

OSTEOMETRY OF THE OSSA SESAMOIDEA PHALANGIS PROXIMALIS IN CATTLE (*BOS PRIMIGENIUS F. TAURUS LINNÉ 1758*)

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Abstract

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The sesamoid bones of the proximal phalanges of the digits from 14 bovine females of the Bohemian Spotted cattle were subject to osteometric examination. Statistical significance of four characteristics was studied. There was no statistical significance in the weight and diameter differences. Highly significant differences were recorded for the maximum height values when comparing the abaxial sesamoid bones of the proximal phalanges of the fourth and third digits from the thoracic limbs and the maximum width when comparing the abaxial sesamoid bones of the proximal phalanges of the third and fourth digits from the pelvic limbs. Also the width values for the abaxial sesamoid bones of the proximal phalanges of the third digits from the thoracic limbs and the abaxial sesamoid bones of the proximal phalanges of the third digits from the pelvic limbs showed highly significant differences. Likewise, the differences in the maximum height values between the abaxial sesamoid bone of the proximal phalanx of the fourth digit and the abaxial sesamoid bone of the proximal phalanx of the third digit on the pelvic limbs showed statistical significance. Similar relations were recorded between the abaxial sesamoid bones of the proximal phalanx of the fourth and third digits on the thoracic limb. Also the difference between the maximum height values of the axial sesamoid bone of the proximal phalanx of the third digit from the thoracic limb and the axial sesamoid bone of the proximal phalanx of the third digit from the thoracic limb and the axial sesamoid bone of the proximal phalanx of the third digit from the pelvic limb was statistically significant. The osteometric findings on the sesamoid bones of the proximal phalanges of the cattle digits form a complement to anatomical characteristics and are another criterion for differentiation and identification of these bones.

Cattle, digits, ossa sesamoidea phalangis proximalis, osteometry.

The proximal phalangeal sesamoid bones of digits of cattle, sheep, goat, horse and dog are a regular component of their skeleton (Nickel et al. 1977). In cattle, their ossification centres appear late in the intrauterine life (Vokken and Tarasov, 1968; Lindsay 1969). Červený (1983) found a regular sequence in their appearance. The first to appear is the ossification centre of the axial sesamoid bone of the proximal phalanx of the fourth digit, followed by the ossification centre of the axial sesamoid bone of the proximal phalanx of the third digit and that of the abaxial sesamoid bone of the proximal phalanx of the fourth digit. And the last to appear is the ossification centre of the abaxial sesamoid bone of the third digit. This sequence is common for all limbs, with advanced appearance of ossification centres of the pelvic limbs compared to the thoracic limbs. Basic anatomical data of these small bones in cattle are given in both the classical and modern text books of veterinary anatomy (Martin and Schauder 1934; Kolda 1936; Ellenberger and Baum 1943; Sisson and Grossman 1947; Vokken 1961; Barone 1966; Getty 1975; Nickel et al. 1977). However, the data in these textbooks are not accurate enough to provide criteria for differentiation of the bones and determination of their location and origin with respect to the different digits of the limbs. These problems were discussed by Červený (1985) who established, on the basis of detailed description of outer characteristics, criteria for their differentiation. The purpose

of the present paper is to supplement these data with osteometric data. No osteometry of the proximal phalangeal sesamoid bones is available in the classical osteometric literature (Duerst 1930), except osteometry of the os sesamoideum phalangis distalis in the horse described by Driesch (1976). Seeing that we have developed an osteometric method for the ossa sesamoidea phalangis proximalis in cattle and attempted to determine their osteometric characteristics.

Materials and Methods

For osteometry we used proximal phalangeal sesamoid bones of the digits from all limbs of 14 Bohemian Spotted cattle females from 3 to 12 years. The sampled distal portions of the limbs (metapodia and acropodia) were subject to osteological treatment, i.e. hot water maceration. After thorough bleaching and long-term drying, 6 months at room temperature, the proximal phalangeal sesamoid bones were subject to osteometric treatment. Measurement was based on reliable osteometric methods according to Duerst (1930) which we applied to the proximal phalangeal sesamoid bones of cattle digits.

