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THE EFFECT OF THE SIZE AND SHAPE OF CHESTNUTS ON THE IDENTIFICATION OF HORSES

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Abstract

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A study was carried out on 11 horse breeds comprising of the Akhal Teke (n = 23); English Thoroughbred (n = 23); Arabian Thoroughbred (n = 18); Czech Warm-Blood (n = 21); Old Kladrubian horse (n = 20); Hucul horse (n = 20); Czech – Moravian Belgian horse (n = 20); Noriker horse (n = 7); Silesian Noriker (n = 14); Haflinger (n = 20); Shetland pony (n = 20) to determine the shape and size of chestnuts. Chestnuts of 206 horses classified in three phylogeny classes were measured and drawn. The necessary data (breed; sex; name; sire; dam; sire of dam; age of horse; colour of horse; colour of the chestnut; bone) were entered into a special form. In the form the outlines of the shapes of the chestnuts were drawn; using a calliper we measured the protrusion of the chestnut at its highest point and the width at the widest part of the chestnut. We found no identical or similar shapes of the chestnuts within the breed or phylogeny class. We confirmed that the outlines of the chestnuts can be used as identifying marks because they are unique for each horse. We also tried to determine how the size of the chestnut is related to the strength of the skeleton but we failed to prove this dependence statistically. Using the general linear model (GLM) we discovered a statistically highly significant effect of the phylogeny class on the height and width of the chestnuts on all four limbs. The age factor has a statistically highly significant effect on the width of the chestnut on both front legs. Sex has a statistically significant effect on the height of the chestnut on both hind legs.

horse, breed, chestnut

The rudimentary structures on the thoracic limb on the medial plane of the distal end of the forearm and on the pelvic limb on the medial plane of the tarsus are chestnuts and the remnants of the first toe of prehistoric ancestors of horses. Most horses have these rudimentary structures on all four limbs.

On their limbs farm animals have rudimentary structures of the original pads of five-toed animals. These skin structures are made up of horny skin, corium and subcutaneous ligament of the pad. The *torus carpalis* is on the thoracic limbs of the horse on the medial plane of the distal end of the forearm; the *torus tarsalis* is on the pelvic limbs, which is on the medial plane of the tarsus. The *torus metacarpalis* is on the palmar metatarsus area and the *torus metatarsalis* on the plantar area of the distal end of the metatarsus; they are small bony projections or spurs (Hintze, 1910; Komárek *et al*., 1964; Marvan *et al*., 2003). The toe pads (*torus digitales)* in ungulates have the form of frog and heel (Komárek *et al*., 1964; Marvan *et al*., 2003). Hintze (1910), Lechner (1922), Kolda (1936), Hanslian (1947), Popesko (1964), Bílek *et al*. (1955), Lerche (1962), Komárek *et al*. (1964), Talukdar (2002), Stehlík and Trantírek (1971), Čollák *et al*. (1987), Čollák *et al*. (1984), Najbrt *et al*. (1982), Hermsen (1999), Marvan *et al*. (2003), Kapitzke (2008) and Kojouri *et al*. (2010) described the places where the chestnuts appear.

Kolda (1936) reported that the chestnuts of oriental horse breeds are smaller or they may altogether be absent, whereas in horses of the western world they are always developed and are always large. Kapitzke (2008) found that not all horse breeds develop chestnuts. In warm-blood horses Komárek *et al.* (1966) described the chestnut as smooth on the surface, not very rough and generally smaller. In cold-blood horses they are deeply cracked and ragged and are generally larger. On the thoracic limbs they are normally larger than on the pelvic limbs where they may be altogether absent (Komárek *et al.*, 1966). Kojouri *et al.* (2010) maintained that the shapes of chestnuts on the front legs are longer than on the hind legs and that the chestnuts are bigger in horses with heavier body weight. Najbrt *et al.* (1982) agree that chestnuts are smaller on the hind legs and that sometimes they may be absent. Stehlík and Trantírek (1971) presented two opinions on how they come into being; they are thought to be atavistic remnants of the carpus and tarsus pliable horn-like pads of five-toed ancestors of horses, or that the chestnut is what remained of the first or second toe. Kolda (1936), Komárek *et al.* (1964) and Talukdar (2002) monitored chestnuts protruding as much as 10 cm, 1–10 cm long and 1–4.5 cm wide. In contrast Najbrt *et al.* (1982) described the chestnut as a 5 cm long, vertically oval, flat structure. Stehlík and Trantírek (1971) also saw the chestnut as an oval, flat, hairless structure with an uneven and frequently rough surface. Kolda (1936) described a chestnut oval in shape, grey-black in colour, sometimes yellow-brown or yellowish; however Komárek *et al.* (1964) saw the colour as rather dark grey to black and sometimes yellowish. Talukdar (2002) described the colour as grey-black or yellow-grey; the surface of the chestnut as smooth and that the most prominent chestnuts developed on horses aged 6 to 19 years. According to Novotný *et al.* (1966) the chestnut and the spur are bony protrusions, the basis of which is the ligament of the corium which forms a profuse papillary body and above it is a thick layer of tubular and intertubular horn. Komárek *et al.* (1964) added that the corium of the chestnut and spur is papillary, hairless and has no glands, the horn-like layer is relatively soft and its structure is tubular. Najbrt *et al.* (1982) described the keratin of the chestnut as rigid, cracked and ragged on the surface with whole parts peeling off. The pad of the chestnut is only slightly separated from the surrounding subcutaneous ligament; usually the subcutaneous ligament is firmly attached to the fascia.

