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Original Research Articles

Comparative Analysis of Whinnies of Czech Warmblood and Thoroughbred Horses

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Abstract

Loud acoustic signals of mammals may contain information about their progenitors. There is a question whether such phenomenon is possible to expect in domestic animal breeds as well, since the time of breed establishment has been a rather long one. Therefore we tested whether a significant morphological distinction of a newly established horse breed and its important founding contributor differed in their vocalization. We analyzed 304 whinnies of 35 individual horses (197 whinnies of 23 individuals belonging to Czech Warmblood and 107 calls of 12 Thoroughbreds). Despite of the fact that the two breeds differed significantly in most of their morphological measurements (height at withers, thoracic perimeter, cannon bone perimeter, and body weight), they did not differ in any of the measured acoustic parameters (both frequency and temporal ones). Our results indicate that morphological distinction of Thoroughbred and Czech Warmblood was not accompanied by distinct vocalization.

Keywords: *Equus caballus;* breed; vocalization; communication; morphology.

INTRODUCTION

Loud acoustic signals of mammals may contain information about their progenitors (see Meyer et al., 2012). There is a question whether such phenomenon may be expected in domestic animal breeds as well, since the time of breed establishment was sufficient. The common topics in equine research resolve studies of different aspects of domestication process and establishing various breeds including their morphological descriptions. Other works dealt with impact of imported breeds on sport performance. This is the case of the young Czech breed, the Czech Warmblood as well (Jiskrová, 2011; Makovská-Krčová, 2012). However, there is little knowledge of other breed-specific traits such as differences in behaviour patterns including horse communication; therefore more behavioural comparative studies are needed (Goodwin et al., 2008). Yeon (2012) noticed the importance of understanding horse vocalizations to reveal their motivation and physiological states including human-horse relationships. Knowledge of inter-breed variations could show whether artificial selection has altered communication signals of horses in the course of their domestication. Among various vocalization types especially loud calls represent signals potentially encoding inter-species relationships in wild members and possibly among domestic breeds as well (Policht et al., 2011).The most pronounced loud call of horses is the whinny. This signal contains information about behavioural context, individual identity, social status, including body size (Kim et al., 2010; Lemasson et al., 2009; Pond et al., 2010; Proops et al., 2009), and therefore represents an ideal model signal to test this question.

The purpose of the present study was (1) to describe the most frequently used acoustic equine signal (whinny) in two breeds and (2) to characterise the potential level of divergence of Czech Warmblood from its important founding contributor and to formulate how it differs from (or is similar to) the Thoroughbred based on the acoustics.

MATERIALS AND METHODS

Animals

Pedigree records of Thoroughbred horses are spanning 300 years (Cunningham et al., 2001; Hill et al., 2002) whereas the Czech Warmblood was formed recently as a new breed (Ignor and Cieśla, 2009; Jiskrová et al., 2002) with Thoroughbred, Holstein, Hanoverian and Trakehnen horses used as the breed basis. The name was introduced in 1983 (Ignor and Cieśla, 2009). Czech Warmblood is the most common breed in the Czech Republic (Misař, 2011). The English Thoroughbred represents the most important breed used for the improving of warm-blooded horses (Jiskrová, 2011).

The equine vocalizations were recorded at seven localities in the Czech Republic. The horses under study belonged both

Table 1. Measured parameters and acoustical software used for the analysis

Abbreviated name of parameter	Name of parameter	Acoustic software
qmed	median frequency of DFA (distribution of frequency amplitude)	LMA
df1mean	mean frequency 1st DFB (dominant frequency)	LMA
df2mean	mean frequency 2st DFB	LMA
df3mean	mean frequency 3st DFB	LMA
	duration of Introduction	Avisoft
	start of Introduction	Avisoft
	end frequency of Introduction	Avisoft
	duration of Climax	Avisoft
	start of Climax	Avisoft
	end frequency of Climax	Avisoft
	duration of End	Avisoft
	start of End	Avisoft
	end frequency of End	Avisoft
	call duration	Avisoft
	fundamental frequency of Introduction	Avisoft

to state and private owners and lived in social groups, on the pasture or in box stalls, i.e. in several kinds of housing. The state farm Písek kept only breeding stallions of various breeds. Stallions lived in large box stalls with the possibility of moving in paddocks. Vrchovany, Svinčice, Ctidružice, Brno, Křenek and Benešov were private farms housing horses for recreation, breeding and sport. The horses were kept in stalls or on pasture.

Data collection

Whinnies (gentle high sounds) of 35 individuals were recorded between July 2010 and December 2012. The calls were recorded using digital recorder Marantz PMD 620 (frequency response 20–20 000 Hz) with sampling rate of 44.1 kHz with a 16 bit sample size and saved in wav format. Vocalizations occurred after separation of an individual horse from the others. They were recorded mainly in outdoor conditions but some of them also in indoors. Information about breed, age, sex, and basic morphological measurements (height at withers, thoracic perimeter, head width, length of head, and cannon bone perimeter) were measured using standard measuring procedures (Gómez et al., 2012).