Table 1

Material used in the study

Sample No.	Age years	Body mass kg	Sex
1	6	610	♀
2	9	530	♀
3	10	575	♀
4	5	567	♀
5	4	712	♀
6	12	654	♀
7	4	428	♀
8	8	567	♀
9	4	515	♀
10	3	430	♀
11	7	523	♀
12	5	485	♀
13	9	550	♀
14	3	481	♀

The following was studied:

1. Maximum height (proximodistal size) - the maximum distance between the facies m. interossei and facies distalis.
2. Maximum width (mediolateral size) - the maximum distance between the facies contactus and facies interdigitalis on the axial, and/or the facies contactus and the facies externa on the abaxial sesamoid bones of the proximal phalanges of the digits.
3. Maximum diameter (length) - a dorsopalmar (plantar) size, the longest distance between the facies articularis and facies flexoria.
4. Mass of the sesamoid bones.

To measure the maximum height and width, the bones were placed on a flat supporting plate with their articular surfaces (their bigger part) down. The measurements were read on a vernier calliper with prism-like points which was placed on the plate in such way as to obtain the maximum height values, centre lines of these distances being perpendicular one to the other.

To measure maximum diameters (lengths), the sesamoid bones were placed on the plate with their facies distalis down and the vernier calliper was placed so as to obtain maximum values of the bone lengths, the centre lines of which were perpendicular to those of the previously measured distances. The abaxial sesamoid bones were easy to place in the position required owing to the developing distal surfaces. The abaxial sesamoid bones, because of their uneven distal surfaces, were fixed in that position with the left hand.

The mass of the sesamoid bones were determined using analytical balance accurate to one tenth of the gram. The values obtained were recorded in tables and treated statistically. To obtain the different osteometric values we used the main statistical characteristics, i.e. arithmetic mean (\bar{x}), standard error of the mean (SEM), standard deviation (SD), coefficient of variation (V) and extent of dispersion (R).

Results

According to location and origin of the bone with respect to a digit it can be distinguished the axial sesamoid bone of the proximal phalanx of the third digit (in tables given as AX III) and/or of the fourth digit (in Tables given as AX IV), no matter if from the left or right thoracic or pelvic limbs. The abaxial sesamoid bones of the proximal phalanges are located on the respective proximal phalanx and metapodium which is deflected from the axis (AB III in the Tables means the abaxial sesamoid bone of the proximal phalanx of the third digit and AB IV means the abaxial sesamoid bone of the proximal phalanx of the fourth digit, again no matter if from the right or left thoracic or pelvic limb). The shapes and sizes of the different sesamoid bones of the proximal phalanges of the cattle digits were regular enough to permit us to subject them to osteometric measurement.

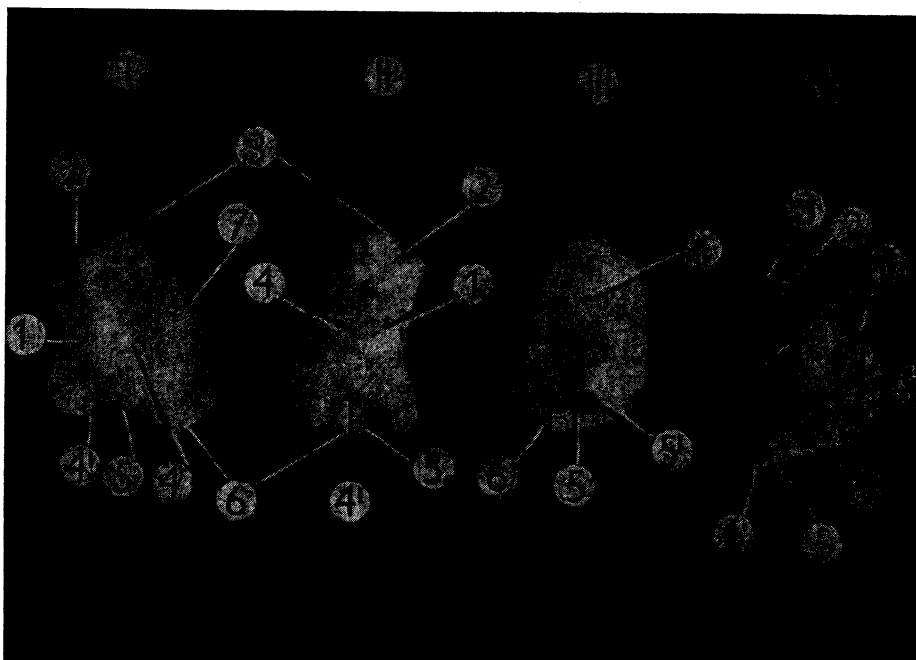


Figure 1

Different shapes of the sesamoid bones of the proximal phalanges of cattle digits.