The horse's ID card includes drawings of inherent markings, acquired markings, colour of the horse, hair whorls and/or brand if required by the rules of the respective studbook. The outlines of the chestnut are drawn only if the horse has no markings and has less than three hair whorls.

Our objective was to explore if the shapes of the chestnuts in horses are similar or if drawing the outlines in the horse's card would be suitable identifying marks.

Some horse breeds and their pedigrees

The Akhal-Teke horse

According to Dušek *et al.* (2007) the Akhal-Teke horse originating from Turkmenistan is thought to be one of the oldest horse breeds. Kapitzke (2008) indicated that this breed was known as far back as the time of Alexander the Great (356-323 B.C.)

They are the result of long-term selection of local and commercial types of Central-Asian Iranian and Turkmen horses (Dušek *et al.*, 2007).

The Arabian Thoroughbred

According to Dušek *et al.* (2007) the Arabian horse was bred on the Arabian Peninsula. Arabian nomads were obtaining the noble horses from nearby countries such as Mesopotamia, Persia and Central Asia as early as from the 4th century A.D.

The Arabian Thoroughbred is the oldest and most important representative of warm-blood horses. To a great extent it contributed to the improvement of almost all warm-bloods and to some heavy horse breeds (Hörman *et al.*, 1957).

The Old Kladrubian horse

The Old Kladrubian is the only autochthonous Czech breed named after the stud farm where it originated (Dušek *et al.*, 1999). Rudolf II imported the originally Spanish horse and then horses from Northern Italy because the horses bred at the stud farm were to serve particularly as "carosiers" (carriage horses) that is heavy draft horses. Therefore the Old Kladrubian horse was later bred as an Italian-Spanish horse (Bílek, 1954).

During its regeneration The Old Kladrubian black horse the typical characters of the breed were preserved improving the former conformation defects and characteristic gaits. Since the population was small, in various post-war periods gene immigration was discovered. In the herd of grey horses the Orlov trotter was gradually used, but only to a limited extent; to a large extent it was infusion of Lipizzaner blood, and in the last stage it was the sire of the Lusitano horse. In the herd of Old Kladrubian black horses the Friesian sire Romke with the Lipizzaner Siglavi Pakra were founders of the new genealogical line (Dušek *et al.*, 2007).

The English Thoroughbred

The tradition of horse breeding in the British Isles is very long, since the Celtic period. Dušek *et al.* (1999) informed that even Caesar in his memoirs mentioned how the Brits competed on their small horses with horses of the Roman legionaries in the year 55 B.C. At that time their horses were not fit enough for speed races; they were either small Nordic horses or their crosses with heavy western Friesian horses imported from the coast of the

nearby European continent. Efforts were made to improve the speed of the horses. There are reports from as far back as the time of the Crusades when several oriental stallions and mares were brought to England (Bílek, 1954). Racehorses were imported to England at the time of King Alfred the Great, in the 9th century. In the following centuries Spanish and Arabian horses as well as horses from the Germanic countries were gradually imported to the British Isles and these horses were used to upgrade the existing breeds of mares (Dušek *et al*., 2007).

The Czech warm-blood

Breeding the Czech warm-blood in the Czech Republic proceeded in two directions; in Bohemia these horses were bred as draft horses and were influenced by imported Oldenburg sires and their progeny while in Moravia the horses were of a more noble type thanks to sires of the Austrian-Hungarian half-bred horses. In the late 19th century the breeding of the Czech warm-blood intensified and was based on imported heavy warm-blood sires of the Oldenburg and East-Friesian breeds with a smaller proportion of Norman horses. At about the year 1950 the farm co-operatives began giving preference to horses of the warm-blood draft type. Later the breeders revived the riding horse using the English Thoroughbred and the Trakehner horse. Breeding for sports performance infused the blood of Hanoverian, Holstein, Selle Français, the Dutch Royal Riding Horse and other breeds into the blood of the Czech warm-blood (Dušek *et al*., 2007). Jiskrová et. Misař (2001) described the random and fixed factors affecting the sports performance of the Czech warm-blood.

The Hucul horse

According to Dušek *et al*. (2007) the ancestor of the Hucul horse was probably the domesticated Carpathian Tarpan. This domesticated horse was partly influenced by the Mongolian invasion and was bred by the Carpathian mountain dwellers; however the Mongolian type was to disappear early. During the Turkish raids the breed was influenced by oriental horses resulting in the Arabian type of Hucul horse; then the Tarpan type of Hucul and as the third and last type the Noriker type of Hucul horse as the result of migration of religious refugees and their Norik horses.