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Analyses

For the analyses only good quality calls were selected. We constructed spectrograms of the following parameters: FFT 1024, Hann window, frame size 100%, overlap 87.5%) with help of Avisoft-SASLab Pro 5.1.01 (Specht, 2010). For comparison purposes we analysed only calls containing all three typical parts of whinny: Introduction, Climax and End (Lemasson et al., 2009; Waring, 2003). Whinnies with the absence of any of these parts were excluded from the analyses. In Avisoft we measured following acoustical parameters directly from the spectrograms: duration, start and end frequency of Introduction, Climax and End part, call duration (duration of the whole whinny) and fundamental frequency of Introduction. Created spectrograms were saved as a txt format for the analyses in LMA 2008 (developed by K. Hammerschmidt), which extracts acoustical parameters based on the statistical distribution of an amplitude in the spectrum containing bands of dominant frequency including their global and local modulations, global energy distribution and main energy peaks (Fischer et al. 2001; Schrader and Hammerschmidt, 1997). We used the following parameters related to DFA (distribution of frequency amplitude) and DFB (dominant frequency bands): qmed (median frequency of DFA), df1mean (mean frequency 1st DFB), df2mean (mean frequency 2st DFB), df3mean (mean frequency 3st DFB) and mean frequency range (see Table 1). Some of these parameters were adopted from Lemasson et al. (2009): Duration of Introduction, Climax and End part, call duration (duration of the whole whinny), fundamental frequency of Introduction." All statistical tests were performed in STATISTICA ver.10.

RESULTS AND DISCUSSION

We analyzed 304 whinnies of 35 individual horses (197 whinnies of 23 individuals of Czech Warmblood and 107 calls belonged to 12 Thoroughbreds). The typical whinnies in both breeds are shown in Figures 1 and 2. These typical

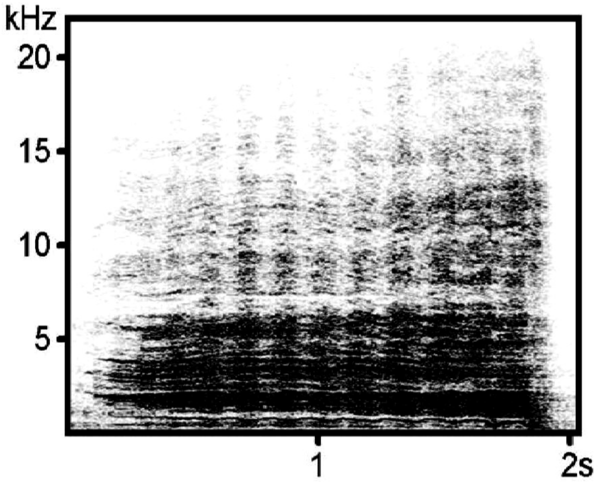

Figure 1. Spectrogram of typical whinny of a Thoroughbred

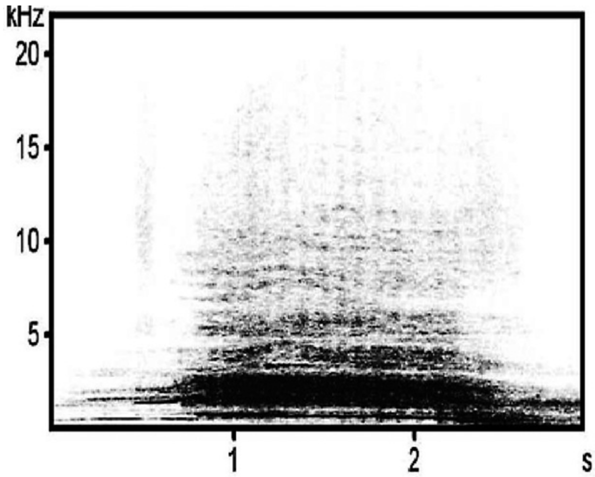

Figure 2.. Spectrogram of typical whinny of a Czech warmblood

horse calls contain three different segments: Introduction, Climax, and End (see Waring, 2003; Lemasson et al., 2009). Starting Introduction has a tonal frequency character resembling like a squeal. The longest and most conspicuous Introduction represents repetitive frequency modulated sounds ending with a more quiet End part showing chaotic frequency structure.

Duration of the whinny in Czech Warmbloods was 1.6 s, Introduction part lasted 0.37 s, Climax 1.02 and End 0.21 s. Whinny of Thoroughbreds lasted 2.0 s, Introduction showed 0.4 s, Climax 1.02 s and End 0.14 s. From of all acoustic parameters only call duration and climax duration significantly differed (call duration: Mann-Whitney U Test, $p = 0.016$; climax duration: Mann-Whitney U Test, $p = 0.023$). Duration of the call including of its main part climax could be the most effective structural unit for encoding information and manipulation with him could be linked with morphological variation like sex and inter-individual differences as well. Similarly call duration showed a significant importance in acoustic differentiation of equids (Policht et al., 2011).

This comparison included all individuals. To control the effect of sex we analysed whinnies in mares and stallions independently and they did not differ in any of measured acoustical parameter. It is obvious, that whinnies of Czech Warmblood and its important blood contributor do not significantly differ.