- I — os sesamoideum phalangis proximalis abaxiale of the fourth digit from the right thoracic limb,
 II — os sesamoideum phalangis proximalis axiale of the fourth digit from the right thoracic limb,
 III — os sesamoideum phalangis proximalis axiale of the third digit from the right thoracic limb,
 IV — os sesamoideum phalangis proximalis abaxiale of the third digit from the right thoracic limb,
 1 — facies articularis, 2 — facies m. interossei, 3 — tuberculum proximale, 4 — facies contactus,
 4' — small articular surface, 5 — facies distalis, 5' — small articular surface, 6 — tuberculum distale,
 7 — facies flexoria, 8 — tuberculum externum.

The arithmetic means of the values, including their statistical characteristics are presented in Tables 2, 3, 4 and 5.

Variability of the different characteristics was calculated according to the coefficient of variation (Tables 2, 3, 4 and 5). The weight is one of the most characteristic variable. Its coefficient of variation ranged between 18.9 and 25.8%. Next comes the maximum diameter (length), with coefficient of variation of 6.28–13.29%. The maximum width appears as the least variable characteristic; its coefficient of variation reached the maximum value of 10.2%.

The statistical evaluation of the different osteometric values was followed by study of significance of the difference of the characteristics measured. The comparison was made on the right thoracic and right pelvic limbs (Fig. 3 and Table 6).

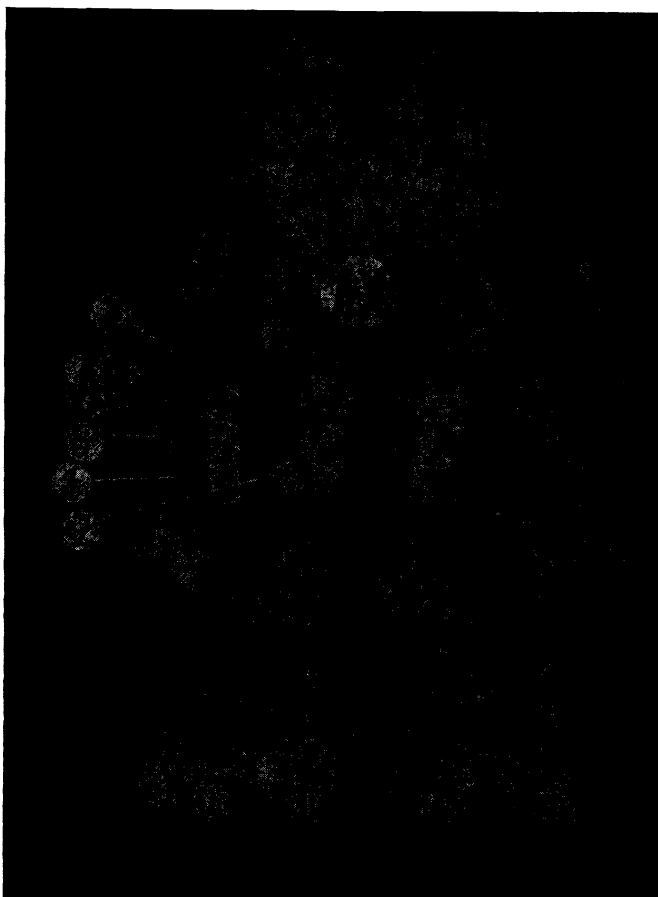


Figure 2

Ossa sesamoidea phalangis proximalis from the right thoracic limb of cattle in the palmar aspect in situ. AX — ossa sesamoidea phalangis proximalis axialia, AB — ossa sesamoidea phalangis proximalis abaxialia, 1 — os sesamoideum phalangis proximalis abaxiale of the third digit, 2 — os sesamoideum phalangis proximalis axiale of the third digit, 3 — os sesamoideum phalangis proximalis axiale of the fourth digit, 4 — os sesamoideum phalangis proximalis abaxiale of the fourth digit, 5 — facies flexoria, 5' — tuberculum externum, 6 — facies interdigitalis, 7 — facies contactus, 8 — facies externa, 9 — os metacarpale III et IV, 10 — phalanx proximalis of the fourth digit

