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Research article

Phenotypic analyses support investigations of phylogeny in the Skyrian pony and other breeds

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Although genetic analyses suggest that the Skyrian pony is unrelated to other breeds, it shares some physical features with Exmoor ponies, thought to originate in the primitive pony referred to as Pony Type 1, and the Caspian horse, thought to be descended from Horse Type 4. To test the hypothesis that the Skyrian shares the Exmoor's origin in Pony Type 1, comparisons were made of defined physical characters and morphometric measurements amongst Skyrian ponies, Exmoor ponies and Caspian horses. The average mean character differences were 0.56 ± 0.12 between the Skyrians and Exmoors, 0.43 ± 0.15 between the Skyrians and Caspians and 0.83 ± 0.06 between the Caspians and Exmoors. This approximates to reports comparing other horse breeds and breeds in other species, confirming that the Skyrian is a distinct breed. Using two-way analysis of variance (ANOVA), Friedman's ANOVA and *post hoc* tests, no significant differences were found between Skyrians and Caspians in the eye, neck, body and limb shape ($P = 1.000$) nor shoulder angle ($P = 0.222$) nor in the ratios of body length:elbow height, neck length:neck circumference and heart girth: height to withers. However, there were significant differences ($P < 0.001$) between Skyrians and Exmoors for these physical characters and ratios. While significant differences existed between Skyrians and Caspians in cephalic profile, parietal crest and tail placement ($P < 0.001$) and there were similarities between Skyrians and Exmoors in these physical characters ($P = 1.000$ or 0.098), overall the Skyrians appeared phenotypically closer to the Caspian, but unrelated to either breed. This investigation enabled the evaluation of a methodology comprising systematic, comprehensive investigations of phenotype, with data reduced and analysed by appropriate statistical methods, to clarify equine breed ancestry and phylogeny. The studies confirmed that the analysis of phenotype has utility and potential for investigations of phylogeny in species where there may be a paucity of information from the genetic base. Moreover, this approach has been shown to support and augment knowledge derived from studies based on genetic testing and provide a cost-effective and easily performed method of determining relatedness amongst equine breeds.

Key words: phenotypic variation, evolution, phylogeny, ancestry, horse

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Introduction

There remains considerable debate over the origin of the rare pony native to the Greek Island of Skyros, the Skyrian pony, which has declined rapidly in number to an estimated 200 since the introduction of agricultural mechanization in the 1960s and European Union grants to promote sheep and cattle grazing (Silva Project, 2009). The Skyrian is purported to originate in the mountain ponies, referred to as Pony Type 1, which migrated to Europe from America in the early Holocene period (Pickeral, 2003), while another theory is that its resemblances to Middle Eastern breeds

suggest an origin in Horse Type 4, the putative Arab progenitor.

There are two theories concerning the evolution of the domestic horse, *Equus caballus:* the restricted origin hypothesis postulates that domestic horses derive from one species, Przewalski's horse, *Equus przewalski prezewalski poliakov*, diversification into different breeds occurring through different environmental pressures and selective breeding (Vilà *et al.*, 2001).The second theory is the multiple origins scenario which maintains that domestic horses developed from a large number of ancestral equid species over a long period of time and is consistent with genetic studies confirming a high diversity of matrilines in faunal remains (Budiansky, 1997; Vilà *et al.*, 2001) and with phylogeny based on autosomal sequences, which suggested that Przewalski's and domestic horse lineages diverged at least 0.117 Ma (Goti *et al.*, 2011).

A polyphyletic theory proposed following morphological studies in the early 1950s suggested there were two sub-species of *Equus caballus* from which modern horses are derived: a Northern group, further divided into Pony Types 1 and 2, and a Southern group, comprising Horse Types 3 and 4 (Dalton, 2000; Pickeral, 2003). Teeth and mandible conformation of modern Exmoor ponies and Hipparion fossils suggests that the Northern group were specialized grazing animals, indicated in the curved mandible, accommodating a powerful musculature (Budiansky, 1997) and long, crowned hypselodont and hypsodont cheek teeth (Speed and Etherington, 1953). It was proposed that Pony Types 1 and 2, from which the Exmoor and Highland ponies may respectively derive, were adapted to cooler climates and had stocky proportions, thick skin and long manes. This contrasts with faunal skeletal remains and bone structure of modern Middle Eastern horses, which have a straight, shallow mandible and maxilla, short-crowned cheek teeth with roots curving backwards and straight incisors meeting at an acute angle, features attributed to the Southern group, likely to be browsers in a sub-tropical climate (Speed and Etherington, 1952). Horse Types 3 and 4 were slender, thin skinned and may have been the respective ancestors of the Akhal-Teke and the Caspian Horse (Dalton, 2000; Pickeral, 2003).