Additionally, we tested, whether investigated individuals differ morphologically (Table 2). Except for one variable (CB perimeter in Thoroughbreds) the values had normal distribution. Both breeds significantly differed in most of their morphological measurements: width of chest (Mann-Whitney U Test, $p < 0.001$), height at withers (Mann-Whitney U Test, $p = 0.004$), cannon bone (Mann-Whitney U Test, $p < 0.001$) and body weight (Mann-Whitney U Test, $p < 0.001$). Width of head and length of head did not differ (Mann-Whitney U Test, $p = 0.639$ and $p = 0.079$, respectively). The significant differences are not explained by the age variation of studied individuals because the average age did not differ between both breeds (Mann-Whitney U Test, $p = 0.45$).

Some of half-warmblood breeds look alike. The Czech Warmblood does not differ from Polish noble half-breed in their exterior as well (Ignor and Cieśla, 2009). Our results indicate that morphological distinction of Thoroughbred and Czech Warmblood was not accompanied by distinct vocalization, the two breeds did not differ in any of measured frequency parameter. Considering their significant morphological distinctness this finding is surprising because body size often has a direct link to vocal tract anatomy, e.g. larger larynx produces lover-frequency sounds in mammals (Riede and Fitch, 1999; Fitch and Reby, 2001). The influence of body size on design of vocalizations was found in Equids on inter-species level (see Policht et al., 2011). However, some authors found that domestication does influence the structure of some vocalisations (Monticelli and Ades, 2011), on the other hand, data have shown that vocalization characters have not changed much during domestication (Andersson et al., 2001; Miller and Gottlieb, 1981). This conclusion is supported by out results in that significant morphological differences, found in our study, did not result in distinctnes in whinny of the two equine breeds.

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Table 2. Morphological variables in Thoroughbreds (TH) and Czech Warmbloods (CW).

Breed	**Sex**	**Age years**	**TP**	**HAW**	**CB**	**LOH**	**WOH**
TH							
	mare	6	175.0	150.0	18.5	61.0	63.0
	mare	13	178.0	156.0	19.0	62.0	61.0
	mare	15	169.0	150.0	18.5	58.0	60.0
	mare	6	177.0	155.0	18.0	60.0	62.0
	mare	13	179.0	155.0	19.0	60.0	61.0
	mare	7	185.0	157.0	20.0	61.0	62.0
	mare	11	175.0	151.0	19.0	65.0	61.0
	stallion	4	174.0	159.0	18.5	63.0	64.0
	stallion	5	175.0	160.0	18.5	64.0	62.0
	stallion	17	177.0	163.0	19.5	61.0	63.0
	stallion 12	185.0	170.0	20.0	63.0	64.0	
	stallion 12	185.0	170.0	20.0	63.0	64.0	
Mean			177.83	158.00	19.04	61.75	62.25
SD			4.98	6.86	0.68	1.96	1.35
Median			177.00	156.50	19.00	61.50	62.00
CW							
	mare	12	192.0	167.0	21.0	64.0	63.0
	mare	10	193.0	161.0	21.0	61.0	59.0
	mare	11	190.0	162.0	21.0	62.0	61.0
	mare	20	210.0	163.0	21.0	63.0	67.0
	mare	11	193.0	163.0	22.0	66.0	64.0
	mare	14	189.0	171.0	21.5	65.0	67.0
	mare	5	200.0	160.0	21.0	61.0	59.0
	mare	6	193.0	164.0	21.0	64.0	61.0
	mare	10	187.0	166.0	20.0	65.0	64.0
	mare	17	186.0	160.0	20.0	63.0	61.0
	mare	21	197.0	168.0	21.0	65.0	64.0
	mare	7	190.0	158.0	20.0	60.0	59.0
	mare	12	180.0	153.0	19.5	65.0	63.0
	stallion	4	200.0	168.0	22.0	62.0	64.0
	stallion	4	195.0	165.0	21.0	61.0	62.0
	stallion	7	195.0	165.0	21.2	63.0	62.0
	stallion	9	195.0	160.0	21.0	60.0	59.0
	stallion	11	195.0	163.0	21.0	63.0	61.0
	stallion	13	195.0	163.0	21.2	65.0	64.0
	stallion	8	194.0	165.0	21.5	64.0	67.0
	stallion	8	196.0	167.0	21.5	62.0	63.0
	stallion	8	190.0	161.0	21.0	62.0	64.0
	stallion	14	193.0	163.0	21.5	64.0	63.0
Mean			193.39**	163.30*	21.00**	63.04^{ns}	62.65^{ns}
SD			5.75	3.85	0.62	1.75	2.46
Median			193.00	163.00	21.00	63.00	63.00
Mann-Whitney (p-value)			*0.0000*	*0.0106*	*0.0000*	*0.0793*	*0.6390*

Morphological measurements in cm: (TP) Thoracic perimeter, (HAW) Height at withers, (CB) Cannon bone perimeter, (LOH) Lenght of head, (WOH) Width of head.

Comparison of morphological measurements: Mann-Whitney U Test, (*) $p < 0.05$, (**) $p < 0.001$, (^{ns}) $p > 0.05$.

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