2007

# Investigation of the Kiang (*Equus kiang*, Equidae) Skull from Ladakh, India

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Erforsch. biol. Ress. Mongolei (Halle/Saale) 2007 (**10**): 227-230

# Investigation of the kiang (*Equus kiang,* Equidae) skull from Ladakh, India

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## Abstract

The species-rank of *Equus kiang* was recently supported by molecular and genetic studies (RYDER & CHEMNICK 1990). Three subspecies are currently recognized in this species: eastern - *E. k. holdereri*, southern - *E. k. polyodon* and western - *E. k. kiang*, differing in some cranial and external features (GROVES & MAZAK 1967). Kiang populations are scarce and widely separated at present; which was a reason for a reassessment of the taxonomic status and distribution of at least one or two of these three races.

An interesting skull of kiang was recovered by N. Paklina and C. van Orden from Ladakh (India) in 2001. It is the only kiang skull from the most western population in Russian zoological collections. Museum materials can be divided into two groups. One (*wild*) group of specimens originated from North and North-East Tibet, including skulls and skins collected by Russian scientists and travellers: N.M. Przewalskji (in 1886), G.E. and M.E. Grum-Grzhimailo (in 1890), P.K. Kozlov (in 1900). These animals putatively belong to *E. k. holdereri*. The second group (*captive*) consists of animals from zoos, belonging to *E. k. holdereri*, too*.* The association of the Ladakh skull is questionable. Both groups (*wild* and *captive*) differ well in terms of skull proportions (38 % measurements and 19 % indexes, $p < 0.05$), but there is some overlap in their cranial variability. The mentioned skull from Ladakh is also intermediate with respect to cranial features. Discriminant function analysis (Statistica for Windows 6.0) based on a set of cranial measurements distinguishes these two groups well (Wilks lambda = 0.0006), and ascribes the skull from Ladakh to the captive group (by Squared Mahalanobis distance and Posterior probabilities).

This result supports the view that the kiang populations from East Ladakh, North and North-East Tibet belong to the same subspecies - *E. k. kiang.* Results also demonstrate trends of cranial variability in animals bred in captivity.


**Key words:** *Equus kiang*, Ladakh, subspecies of kiang, cranial variability, captive

## Introduction

*Equus kiang* Moorcroft, 1841 is a relatively rare and poorly investigated ungulate species. The populations of this wild Asiatic horse in the Tibet region are difficult to access. There is only limited data on the natural history of this species, and collection materials are very limited. All this underlines the importance of the skull collected by N. Paklina and C. van Orden from Ladakh (India) in 2001. This is the only kiang skull in Russian zoological collections from the most western population of the species.

Species rank of *Equus kiang* was confirmed by recent molecular and genetic studies (RYDER & CHEMNICK 1990). Three subspecies are currently recognized: eastern - *E. k. holdereri*, southern - *E. k. polyodon* and western - *E. k. kiang*, which differ in cranial and external features and their geographical distribution (GROVES & MAZAK 1967, SHAH 2002). Kiang populations are small and widely separated at present; and the taxonomic status and relationships among populations still need to be reassessed.

Specimens kept in the Russian zoological museums can be divided into two groups. The first one (*wild*) originated from North and North-East Tibet, including skulls and skins collected by Russian scientists and travelers: N.M. Przewalskji (in 1886), G.E. and M.E. Grum-Grzhimailo (in 1890), P.K. Kozlov (in 1900). These animals putatively belong to *E. k. holdereri*. The second group (*captive*) represents animals from zoos. Kiangs in zoos also descended from the eastern

population - *E. k. holdereri* (SHAH 2002). Animals have successfully reproduced in zoos since the 1950s. There is an international studbook and schemes for exchanging breeding animals to reduce inbreeding effects.

The mentioned kiang skull from Ladakh (S-172787 ZM MSU) originated from the western part of the species' distribution area and may belong to *E. k. kiang.*

The main aims of this study were to investigate the morphological features of the two kiang subspecies and describe variability in cranial features that appeared during the time of captive breeding.

## Material and methods

The material includes 8 skulls of kiangs older then 5 years, held in the Zoological Institution of RAS (St.-Petersburg) and in the Zoological Museum of Moscow at M.V. Lomonosov State University. Methods of cranial measurements were described earlier (GROMOVA 1949a, b, 1959, 1963, EISENMANN 1980). Data were processed with the software packages Statistica for Windows 6.0 and MS Excel 7.0. For revealing parameters usable for determination of these subspecies we used further statistical procedures: Anowa and General Discriminant Analysis.

