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The Emerging Dziggetai (Equidae: *Equus hemionus* PALLAS): An Illustrated History of Taxonomic Concepts for the Identification, Classification, and Distribution of Hemiones from Central Asia

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The emerging dziggetai (Equidae: *Equus hemionus* PALLAS): An illustrated history of taxonomic concepts for the identification, classification, and distribution of hemiones from Central Asia [1)]

[1)] Herrn Prof. Dr. Michael Stubbe, Halle, in Anerkennung für seine jahrzehntelange wissenschaftliche Tätigkeit in Zentralasien gewidmet

A. Schreiber

Abstract

The history of the discovery and the exploration of the hemione populations (*Equus hemionus* PALLAS) from Central Asia (Mongolia, north-west China, north-east Tibet, Kazakhstan, and Russian Siberia) from the 13th century to approximately 1950 are compiled with the aim to provide materials for a taxonomic and population genetic revision of the dziggetais. Data on their phenotypic differentiation, historical distribution status, and their husbandry history in European zoological gardens, are reviewed, as is the gradual emergence of concepts of how to identify and to classify these populations. Hemiones were an important historical case in the discussion of how to represent the geographical-genetic diversity contained in a large mammal species from a geographically continuous range by taxonomic nomenclature best. The numerous opinions published about this Formenkreis reflect various contemporary concepts of zoological systematics in different periods of its development. In particular the existence and the nature of (transitory?) contact populations between named taxa needs attention, in order to demonstrate the ability of the ternary nomenclature to represent such a Formenkreis.

The historical evidence permits the inference of hypotheses for taxonomic and population genetic work. In recent historical times Transbaikalian Siberia has been visited seasonally by dziggetais from Mongolia. For this reason alone the subspecies *Equus hemionus hemionus* PALLAS, based on a type specimen from Dahuria, comprises the source herds of Gobi dziggetais from south Mongolia too. *E. h. bedfordi* MATSCHIE is a junior synonym of this same taxon. The genetic introgression of the Central Asian dziggetais from Dzungaria, south-west Siberia, and perhaps north-west Mongolia, by Middle Asian kulans (or the reverse introgression from the dziggetas into the kulans) is assumed, but it has been documented insufficiently. The name *E. h. castaneus* (LYDEKKER) had been based on the painting of a single zoo animal of doubtfully correct origin, and it cannot be employed until the mysteries around the identity of its type specimen have been clarified. A few hints concerning the possible contact and the (historical) exchange between dziggetai and kiang populations need attention and verification. The identity of a few historically important specimens in zoological gardens and museums could be clarified.

Key words: *Equus hemionus*, dziggetai, kulan, kiang, historical zoology, taxonomy, captive husbandry, conservation, Mongolia, China, Russia

1. Introduction

The Gobi dziggetais from Mongolia and China represent one of the largest surviving equid herds of the world. Being migratory herbivores in a semidesert created by an extremely continental climate regime, which roam over huge areas, dziggetais require a conservation strategy that considers very vast expanses of land (MONGOLIA MINISTRY FOR NATURE AND THE ENVIRONMENT 1999). Therefore a closer look into their genetic differentiation seems worthwhile to identify the geographical units for their population management. Unfortunately, hemiones had been exterminated from most areas bordering on the Mongolian and the Chinese Gobi before specimens, let alone series of specimens, could be collected. Therefore, the analysis of the population diversity of Central Asian hemiones has to include historical information, and sometimes even anecdotal observations and notes from early travellers and hunters.

This essay compiles and interprets historical concepts on the taxonomy and the ranges of hemiones, as far as they relate to the populations from Central Asia. It is meant to support the current genetic and taxonomic revision aimed at by our team of Mongolian (University of Ulanbataar), French (Musée National d'Histoire Naturelle, Paris) and German zoologists (Universities of Halle, Heidelberg, Karlsruhe, and Staatliches Museum für Naturkunde Görlitz) by historical evidence. The reconnaissance expeditions and projects from which the knowledge on dziggetais has grown are also reviewed to characterize the relevance and the scientific precision of the scattered historical reports. This review departs from two important studies: SCHLAWE (1986) had compiled the husbandry history of Central Asian hemiones in European zoological gardens, and DENZAU & DENZAU (1999) had provided information of many aspects of hemione biology. Though valuable, both predecessors are incomplete for many relevant details. The present study has aimed at the comprehensive coverage of the literature in the German, English, and French languages. It suffers from the neglect of most evidence published in Russian[1] , and of all papers in Mongolian or Chinese[2].

2. Hemione Taxonomy introduced

The genetic diversity contained in the Formenkreis[3] of *Equus hemionus* has elicited the attention of many professional and amateur zoologists alike, more so perhaps than has any other equid and possibly even the majority of ungulate mammals. A polytypic taxon formerly distributed from (Europe and) the Near East to Mongolia and Tibet, hemiones display phenotypic variability at both the local and at the continent-wide levels (cf. GROVES & MAZÁK 1967, DENZAU & DENZAU 1999, SCHREIBER et al. 2000). The initial description of *Equus hemionus* PALLAS 1775 from Central Asia was followed by the designation of the principal geographical races by the mid-19th century: *E. h. onager* BODDAERT 1785 from Persia; *E. h. khur* LESSON 1827 from Cutch in India; *E. h. kiang* MOORCROFT 1841 from Ladakh (India); *E. h. polyodon* HODGSON 1847 from Sikkim; and *E. h. hemippus* ISIDORE GEOFFROY 1855 from Syria. The subsequent 56 years saw the proposal of roughly another dozen names to designate more subtle variants (demotaxa): Six races were suggested for Mongolia and her neighbourhood alone, including adjacent territories in Russia, Kazakhstan and China (table 1). This period of taxonomic splitting might have ended in 1911 (1922; see chapter 10) with the description of three Central Asian subspecies alone in one paper (MATSCHIE 1911). The suggestion of two races of questionable validity in the 1940s (POCOCK 1947a) was not followed by further work during half a century in a prolonged period of neglect, and of an intellectual climate of taxonomic lumping. The revision by GROVES & MAZÁK (1967) defines the onset of yet another phase of hemione taxonomy. These authors were presumably the first zoologists who had visited many museums, and had viewed specimens from most named taxa. Other than the purely academic (and sometimes sterile) previous debates about the validity of races based on a few specimens this first revision proper entailed practical consequences: The International Studbook at the Tierpark Berlin accepted the separation of the freshly described Turkmenian kulan, *E. h. kulan* GROVES & MAZÁK 1967, from the geographically adjacent Persian onager, *E. h. onager* BODDAERT 1785, and has kept two studbook herds for breeding them (POHLE 2000). Ever since the numbers of accepted species and sub-species have risen again, partly also influenced by the idea that a philosophy of taxonomic splitting might represent the best approach to turn the attention of scientists and politicians to the rapid erosion of the genetic variability contained in hemiones. The World List of Mammalian Species compiled by the Smithsonian Institution and the American Society of Mammalogists recognized even three hemione species,

[1] The bilingual Latin and Cyrillic bibliography by MURZAEV (1954) facilitates the entry into the Mongoliana literature in the Russian language before 1950.

[2] Geographical site names in the Mongolian, Chinese, and Russian languages have been transliterated into one standardized spelling throughout the text. In cases of questionable identity the site names are spelt like in the quoted source. Author names are written like in the quoted papers, even though this decision implies multiple orthography for one and the same person (e.g. PRZEWALSKI, PRSHEWALSKI, PRJEVALSKI).

