the third and fourth digits, i.e. in the artiodactyla and beasts of prey (Nomina Anatomica Veterinaria 1983). Since the number of these small bones in cattle is 16, their designation should be completed with respect to their origin from the third or fourth digit and by including their origin from the thoracic or pelvic limb as left-side or right-side. All these criteria must be kept to provide an exact name of these small bones. The description of the different surfaces of the bones was based on the NAV (1983) and some other names are proposed. To designate the lateral surfaces on the axial and abaxial sesamoid bones of the proximal phalanges of the digits, names based on the topographic interrelations of these surfaces and their topographic relations to the digits and the functional axis on the limb are proposed. To designate the opposite surfaces on the pair of sesamoid bones pertaining to the respective digit, the name "facies contactus" is proposed, that is the surface where the two bones come into contact and, on small articular surfaces that are situated here, they even articulate one with the other. The oposite surface on the axial sesamoid bones of the proximal phalanges of the digits turns into the interdigital area - hence the "facies interdigitalis". On the abaxial sesamoid bones, this opposite surface is diflected from the long axis of the digit as well as from the long axis of the limb - hence the "facies externa". In the distal direction, this bone is limited by the distal surface, the facies distalis, which has a clear small articular surface for articulation with the proximal phalanx. On the basis of our experience we propose the following anatomical names for the cattle sesamoid bones studied:

os sesamoideum phalangis proximalis axiale

os sesamoideum phalangis proximalis abaxiale
facies articularis
facies flexoria
tuberculum proximale
facies m. interossei
facies distalis
tuberculum distale
facies contactus
facies interdigitalis
facies externa
tuberculum externum

The anatomical terms proposed for the sesamoid bones of the proximal phalanx of the cattle digit can also be used in animal species where the axis of the limb passes between the third and fourth digit. From domestic animals they are: cattle, sheep, goat, domestic pig, dog. In the horse, only the third digit with two sesamoid bones of the proximal phalanx of the digit occurs and therefore quite a different name is required, for the axis of the limb coincides with the axis of the digit. Accordingly the bones can be designated with respect to their topographic relations to the axis of the digit only. Then the »os sesamoideum phalangis proximalis mediale (radiale)« and »os sesamoideum phalangis proximalis laterale (ulnare)« would be appropriate names for the respective bones. The names for designation of the surfaces of the sesamoid bones of the proximal phalanges of the digit in the horse should be the same as for the cattle except »facies interdigitalis«. In animals with 3, 4 or 5 digits, on the other hand, interdigital surfaces can be found on the axial and abaxial sesamoid bones of the proximal phalanges of all digits with exception of the abaxial sesamoid bones of the proximal phalanges of the peripheral digits. The surface diflected from the axis of the digit on the abaxial sesamoid bones of the two peripheral digits is described as »facies externa«.

When judging possibilities of determining the origin of the bones studied it can be concluded that in cattle it is possible to distinguish safely the axial sesamoid bones of the proximal phalanges from the abaxial ones. There are a number of different anatomical characteristics that certainly enable differentiation of the abaxial sesamoid bone of the proximal phalanx of the third digit from that of the fourth digit and hereby their origin from the left or right limb. Two characteristics are proposed for utilization in attempts to determine whether an axial sesamoid bone of the proximal phalanx of the digit comes from the thoracic or pelvic limb. The only characteristic on the abaxial sesamoid bones of the proximal phalanges of digits that can be employed for determination of their origin from the thoracic or pelvic limb appears less convincing. The determination of origin of the axial sesamoid bones of the proximal phalanges from the respective digits and hereby the right or left limb appears as a more serious problem. In obscure cases like this osteometry could be taken recourse to despite the fact that no osteometric processing of these small bones have been reported (Duerst 1930).

The anatomical findings as well as the characteristics of the sesamoid bones of the proximal phalanges of the digits in cattle as described in the present report can contribute to knowledge of the comparative anatomy and can be a useful tool in the archaeological osteology.

Anatomické rozlišovací znaky na ossa sesamoidea phalangis proximalis u skotu (Bos primigenius f. taurus Linné 1758)

Studovali jsme anatomickou stavbu a rentgenový obraz sezamských kostí proximálních článků prstů skotu. Svá pozorování jsme provedli na osteologickém materiálu a rentgenogramech 18ti krav a pěti býků. Na základě podrobného anatomického popisu předkládáme návrh na doplnění anatomické nomenklatury o názvy důležitých anatomických útvarů pro orientaci na kostech a přesné označení jednotlivých kostí a jejich příslušnosti k prstu, případně hrudní či pánevní končetině.

Na základě podrobného anatomického popisu je možné rozlišit axiální sezamské kosti proximálních článků prstů od abaxiálních. Dobře se dají vzájemně rozlišit též abaxiální sezamské kosti proximálních článků třetích a čtvrtých prstů. Lze určit i jejich příslušnost k hrudní či pánevní končetině.

Podle zevních znaků lze s jistotou vzájemně rozlišit axiální sezamské kosti proximálních článků prstů hrudní či pánevní končetiny. Příslušnost axiálních sezamských kostí proximálních článků prstů k třetímu, případně čtvrtému prstu na hrudní i pánevní končetině a jejich příslušnost k levostranné či pravostranné končetině můžeme určit nepřímo, podle vzájemných topografických vztahů zde popsaných anatomických útvarů, a to pouze za předpokladu, že je nám jeden z hledaných údajů o původu kosti známý.

Na rentgenogramech lze podle typického tvaru a polohy stínů rozlišit stíny axiálních sezamských kostí proximálních článků prstů od abaxiálních. Dle nestejně sytého stínu na rentgenogramu v dorsopalmární či dorsoplantární projekci lze rozlišit abaxiální sezamskou kost proximálního článku čtvrtého prstu od stejnojmenné kosti prstu třetího.

Анатомические различительные признаки на сезамовидной кости основной фаланги у крупного рогатого скота (Bos primigenius f. taurus Linné 1758)

Нами изучалось анатомическое строение и рентгеновское изображение сезамовидных костей основных фаланг крупного рогатого скота. Свои наблюдения мы проводили на остеологическом материале и рентгенограммах 18 коров и 5 быков. На основе подробного анатомического описания представляется проект дополнения анатомической номенклатуры названиями важных анатомических образований с целью ориентации на костях и точного обозначения отдельных костей и их принадлежности к пальцу, передней или задней конечности.

На основе подробного анатомического описания можно различить аксиальные сезамовидные кости основных фаланг пальцев от абаксиальных. Хорошо можно взаимно различить также абаксиальные сезамовидные кости основных фаланг третьего и четвертого пальцев. Можно также определить их принадлежность к передней или задней конечностям.

По внешним признакам можно с определенностью взаимно различить аксиальные сезамовидные кости основных фаланг пальцев передней или задней конечностей. Принадлежность аксиальных сезамовидных костей основных фаланг пальцев к третьему или четвертому пальцам передней или задней конечностей и их принадлежность к левой или правой конечности можно определить косвенно, по взаимным топографическим отно-

шениям описанных здесь анатомических образований, но только при предпосылке, что известен один из определяемых нами фактов происхождения кости.

На рентгенограммах можно по характерной форме и расположению теней различить тени аксиальных сезамовидных костей основных фаланг пальцев от абаксиальных. По одинаковой густой тени на рентгенограмме в дорзо-пальмарной или дорзо-плантарной проекции можно различить абаксиальную сезамовидную кость основной фаланги четвертого пальца от одноименной кости третьего пальца.

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