The Skyrian pony (Fig. 1a) has phenotypic similarities with both the Caspian horse (Fig. 1b), in its long, slender neck, body and limbs and with the Exmoor pony (Fig. 1c), in its coat colours, mealy muzzle and low-set tail (Dalton, 2000). It is possible therefore that the Skyrian Pony either shares the Exmoor Pony's ancestry in Pony Type 1 and that the Skyrian's phenotypic similarities with the Caspian Horse are explained by adaptation of Pony Type 1 to the warmer climate of Skyros (A. Copland, Personal communication), or the Skyrian shares the Caspians origin in Horse Type 4.

Although in recent years equine phylogenies have been investigated mainly at the genomic level (Jordana, Manteca and Ribo, 1999), the literature contains accounts of phenotypic investigations which have enabled the quantification of evolutionary traits and the reconstruction of phylogenetic relationships (Jordana, Pares and Sanchez, 1995; Khatouf, *et al.*, 2006). The main aim of this investigation was to compare defined phenotypic features, including physical characteristics and morphometric measurements, of Skyrian ponies, Exmoor ponies and Caspian horses, in order to test the hypothesis that the Skyrian shares the Exmoor's ancestry in Pony Type 1.

Figure 1. (**a**) A Skyrian pony. (**b**) A Caspian horse. (**c**) An Exmoor pony.

Additional aims were to contribute to the establishment of a breed standard for the Skyrian Pony and to evaluate these methods in determining horse ancestry.

Materials and Methods

The study followed ethical and welfare guidelines and advice obtained from the legislation (Anon, 2006) and the National Equine Welfare Council Compendium of Welfare Standards (NEWC, 2009). Forty-two horses (14 each of Skyrians, Exmoors and Caspians) were recruited for a cross-sectional study. The horses conformed to the appropriate breed standard for the Exmoor (Pickeral, 2003) and Caspian (Dalton, 2000) and to available descriptions of the Skyrian pony (Silva Project, 2009). At the time of the investigation, there were only 14 Skyrians present in Great Britain and all were recruited to the study. They were aged 2–6 years and comprised 3 stallions and 11 mares, 6 of which were pregnant. The Exmoor ponies, aged 8–22 years, included 11 geldings and 3 non-pregnant mares and the Caspian horses (4–18 years) comprised 8 stallions, 5 non-pregnant mares and 1 gelding, all selected at random by catching them in the order in which they walked up from the field to the observer and handlers. Age, sex and reproductive state of the horses recruited to the study could not be matched. All horses recruited were observed and measured during March 2011, by one author (S.A.B.) using the same measuring equipment. All horses were unshod and concurrent veterinary inspection showed them to be in good health and satisfactory condition: body condition scores, assessed using NEWC guidelines (2009), were in the range of 2.0–3.0 on a 5-point scale.

Thirty-three phenotypic assessments, comprising assessment of 18 physical characteristics (A–R) and 15 morphometric measurements (1–15) were studied. Each state of each physical character, A–R, was assigned an arbitrary number as detailed in Table 1.

Table 1. Physical characters and states assessed for each horse or pony

Physical character	State 0	State 1	State 2
A. Cephalic profile	Concave	Straight	Convex
B. Parietal crest	Absent[a]	Present	
C. Eye features	Almond shaped	Round, prominent	Round, thick upper eyelid
D. Coat around eyes	Colour as for rest of head	Paler around eyes	
E. Ear shape and size	Short, vertically inclined	Long, sloping	
F. Coat around muzzle	Colour as rest of head	Pale coat around muzzle	
G. Neck	Long, slender	Short, wide	
H. Shoulder	Sloping	Straight	
I. Prominency of withers	Low	Mid	High
J. Body	Slim, deep girth, close-coupled	Stocky, broad back, level across quarters	
K. Dorsal stripe	Absent	Present	
L. Limbs	Slender, no feather	Stocky, no feather	
M. Tail placement	Low	Mid	High
N. Tail head	As for rest of tail	Ice-fan[b]	
O. Shape of fore and hind feet	Both fore and hind oval	Fore foot rounder than hind	
P. Hoof horn	Dense black or white	Dense, black, no white	Mostly black, some white
Q. Coat colour and skin thickness	All colours with white markings and thin skin	Bay, brown, dun with no white and thick skin	Bay only. No white markings and thin skin
R. Overall body shape	Horse shaped	Pony shaped	