[3] Formenkreis (in the meaning of OTTO KLEINSCHMIDT, Wittenberg): A polytypic taxon of allopatric populations, any one of them residing either below or just beyond the level of speciation (biospecies), without fixing the formal category (species, subspecies) of the LINNEAN hierarchy.

i.e. *Equus hemionus* from Mongolia and her neighbourhood, *E. kiang* from Tibet, Ladakh, and Sikkim, and *E. onager* from Iran and her surroundings (GRUBB 1993). The latest conservation action plan of the I.U.C.N. Equid Specialist Group recognized an additional fourth species, i.e. *E. khur* from Cutch in India (GROVES 2002). It also accepted the long forgotten subspecies *E. h. castaneus* again. By the turn into the 21st century the splitting-lumping-splitting cycle has produced again opinions similar to those which had prevailed one hundred years before. Many of these changes of hemione nomenclature have not resulted from new data, but have rather reflected the opinion of (albeit experienced) observers[4].

Table 1: Classification of Central Asiatic dziggetais (*Equus hemionus* subspec. PALLAS)

The geographically adjacent kiang races *holdereri* MATSCHIE and *tafeli* MATSCHIE are treated in the text.

Taxon	*hemionus* PALLAS 1775, 1781	*castaneus* LYDEKKER 1904	*finschi* MATSCHIE 1911	*bedfordi* MATSCHIE 1911	*luteus* MATSCHIE 1911
Type material	iconotype, no museum specimen	iconotype, no museum specimen	iconotype, juvenile skull of immature, (ZMB 5216), skin of adult	skull (BM 1939.2472), skin, iconotype (LYDEKKER 1904a), photos (EDWARDS 1996)	skull (ZMB 32173), skin
Terra typica	Tarei Nor, Dahuria 50° N, 115° E	uncertain, perhaps Kirghiz-Nor; 48° N, 93° E	Lake Zaissan, Kazakhstan 48° N, 84° E	uncertain, perhaps SW Mongolia or Dzungaria	Suzmigal, Kansu Province, China

Diversified phenotypes from continuous, continental ranges represent one of the most difficult species constructions of mammals from the point of view of systematics. Their subdivision into subspecies almost by necessity conceals population genetic phenomena, e.g. belts of genetic introgression in hybrid zones, clines, or series of stepwise character transitions. This mismatch of population genetics and taxonomy can become relevant when the population units for species conservation and wildlife management need to be identified. But even on the academic level the extension of the LINNEAN approach to designate the population units below the species level has not convinced every zoologist working with species like hemiones. The insightful contributions by SCHLAWE (1986, 1990) confirmed the problems inherent in the subdivision of a (former) population genetic continuum in space into equivalent, intraspecific taxa. In fact the unresolved debate about both the categories and the nomenclature for the classification of hemione populations over two and a half centuries reflects the conceptual stage of systematic zoology prevailing in the respective periods of learned writing. Hemione taxonomy oscillated between predominantly pattern-based and function-based classifications. Several of the names offered reflect opinion rather than data, and single ones appear to be frankly arbitrary expressions of belief by authors who felt privileged enough to do so. Hemione taxonomy has thus remained a showroom for the historical development of zoological concepts, rather than approaching the much-desired consensus of how to understand this species (species complex). SCHREIBER et al. (2000) reviewed the major taxonomic schemes offered for the entire Formenkreis[5] for the use of those biologists who are responsible for breeding hemiones in captivity.

[4] An example of what seems to be a changed opinion is the equid taxonomy in the third edition of "Mammalian Species of the World" (GRUBB 2005). Instead of following GROVES's (2002) recent move from a three-species to a four-species concept, GRUBB (2005) combined *E. hemionus* and *E. onager* into one species *E. hemionus*, and upheld only the specific distinction of the kiang, *E. kiang*. This modified scheme from his previous edition (GRUBB 1993, see text) back to a two-species classification did not rest on new data, but is referred to GROVES & MAZÁK (1967), whose species concept had been ignored before (GRUBB 1993), and to SCHLAWE's (1986) compilation, which was a historical study of keeping hemiones in zoos however, and not intended as a revision.

[5] We continue to treat all hemiones (including the kiangs) as members of one Formenkreis, *Equus hemionus* (cf. SCHREIBER et al. 2000, SCHREIBER & ZIMMERMANN 2006). The validity of (two or more) different biospecies contained in this Formenkreis, or the application of more highly-resolving structural species concepts (e.g. the

3. The Discovery of Dziggetais by Europeans

There has probably never been a complete break in contact between Europe (and the Levant) and China: The land routes (including the silk routes) to the east almost inevitably led travellers through Chinese Turkestan, e.g. Xinjiang and the north Chinese desert belt (DABBS 1963). The first written record of a Gobi dziggetai might be credited to the Venetian merchant MARCO POLO[6], who travelled from Europe to the Chinese capital of Schangdu from 1271 to 1275 (CHARIGNON 1924, 1926, 1928, WRIGHT 1892, YULE 1871a, 1871b). He recorded the common occurrence of wild asses in the uninhabited sandy desert near the city of Eçina (= Edzina) in Tartary. Located at a distance of twelve day trips from Kampion, the capital of the Province of Tanguth (= Kan-cheu in Shen-si, China; cf. WRIGHT 1892), Eçina presumably represents the ancient "black city" of Chara-Choto on the lower reaches of the river Edzin-Gol, which runs into the Chinese Gobi and terminates just south of the Mongolian boundary (CHARIGNON 1924). The sand-blown ruins of that city were rediscovered by the Russian traveller KOZLOW in 1908 (HENZE 1993). POLO had either not observed these dziggetais himself, or at least he had not observed them from close quarters, because the same designation, i.e. w i l d a s s , had been employed by this attentive naturalist also for the onagers spotted previously when travelling from the Persian city of Yezd (Yasdi) to Kerman (WRIGHT 1892), and from Kerman to Cobinan (YULE 1871a, p. 116). A further record of "w i l d a s s e s in great numbers" by MARCO POLO refers to "northern Tartary", i.e. a land that also contained "white bears, foxes with black fur, sable and Pharao mice" (WRIGHT 1892, p. 447; YULE 1871a). These lands could be reached after crossing for two weeks a wide plain covered by an entirely uninhabited desert. This paragraph evidently refers to (all latitudes of) Siberia, and for the hemiones the vaguely indicated territory seems to correspond to the steppes of southern Siberia (then a part of the Mongolian-Chinese empire). Since POLO did not travel so far north himself at least this earliest record of hemiones in Siberia might rest on hearsay (see footnotes 6 and 7)[7].

The next account of a Gobi dziggetai might originate from the Jesuit missionary and scientist JEAN-FRANCOIS GERBILLON[8]. This record is undoubtedly of an authentic nature and likely the oldest observation in the territory of the present Republic of Mongolia. As the superior of the "Compagnie de Jésus" at Beijing, FATHER GERBILLON was elected by the Emperor as an

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Phylogenetic or the Recognition Species Concepts), are not denied by this pragmatic decision, but we deem the present insight insufficient to decide which of the many competing opinions about the nomenclature of *E. hemionus* is most pertinent. Nomenclatorical decisions on the basis of insufficient data easily divert the attention from the many conservation and management issues connected with certain classificatory aspects of hemiones.

[6] Born at Venice in ca. 1254, died there on 8th January 1324. POLO's travel books have been questioned. Many historians glorified his achievements as a masterpiece of geographical exploration far ahead of their time, while others doubted the credibility of his narratives. The secondary (and tertiary) literature on this subject is immense. HENZE's (2000) recent synthesis concluded that MARCO POLO had never visited China, and perhaps not even Asia, but he had compiled his books from reports by other (unquoted) travellers. HENZE (2000) felt that POLO's narratives represented the most impertinent fraud of the world's travel literature, but he conceded that the accounts from Persia, and somewhat less those from the Gobi, would contain many details which suggested authentic observations, from whatever source they had originated.