Table 2

Statistical values obtained from the measurement of the right thoracic limb

	Variables measured	R min. — max.	\bar{x}	SEM	SD	V (%)
AB	height	20,5 —25,1	23,02	0,458	1,709	7,42
	width	15,1 —18,2	16,52	0,269	1,006	6,09
IV.	length	15,9 —24,8	21,821	0,617	2,310	10,586
	weight	2.29— 6.0	4.349	0.299	1.121	25.78
AX	height	21.0 —25.9	23.65	0.445	1.666	7.04
	width	14.0 —20.4	16.179	0.441	1.652	10.21
IV.	length	14.0 —17.4	16.136	0.279	1.044	6.47
	weight	2.45— 5.59	4.302	0.266	0.995	23.13
AX	height	20.8 —27.5	23.900	0.475	1.780	7.44
	width	14.4 —16.7	15.629	0.165	0.616	3.94
III.	length	14.2 —18.6	16.400	0.294	1.101	6.71
	weight	2.16— 5.67	3.981	0.252	0.944	23.71
AB	height	17.2 —23.2	20.714	0.507	1.898	9.16
	width	15.2 —18.0	16.471	0.249	0.933	5.66
III.	length	20.0 —24.0	21.464	0.646	2.417	11.26
	weight	2.26— 5.21	4.089	0.264	0.988	24.16

Height, width and length of the bones are given in mm, weight (mass) is given in g.

Table 3

Statistical values obtained from the measurement of the right pelvic limb

	Variable measured	R min. — max.	\bar{x}	SEM	SD	V (%)
AB	height	18.0 —23.3	21.279	0.458	1.715	8.05
	width	15.1 —17.5	16.350	0.192	0.718	4.39
IV.	length	19.1 —24.9	22.107	0.453	1.696	7.67
IV.	length	19.1 —24.9	22.107	0.453	1.696	7.67
AX	height	20.1 —24.6	22.614	0.370	1.385	6.14
	width	14.6 —18.8	16.079	0.328	1.226	7.62
IV.	length	13.8 —18.1	15.907	0.479	1.795	11.28
	weight	2.48— 5.37	4.274	0.221	0.826	19.32
AX	height	20.2 —24.0	22.393	0.376	1.408	6.28
	width	14.3 —16.7	15.536	0.261	0.978	6.29
III.	length	13.6 —18.7	16.493	0.586	2.193	13.29
	weight	2.24— 5.42	4.105	0.235	0.878	21.38
AB	height	17.4 —21.9	19.821	0.340	1.273	6.42
	width	15.0 —16.9	15.636	0.166	0.620	3.96
III.	length	19.4 —23.0	21.450	0.390	1.462	6.81
	weight	2.11— 5.06	4.169	0.227	0.849	20.36

For explanation see Table 2

The majority of significant findings were in differences in the maximum height values. Highly significant was the difference between the values for the abaxial sesamoid bone of the proximal phalanx of the fourth digit and the abaxial sesamoid bone of the proximal phalanx of the third digit on the thoracic limb. Statistically significant differences were also seen between the abaxial sesamoid bone of the proximal phalanx of the fourth digit and the abaxial sesamoid bone of the proximal phalanx of the third digit on the pelvic limbs; between the abaxial sesamoid bone of the proximal phalanx of the fourth digit on the thoracic limb and the abaxial sesamoid bone of the proximal phalanx of the fourth digit on the pelvic limb; between the axial sesamoid bone of the proximal phalanx of the third digit on the thoracic limb and the axial sesamoid bone of the proximal phalanx of the third digit on the pelvic limb.