The Bohemian-Moravian Belgian horse

Dušek *et al*. (2007) pointed out that the breeding of the Bohemian-Moravian Belgian horse began as grading up of local mares of different pedigree and different degree of breeding with imported original Belgian sires. According to Lerche (1962) the pedigree of the Belgian horse goes back to the 13th century in Belgium, the time of its heyday. From Belgium it was distributed all over the world. In Bohemia breeding of the Belgian horse began in 1870, in Moravia in 1879 (Lerche, 1962). Dušek *et al*. (2007) stated that a hundred years later, after 1970, the heavy horses were not distinguished on the basis of breeds; however this increased the reproduction base of the Bohemian-Moravian Belgian horse to the detriment of its pedigree. In the past decade pure breeding has been restored and the breed has the statute of genetic source of the Czech Republic.

The Noriker horse

The Noriker horse was named after the Roman province Noricum, its home. In earlier times there were several types of which the best known and the most frequently used was the Pinzgauer horse bred in the Salzburg region in the Pinzgau and Pong valleys (Bílek, 1954).

The Silesian Noriker horse

In the territory of what was later Czechoslovakia, in the Silesian region, the local mares were refined with sires of the Norfolk horse; later on mares from this refinement were repeatedly mated with the original Noriker stallions. Expulsory grading crossing with Noriker sires gradually resulted in the Silesian Noriker horse. The breed has the statute of genetic source of the Czech Republic (Dušek *et al*., 2007).

The Haflinger horse

The Haflinger horse developed in South Tyrol where the small Tyrolean mares were crossed with Arabian half-bred stallions of the El-Bedavi and Dahoman families; inbreeding and improvement of life conditions and at the same time consistent selection resulted in an integrated herd and gave rise to a new breed (Bílek, 1955).

The Shetland pony

Dušek *et al*. (2007) mention the origin of the Shetland pony only briefly saying that in all likelihood it is the descendant of small Norse horses of earlier times. According to Edwards (1998) its pedigree is not known, but it is close to the tundra-type pony and to the Scandinavian breeds.

MATERIALS AND METHODS

We carried out analyses on 206 horses of 11 breeds. The horse breeds were divided on the basis of phylogeny groups. Measurements were conducted in the eastern, western and northern groups. The group of eastern horses was divided into the Iranian subgroup with representatives of the Akhal Teke horse. The second subgroup consisted of Arabian horses; the selected breed was the Arabian Thoroughbred. The third subgroup consisted of Arabian-Berber horses and the only concrete autochthonous Czech breed was the Old Kladrubian horse (black horse). The fourth subgroup of English horses included two breeds, English Thoroughbred and the Czech warm-blood. The fifth subgroup of Tarpan horses included the Hucul horse. For the group of western horses we selected the Czech-Moravian Belgian horse, Silesian

Noriker, Noriker horse and the Haflinger. The last group included northern horses represented by the Shetland pony. The total number of 206 horses, 44 were stallions, 119 were mares and 43 were geldings.

For measurements of the chestnuts we used the following work aids: calliper, tape, a special-purpose form and a digital camera. Into the form we drew the shapes of the chestnuts and then we measured them using the calliper and we entered the measured data in mm.

Into the table in the Excel programme we entered the following data: horse, breed, sex, age, colour, how much the chestnut protruded and its colour. We also entered the following effects: breed, sex, age and bone. In terms of the dependent variable we entered: chestnut height of the right front leg (RF I), chestnut width of the right front leg (RF –), chestnut height of the right hind leg (RH I), chestnut width of the right hind leg (RH –), chestnut height of the left front leg (LF I), chestnut width of the left front leg (LF –), chestnut height of the left hind leg (LH I), chestnut width of the left hind leg (LH –).

The objective of our investigations was to assess if the concrete breed and phylogeny class had an effect on the shapes and dimensions of the chestnuts; if the age, sex or strength of the skeleton based on the measured bone played a part. We used the analysis of variance to assess the effect of the factors on the height and width of the chestnuts. The Tukey – B method was used for multiple comparisons. We compared the height and width of the chestnuts on the left hind leg of significantly different pairs of breeds.

Using the General Linear model (GLM) we explored whether the phylogeny class, sex and age have a statistically significant effect on the dependent variables height and width of the chestnuts on all four limbs. We tested the effect of the above factors on the height and width of the measured chestnuts.

The data were processed in Unistat for Excel version 5.1.