[7] POLO's travel book mentions the occurrence of African wild asses in Abyssinia too (WRIGHT 1892, CHARIGNON 1924, 1926, 1928). However authentic his writings were (see footnote 6), this Venetian writer from the late 13th century writer was aware of four hemione and wild ass populations (i.e. Persian onagers, Gobi dziggetais, Siberian hemiones, African wild asses). POLO's record of w i l d a s s e s from the island of Madagascar could refer to feral donkeys which later became extinct. Since giraffes and wild pigs were reported from this island too, this record more likely rests on fiction however, or on the confusion with the feral donkeys from Socotra. The latter island in the Gulf of Aden had been described in the chapter preceding the account on Madagascar. POLO has definitely not visited one of these islands in the Indian Ocean.

[8] Born at Verdun in Lorraine on 4th (11th) June 1654, died in Beijing on 25th (27th) March 1707. FATHER GERBILLON was one of six Jesuit priests sent by KING LOUIS XIV. to the court of the second Manchou Emperor KANGXI (K'ANG-HI) in Beijing, where they taught the Chinese royalty mathematics, cared for a small elite community of baptized Beijing citizens, and as a member of the "Académie des Sciences" corresponded with European scholars on Chinese geography, history and culture (DE THOMAZ DE BOSSIÈRE 1994).

interpreter and diplomat to negotiate for China the treaty of Nercinsk (= Niptchou)[9] in Dahuria: Russian troops had penetrated to the Amur, had built fortresses on the edge of Mongolia, menaced the independence of the Kalkas and the Manchou tribes, and disturbed Chinese hegemony plans. Two voyages to the Dahurian steppes, the second in company with the Portuguese priest PEREIRA, brought FATHER GERBILLON the honour of preventing war between Russia and China (the peace treaty kept valid till 1860), but they also led to the discovery of the dziggetai for western science. The original manuscripts of his travel diaries to Tartary seem to be lost (LANDRY-DERON 2002), but they had become incorporated into the Jesuit encyclopaedia for China and Mongolia compiled and edited by PÈRE JEAN-BAPTISTE DU HALDE at Paris in 1735. On 13th July 1689, two weeks before starting their diplomatic duties at Nercinsk (DE THOMAZ DE BOSSIÈRE 1994), GERBILLON and PEREIRA witnessed a battue hunt for plains game in what is today east Mongolia, where among other bags a female w i l d h i n n y could be driven into an enclosure and killed (GERBILLON 1749 [reprint], p. 169). Named t c h i k r e y by the Mongolian hunters the bodily proportions of this dziggetai reminded the two jesuits of a hinny foal of several months of age. They noted its long ears, a high-legged stature, a slender rump and a longish head. Hairs were ash-grey (sic), and the claws (sic) and feet resembled those of mules. The hunt took place outside the borders of the Chinese Empire, in the then politically neutral zone between China and Russia used by the Kalkas Mongols. According to the "Carte Général de la Tartarie Chinoise" issued in 1732 by FATHER JEAN-BAPTISTE BOURGUIGNON D'ANVILLE (1737/1785)[10] the camp site on the night following the hunt, named E r d e n i T o l o h o r i , was located about half-way between the Matad Uul Hills and the southward bend of the Kerlen River (= Kherlen Gol) in what is today the Dornod Aimak[11]. This first record of a hemione in Mongolia is located not too far away from the Lake Tarei-Nor in adjacent Russia, where 83 years later P. S. PALLAS will collect the taxonomic type specimen of the dziggetai. In summer 1689 this area contained several rivers and lakes, and after the rains it had offered plenty of water and grass forage for thousands of y e l l o w g o a t s (= Mongolian gazelles, *Procapra gutturosa*). DU HALDE (1735, 1749) condensed this account and other observations of dziggetais, all of them drawn from the travel activities of the French jesuits in Tartary, into a short textbook paragraph on the w i l d h i n n i e s o f T a r t a r y (op. cit., p. 31). The database for DU HALDE's encyclopaedia had been compiled from the direct communication with the China-based missionaries, and from their replies to questionnaires issued to them by the Académie des Sciences in Paris, and to a second one from the German philosopher GOTTFRIED WILHELM VON LEIBNIZ (LANDRY-DERON 2002). DU HALDE (1749) had compiled the reports from all 27 jesuit missionaries in China into his four volume treatise on Chinese geography without giving credit to the individual informants (LANDRY-DERON 2002, p. 69)[12]. However FATHER GERBILLON alone had contributed the equivalent of 360 pages to the encyclopaedia, and as a naturalist he seems not to have missed any opportunity for wildlife watching and hunting during his religious and political missions[13]. Quite likely therefore the texts concerning the Gobi fauna can be traced to him at least partly. The wild hinnies of Tartary could be met in small groups, but they were less frequently encountered than were the y e l l o w g o a t s (= gazelles). The designation of w i l d h i n n y was traced to the Chinese term Y e l o t s e. DU HALDE (loc. cit.) objected to this designa-

[9] Also Nerchinsk, Nertschinsk.

[10] "Premier géographe du roi", born in 1697, died in 1782.

[11] Stielers Handatlas (HAACK 1939) presents a site named T o l o h o r i at ca. 47.5° N, 116.0° E, close to the Manchurian border.

[12] A closer inspection of the writings by these missionaries on the large mammal fauna of the Gobi may prove rewarding. The jesuits stayed long in the Far East (on average 25 years each), enjoyed intimate contacts with the political and scientific elite communities of China (characterized by friendship and personal appreciation), and were fluent in Chinese or "Tartarian". These are very important differences to the working conditions of almost every later European explorer. They travelled before Chinese supremacy had changed the politics, and the land use economy, of many tribal lands in Central Asia.

[13] GERBILLON visited east and south Mongolia eight times, in the years 1688, 1689, 1691, 1692, 1696 (twice), 1697, and 1698, and traversed the Gobi several times (HENZE 1983).

tion because the external appearance of these animals, and the texture and the taste of their flesh, differed from domestic mules. They were relished as venison, but many efforts of taming dziggetai for the use as pack animals had failed. This hint to the attempted domestication of dziggetais in "China and Tartary" may be the oldest such evidence for Central Asiatic hemiones. Dziggetais rather than kiangs are surely referred to in this chapter on Mongolia and other regions in the Central Asiatic forelands in the north of Tibet, and wild horses are clearly distinguished too[14].

In the years 1724 and 1725 DANIEL GOTTLIEB MESSERSCHMIDT[15] explored, within the frame of a seven-year expedition to Transuralian Russia supported by the CZAR PETER, the geography and the natural history of south Siberia. Dahuria was traversed through the Onon steppes and along the Argun River to the Lake Dalai-Nor. On 19th and 20th August 1724, his hunters collected four z i g i t h a y [16] in the steppes of the Onon River country, where the Central Asian arid belt extends north-eastwards into Siberian territory (PALLAS 1782, MESSERSCHMIDT 1966 [reprint]). Located at some 176 wersts (1 werst = 1066.78 m) beyond Nercinsk en route to Argun'skij-Zavod this site produced the first record for Siberia approximately 650 years after MARCO POLO had vaguely announced the occurrence of hemiones thus far north. Dahuria is the northernmost and easternmost territory in the vast range of hemiones across Asia. The first Dahurian dziggetai shot was eaten by the expedition crew before scientific examination. The others were used on the following four days to prepare a drawing, to record body measurements ("rheinländische Fortifikationsmaße"; op. cit., p. 119) and to take notes of the internal anatomy after dissection[17]. At least one skin was prepared for tanning, and deposited (exhibited as a mount?) at the Zoological Museum of the Russian Academy of Science in St. Petersburg. It was soon lost in a fire (PALLAS 1781a). The notes and the drawing seem to have never been published, but a hand-written and apparently very detailed manuscript on osteology ("... bis zum Ekel weitläufige Osteologie ..."; PALLAS 1781a, p. 4) had been stored for at least 50 years till PALLAS's days. It seems lost too. MESSERSCHMIDT's (1966 [reprint]) observations were obviously guided by the ancient ARISTOTELIAN diagnosis that hemiones (i.e. in that case hemippes and onagers) were free-ranging (albeit fertile) mules, and he designated them as d a v u r i s c h e s M a u l t i e r or M u l u s f o e c o n d u s D a v u r i c u s .