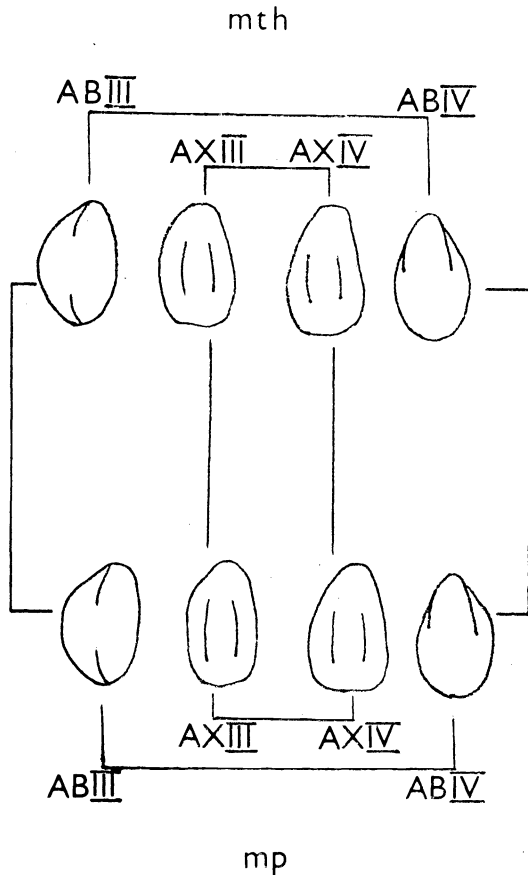


Figure 3

Comparison of osteometric values of the different sesamoid bones of the proximal phalanges of the digits of the thoracic and pelvic limbs. AB III — os sesamoideum phalangis proximalis abaxiale of the third digit, AX III — os sesamoideum phalangis proximalis axiale of the third digit, AX — IV — os sesamoideum phalangis proximalis axiale of the fourth digit, AB IV — os sesamoideum phalangis proximalis abaxiale of the fourth digit, mth — ossa sesamoidea phalangis proximalis membri thoracici, mp — ossa sesamoidea phalangis proximalis membri pelvini.

The width values showed highly significant differences between: the abaxial sesamoid bone of the proximal phalanx of the fourth digit and the abaxial sesamoid bone of the proximal phalanx of the third digit on the pelvic limb; the abaxial sesamoid bone of the proximal phalanx of the third digit of the thoracic limb and the abaxial sesamoid bone of the proximal phalanx of the third digit of the pelvic limb.

In all groups of bones under study, the differences in the weight and the maximum diameter (length) values were not significant. Neither were significant the differences between the values of all the variables measured of the axial sesamoid bones of the proximal phalanges of the third and fourth digits on both the thoracic and pelvic limbs, except for the values compared of the maximum height of the axial sesamoid bones of the proximal phalanges of the third digits from the thoracic and pelvic limbs.

It can be concluded that it is possible, on the basis of osteometric values, to differentiate some of the sesamoid bones of the proximal phalanges of the digits. The proximo-

distal distance (the maximum height of the bone) can be employed for determination of the origin of the abaxial sesamoid bones of the proximal phalanges of the third or fourth digit of the thoracic limb. In the abaxial sesamoid bones from the pelvic limbs it is possible to use, apart from the maximum height, also the mediolateral distance (the maximum width of the bone). The abaxial sesamoid bones of the proximal phalanges of the digits from the thoracic and pelvic limbs can be differentiated on the basis of the maximum height - in the abaxial sesamoid bones of the proximal phalanx of the fourth digit and the maximum width - in the abaxial sesamoid bone of the proximal

Table 4

Statistical values obtained from the measurement of the left thoracic limb

	Variables measured	R min. — max.	\bar{x}	SEM	SD	V (%)
AB	height	20.5 — 25.6	23.157	0.431	1.612	6.96
	width	14.9 — 18.3	16.664	0.255	0.956	5.73
IV.	length	19.4 — 24.6	22.186	0.478	1.791	8.07
	weight	2.63— 6.09	4.411	0.290	1.087	24.64
AX	height	21.8 — 26.4	23.800	0.416	1.558	6.54
	width	14.3 — 17.6	15.700	0.278	1.039	6.61
IV.	length	14.1 — 18.5	16.664	0.348	1.304	7.82
	weight	2.46— 5.41	4.286	0.278	0.039	24.24
AX	height	21.1 — 27.3	24.043	0.478	1.790	7.44
	width	14.3 — 16.7	15.664	0.192	0.720	4.59
III.	length	14.1 — 17.6	16.229	0.249	0.931	5.73
	weight	2.32— 5.71	4.017	0.254	0.950	23.64
AB	height	17.8 — 23.4	20.936	0.496	1.857	8.86
	width	15.6 — 21.2	17.064	0.381	1.426	8.35
III.	length	20.0 — 23.5	22.150	0.405	1.516	6.84
	weight	2.25— 5.77	4.129	0.266	0.997	24.14