[a]Parietal bones do not meet so forehead is elevated to form the 'jibbah'.
[b]Tail head hair is short and spreads out to form a fan.

Morphometric measurements (1–11) were noted in centimetres and comprised circumferences of knee, cannon, torso and neck; heights to elbow, withers and croup; lengths of torso and neck; diameters of fore and hind feet at their widest points. The ratios of body length:height at withers, body length:height at elbow, neck length:neck circumference and heart girth:height at withers were subsequently calculated according to the modified methods of Khatouf *et al.* (2006) (Fig. 2).

Using the assessments made of physical characteristics (A–R), a matrix of resemblances of physical characters was composed and used to calculate the mean character difference (MCD) between each pair of the 42 horses (i.e. each horse was compared with the remaining 41 horses) according to the equation:

$$\text{MCD} = \frac{\text{number of unmatched (differing) characters}}{\text{divided by sequence length}}$$

where sequence length = the total number of characters) (Colegrave *et al.*, 2010).

The average MCDs and standard deviation between pairs of Skyrian ponies, Exmoor ponies and Caspian horses and between Skyrian and Exmoor ponies, Skyrians and Caspians and Caspians and Exmoors were then calculated, and a matrix of average MCDs composed.

The average MCD values between breeds obtained in this study were used to carry out multiple alignment and to construct a phylogenetic tree using the unweighted pair group method with arithmetic mean (UPGMA), the method of preference where evolutionary rates are considered constant (Colegrave *et al.*, 2010). Thus, the two breeds between which there was the smallest average MCD were grouped and the branch length to each breed from their proposed common ancestor was calculated as the difference between the two breeds divided by two (as the rate of evolution is assumed constant). A new matrix was then created treating the two breeds as a single composite group and the difference between this new group and the third breed was calculated as the arithmetic mean of the individual differences from each of the first two breeds, e.g. difference between breed (1/2) and breed 3 = (difference between 1 and 3 + difference between 2 and 3) divided by two. This result was then divided by two to give the length required of the third branch (Colegrave *et al.*, 2010).

Apparent differences in physical characters and morphological measurements were analysed statistically using two-way analysis of variance (ANOVA), Friedman's ANOVA and *post hoc tests*, the Mann–Whitney *U* (MWU) and Fisher's least significant difference of means (LSD) (GenStat, 2009).