In 1727 the German LORENZ LANGE traversed the Mongolian Gobi en route from Kyakhta to Beijing (LANGE 1781). The desert had been entered at the station Udde on 30th October 1727. Apart from the goat D s e r e n (= goitred gazelles?) migratory herds of the "w i l d e H a l b p f e r d D s c h i g g e t a i " occupied the "High Gobi" (op. cit., p. 101). P. S. PALLAS edited and published LANGE's diaries several decades later in 1781, i.e. six years after his own description of *Equus hemionus* (see below), and he had presumably introduced the designation D s c h i g g e t a i into this report, which had recorded these equids in the Mongolian Gobi long ago.

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[14] This possibly earliest and widely overlooked record of the Przewalski's horse (DU HALDE 1749, p. 32) points out that they ranged further in the west than did the w i l d h i n n i e s , namely in the landscape Kalkas (= central and east Mongolia; cf. D'ANVILLE 1737/1785), and in the borderlands of Hami. They lived in small groups and upon contact with domestic horses they attempted to integrate them into their groups, or pushed them aside and frightened them. Perhaps a more detailed evaluation of early Chinese (and, for that matter, French jesuit) sources will reveal more detailed information about the relationship and perhaps the interbreeding of wild horses and domestic ponies.

[15] MESSERSCHMIDT (born at Danzig in 1685, died at St. Petersburg in 1735) was a doctor of medicine with an interest in natural history. He doctorated at the University of Halle in 1707. His scientific collections from Siberia were lost by shipwreck. Returned to his natal city Danzig MESSERSCHMIDT found himself not well received, and he proceeded to St. Petersburg to end his life in poverty.

[16] MESSERSCHMIDT distinguished the Tungusan name Z i g i t h a y into A d s h i r g e k a j a for the stallion, and into G g o e c k for the mare.

[17] SCHREBER (1844a) added that the dissection of MESSERSCHMIDT's mare produced a mouse-sized embryo.

In 1735 JOHANN GEORG GMELIN[18] traversed the Dahurian steppes. Referring to MESSERSCHMIDT's report he and his companion GERHARD MÜLLER (1705-1783) spent the 4th and the 5th August 1735 near the salt lake of Zagan-Nor in the pursuit of dziggetais. Not seeing a single one of them, GMELIN recounted the presumably pertinent information from his Tungusan hunters that dziggetais used to roam widely, and that they would emigrate from Mongolia to fill the Argunian steppes only during periods of climatic drought (GMELIN 1752). In Dahuria one could encounter either none of them or instead large numbers. A few years later GMELIN saw the corpses of hunted dziggetais in the city of Irkutsk, and he noted that they were "light brown equids with a cow tail and very long ears" (op. cit., p. 107). He designated them as w i l d e M a u l e s e l (= wild hinnies), and explained MESSERSCHMIDT's choice of the designation w i l d e s M a u l t i e r (= wild mule) rather than wild ass by their rapid gait, which would surpass the speed of a donkey.

The taxonomic priority for the dziggetai and, at the same time, the entire Formenkreis of *Equus hemionus*, is due to PETER SIMON PALLAS[19], who traversed the Dahurian steppes 50 years after MESSERSCHMIDT. The type specimen was an approximately three year old mare collected by his Tungusan hunters near the Lake Tarei-Nor ("ad lacum Tarei Davuriae") in the steppes between the rivers Onon and Argun on May 26th, 1772 (PALLAS 1775)[20]. It was brought for investigation to the village Kulussutai. The Tarei-Nor was an extensive saltpan amidst plains covered by tall steppe, which fell dry in summer except a few pools (PALLAS 1782)[21]. This site is located on Russian territory, just outside the north-eastern boundary of contemporary Mongolia. HARPER (1940) located the terra typica at 50° N, 115° E, and DENZAU & DENZAU (1999) at 50.2 ° N, 116° E[22]. PALLAS (1775) provided a very detailed diagnosis in Latin language, which is unusually exhaustive when compared with other taxonomic species diagnoses of the late 18th century, and which was accompanied by a black and white drawing (fig. 1a)[23]. The subsequent German version (PALLAS 1781a) included a coloured version of the same illustration (fig. 1b), showing a reddish-

[18] "The older GMELIN", born at Tübingen on 10th (12th) August 1709, died there on 20th May 1755. From 1731-1747 he worked as a professor for chemistry and natural history at the Imperial Academy of Sciences, St. Petersburg. Botanical explorations in Siberia in the years 1733-1743. From 1749 till his death in 1755 he served as the professor for botany and chemistry at the University of Tübingen. His travels in Siberia concentrated on botany (HENZE 1983).

[19] P. S. PALLAS was born in Berlin on 22nd September 1741, and died there on 8th September 1811. He was educated at the Universities of Halle and Göttingen, doctorated at Leiden, and gained experience as a taxonomist when working in the Dutch animal collections of the period. Invited by CATHERINE II. of Russia, he became a professor at the Academy of Sciences of St. Petersburg in 1769. The 1769-1774 expedition took him to the Caspian Sea, the Ural Mountains, the Altai, and the Amur basin. Explorations of southern Russia followed in 1793-1794. PALLAS was an experienced zoologist whose taxonomic proposals often stood the test of time.

[20] The date refers to the "old calendar" (PALLAS 1781a). Therefore the collection date should have been in early June (approximately 10th June) 1775 in the modern Gregorian calendar.

[21] RADDE (1861 [1970 reprint]) found the Tarei-Nor subdivided into two salt lake basins, the Barün Tarei and the Dsün Tarei, a situation which had presumably prevailed during PALLAS's earlier visit too. PALLAS collected the dziggetai apparently near the larger lake basin, the Barün Tarei, which extended over an area of 40 x 20-25 square wersts, and was located on Russian territory exclusively (op. cit., p. 358).

[22] LYDEKKER (1916a) assigned the terra typica incorrectly to the "Altai". This error likely misled ANDREWS (1924) to believe that his dziggetai series from the south Mongolian Gobi would extend the known geographical range of the nominotypical race (to which he affiliated the Gobi herd) several hundred miles to the east.SCHWARZ (1929) erroneously cited the Lake Dalai-Nor in Manchuria as the collection site, possibly deceived by the short abstract in PALLAS (1811), whose geographical record only reads "Animal equifero...frequens... ad deserta in finibus Sibiriae, Argunum fl. et lacum Dalai circum jacentia accedens..." (op. cit.; p. 262).

