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Characteristics of Mongolian Wild Ass hooves (*Equus hemionus hemionus*)¹

J. Gahsche, M. Stubbe, M. Opfermann, N. Batsajchan & A. Stubbe

Abstract

Measurements of hoof angles, hoof length, toe length etc. and non-metrical hoof characters of Mongolian Wild Ass carcasses collected in in the South Gobi and in Bordzongijn-Gobi desert are presented. Khulan hooves are flat, wide and look big in relation to the animal's dimensions. Remarkably is the wide variability in size, angles, in non metric characteristics like shape, colour and the occurrence of particularly prolonged hoof wall and flaring walls. For example, toe angles are 52° for front and 54° for hind hooves in average. This measures and the suggested graphical model of the „ideal hoof shape“ can assist to understand equine hoof morphology and to choose proper hoof care methods for domestic equids as well as for zoo-living wild equids.

Keywords: Mongolian Wild Ass, hooves, measurements, size variation

1. Introduction

Inspired by investigations on hoofs of wild living mustangs as the free living offspring of domestic horses that have been turned loose or escaped into the wild some hundred of years ago in Northwest America (JACKSON 1997, RAMEY 2003) we did several measurements on hooves of Mongolian Wild Ass (*Equus hemionus hemionus*) from the Julius-Kühn-collection of the Institute for Agricultural and Nutritional Science of the University of Halle. The material was collected by Prof. Dr. Michael Stubbe, Dr. Annegret Stubbe and the Mongolian scientist N. Batsajchan between 2002 and 2009 mainly in the South Gobi desert (Bordzongijn-, and Galbyn-gobi) during several Mongolian-German Biological Expeditions (see STUBBE 2007). Most of the animal material was found as dried carcasses nearly all killed by poachers, only few seem to have died by natural causes (ANSORGE et al. 2007). First results of hoof measurements and other morphological data were published by STUBBE et al. (2007).

The results of measurements on hoof angles, hoof length, toe length etc. and the non-metrical hoof characters presented here can assist to understand equine hoof morphology and to choose proper hoof care methods for domestic equids as well as for zoo-living wild equids.

2. Methods

The material investigated is small and consists of dried hoof capsules which were separated from coffin bone by maceration. Drying hoof horn gets compacter and hoof shape changes, it becomes smaller, and angles get sharper. Therefore we concentrated on a minimum of basic measures and two methods of measurement. At first dry hoof capsules were measured. Then the best preserved hoof capsules were soaked in water for 48 hours and measured again. Nevertheless, the measurement results may differ from measures of living animals. Under pressure of body mass the hooves will be flatter, wider and may be longer.

Measures of hoof capsules and coffin bones were taken with digital calliper on squared paper/underground and round head protractor (see fig. 1, 2).

¹ Results of the Mongolian-German Biological Expeditions since 1962, No. 301.

To get a visual idea of the natural hoof shape as a non-metrical characteristic we took photos of all appropriate hoof capsules in the relevant views. With the measurements and hoof photos a graphic designer digitally generated the “ideal hoof shape”.

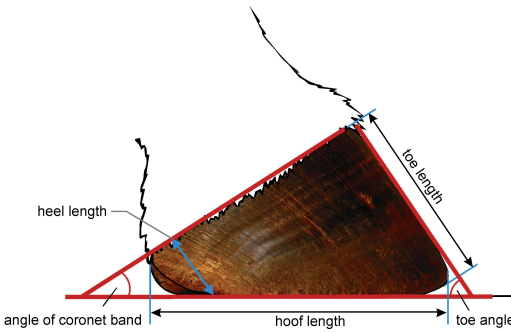


Fig. 1: Measures on Khulan hooves.

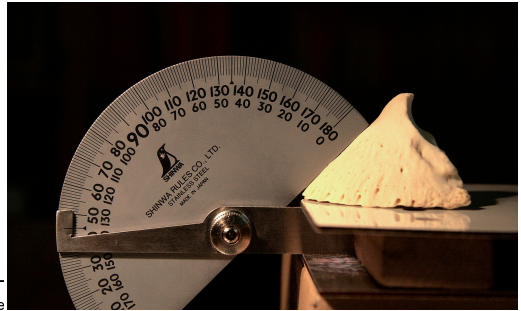


Fig. 2: Measuring toe angle with protractor.