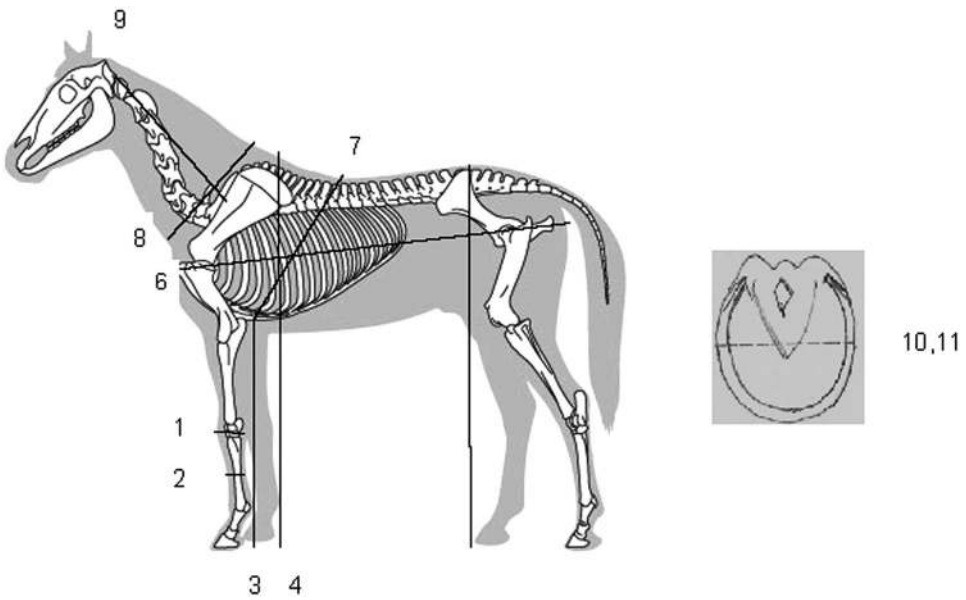

Figure 2. Morphometric measurements (centimetres) made for each recruited horse (adapted from Khatouf *et al.*, 2006). Circumferences of (1) knee (carpus, around the intermediate and third carpal bones), (2) cannon (midway between the distal end of the fourth carpal bone and the distal end of the cannon bone), (7) torso (heart girth; between the fifth rib (at the elbow) and the spinous processes of thoracic vertebrae 11–13 (bottom of withers)) and (8) neck (at the widest point). Heights to (3) elbow (olecranon process of the ulna), (4) withers (interscapular region at the highest point of the spinous processes of thoracic vertebrae 3–8) and (5) croup (tuber sacrale of the ilium), lengths of (6) torso (body), from the point of the shoulder (cranial part of the lateral tuberosity of the humerus) to the point of the buttock (tuber ischii of the ischium) and (9) neck, from the poll (external occipital protruberance) to the anterior border of the scapula, diameters of (10) fore and (11) hind feet at their widest points. The ratios of (12) body length:height at withers, (13) body length:height at elbow, (14) neck length:neck circumference and (15) heart girth:height at withers.

Results

The average MCDs and Standard deviations between Skyrian ponies and Exmoor ponies were 0.56 ± 0.12, between Skyrian ponies and Caspian horses, 0.43 ± 0.15 and between Caspian horses and Exmoor ponies of 0.83 ± 0.06.

The phylogenetic tree constructed using the average MCD values between breeds is shown in Fig. 3.

In respect of the physical characteristics which were nominal variables unsuitable for statistical analysis, all Skyrians and Caspians were thin skinned and horse shaped whilst all Exmoors were thick skinned and pony shaped. The majority of Skyrians (11/14), 13/14 Exmoors and 11/14 Caspians had hard, black feet, with the remainder showed varying degrees of white horn. Only the Caspians (14/14) had round fore and hind hooves while in all Exmoors (14/14) and most Skyrians (8/14) the hind hooves were more oval than the fore. The majority of Skyrians (8/14) shared the ice-fan tail head (tail head hair short and spreading out to form a fan) of all the Exmoors, whereas this feature was absent in the Caspians. The dorsal stripe was shared by all three breeds (13/14 Skyrians, all Exmoors and 10/14 Caspians); however, the paler coat around the muzzle and eyes was seen only in the Skyrians (12/14) and Exmoors (14/14). Features unique to the Skyrian were observed: its long and abundant mane, pendulous abdomen and steeply sloping hindquarters.

Results of Friedman's ANOVA test showed differences ($P = 0.001$ or 0.002) in each of the 10 ordinal characters amongst the 3 breeds with the exception of ear shape: all 42 animals had short, vertically inclined ears. Differences amongst the horses for each character are shown in Table 2.

There were significant differences ($P < 0.001$) between the Exmoors and Caspians in all nine remaining physical characters. The Skyrians and Exmoors differed significantly in six characters ($P < 0.001$): the shape of the eye in the Skyrians was large and round, whilst the Exmoors had prominent thickened upper eyelids. The Exmoors were thick necked and short and stocky in the limb and the body in contrast to the Skyrians that were slender and long in the neck, limbs and body. The sloping shoulder and mid-height withers of the Skyrian contrasted with the straight shoulder and low withers of the Exmoor.