[23] The plate 22 of Reclam's reprint of 1987 of PALLAS's book "Reisen durch verschiedene Provinzen des Russischen Reichs" (PALLAS 1771-1776) depicts a misidentified horse foal as a "K u l a n (*Equus hemionus*)". The horse-like tail readily reveals this error of what presumably represents the feral horse from Buzuluk, which has been characterized by PALLAS elsewhere (op. cit., p. 363). UNRUH (2002) reproduced this misidentified specimen in the erroneous belief to illustrate a Siberian dziggetai. Centuries before SESTINI (1786) had copied the same plate mistakenly as a Syrian hemippe (see SCHLAWE 1990).

brown dziggetai which does not fit the species description exactly. A summary was reproduced in English language (PALLAS 1798). A reprint of PALLAS's article, augmented by editorial notes, appeared in DE BUFFON's (1798) treatise, which was arguably the most complete zoological encyclopaedia in the 18th and early 19th centuries, and (re)appeared in various edited and amended versions in several European languages. Presumably this widely disseminated encyclopaedia popularized PALLAS's description, and helped to coin the common usage of the Germanized name Dschiggetai as a synonym of all hemiones throughout the 19th century[24].

The type specimen had terminated the moult into the smooth, short-haired summer coat of a pale isabelline ground colour. The head colour was yellowish, the neck paler yellow, and the dorsal and upper lateral rump ochre yellow (apart from the dark eel-stripe). The rump turned fallow on the lower flanks. The dorsum and the ventrum were connected by a continuum of tones, without strong counter-shading. The muzzle, the rear faces of the front legs, the inner faces of the hind legs, the belly and the rear margins of the haunches were whitish. The lips, ear tips, mane hair (with greyish yellow tips), the dorsal eel-stripe, and the tail tuft were (brownish-) black. The coronets were topped by a narrow ring of black bristles. The dorsal eel-stripe extended until the tuft of the tail, and it was not framed by light border stripes. The hair of a few winter skins in the possession of local herdsmen were soft as camel wool, up to two inches ("Zoll") thick, curly and at places shaggy. The tips of the winter hair were of a greyish isabelline colour, but their bases were iron-grey. Unfortunately, the exact pigmentation of PALLAS's type mare is not entirely clear. The term "isabelline" has been derived from an Arabic word meaning "lion-coloured", and at least originally this colour variant has designated a pale creamy yellow tone ("café au lait"). In fox-coloured horses whose hair colour is brightened by a dilution gene to the isabelline phenotype, the short hairs are yellow or golden-yellow, and the long hairs are cream- or silver-coloured. More recently some geneticists have employed the adjective "isabelline" also for palomino phenotypes, whose basically chestnut-coloured hair are transformed to different tones of golden yellow, ranging from light cream through liver chestnut (reddish-pink) to chocolate-brown. The term "isabelline" therefore is ambiguous, but more likely than not PALLAS had the original meaning of yellow cream in mind. In this context one has to accept that further descriptions of PALLAS's (PALLAS 1781a, SCHREBER 1775-1844) dziggetai differ in certain details from the original Latin version (PALLAS 1775): "Color in cervice gryseo-albidus, in trunco superius toto dilutissime gryseo-fulvescens (quod Galli vocant i s a b e l g r i s â t r e)". The coloured copper by PALLAS (1781a) displays a reddish-brown rather than an isabelline-coloured dziggetai. DENZAU & DENZAU (1999) reproduced a plate of the dziggetai from SCHREBER's (1775-1844) mammal encyclopaedia possessed by the Museum Alexander König at Bonn, to argue that the Dahurian dziggetais were of a yellowish ground colour, identical to the specimens from the Gobi. An independent reproduction from SCHREBER (1775-1792, no year given) in fig. 1c (courtesy of DR. R. HUTTERER)[25] does not appear as yellow as did the plate in DENZAU & DENZAU (1999), but it fits the original description of a yellowish body colour better than did the iconotype in the species description in German indeed (PALLAS 1781a; fig. 1b). Had PALLAS (1781a) figured one of his winter skins (see chapter 4), while SCHREBER (1792) had been guided by the original species description of a summer phenotype? PALLAS's sojourn in the Dahurian dziggetai country in late May (old calendar) or better mid-June (Gregorian calendar) implies the possibility that despite his report the type specimen, or at least other dziggetais seen, were moulting, and contained patches of both the darker hibernal fleece and of the lighter summer pelage (see chapter 4, and 12, conclusion 5). As it stands the precise pigmentation of PALLAS's type specimen will perhaps never be unambiguously resolved if its remains at St. Petersburg cannot be found (M. SABLIN, pers. comm.).

[24] The earliest use of the textbook name Halbesel ("half-ass", "demi-âne"), evidently a literal translation of the Greek hεμi-ονos (latinized into hemionus), could not be traced. It was but rarely used in the first decades of modern scientific writing. PALLAS (in LANGE 1781) used the term "Halbpferd" in addition to dziggetai.

[25] The edition (SCHREBER 1844b) of the library Johann Christian Senckenberg (Frankfurt) includes a black-and-white copy of the same dziggetai (fig. 1d), and the version kept by the library of Halle University misses the plate completely, although its text chapter that describes *Equus hemionus* refers to the correct plate number, and other perissodactyls are illustrated.

Fig. 1: 1 a, top left: Copper in black and white to illustrate the iconotype of the original species description of *Equus hemionus* PALLAS 1775 in Latin language by P. S. PALLAS (1775), presumably showing a mare obtained from the Lake Tarei-Nor in the Siberian district of Dahuria on 26th May, 1772. 1b, top right: Coloured copper of presumably the same individual, reproduced from the species description in German language (PALLAS 1781a). 1c, bottom left: Coloured copper of PALLAS's dziggetai in a supplement volume of SCHREBER's (1775-1792) encyclopaedia of mammals (the volume which contains the copper is undated). Courtesy of the Forschungsmuseum Alexander König, Bonn. 1d, bottom right: The corresponding plate in black and white from SCHREBER (1844b), courtesy of the library Johann Christian Senckenberg, Frankfurt.

PALLAS (1775, 1781a) provided very detailed descriptions of the external anatomy, of the inner organs, and of the bones of the type mare of his dziggetai taxon, using the hippological protocol

issued by the French zoologist LOUIS JEAN-MARIE D'AUBENTON[26] to assess equid morphology thoroughly. Although bleached by the influence of sunlight and the tanning process, the skin of the type was deposited in the Zoological Museum of the Russian Academy of Sciences in St. Petersburg. According to M. SABLIN (in litt.) this specimen is no longer available for study. Nevertheless, the detailed descriptions and the iconotypes provide a lively impression of this northernmost, and now exterminated, Dahurian population. PALLAS (1772/73 [1967 reprint], 1771-1776 [1987 reprint]) confirmed GMELIN's (1752) opinion that only straying dziggetais reached Russian territory when migrating from the Mongolian source herds into the Argunian steppes south of the Lake Tarei-Nor, and around Abagaitu. From hearsay he reported their abundant occurrence in the Gobi desert of Mongolia (PALLAS in LORENZ 1781), and in Tibet[27]. About half a century later, BRANDT (1845) rated the dziggetai (Dzigatai, p. 454) as an occasional visitor to southern Siberia.

From March to autumn 1856 the 25 years old German-descended zoologist and traveller GUSTAV RADDE[28] explored the Dahurian steppes and ranges between the Lake Baikal and the Amur lands in the duty of the Russian Imperial Geographical Society (RADDE 1859, 1860, 1861 [1970 reprint], 1862a, 1862b, 1863). After an exploration of the shores of the Lake Baikal RADDE left Irkutsk on 1st March 1856, and passed the Selenga Valley to the Cossacks station of Kulussutai on the northern shore of the Lake Tarei-Nor. After extensive hunting and collection trips in the Tarei-Nor basin (13th March to 30th May, 1856) he followed the Argun River to Nercinsk, and the Onon Valley to Abagaitu. A first hunting stage for gazelles and dziggetai around the borderpost of Soktui lasted until 9th June, before the expedition returned via Abagaitu to the Tarei-Nor. There followed a deviation to the Adontscholon Mountains in companion with the Polish naturalist A. WALETZKY. The Chinese authorities had denied RADDE the access to the Lake Dalai-Nor (ANON. 1862), in whose surroundings GERBILLON had discovered the dziggetai for western science. The September 1856 was spent to observe the autumn bird migration near Kulussutai. Another hunting trip for dziggetais led RADDE from 16th October to the first week of November to the Soktui area again. This site is presumably identical to the Russian-Chinese borderpost of Soktujew, which "Stielers Handatlas" locates at 50.3° N, 117.7° E (HAACK 1939). There followed a stage of ibex hunting in the Apple Mountains, before the expedition ended at Irkutsk on 8th January 1857.