3. Results and discussion

The results of the measurements relating to hoof size are summarized in table 1, these of coffin bones are presented in table 2. A brief description of characteristics of hooves and coffin bones follows below. Remarkable is the wide variability in size, angles, in non metric characteristics like shape, colour and the occurrence of particularly prolonged hoof wall and flaring walls. Fig. 3 shows impressions of the „ideal hoof shape“ of Mongolian Wild Ass as a model which combines the basic metric and non-metric morphological characteristics of Khulan hooves in a graphic.

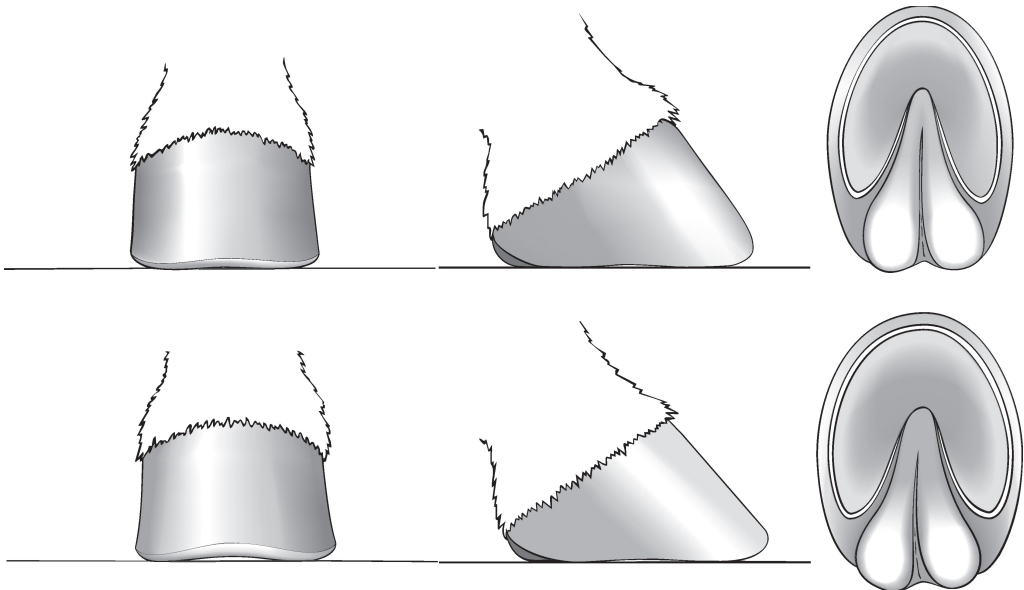


Fig. 3: „Ideal hoof shape“ of Mongolian Wild Ass - front hoof (above) and hind hoof (below) in anterior, lateral and bottom view (graphic design: C. SCHMIDT).

However, hooves of Khulan show the characteristics of horses living in plains and grasslands on soft or wet ground: their hooves are normally flat, wide and look big in relation to the animal's dimensions.

Mongolian Wild Ass live in the plains and hilly deserts, semi-deserts and grassy steppes (HEPTNER & NAUMOV 1966) with ground contains more sand, grit and gravel, usually without harsh and rugged rocks (like that area North American mustang lives). Vegetation types occurring in the southeast Gobi are generally dominated by shrubs and are classified as belonging to shrub desert steppe (DENZAU & DENZAU 1999, KACZENSKY et al. 2006, WEHRDEN et al. 2006a, b; WEHRDEN & WESCHE 2007). Khulans use a variety of plant communities but this species seem to seek areas of high biomass production, so called 'green-up spots'. These very nutritional and high-quality foraging areas are usually spatially and temporally variable and result from differences in local rainfall patterns (KACZENSKY et al. 2006). Within less than one year, animals collared in a study of KACZENSKY et al. 2006 ranged over an area in excess of 90,000 km². These excessive home ranges require a lot of movement – resulting in hooves with the characteristics described below: mustang roll, bevelled heels, flattened frog and the concave gouge in the hoof wall on the toe tips (especially if moving on sandy ground where the toe tip sinks deeper in the abrasive ground during rolling over).