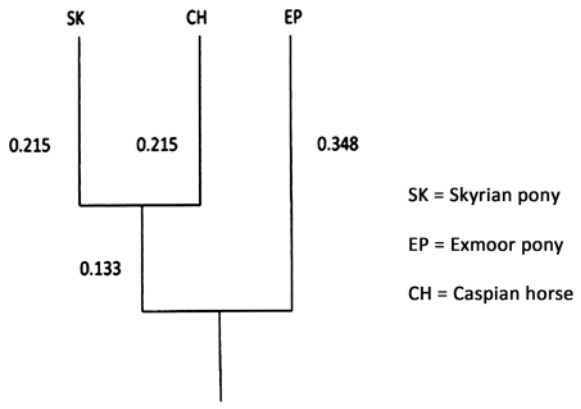

Figure 3. Phylogenetic tree constructed using the UPGMA applied to average MCDs.

Table 2. Differences amongst the horses (SK = Skyrian, EP = Exmoor, CH = Caspian) in each of the nine ordinal physical characters (NS = not significant, S = significant) ($P < 0.05$)

Variate	Description	SK/EP	SK/CH	EP/CH
A. Cephalic profile	SK/EP straight, CH concave	NS	S	S
B. Parietal crest	SK/EP present, CH absent	NS	S	S
C. Eye shape	SK/CH round, EP prominent	S	NS	S
G. Neck shape	SK/CH long, slender, EP wide, short	S	NS	S
H. Shoulder angle	SK/CH sloping, EP straight	S	NS	S
I. Prominency of withers	SK mid, CH high, EP low	S	NS	S
J. Body shape	SK/CH slim, EP stocky	S	NS	S
L. Limb shape	SK/CH slender, EP stocky	S	NS	S
M. Tail placement	SK/EP low, CH high	NS	S	S

Skyrians and Caspians differed significantly in four physical characters ($P < 0.001$): the Caspians had a high-set tail, concave profile and varying degrees of the 'jibbah' (the elevation of the parietal and frontal bones of the skull, as they fail to meet to form a flat crest); the Caspians also had high withers, contrasting with the mid-height withers of the Skyrians ($P = 0.018$).

Two-way ANOVA (Minitab, 2010) for each morphometric measurement in each breed showed significant differences ($P < 0.001$) for all measurements and ratios. Fisher's LSD (5% level) (GenStat, 2009) indicated that all three breeds were significantly different from each other in respect of 8 of the 15 measurements (Table 3): cannon bone circumference, height to elbow, height to withers, height to croup, neck circumference, diameters of fore and hind feet, and in the ratio of body length:height to withers. The Skyrians and Exmoors showed no significant differences in their neck length, but both breeds were significantly different from Caspians in this measurement. However, in 6/15 measurements there were no significant differences between the Skyrians and Caspians, but both breeds differed significantly from the Exmoors: knee circumference, body length, heart girth and in the ratios neck length:neck circumference, heart girth:height to withers and body length:height to elbow.

Table 3. Mean morphometric measurements (cm) of the Skyrian ponies (SK), Exmoor ponies (EP) and Caspian horses (CH)

Measurement	Skyrian	Exmoor	Caspian	SED	Significance
Knee circumference	23.64[a]	27.87[b]	23.16[a]	0.45	SK/CH ns < 0.001
Cannon circumference	15.61[b]	18.44[c]	14.43[a]	0.44	<0.001
Height to elbow (HE)	62.82[a]	68.54[c]	65.32[b]	1.09	<0.001
Height to withers (HW)	108.04[a]	122.39[c]	112.96[b]	1.53	<0.001
Height to croup	108.27[a]	126.07[c]	112.46[b]	1.59	<0.001
Body length (L)	117.70[a]	144.40[b]	118.10[a]	2.77	SK/CH ns <0.001
Heart girth (HG)	128.80[a]	165.30[b]	131.20[a]	2.82	SK/CH ns <0.001
Neck circumference (NC)	86.14[b]	111.68[c]	80.29[a]	2.07	<0.001
Neck length (NL)	51.39[b]	54.25[b]	46.00[a]	1.73	SK/EP ns <0.001
Diameter fore foot	7.26[a]	11.32[c]	8.80b	0.27	<0.001
Diameter hind foot	6.85[a]	10.55[c]	8.46[b]	0.23	<0.001
Ratio L:HW	1.09[b]	1.18[c]	1.04[a]	0.02	<0.001
Ratio L:HE	1.88[a]	2.11[b]	1.81[a]	0.04	SK/CH ns <0.001
Ratio NL:NC	0.60[b]	0.49[a]	0.57[b]	0.02	SK/CH ns <0.001
Ratio HG:HW	1.19[a]	1.35[b]	1.16[a]	0.02	SK/CH ns <0.001

Values sharing the superscripts a, b and c are not significantly different.