RADDE collected four dziggetais for the museum of St. Petersburg, apparently all of them in the surroundings of Soktui. A mare was obtained in June, and two more females and a stallion in October of the year 1856 (RADDE 1861 [1970 reprint], 1862a). This series might represent the northeasternmost origin confirmed by a museum specimen and, for that matter, of a hemione in Asia. The summer coat (June) of the mare, estimated at four years of age, was characterized as being short, glossy and rather dense, and of a yellow-reddish ground colour with a grey hue ("gelb-röthlich mit einem Stich ins Graue", RADDE 1862a, p. 293). The ventral portions of the neck were pigmented like the rump, to become lighter only on the belly between the forelegs, and to grow whitish

[26] D'AUBENTON, also spelt D A U B E N T O N , was a botanist, veterinarian and zoologist at the Jardin du Roi, Royal College, and later the director of the Musée National d'Histoire Naturelle in Paris. He was born at Montbard (Bourgogne) in the year 1716, and died at Paris in 1800.

[27] PALLAS's knowledge of the existence of kiangs was apparently not precise. At least he did not mention the species in his essay on the geography of the Tibetan highlands (PALLAS 1783b).

[28] G. RADDE, born at Danzig on 27th November 1831, died at Tbilissi on 16th March 1903, had started his professional career as an apprentice in a pharmacy, before the Naturforschende Gesellschaft Danzig supported his scientific interest by a travel grant to explore the zoology and the botany of the Crimea in 1852-1855. The results of this trip were sufficient for the Russian Imperial Geographical Society to fund the east Siberia expedition of 1855-1859. The results from it were analyzed during his employment as a custodian of the Zoological Museum of the St. Petersburg Academy of Science during 1860-1863. Afterwards RADDE worked in Tbilissi, where he founded the Caucasian Museum in 1867, and he undertook expeditions into the Caucasus, Transcaucasia, Persia and Transcaspian Russia. The scientific names of a few plant and animal species honour RADDE's name, and a few English (but not German) names of birds were coined to honour his achievements too.

backwards between the hind legs (though not as purely white as the muzzle). A brown ring of one finger breadth topped the coronets. The three other dziggetais had already moulted into their winter coats by October: Their ground colour was more reddish rather than yellow, with hair of 25-28 mm lengths, and with reddish-grey rather than whitish bellies. RADDE (1862; ANON. 1863) observed that the dziggetais migrated from the central Gobi in adjacent Mongolia to the rangelands on Russian territory in autumn, in order to seek the winter pasture and the moisture derived from snow[29]. No dziggetais had survived around the Lake Tarei-Nor into the time of RADDE's visit, and the formerly abundant herds of Mongolian gazelles met by PALLAS in this area had gone almost extinct too. Soktui, the last remaining dziggetai sanctuary, was the remotest, southernmost and, due to the lack of spring water, the economically poorest district in this part of the Russian Empire, with a human population density estimated at five to six inhabitants per square mile (RADDE 1861 [1970 reprint]). In this steppe country with *Artemisia*, *Tanacetum sibiricum*, and a lot of bare soil the dziggetai did not occur regularly, because the herds migrated in the search for fodder (op. cit.). The best prospects for recording dziggetais remained in the south-west of the Mount Soktui. The autumn saw the influx of plains game, i.e. gazelles and wild asses, from the Gobi, since the hemiones migrated when the newborn foals had become sufficiently strong for migration (fig. 2).

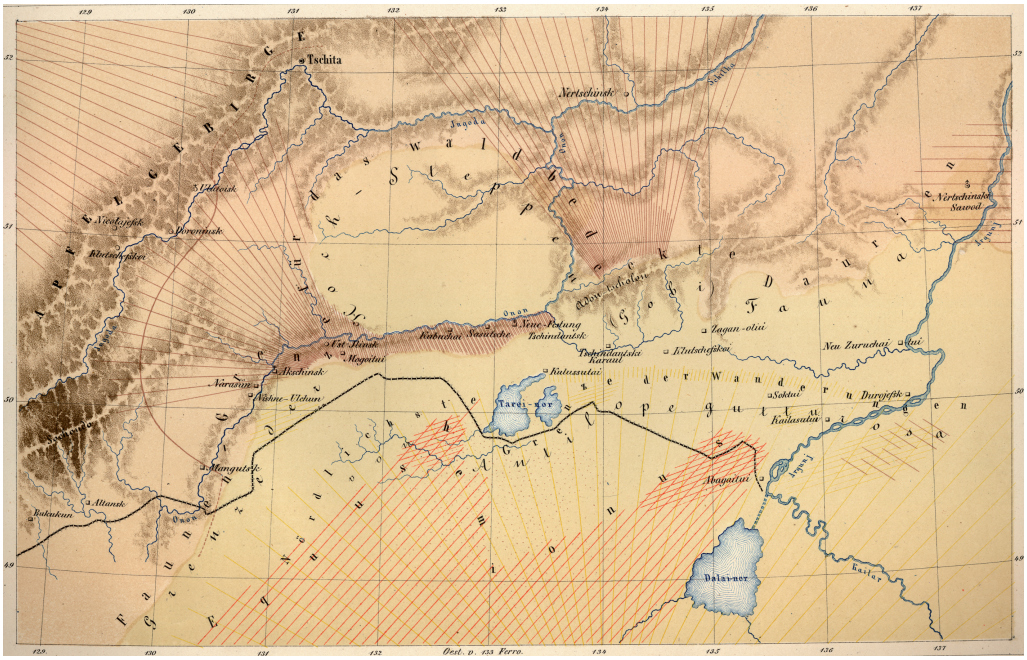

Fig. 2: Mid-19th century map of Dahuria for the year 1856 (RADDE 1862a). Grassland (buff ground tone) and taiga (red-brown ground colour) are distinguished. MESSERSCHMIDT had discovered the dziggetai in the steppe between Nertschinsk (Nercinsk) and Argun'skij Zavod, and PALLAS's type specimen originated from the vicinity of the Lake Tarei-Nor. The distribution ranges of some mammals are indicated by colour marks. Red lines: Winter range of the dziggetai, *Equus hemionus*. Yellow marks: Mongolian gazelle, *Procapra gutturosa*. Brown dots: Steppe fox, *Vulpes corsac*. Brown hatching: Siberian roe deer, *Capreolus pygargus*. The brown line, which bisects the meridian 130° E twice, denotes the range limit of the isubra deer (*Cervus elaphus xanthopygus*) towards the steppe country.

[29] RADDE's (1861) description of the migrating dziggetais has been quoted in detail by DENZAU & DENZAU (1999, p. 111), and needs not be repeated here.

Young stallions would leave their herd at an age of three or four years[30]. RADDE (op. cit.) described at length the methods of how to hunt the dziggetais, and he also noted that the preservation of game required large populations, because small herds were easily eliminated by the adverse effects of the severe climate. Hard winters were a season of special hardship for Dahurian wildlife, either by a lack of precipitation or by too high a snow cover. The hard winter of 1831/1832 had driven at least the argalis into extinction (RADDE 1860). Since the days when PALLAS had focused the interest of the local people on the dziggetai, various attempts to raise tamed foals in captivity had failed, because the milk from cattle was an inappropriate diet for hemiones (RADDE 1861 [1970 reprint]).