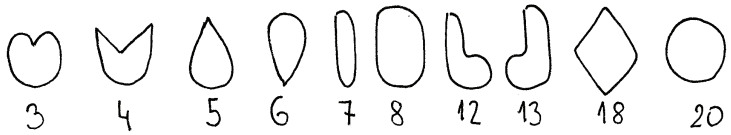
RESULTS AND DISCUSSION

We discovered that 12 different shapes of chestnuts occurred most frequently; see Fig. 1. A missing chestnut was indicated as number 1; number 2 was an undistinguishable chestnut; 3 was heart-shaped; 4 was forked; 5 was teary-shaped; 6 was amygdalate; 7 was a narrow oval; 8 was an oval; 12 was a chestnut in the shape of the letter "b"; 13 was a chestnut in the shape of the letter "d"; 18 a rhombus; 20 a circle. The shapes were arranged according to the RF, RH, LF, LH limbs and their shapes 1, 2, 3, 4, 5, 6, 7, 8, 12, 13, 18, 20 in a table and evaluated as follows.

The analysis of variance of the dependent variables of height and width of the chestnuts on all limbs showed that with the exception of the left hind leg all the effects in question were statistically insignificant.

We discovered that the breed had a statistically highly significant effect on the height and width of the chestnut only on the left hind leg. We performed multiple comparisons of the height and width of chestnuts on the left hind legs of the horses. The results are seen in Tab. I.

Tab. I shows that the Silesian Noriker and the Noriker horses developed the most prominent chestnuts on the left hind legs. The Silesian Noriker differs from all the other breeds; the Noriker horse



1: *The most frequently occurring shapes of chestnuts based on results of our measurements*

I: *Comparisons of the height of the chestnut on the left hind leg*

Group	Number of cases	Average	SHP	HF	STKL	OR 1/1	ACH	A1/1	CMB	H	CT	N	SN
SHP	20	25.6				*	*	*	*	*	*	*	*
HF	20	35.2										*	*
STKL	20	37.4										*	*
OR 1/1	18	41.7	*										*
ACHAL	23	42.6	*										*
A1/1	23	43.0	*										*
CMB	20	44.6	*										*
H	20	46.0	*										*
CT	21	47.5	*										*
N	7	59.1	*	*	*								
SN	14	61.7	*	*	*	*	*	*	*	*	*		

II: *Comparison of the width of the chestnut on the left hind leg of the respective breeds*

Group	Number of cases	Average	SHP	HF	H	OR 1/1	A1/1	CT	STKL	ACHAL	N	ČMB	SN
SHP	20	9.4		*	*	*	*	*	*	*	*	*	*
HF	20	15.0	*							*	*	*	*
H	20	15.5	*							*		*	*
OR1/1	18	15.6	*									*	*
A1/1	23	16.0	*							*		*	*
CT	21	17.8	*									*	*
STKL	20	20.3	*										
ACHAL	23	20.8	*	*	*		*						
N	7	23.0	*	*									
CMB	20	23.3	*	*	*	*	*	*					
SN	14	24.1	*	*	*	*	*	*					

III: *Minimal size of chestnuts on the limbs based on the phylogenetic classes*

Phylogeny group	RF I	RF –	RH I	RH –	LF I	LF –	LH I	LH –
Eastern	29	10	0	0	26	10	14	3
Western	33	14	11	6	33	12	0	0
Northern	15	5	0	0	12	6	0	0
Total minimal	15	5	0	0	12	6	0	0

IV: *Average sizes of chestnuts on the limbs based on phylogeny classes*

Phylogeny class	RF I	RF –	RH I	RH –	LF I	LF –	LH I	LH –
Eastern	49	25	43	18	48	25	43	18
Western	58	32	48	21	57	31	47	21
Northern	30	15	26	8	29	14	26	9
Total average	50	26	43	18	49	25	43	18

V: *Maximal sizes of chestnuts on the limbs based on phylogeny classes*

Phylogeny class	RF I	RF –	RH I	RH –	LF I	LF –	LH I	LH –
Eastern	85	45	84	33	81	37	80	38
Western	91	54	91	33	90	50	94	37
Northern	49	24	49	15	48	26	48	24
Total max	91	54	91	33	90	50	94	38

differs only from the Shetland pony, the Haflinger and the Old Kladrubian horses. On the other hand the smallest chestnuts developed on the Shetland pony which differed from all the other breeds, with the exception of the Old Kladrubian horse and the Haflinger.

Tab. II shows horses with the widest chestnuts; they relate to the Silesian Noriker, Bohemian-Moravian Belgian horse and the Noriker; the Shetland pony developed the narrowest chestnuts. The Shetland pony differs from all the other breeds. The width of the chestnut distinguishes the Haflinger from the Silesian Noriker, Czech-Moravian Belgian, Noriker and the Akhal Teke. The Hucul horse and the English Thoroughbred differ from the Silesian Noriker, Czech-Moravian Belgian and the Akhal Teke. The Arabian Thoroughbred and the Czech warm-blood differ from the Silesian Noriker and the Bohemian-Moravian Belgian horses.

By means of the general linear model (GLM) we proved that the phylogeny class had a statistically highly significant effect on the height and width of the chestnuts on all four limbs. Age has a statistically highly significant effect on the width of the chestnut on the right front leg and the left front leg. Sex has a statistically significant effect on the height of the chestnut on the right hind leg and left hind leg.