## Results and discussion

Cranial measurements of *E. k. holdereri* and *E. k. kiang* are generally larger than those of *E. k. polyodon*, but there is great overlap between these two forms (table 1). Thus, qualitative skull features can not be used for subspecies' identification. We identified parameters useful for discrimination of these subspecies using the statistical procedures Anova and General Discriminant Analysis. *Equus k. holdereri* and *E. k. kiang* differ most distinctly in basal length of skull, skull width at the *processus jugularis*, mandible length, and mandible incisor breadth. However, *E. k. kiang* has so far been present by a single skull, so all described features may also represent only individual deviation. Nevertheless, discriminant analysis divides the subspecies very well (after the addition of the group of *E. hemionus luteus*): correctness of the identification is 98%, Wilks lambda is 0.08 (fig.1, table 2). The skull from Ladakh (S-172787 ZMMSU) is separated from both wild and captive samples of *E. k. holdereri* (by both Squared Mahalanobis distances and posterior probabilities). This implies that the Ladakh skull is different from the skulls of *E. k. holdereri* but may belong to the subspecies *E. k. kiang.* This kiang population occurs in East Ladakh, North and North-East Tibet.

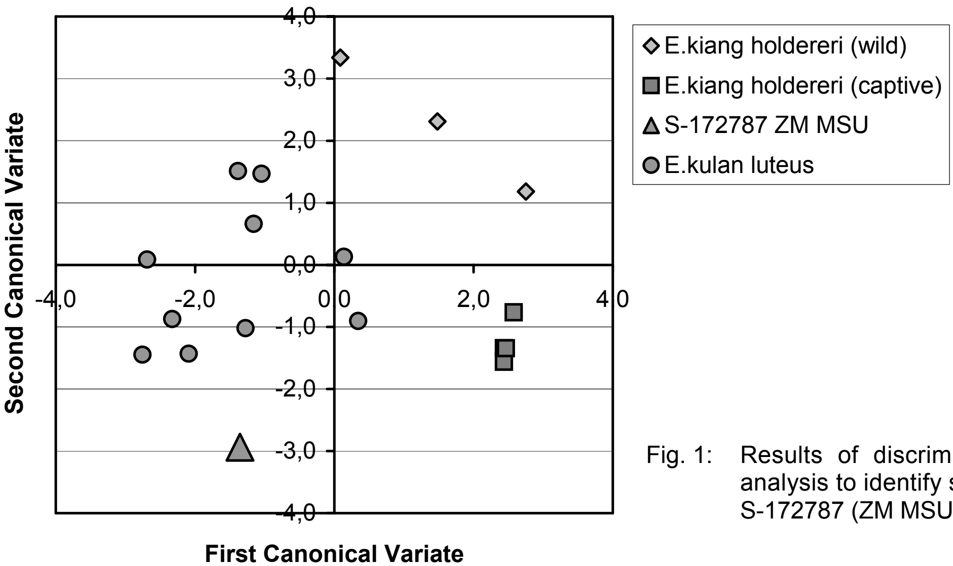


Fig. 1: Results of discriminant analysis to identify skull S-172787 (ZM MSU).

Table 1: Some cranial measurements of *Equus kiang* (in mm, means ± standard deviation)