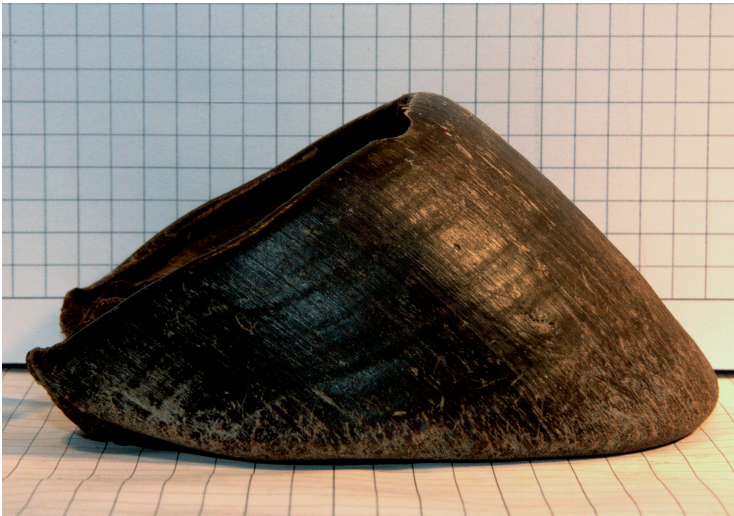


Fig. 4:

Lateral view of the hind hoof (Foto: U. ZÖPHEL).

Using this green-up spots causes also nutritional imbalances which results in deformations of hoof walls like nutritional rings, flared walls and other unnatural looking hoof shapes. Nevertheless the Khulan is highly mobile and inhabit a wide home range, move thousands of kilometres and reach maximum speed of 60 kilometres per our.

3.1. Hoof characteristics

Based on the material investigated and the results of measurements the hooves of Asiatic Wild Ass can be described as follows:

Anterior View:

- front hooves are wider than hind (see also measures in STUBBE et al. 2007),
- on toe tip of all hooves you can find the so called mustang roll (see JACKSON 1997),
- most of hooves investigated have a concave gouge in the hoof wall, this is much more remarkable in front than hind hooves (fig. 5).



Fig. 5:
Front hoof in anterior view, notice the remarkable gouge on the toe tip.

Superior view:

- front hooves tend to be rounder than hind hooves,
- front hoof length tends to be slightly longer and obvious wider than in hind hooves (see also the measuring results in STUBBE et al. 2007),
- median line of front hooves tends to divide the profile into two equal and symmetrical shaped sides,
- the median line of hind hooves tends to divide the profile into two unequal and asymmetrical shaped sides,
- median and lateral angles vary extremely and flaring walls in most of the hooves make precise measurements impossible.

Lateral view:

- toe length of front hooves tend to be slightly shorter than hind hooves,
- toe angles are 52° for front and 54° for hind hooves in average (see table 1) and therefore remarkably flatter (!) compared to angles of $58 - 63^\circ$ suggested for donkeys in different literature (e.g. FRIEDRICH 2005), the northwest American wild living horses have average toe angles of 54° for front and 58° for hind hooves (JACKSON 1997),
- average angle of coronet band (hairline) are 32° for front and 33° for hind hooves,
- heels of front and hind hooves tend to have approximately the same length,
- the heels of Khulans seem to be longer than such in mustang hooves but heels are difficult to measure and thus not really comparable (we tried 2 measuring points – in the region of heel triangle and in the area of maximum bend of bevelled heels) – at the maximum bend the heel length of Khulan is about twice the heel length of mustang hooves (JACKSON 1997),
- usually the heels are strongly bevelled (fig. 4).

Bottom (volar) view:

- front hooves tend to be rounder than hind hooves; hinds look arrowed at the front side,
- the soles are concaved, 15 - 17mm deep in median of measured soaked hoof capsules, measured from the level of hoof wall to deepest point of sole at the apex of frog,
- the frog appears to be pressed or worn flat,
- many of the Khulan hooves investigated have laid over bars - they appear to seamlessly pass over to the sole and then being worn off through animal movement (a significant amount of the sole might be coming directly from the bar laminae - see BOWKER 2003),
- thickness of hoof wall varies between 7mm (dried hoof capsules) and 9mm (soaked) (measured with digital calliper between outer hoof wall and beginning of white line on toe tip).