Tabs. III to V give the minimal, average and maximal dimensions of chestnuts of horses of the respective phylogenetic classes.

Tabs. VI to VIII give the minimal, average and maximal dimensions of chestnuts of horses of the respective breeds.

VI: *Maximal sizes of chestnuts on limbs based on the breed of the horse*

Maximum	RF I	RF –	RH I	RH –	LF I	LF –	LH I	LH –
ACHAL	85	35	70	33	81	37	64	38
A1/1	70	32	78	21	63	33	74	30
CMB	76	54	75	33	82	50	67	37
CT	80	39	84	33	77	34	80	33
HF	67	37	59	24	63	32	57	20
H	58	30	79	23	59	29	71	22
N	85	45	91	31	90	50	85	28
OR1/1	59	32	69	30	63	32	74	21
SHP	49	24	49	15	48	26	48	24
NS	91	47	81	33	86	47	94	34
STKL	60	45	60	32	60	37	58	30
Total maximum	91	54	91	33	90	50	94	38

VII: *Minimal dimension of chestnuts on limbs based on the horse breeds*

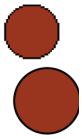
Minimum	RF I	RF –	RH I	RH –	LF I	LF –	LH I	LH –
ACHAL	36	10	0	0	28	10	20	3
A1/1	31	14	18	10	26	13	18	10
CMB	48	23	20	13	42	24	22	12
CT	29	19	19	11	27	15	25	11
HF	33	14	16	6	33	12	0	0
H	32	10	10	8	31	12	14	8
N	39	25	11	13	36	21	12	10
OR1/1	33	11	16	7	30	10	15	7
SHP	15	5	0	0	12	6	0	0
NS	45	27	29	12	45	25	32	16
STKL	34	20	20	12	28	20	20	11
Total minimum	15	5	0	0	12	6	0	0

VIII: *Average dimension of chestnuts of limbs based on the horse breeds*

Average	RF I	RF –	RH I	RH –	LF I	LF –	LH I	LH –
ACHAL	55	27	42	19	52	27	43	21
A1/1	51	23	44	16	48	23	43	16
CMB	60	33	45	23	59	33	45	23
CT	51	27	48	19	50	27	48	18
HF	46	26	38	16	44	25	35	15
H	43	19	46	15	44	19	46	16
N	66	37	60	22	63	36	59	23
OR1/1	44	23	42	15	43	23	42	16
SHP	30	15	26	8	29	14	26	9
NS	68	37	61	24	68	34	62	24
STKL	49	31	37	20	49	30	37	20
Total average	50	26	43	18	49	25	43	18

Tab. VI shows that the most prominent chestnut developed on the RF of the NS and the same was seen on the Akhal Teke and Noriker horses; the widest chestnut was seen on the CMB, NS, N and STKL. The NS, CT, H and A1/1 had the most protruding chestnuts on the RH, while the width of the chestnut on the RH was the same in four following breeds - ACHAL, CT, CMB and NS. N, NS and CMB had the largest chestnut on the LF; CMB and N have the widest chestnuts on the LF; somewhat smaller on NS. The maximal height of the chestnut on the LH

IX: *Shapes of chestnuts of three different breeds according to Kojouri et al. (2010)*

	Oval	Elongated oval	Circular oval	Amygdalate	Gyrate	Bean like	Undistinguishable shape
							
Left front	20	12	12	16	16	24	-
Right front	24	8	32	12	20	-	4
Left hind	56	4	16	4	16	-	4
Right hind	48	8	24	8	12	-	-

X: *Frequency of shapes of chestnuts on horse limbs*

Number of shape of chestnut		2	3	4	5	6	7	8	12	13	18	20
RF	/	41	4	5	67	7	9	38	7	2	24	2
RH	3	26	8	24	54	12	27	14	6	16	5	11
LF	/	37	4	7	63	13	17	31	5	8	20	1
LH	2	25	10	23	51	9	35	19	21	3	1	7
Total	5	129	26	59	235	41	88	102	39	29	50	21

was found on NS, N and CT and the maximal width on ACHAL, CMB and NS.

Tab. VII presents the minimal height of chestnuts on the front and hind legs; the least protruding chestnut developed on the RH of the SHP and ACHAL and on the LH of HF. The value is 0, i.e. missing chestnut. CT and A1/1 have the second minimal height of the chestnut on the RF and SHP, ACHAL, H and OR1/1 developed the narrowest chestnuts on the RF. H and N developed the smallest chestnut on the RH, and HF and H developed the narrowest chestnuts. A1/1, CT and ACHAL, as well as STKL, developed chestnuts of minimal height on the LF and the breeds are graded by 1mm. ACHAL and OR 1/1, HF and H developed chestnuts of a minimal width on the LF; as already mentioned the chestnuts on the LH of SHP and HF were minimal, i.e. 0 on the LH as well as N, H and OR1/1. The chestnut on ACHAL was 3 mm wider than on SHP with HF, OR 1/1 and H.