| measurements (males) | by GROVES & MAZAK (1967) | | | | | |
|---|---|---|---|---|---|---|
| | n | **E. k. holdereri** | n | **E. k. kiang** | n | **E. k. polyodon** |
| greatest length (temporal) | 7 | 527.7 ± 12.6 | 10 | 518.4 ± 12.0 | 2 | 473 |
| basal length | 7 | 463.1 ± 9.4 | 10 | 461.2 ± 12.9 | 2 | 426 |
| palatal length | 7 | 238.4 ± 6.6 | 10 | 235.0 ± 10.7 | 2 | 226.5 |
| diastem length | 7 | 87.0 ± 6.7 | 10 | 81.5 ± 6.3 | 2 | 75 |
| length of tooth row | 5 | 168.2 ± 3.3 | 5 | 159.8 ± 4.0 | 3 | 156.0 ± 2.6 |
| diastem breadth | 7 | 47.3 ± 3.5 | 10 | 45.9 ± 2.0 | 2 | 40 |
| incisor breadth | 7 | 69.1 ± 4.0 | 10 | 69.8 ± 3.0 | 2 | 66 |
| palatal breadth | 7 | 60.6 ± 4.3 | 10 | 55.4 ± 6.5 | 3 | 45.7 ± 2.1 |
| orbital breadth | 7 | 207.4 ± 6.8 | 10 | 211.8 ± 8.3 | 3 | 201.3 ± 5.1 |
| occipital breadth | 7 | 58.9 ± 2.9 | 10 | 55.2 ± 4.0 | 2 | 53.5 |
| opisthion to inion | 7 | 61.3 ± 2.5 | 10 | 60.3 ± 2.9 | 2 | 55 |
| nasal length | 6 | 220.2 ± 6.1 | 9 | 203.2 ± 6.8 | 3 | 195.0 ± 3.5 |
| | | | | | | |
| **measurements (males)** | **n** | **S-172787 ZM MSU** | **n** | **E. k. holdereri (wild)** | **n** | **E. k. holdereri (captivity)** |
| greatest length (temporal) | 1 | 537.8 | 3 | 523.6 ± 8.9 | 4 | 530.9 ± 9.0 |
| basal length | 1 | 474.4 | 3 | 467.5 ± 6.6 | 4 | 484 ± 7.1 |
| palatal length | 1 | 254.2 | 3 | 243.9 ± 3.5 | 4 | 252.5 ± 2.6 |
| diastem length | 1 | 90.5 | 3 | 88.6 ± 3.1 | 4 | 83.3 ± 0.3 |
| length of tooth row | 1 | 165.2 | 3 | 165.1 ± 2.5 | 4 | 165.6 ± 4.8 |
| Diastem breadth | 1 | 46.3 | 3 | 50.6 ± 2.4 | 4 | 44.1 ± 2.7 |
| incisor breadth | 1 | 68 | 3 | 72.0 ± 2.5 | 4 | 69.2 ± 1.8 |
| palatal breadth | 1 | 62.6 | 3 | 63.1 ± 1.8 | 4 | 64.7 ± 1.8 |
| orbital breadth | 1 | 209.4 | 3 | 209 ± 5.8 | 4 | 210.1 ± 4.0 |
| occipital breadth | 1 | 55 | 3 | 54.5 ± 3.0 | 4 | 60.1 ± 0.7 |
| opisthion to inion | 1 | 63 | 3 | 63.3 ± 0.5 | 4 | 61.3 ± 1.8 |
| nasal length | - | - | - | - | - | - |

It is necessary to pay attention to differences in certain measurements which appeared in the animals from captivity. The samples from zoo animals were clearly separated from the wild kiangs of the same subspecies in the Discriminant function analysis (fig. 1). Zoo kiangs differ from wild individuals by larger values for the following features (Anova, $p < 0.05$):

- skull length: basal (3.5 %); premolars (3.8 %); anterior eyes (1.9 %) and posterior eyes (2.9 %) lines; anatomical facial axis (2.5 %); premolars' row length (19.1 %); orbito-facial length (2.4 %); mandible length (4.7 %) and symphyse length (10.5 %);
- skull breadth: skull width at *processus jugularis* (9.8 %); width between anterior orbital edges (3.4 %); interorbital width ( 4 %); external eminence of occiput (max.) (7.2 %);
- skull height: at P4-M1 (12.4 %); at M3 (7.3 %); on mandible at M1 (6.7 %), ascent part of lower jaw (4.6 %), at processi of mandible (8.9-10.1 %).

At the same time diastem length (7.3 %), cerebral box width (5.1 %) and maximal occiput height (4.9 %) are smaller than in wild populations ($p < 0.05$).

Table 2: Factor structure matrix (correlations variables - canonical roots)

| Skull measurements | Variate 1 | Variate 2 |
|---|---|---|
| basial length | 0.192797 | 0.91168 |
| width at *processus jugularis* | 0.143647 | - 0.49864 |
| mandibul length | 0.392911 | - 1.39146 |
| mandibul's incistor breadth | 0.730171 | 0.62549 |

These results correspond well to the data on the deviation of *Equus przewalskii* bred in captivity over more than 100 years (SPASSKAYA & ORLOV 1999, SPASSKAYA 2001). However in horses, in contrast to kiangs, basial length decreased and diastem length, occiput height, incisor and diastem widths increased in captivity ($p < 0.05$).

In 1966, GROVES (1966) also described common trend of decreases in skull proportions in kulans (*E. h. onager, E. h. khur*) and wild ass (*E. africanus africanus*) bred in captivity.

Undoubtedly, any further investigation on the variability of skull proportions in kiang, and diversification of the races of this species requires richer and more complete material for comparative studies. We are confident that this would reveal new and probably even qualitative features discriminating the subspecies of kiang.

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