3.2. Coffin bone characteristics

The coffin bone principally causes the shape of the hoof capsule; some of statements above are transferable to coffin bones (fig. 6 - fig. 9). In anterior view the coffin bones of front hooves are wider than hind, in that view the median line of booth front and hind coffin bone tends to divide the profile into two equal and symmetrically shaped sides. A great number of coffin bones investigated have a concave gouge in the toe tip area (similar to the hoof capsules).

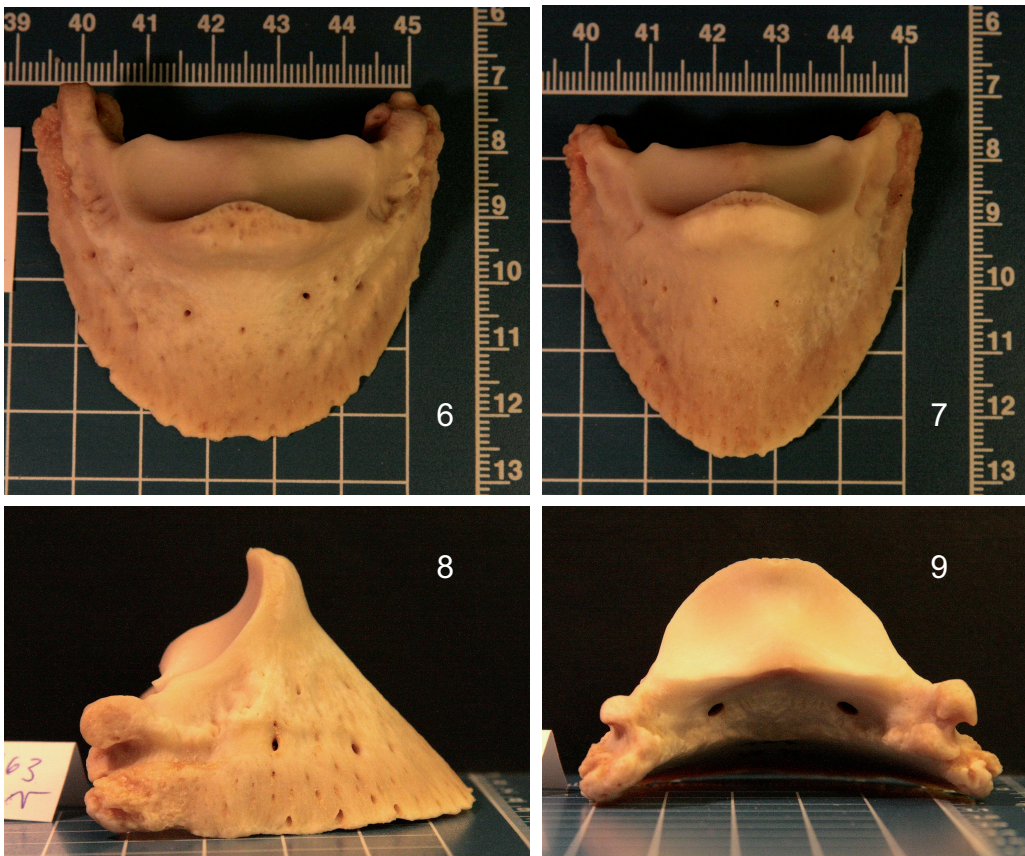


Figure 6 - 9: Coffin bones of Khulan: front right superior view, hind right superior view, front right lateral view, front right – view from behind.

Table 1: Results of measurements (in mm) on Khulan hooves (dried and wetted hoof capsules)