Tab. VIII shows that the average height and width of chestnuts on the front legs was almost the same; on RF the height is 50 mm and on the LF 49 mm; the width on RF is 26 mm and on LF 25 mm; the height on RH is 43 mm and on LH 43 mm and the width on RH is 18 mm and on LH also 18 mm. Out of the total average based on the horse breed, the Shetland pony, Arabian, Hucul horse and Haflinger have the smallest chestnuts.

The Silesian Noriker and Noriker horse and of the warm-blood breeds the CT, ACHAL, A1/1 and OR1/1 developed the largest and widest chestnuts.

Evaluation of the shapes of the chestnuts

Out of the 206 horses investigated in our study the chestnuts were absent on the legs of 4 horses. The chestnut was missing on the RH of an Akhal Teke mare, on the LH of a mare of the Haflinger horse and on two mares of the Shetland pony, on one mare the chestnut was missing on the RH and on the other the chestnuts were missing on both hind legs.

In contrast to these cases we discovered that two horses developed two chestnuts on one leg, and again only on the hind legs, i.e. only on the CMB mare 49/997 FÍBÍ by 2696 KORBUS of mare 49/493 FIRMA by 2537 SAPON and the other case was sire 2694 SASUN by 2537 SAPON of mare JM 4448 DARINA by 2255 AGRISUN – 2. This sire had two chestnuts on the left hind leg, but it is possible that there could have been a genetic predisposition due to 2537 SAPON.

In their study Kojouri *et al.* (2010) did not mention missing chestnuts at all; according to their calculations none of their horses had a missing chestnut or two chestnuts on one limb.

Within the framework of all the studied breeds the shapes of the chestnuts differed considerably as indicated by Kojouri *et al.* (2010) who explored the shapes in three breeds only (English Thoroughbred, Arabian Thoroughbred and the Akhal Teke horse). They indicated the shapes as oval, circular oval, amygdalate, gyrate, bean-like and in some cases where the shapes were very irregular as undistinguishable shape. These shapes are illustrated in Tab. IX.

Tab. X gives the most frequently occurring shape of the chestnut which is definitely No. 5 the teary-like shape; this shape can be seen mostly on A 1/1, CT, CMB, STKL, OR 1/1, HF, SHP, H and N, and the least on ACHAL. Most of the shapes were undistinguishable shapes due to the rich diversity;

these shapes appeared most frequently on the front legs.

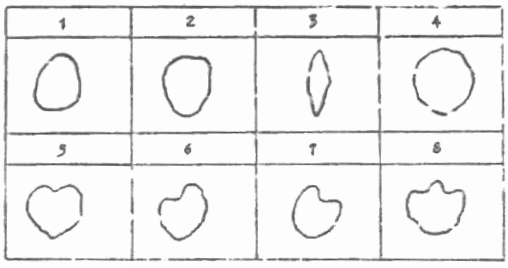
Undistinguished chestnuts appeared most frequently on the ACHAL breed where most of the structures were seen on the LH leg – 27 chestnuts out of the total undistinguished number of 56 on this breed. The other breed on which these chestnuts appeared is the Shetland pony where we discovered 19 undistinguishable chestnuts. The undistinguishable shapes appear less often on the CT, OR 1/1, H, CMB and A1/1 breeds and least of all on N, HF, STKL.

According to Kojouri *et al*. (2010) out of the total number of 100 horses with 400 chestnuts, only 4 were undistinguishable shapes.

The next most frequent shape in the majority of horse breeds is the oval with the exception of Akhal Teke on which the oval-shaped chestnut did not appear on any limb. In terms of the phylogeny the oval appeared more frequently in the eastern and northern horses.

As can be seen in the tables no concrete shape of chestnut is specific for a certain breed or phylogeny class. Even though the chestnuts were grouped into concrete shapes they were highly variable.

Chestnuts which at present have no high value in the identification of horses eventually could come in useful. This begs the question whether their shape changes during the horse's life. Kojouri *et a*l. (2010) are convinced that on OR 1/1 and A1/1 the length of the chestnuts increases with age and the width decreases, and that the dimensions change with age and body weight.



2: *Code of numbering the shape of chestnuts according to Klement (Navrátil, 2011)*

1) The top is narrow or acuminous, lower part is wider or straight (pear shaped).
2) The top is straight or wider than the bottom part which is acuminous or narrower (strawberry shape).
3) The top and the bottom part are narrower or acuminous (shape of a flame).
4) The top and the bottom part are wide or straight, or the chestnut is circular (orange-shaped).
5) The top has one notch and both edges are the same height (heart-shaped).
6) The right edge of the notch is higher (right flint).
7) The left edge of the notch is higher (left flint).
8) The top has three tips or one big tip in the middle (shape of a coat of arms).
9) The chestnut is irregular and does not match any of the above shapes.