For explanation see Table 2

Table 5

Statistical values obtained from the measurement of the left pelvic limb

	Variables measured	R min. — max.	\bar{x}	SEM	SD	V (%)
AB	height	17.6 — 22.9	20.921	0.433	1.622	7.75
	width	14.9 — 17.2	16.179	0.188	0.704	4.35
IV.	length	19.1 — 24.2	21.907	0.405	1.517	6.92
	weight	2.49— 5.51	4.401	0.238	0.893	20.29
AX	height	19.7 — 23.8	22.529	0.378	1.413	6.27
	width	15.0 — 17.9	16.100	0.295	1.104	6.85
IV.	length	14.4 — 18.2	15.871	0.410	1.537	9.68
	weight	2.60— 5.49	4.305	0.840	0.224	19.51
AX	height	19.8 — 23.8	22.321	0.364	1.362	6.10
	width	14.5 — 17.9	15.464	0.253	0.948	6.09
III.	length	13.5 — 18.0	15.793	0.380	1.425	9.02
	weight	2.30— 5.18	4.108	0.234	0.875	21.29
AB	height	17.2 — 21.5	20.093	0.381	1.427	7.10
	width	14.8 — 17.0	15.793	0.194	0.729	4.61
III.	length	20.0 — 24.2	21.807	0.366	1.370	6.28
	weight	2.51— 4.90	4.124	0.208	0.780	18.91

For explanation see Table 2

Table 6

Statistical significance in the characteristics studied using the t-test.

(Comparison of the osteometric values of the proximal phalangeal sesamoid bones of the digits from the right thoracic (PH) and right pelvic (PP) limbs)

Bones under comparison	height	width	length	weight
AB IV. PH + AB III. PH	highly significant	0	0	0
AB IV. PP + AB III. PP	significant	highly significant	0	0
AX IV. PH + AX III. PH	0	0	0	0
AX IV. PP + AX III. PP	0	0	0	0
AB III. PH + AB III. PP	0	highly significant	0	0
AB IV. PH + AB IV. PP	significant	0	0	0
AX III. PH + AX III. PP	significant	0	0	0
AX IV. PH + AX IV. PP	0	0	0	0

phalanx of the third digit. The origin of the axial sesamoid bone of the proximal phalanx of the third digit from the thoracic or pelvic limb can be determined from comparison of the maximum heights of the bones. The other osteometric values studied cannot be utilized for determination of the axial sesamoid bones of the proximal phalanges.

Discussion

It is suggested that the osteometric values obtained from measurement of the population studied of the proximal phalangeal sesamoid bones of the cattle digits show differences which can provide further criteria for differentiation of these bones. The contradictory data of different sizes of the axial and abaxial sesamoid bones of the proximal phalanges of the digits, as reported by Kolda (1936) on one hand and Vokken et al. (1961) on the other, provide little knowledge of anatomy of these bones. Červený (1985) determined, on the basis of a detailed anatomical description, a number of characteristics of the ossa sesamoidea phalangis proximalis in cattle. He reported that characteristics differentiating the axial sesamoid bones of the proximal phalanges from the abaxial ones, i.e. their anatomy and shape, are quite obvious. Therefore we did not compare their osteometric values. Similarly, as there are differences between anatomical characteristics of the abaxial sesamoid bones of the proximal phalanges of the third and fourth digits from the thoracic and those from the pelvic limbs (Červený 1984), the osteometric values of these bones show differences, too. At least one distance measured in these bones showed statistically significant values and thus provided another criterion for determination of these bones. According to Červený (1984), the origin of the axial sesamoid bones of the proximal phalanges of both the fourth and third digits from the thoracic or pelvic limb can be determined on the basis of different shape of their tuberculum proximale. The osteometric values obtained from measuring the axial sesamoid bones permit to determine the origin of the axial sesamoid bone of the proximal phalanx only of the third digit from the thoracic and pelvic limbs. Thus the osteometric method cannot be used for determination of origin of the axial sesamoid bones with respect to their digits, left - side or

right - side limb, and determination of origin of the axial sesamoid bone of the proximal phalanx of the fourth digit with respect to the thoracic or pelvic limb. These sesamoid bones can be differentiated only indirectly according to topographoanatomical interrelations as described by Červený (1984), on condition that one of the data looked for to determine the origin of the bone is known.