dry hoof capsules		hoof length	hoof width	concav-ity of sole	heel length measured from		toe length	toe angle	median angle	lateral angle	hoof wall thickness (toe tip)		
					area of maxi-mum bend	inner heel triangle							
<i>front</i>	average	99.4	74.1	13.3	24.3	38.2	61.9	52.9	84.4	80.4	7.3		
	standard deviation	11.40	10.87	2.60	7.27	7.24	7.13	3.52	4.07	5.93	1.13		
	median	101.0	73.0	12.5	23.5	38.0	61.0	53.0	84.0	82.0	7.0		
	N	31	31	28	36	37	35	31	29	28	37	37	
	Max	131	95	20	40	61	92	59	93	94	10	10	
Min	79	54	8	10	26	50	45	75	64	64	5		
<i>hind</i>	average	95.2	67.3	13.7	22.3	34.0	63.3	54.6	80.0	78.7	7.3		
	standard deviation	8.73	8.54	3.68	5.75	4.32	5.54	3.01	4.81	6.02	0.79		
	median	97.5	68.0	14.0	21.0	34.0	65.0	55.5	80.0	78.5	7.0		
	N	24	23	18	29	29	28	24	22	22	28	28	
	Max	107	85	18	36	44	72	61	93	92	9	9	
Min	77	49	6	12	24	50	49	72	68	68	6		
soaked hoof capsules		hoof length	hoof width	concav-ity of sole	heel length measured from		toe length	toe angle	median angle	lateral angle	hoof wall thickness (toe tip)	coronet band angle	
<i>front</i>	average	103.7	77.6	14.8	32.9	41.9	65.1	52.3	86.2	81.5	8.9	32.3	
	standard deviation	9.63	8.41	4.05	7.19	7.27	7.80	3.39	4.93	4.93	1.09	2.96	
	median	103.0	76.0	15.0	32.0	41.0	64.0	52.0	86.0	83.0	9.0	31.5	
	N	29	29	29	29	29	29	29	29	29	29	29	26
	Min	133	91	24	49	62	92	59	94	88	12	41	
Max	83	58	7	20	29	52	46	78	67	7	29		
<i>hind</i>	average	98.8	71.5	16.3	30.1	38.3	66.0	53.9	83.2	78.5	8.9	33.6	
	standard deviation	8.49	8.67	4.31	5.11	5.51	6.57	3.58	5.07	4.86	1.14	2.68	
	median	101.0	73.0	17.0	29.5	36.0	67.0	54.0	84.0	79.0	9.0	33.0	
	N	21	21	21	29	21	21	21	21	21	21	21	20
	Max	109	89	26	43	49	76	61	96	88	11	39	
Min	80	52	6	23	29	53	46	75	70	7	29		

In superior view coffin bones of front hooves tend to be rounder than in hind hooves. Front coffin bones are usually slightly longer and obvious wider than that of hind hoof. The median line of booth front and hind tends to divide the profile into two (in the front slightly, in the hind more unequal) asymmetrically shaped sides – the inner arch tends to be narrower and longer.

However, in lateral view coffin bone toes tend to have the same length in front and hind hooves. The toe angles are around 44° in front and 46° in hind (table 2) and therefore considerably flatter compared to the toe angles of hoof capsules!

In bottom view the soles of coffin bones are concaved, about 8.5 tot 9 mm deep measured from the level of outer wall to deepest point of sole at the region of frog’s apex. In that view the median line of booth front and hind divide the coffin bone into two unequal unsymmetrical shaped sides – the inner arch of coffin bone tends to be narrower and longer. The inner arch appears to be stronger, more compact and steep especially in view from behind - the outer arch stretches wider out (see fig. 7 and 9).

Table 2: Measures of Khulan coffin bones

	c.b. length in superior view	c.b. width in superior view	c.b. toe length	c.b. toe angle		con-cavity of sole
				standing on flat area around toe tip	standing mainly ground parallel	
front						
average	48.2	52.4	32.5	46.2	44.5	9.0
standard deviation	5.34	6.53	3.16	2.32	3.35	1.38
median	49.0	53.0	32.0	46.5	45.0	9.0
N	33	33	33	32	33	33
Max	60	75	38	51	51	12
Min	38	42	27	42	36	6
hind						
average	49.7	56.2	32.4	45.4	43.3	8.4
standard deviation	5.49	5.26	3.09	2.64	2.57	1.20
median	51.0	58.0	33.0	46.0	44.0	9.0
N	43	43	43	43	43	43
Max	57	64	38	51	47	11
Min	38	45	26	40	37	6

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Fig. 10: Khulan hoof from a carcass, good to see is the crossover from pelt to hoof with the overlapping hair, Foto: M. STUBBE.



Fig. 11: A herd of khulans in the South Gobi area, Foto: A. STUBBE.

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Mustela eversmanni

Vormela peregusna

Steppe polecat (photos: A. STUBBE) and Marbled polecat (photos: E. DRIECHCIARZ).
308