The 1798 edition of the supplement volume (tome XXI) to DE BUFFON's "Natural History of Quadruped Animals" (German edition by B. C. OTTO) quoted the report by a military officer WLASSOF from the Russo-Mongolian borderpost of Kyakhta from 29th September 1779 on a devastating epidemic disease, which had affected the dziggetai population in south Siberia (also ANON. 1781). Mortality was so severe that at places groups of three to five hemione carcasses could be found on the plains. Mongol herdsmen, seemingly unaware of this disease, collected hemione flesh for consumption at home, thereby infecting and killing not only their ponies, which died very rapidly, but also triggering a deadly epidemic for the horned livestock. Along the Russian-Mongolian border the entire hoofed stock collapsed after developing deadly ulcers.

GREVÉ (1898) hinted to the continued occurrence of dziggetais in the steppe near the Lake Dalai-Nor, between the rivers Argun and Onon (specifically in the Abagaitu area), on the Altangala plateau southwards to the Kerulen (Kerülün) River and near the Lake Buir-Nor (Buirnoor), and northwards to the Ononborsa River and the Gasimur Springs. The species was common north-west of the Soktui Mountains. GREVÉ (1898) did not document the source of this information, or the years from when it had originated. Dziggetais seem to have finally disappeared from the steppes of Dahuria and the far north-eastern Mongolia during the second half of the 19th century (HEPTNER et al. 1989), although single individuals (irregular visitors?) were seen further south (in the east Mongolian portions of this area) in the early 20th century (BANNIKOV 1948).

Considering the huge range of hemiones, or of dziggetais only, one may wonder why the scientific interest from the year 1724 to 1876 (i.e. till the FINSCH-BREHM expedition to Kazakhstan, see below) had focused exclusively on a comparatively insignificant tract of steppe country in remote Dahuria, which contained the species only episodically. By contrast the extensive hemione biotopes in the cis-Altaic forelands of western Siberia, in Kazakhstan, and in the Transcaspian steppes and semideserts seem to have been neglected completely throughout this period. The literature in the Russian language has not been consulted by the present author, but one explanation for the disproportionate attention awarded to the small tongue of the Central Asiatic steppe belt in Transbaikalian Siberia was certainly provided by the local infrastructure: The early construction of military posts along the Russo-Chinese border, e.g. at Nercinsk, founded in 1663 (PALLAS 1783a), and subsequently the construction of the Argunian silver ore mines around that township might have facilitated the access and the work of explorers. The metallurgical plant at Nercinsk started its production in 1704 (PALLAS 1783a)[31]. The plant attracted European experts of metallurgy, and the old caravan routes from south Siberia to China had been upgraded for easier access. The township of Nercinsk-Sawod served also as a station for the deportment of Europeans, including Polish naturalists, who wrote treatises on the local natural history while completing their sentence (HENZE 2000). Remote Dahuria thus provided reasonable travel conditions, and might have been the best-known portion of the dziggetai's range among the late 18th century Europeans. By contrast the western

[30] DENZAU & DENZAU (2000) referred to a few more details from the life of dziggetais, as provided by G. RADDE (1861 [1970 reprint], ANON. 1863).

[31] The Argunian mines produced two pounds of silver in the year of MESSERSCHMIDT's visit, and seven pounds per annum in the year of GMELIN's visit. This production rose until PALLAS's expedition to 400 pounds of silver, some gold and a lot of lead (PALLAS 1782, 1783a). The surroundings of Nercinsk saw the prospecting sites and several mines to dig for these treasures (op. cit.). Dziggetais seem to have been lost from Dahuria a few decades after the onset of mining for ores on a larger scale.

Altai forelands, where kulans continued to be common if not locally abundant at least till the early 20th century (see below), remained much less developed in terms of infrastructure and exploitation of their natural goods for several decades more to come (GENSICHEN in BREHM 1876 [1982 reprint]). These areas attracted another expedition searching for kulans as soon as a military post had been opened there too, and had foreshadowed the extinction of the regional population of hemiones (see chapter 6).

4. The mounts of Siberian hemiones at the Museum Naturalis at Leiden

The reported loss of the type specimen at St. Petersburg (M. SABLIN, pers. comm.) implies that the true appearance of the Dahurian population needs further attention. DENZAU & DENZAU (1999) utilized the yellowish specimen depicted by SCHREBER (1775-1792) to support their argument of the phenotypic identity of the extinct dziggetais from Siberia with those from the Mongolian Gobi. PALLAS (1781a) and RADDE (1862), however, presented reddish rather than yellow-coloured specimens.

There are two mounts of Siberian hemiones in the Museum Naturalis at Leiden, Netherlands. The skin and the skull of an adult mare of the origin “Transbaikalie“ have been received from the “Musée de St. Petersburg“ in the year 1862 (skull catalogue *Equus hemionus* PALLAS, cat. b). The mounted subadult male of the origin “Dahourie“ had been acquired from the collection at St. Petersburg in 1863. No further information about the history of these specimens seems to remain (C. SMEENK & H. VAN GROUW in litt.).

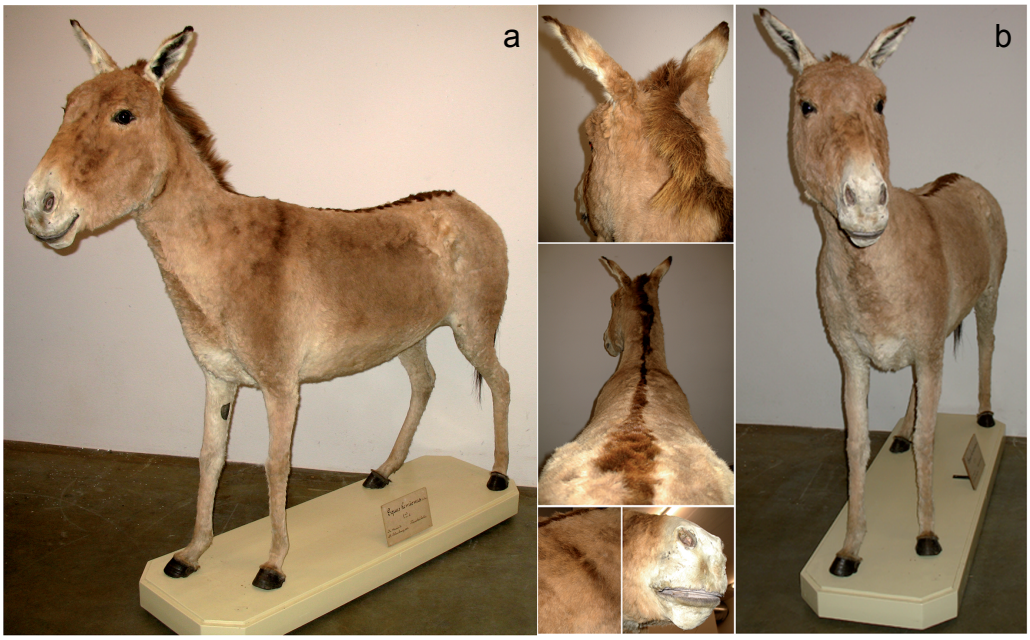

Fig. 3: a: Mount of a female dziggetai (*Equus hemionus*) from “Transbaikalia“ in the Museum Naturalis at Leiden (Netherlands), acquired from the zoological collection of the Russian Academy of Science at St. Petersburg in 1862 (Leiden catalogue: LD 1862). Note the shoulder cross. 3b: Details form the same specimen. Top left: Rear face of the auricles, the head and the mane. Centre left: Median dorsal eel stripe. Bottom left: Close view of the shoulder cross (left) and of the muzzle (right). Right: Front view of the specimen.