Discussion

Although both analyses of genotype and phenotype have been used to clarify the origins of other horse breeds and genetic diversity in horse populations (Royo *et al.*, 2006; Aberle *et al.*, 2007; Rossel *et al.*, 2008), there are few reports of investigations into the origins of the Skyrian pony, thus limiting comparisons with previous work.

Implicit in the use of physical characters to infer equine phylogenies is the assumption that observed variation in the phenotype closely reflects genetic variation. However, equine morphology, in addition to the genotype, is influenced by environmental factors, age, sex and reproductive state and, in this investigation, these factors could not be matched across the 42 horses recruited to the study. Although the pregnant mares were in their seventh month of gestation when studied, and thus not late enough in pregnancy for this to have notably influenced their morphology, the ratios of body measurements found here which showed that the Exmoor Ponies were more rectangular, compared with the Skyrians and Caspians which both tended more towards a square shape, may be an artefact of the unmatched ages of the horses examined: due to allometric growth there are differences in the rate of growth of different body parts, body ratios change with maturation (Grossi and Canals, 2010) and the foal has an overall square shape, which becomes increasingly rectangular with growth. Although the measurements and observations could not be carried out blindly, observer bias is unlikely as this would have tended towards results which supported the hypothesis that the Skyrian shares the Exmoor's ancestry, and this was not the case. However, a further potentially confounding factor in the use of phenotype to clarify phylogeny is the influence of cross breeding such that many recognizable breeds share common characteristics in the absence of a shared ancestry (Speed and Etherington, 1953 and Edwards, 1987). An estimated 150 established breeds of horses and ponies are known to be a product of a variety of crosses (Edwards, 1987) and it may be that the Skyrian is a hybrid with greater than one origin; crossing of the Andravidas, Thessalias and Zakynthos breeds with Thoroughbreds is common in order to improve their value (Cothran et al., 2010). From the foregoing, it is clear that bias was inevitably introduced and some of the findings in this study may be ambiguous and require further investigation.

These limitations notwithstanding the outcomes of analyses of the morphometric measurements, in particular the ratios of measurements, and the assessment of physical characters show that the Skyrian ponies observed had an overall phenotype, which differed significantly from that of the Exmoor pony. Relationships between the Skyrians and Caspians were less clear as 3/4 ratios of measurements were not significantly different. However, the analyses of the physical characters reflected the

differences between Skyrians and Caspians, and average MCDs were similar to those obtained between other horse breeds (Jordana, Pares and Sanchez, 1995) suggesting that, although they have a number of phenotypic features in common, they may not be closely related. Therefore, it can be inferred from the MCD analyses that Skyrians, Exmoors and Caspians are each distinct breeds of horses differing from each other to an extent which approximates average differences between other horse breeds. The phylogenetic tree based on the average MCDs (Fig. 3) shows greater evolutionary distance between Exmoors and, as a group, Skyrians and Caspians which appear slightly more closely related. Nevertheless, the latter two show sufficient divergence to confirm that they are distinct breeds. Phylogenetic analysis of a number of Greek horse breeds, including the Skyrian, showed that the Crete, Pindos and Pinias breeds had a high affinity to Oriental types, particularly those of Middle Eastern origin and the Andravidas, Thessalias and Zakynthos breeds clustered with the Thoroughbred, while the Skyrian appeared unrelated to any group of horses (Cothran *et al.*, 2010). Bömcke, Gengler and Cothran (2011) also concluded that Skyrians and Exmoors were not closely related and their estimation of genetic difference and construction of a dendrogram using blood group and biochemical and microsatellite loci indicated that Skyrian ponies were isolated, showing no close relationship with other Greek and foreign breeds (genetic differences 0.130–0.144). This may have been due to an artefact or due to the low level of variability in these breeds (Cothran and Luis, 2005) and a further explanation may be that the Skyrian originates in horse types not hitherto examined (Bömcke, Gengler and Cothran, 2011).