The osteometric characteristics studied in the present paper are a supplement to anatomical characteristics. The results of the osteometric examination, high variability of the weight and the maximum diameter values for the bones and the lowest variability of the maximum width are in accordance with the osteometric values reported in the literature for different bones of the skeleton (Jablokov 1966).

Osteometric ossa sesamoidea phalangis proximalis u skotu (Bos primigenius f. taurus Linné 1758)

Prověřili jsme osteometricky sezamské kosti proximálních článků prstů čtrnácti jedinců skotu plemene českého červenostrakatého, samičího pohlaví. Sledovali jsme statistickou závislost čtyř znaků. Studované kosti se neliší v hmotnosti a průměru. Zjistili jsme vysoce statisticky průkaznou rozdílnost pro hodnoty maximální výšky při porovnání abaxiálních sezamských kostí proximálních článků čtvrtých a třetích prstů na hrudních končetinách a maximální šířky při porovnání abaxiálních sezamských kostí proximálních článků třetích a čtvrtých prstů na pánevních končetinách. Vysoce statisticky průkaznou rozdílnost jsme zjistili též při porovnání šířky abaxiálních sezamských kostí proximálních článků třetích prstů hrudních končetin a abaxiálních sezamských kostí proximálních článků třetích prstů pánevních končetin. Statisticky průkazné jsou rozdíly hodnot maximální výšky mezi abaxiální sezamskou kostí proximálního článku čtvrtého prstu a abaxiální sezamskou kostí proximálního článku třetího prstu na pánevní končetině. Tytéž vztahy jsme zjistili i mezi abaxiální sezamskou kostí proximálního článku čtvrtého prstu a abaxiální sezamskou kostí proximálního článku třetího prstu na hrudní končetině. Statisticky průkazný je též rozdíl hodnot maximální výšky mezi axiální sezamskou kostí proximálního článku třetího prstu hrudní končetiny a axiální sezamskou kostí proximálního článku třetího prstu pánevní končetiny. Osteometrická zjištění na sezamských kostech proximálních článků prstů skotu doplňují anatomické znaky, takže jsou dalším významným kritériem pro vzájemné rozlišení a identifikaci těchto kostí.

Остеометрия ossa sesamoidea phalangis proximalis крупного рогатого скота (Bos primigenius f. taurus Linné 1758)

Остеометрически проверялись сесамовидные кости проксимальных фаланг четырнадцати голов крупного рогатого скота чешской красно-пестрой породы — самок. Проводились наблюдения за статистической зависимостью четырех признаков. Изучаемые кости не отличаются массой и диаметром. Была установлена высокая статистическая значимость разности величин максимальной высоты при сравнении абаксиальных сесамовидных костей проксимальных фаланг четвертого и третьего пальцев на грудных конечностях и максимальной ширины при сравнении абаксиальных сесамовидных костей проксимальных фаланг третьего и четвер-

того пальцев на тазовых конечностях. Большую статистически значимую разность установили также при сравнении ширины абаксиальных сесамовидных костей проксимальных фаланг третьих пальцев грудных конечностей и абаксиальных сесамовидных костей проксимальных фаланг третьих пальцев тазовых конечностей. Статистически доказательной является разность величин максимальной высоты между абаксиальной сесамовидной костью проксимальной фаланги третьего пальца на тазовой конечности. Те же самые отношения были обнаружены между абаксиальной сесамовидной костью проксимальной фаланги четвертого пальца и абаксимальной сесамовидной костью проксимальной фаланги третьего пальца грудной конечности. Статистически доказательной является также разность между аксиальной сесамовидной костью проксимальной фаланги третьего пальца грудной конечности и аксиальной сесамовидной костью проксимальной фаланги третьего пальца тазовой конечности.

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