For a rapid identification of racehorses prior to the race Klement (cites Navrátil, 2011) elaborated a survey of the most frequently occurring chestnut shapes. He detected that some of the chestnut shapes are frequently repeated and he divided them into 9 of the most frequent shapes; see Fig. 2.

Klement's specialisation was narrow as he focused on one breed only, i.e. the English Thoroughbred; he identified these horses before and after the race. It is a paradox that this method of identification (with a zero number of inherent markings and minimal number of hair whorls) got into the ID card of the horse thanks to FEI.

The Central Register of horses of the Czech Republic does not record shapes drawn in the horse's ID card. According to valid legislation chestnuts are not identifying marks and are subject to description. In foreign passports there is a higher probability that the outlines of chestnuts are included in the passports of horses.

Chestnuts are not usually used as identifying marks for the description of horses in the FEI passport. Around the world passports of horses giving the outlines of chestnuts are sporadic.

CONCLUSION

The shapes of chestnuts are highly variable and a small number are definitely distinguishable; the highest variability of shapes was seen particularly in the Akhal Teke horses.

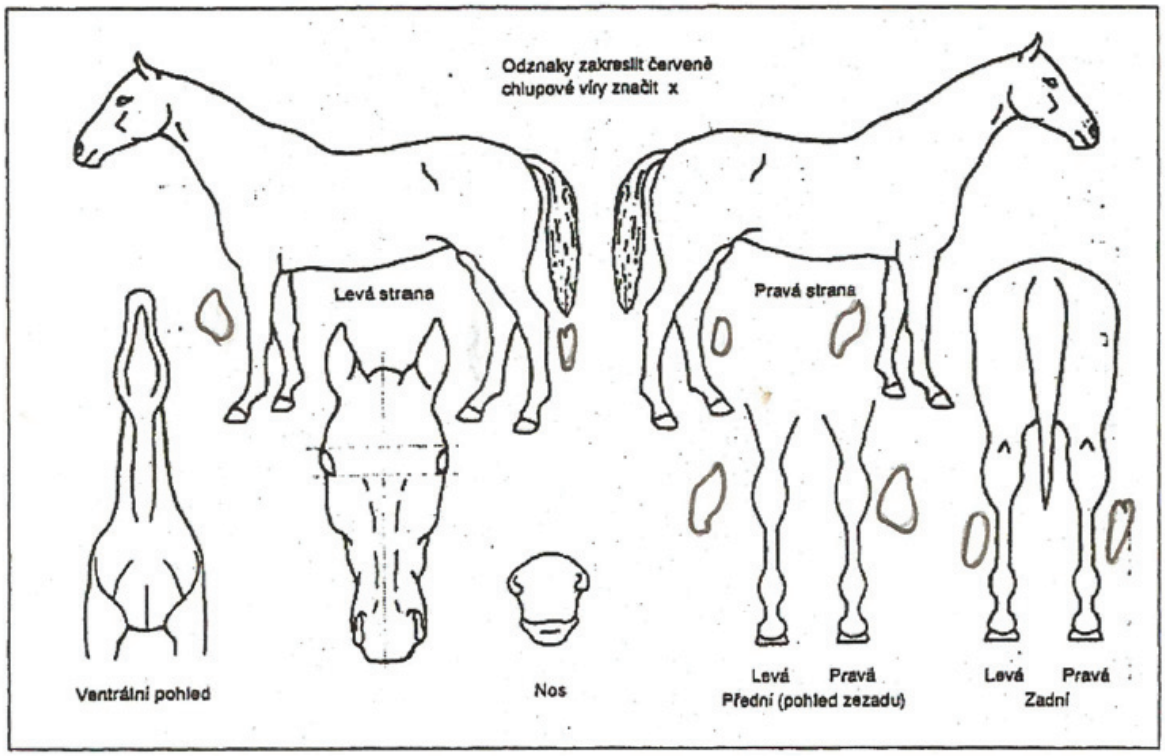
Within the breed many horses differed in extreme dimensions of the chestnuts. The result of our investigations is that the concrete breed does not affect the dimension or shape of the chestnuts. It is apparent that the biggest and widest chestnuts were seen in the group of western horses and the smallest chestnuts in the group of northern horses.

On the basis of GLM we concluded that the phylogeny class and sex have a statistically significant effect on the height of the chestnut both on the right and left hind limb; we also discovered that the phylogeny class and age have a statistically significant effect on the width of the chestnut both on the right front limb and on the left front limb.

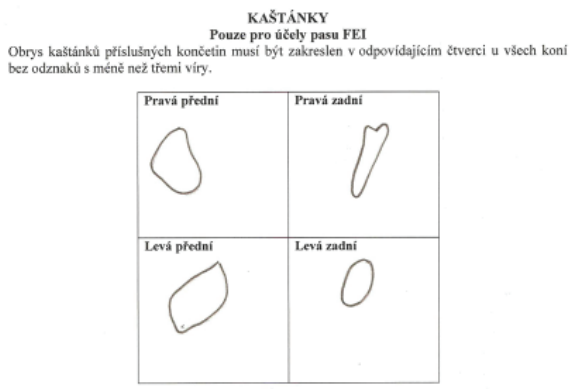
The minimal and maximal values within the phylogeny class were seen on the front limb where the height of the chestnuts ranged from 12 to 91 mm; the width from 5 to 54 mm; on the hind limb the height of the chestnuts ranged from 0, i.e. missing chestnut, to 94 mm; the width ranged from 0 to 38 mm.