The Skyrian and Exmoor shared an overall primitive appearance denoted by the paler coat around the muzzle and eyes, low-set tail and dorsal stripe, reminiscent of Pony Type 1 and Przewalski's horse (Speed and Etherington, 1953) and this may explain and support the theory that the Skyrian shares the Exmoor's ancestry in Pony type 1. Alternatively, rather than symplesiomorphies (shared primitive character states), these superficially similar features in Skyrians and Exmoors may have evolved independently in separate equid lineages as a result of convergent evolution. A further finding of interest was the lack of white markings in the Skyrian and Exmoor, compared with the frequency of white in the Caspian coat. The emergence of white in animal coat colour is regarded as a hallmark of domestication (Trut, Oskina and Kharlamova, 2009) and this may suggest that the former two breeds have been domesticated and bred selectively for a shorter time than the Caspian.

The proposed breed standard for the Skyrian pony (Table 4) is drawn from the findings described in this investigation in addition to features noted during the observations of the animals that give this breed an overall distinctive phenotype: the long winter coat, abundant mane, sharply sloping quarters, pendulous abdomen and notable docility.

The similarities in outcome of this study with genetic studies (Cothran *et al.*, 2010; Bömcke, Gengler and Cothran, 2011) supports the view that evaluation of phenotype is a worthy methodology to accompany studies of genotype. Therefore, it is recommended that this work is repeated to clarify the outcomes of this investigation, both with an assessment of greater numbers of horses from each breed, matched in terms of age, sex and breeding status, and complemented with analysis at the genomic level using single nucleotide polymorphisms (SNP) data to clarify earlier investigations which used microsatellite loci (Bömcke, Gengler and Cothran, 2011). SNP analyses would permit the testing of over 70 000 markers in the genome at one time, and may identify loci which would enable the establishment of characters specific to the Skyrian pony and those, perhaps, shared by other breeds (E.G. Cothran, Personal communication).

Table 4. Proposed breed standard for the Skyrian pony, drawn from observations made during this investigation

Feature	Description
General	Overall proportions of a horse
Eyes	Large, round, prominent, set wide apart
Ears	Short, vertically inclined and close together
Head	Slender nasal bones and jaw. Straight profile
Neck	Long, slender and supple. Abundant mane
Shoulders and withers	Sloping shoulder. Mid-height or prominent withers
Body	Slim, deep-girthed and close-coupled. Slightly pendulous abdomen
Quarters	Steeply sloping from croup to point of buttocks. Low-set tail
Limbs	Slender, long, with long pasterns
Hooves	Hard, black dense hoof horn, occasionally white. Hind feet oval or round, fore feet round
Coat and skin	Long, dense winter coat, darker than the fine, short, silky summer coat. Thin, supple skin
Coat colours	Light bay, dark bay, dark brown. Very rarely stars, snips or socks. Dorsal stripe and mealy muzzle
Height	Mares and stallions similar, 105–115 cm
Temperament	Docile, intelligent and curious about people

Concluding, this study did not show a relationship between Skyrian and Exmoor ponies, nor between Skyrian ponies and Caspian horses, although there were more phenotypic features in common with Skyrians and Caspians than with Skyrians and Exmoors and the hypothesis was thus rejected.

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the horses and ponies, and to Robbie Hopper for guidance on phenetics and construction of the phylogenetic tree. The Caspian horses were kindly provided by Debbie Thompson, Dark Horse Saddlery and the Exmoor ponies by the Edinburgh University Exmoor Pony Trekking Section. Alec Copland imported to Scotland the foundation herd of Skyrian Ponies from Corfu in 2005. The study formed the basis of SAB's undergraduate dissertation for the degree of BSc (Hons) undertaken at the Open College of Equine Studies.

Author biography

S.B. carried out this research as part of her undergraduate dissertation towards the degree of BSc(Hons) in Equine Science completed at the Open College of Equine Studies, Boxted, Suffolk. The course comprised in-depth teaching and study into all aspects of equine science including welfare, nutrition, disease and immunity, theories of equine evolution, learning and behaviour, biomechanics and breeding. S.B. graduated in 2011 with a First Class Honours degree and made plans to complete a PhD project with further phenotypic analyses of Skyrian ponies complemented with studies at the genomic level in order to further elucidate their ancestry and origins. Funding for this work has not been identified so far. However, S.B. is pursuing her interest in the evolution of the horse and the impact of cross breeding and selective breeding on phenotype, with study of an Open University course in Evolution and with breeding and backing Skyrian ponies.

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