The average dimensions of the chestnuts on the RF was 50 mm in height and 26 mm in width; on the LF the height of the chestnuts was 49 mm and width 25 mm, i.e. one mm less on each side. On the hind limbs the width and height were the same on both sides, the height of the chestnut was 43 mm and width 18 mm.

No author mentioned finding two chestnuts on one limb which appeared in two cases in the experimental part, but only on cold-blood horses.



3: *Description of horse*


KAŠTÁNKY

Pouze pro účely pasu FEI

Obrys kaštánků příslušných končetin musí být zakreslen v odpovídajícím čtverci u všech koní bez odznaků s méně než třemi víry.

Pravá přední	Pravá zadní
Levá přední	Levá zadní

4: *Form for drawing the chestnuts*

In the case of the CMB mare the height of the upper chestnut was 22 mm and width 8 mm; the space between the upper and lower chestnut was 19 mm, the lower chestnut was 26 mm high and 8 mm wide. The other case of two chestnuts was seen in a CMB stallion; the height of the upper chestnut was 11 mm and the width was 6 mm; the space between them was again 8 mm; the lower chestnut measured 20 mm in height and was 11 mm wide. In both cases the lower chestnut was several mm higher.

We recommend the use of the shape of the chestnuts as a further partial identifying mark, particularly of horse breeds which are typically of one colour and horse breeds with infrequent markings. Proposal see Fig. 3 and Fig. 4.

As to administration concerning the drawing of the chestnuts, no special procedure would be required and no changes or new special forms. Authorised personnel would draw the outlines of the chestnuts on the respective limb. When issuing the horse's passport in the Central Register of Horses these shapes would be drawn directly into the table in the horse's ID.

SUMMARY

The main objective was to explore whether the size and shape of chestnuts could be used as suitable identification marks of horses. The shape and size of chestnuts were evaluated on 206 horses comprising of 11 breeds: Akhal Teke horse, English Thoroughbred, Arabian Thoroughbred, Czech warm-blood, Old Kladrubian horse, Hucul horse, Czech-Moravian Belgian horse, Noriker horse, Silesian Noriker, Haflinger and Shetland pony. The breeds were divided according to phylogeny classes.

The size of the chestnuts was measured with an adjusted calliper; we measured the height of the most protruding and the widest chestnuts in mm. The shapes were drawn into a special form and then

we evaluated the most frequently occurring shapes of the chestnuts. The form contained data which were used for processing.

The object of the monitoring was to evaluate whether the shapes of chestnuts and their dimensions were affected by a concrete breed and phylogeny class and whether age, sex and strength of the skeleton based on the bone are important. We applied the analysis of variance to evaluate the effects on the height and width of the chestnuts. The Tukey – B method was used for multiple comparisons. By means of GLM we assessed if the phylogeny class, sex and age had a statistically significant effect on the dependent variables height and width of the chestnuts on all four limbs. We tested the effect of these factors on the height and width of the chestnuts. The data were processed in Unistat for Excel version 5,1. From the general linear model we reached the conclusion that the phylogeny class and sex have a statistically significant effect on the height of the chestnut both on the right and left hind limb. We also discovered that the phylogeny class and age have a statistically significant effect on the width of the chestnut both on the right front limb and the left front limb. The analysis of variance of the dependent variables height and width of the chestnut on all limbs showed that with the exception of the left hind limb the effects of all the studied factors were statistically insignificant.

The shapes of the chestnuts are highly variable. Despite this fact we saw that 10 structures appeared most frequently; we also saw shapes that were undistinguishable but rarely two chestnuts or missing chestnuts on the hind limbs.

Acknowledgement

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List of abbreviations

A 1/1 – English Thoroughbred
ACHAL – Akhal Teke horse
CMB – Czech-Moravian Belgian horse
CT – Czech warm-blood
H – Hucul horse
HF – Haflinger
N- Noriker horse
NS – Silesian Noriker
OR 1/1 – Arabian Thoroughbred
SHP – Shetland horse, pony
STKL – Old Kladrubian horse
RF I – height of chestnut on right front limb
RF -- – width of chestnut on right front limb
RH I – height of chestnut on right hind limb
RH -- – width of chestnut on right hind limb
LF I – height of chestnut on left front limb
LF -- – width of chestnut on left front limb
LH I – height of chestnut on left hind limb
LH -- – width of chestnut on left hind limb
RF – right front limb
RH – right hind limb
LF – left front limb
LH – left hind limb
FEI – Fédération Equestre Internationale
Ohol. – bone
ÚEK – Central Register of Horses

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