Fig. 3 shows the adult female from Transbaikalian Siberia in her winter coat. The shoulder height measured 1.175 mm, the head-rump-length 2.170 mm (upper lip to tail root), and the tail (without

tuft) 480 mm. Hair are dense and slightly wavy, and up to 30 mm long (on the dorsum besides the eel-stripe). The ground colour of the coat was darkest in the face, Sayal Brown (plate XXIX)[32], while the flanks of the rump and the haunches were Snuff Brown (plate XXIX). A shoulder cross in Sepia Brown (plate XXIX) was clearly visible. The median dorsal eel-stripe and the mane were Clove Brown (plate XL), but the long mane hairs (or the mane hair tips) Sepia Brown (plate XXIX). In the shoulder region the eel-stripe was 10 mm broad, and it reached a diameter of 80 mm on the croup. The ventrum was tinged in Ochraceous Buff (plate XV). Stripes of Light Buff (or Ivory Yellow) extended upwards from this light ventrum along the shoulders and the groins. From the Light Buff rump patch two light-coloured stripes extended on both sides of the eel-stripe to the tail basis. The rear faces of the extremities were lighter than their front faces, either Light Buff (plate XV) or Ivory Yellow (plate XXX). The contrast between the lighter belly and the intensively coloured dorsum was evident, but tones of pure white were absent. The muzzle of Pale Olive Buff (plate XL) colour provided a strong contrast to the colour of the face. The outside basis of the ear conches was of the same brown colour like the face, but they grew Light Buff tipwards. Their very tips were Clove Brown like the eel-stripe. The naked skin of the inner face of the auricles was blackish-brown, and surrounded by a ring of hair in whitish or Light Buff colour. The tuft of the tail consisted of Blackish Brown (plate XLV) hair.

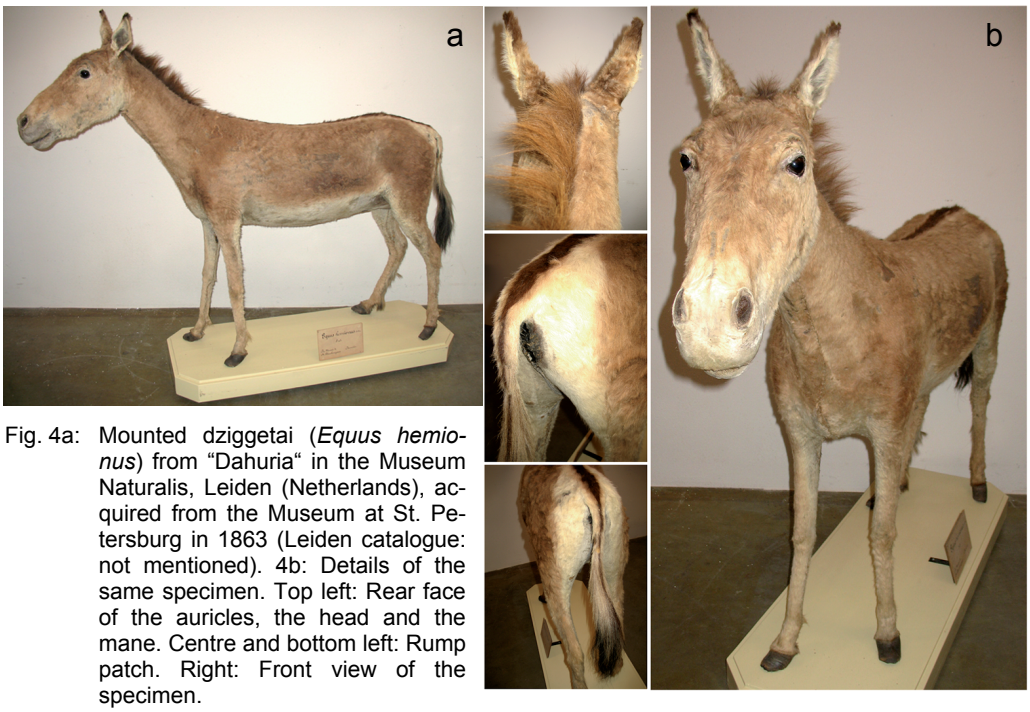

Fig. 4a: Mounted dziggetai (*Equus hemionus*) from "Dahuria" in the Museum Naturalis, Leiden (Netherlands), acquired from the Museum at St. Petersburg in 1863 (Leiden catalogue: not mentioned). 4b: Details of the same specimen. Top left: Rear face of the auricles, the head and the mane. Centre and bottom left: Rump patch. Right: Front view of the specimen.

The mount of a subadult male from Dahuria (fig. 4) measured 1.095 mm at the shoulder, and the head-rump-length 2.040 mm. It carried a winter skin with wavy, somewhat woolly, and at certain sites shaggy hair. The dorsal hairs were up to 28 mm long (adjacent to the eel-stripe). The pigmentation generally resembled the female from Transbaikalia, but the ground colour of the rump was of a brownish, not of a reddish hue. The rump patch was more conspicuous than in the mare, and it sent out light forward extensions on both sides of the eel-stripe (fig. 5). These light borders lines, however, contrasted weakly with the surrounding fur, and were considerably less pronounced than in "*Equus onager castaneus*" (see fig. 11). The tips of the mane hairs were Snuff

[32] The definitions of colours in this report refer to ROBERT RIDGWAY's colour standards and colour nomenclature without exception (RIDGWAY 1912).

Brown (or Dresden Brown, plate XV) in the male, instead of being Clove Brown or Sepia Brown in the female. A narrow ring above the coronets in Sepia Brown was well discernible. The skin of this mount contained bald patches from inadequate tanning or keeping conditions.

Fig. 5: Posterior view of two dziggetais (*Equus hemionus*) in the Museum Naturalis at Leiden. Left: Specimen from Transbaikalia (cf. fig. 3). Right: Individual from Dahuria (fig. 4). Note the more conspicuously marked rump patch in the latter.

The identity of these winter phenotypes can be inferred with a moderate degree of certainty. By the year 1862 only PALLAS's subadult type specimen, and the specimens shot by G. RADDE in 1856 are known to have been collected in Siberia, and deposited at St. Petersburg. The type mare was in her summer coat, however, and therefore both mounts at Leiden likely represent two of the three dziggetais in winter dress shot by RADDE near the Dahurian village of Soktui in October 1856 (RADDE 1862). Their colours are well compatible with the RADDE's description too. They could match the reddish-coloured plate in PALLAS's species diagnosis published in German language (1781a). Seasonal dimorphism of a more yellowish summer skin and a Snuff Brown winter coat could explain this difference.

RADDE's (op. cit.) diaries report dziggetai hunting in the months of June and in October (see above). The mounts at Leiden revealed the winter phenotype without a sign of uncompleted transition. The few field records for the timing of the spring moult in dziggetais, and the more detailed information of the moult in Transcaspian kulans, indicate that the phenotypes seen at Leiden could have been collected in both of these months in principle. A phenotype from June, however, should display patches of long winter and of short, smooth summer hair, rather than the homogeneous winter coat of the mounts at Leiden[33]. A collection date in autumn (and, by inference, in October) is therefore inferred.

Mongolian hemiones retained their winter coat till early (males) or mid-July (females) (BANNIKOV 1948, 1958), and PALLAS noted that the Dahurian dziggetais had retained their winter fleece in May. SLOWZOW (1897 in RASHEK 1972) dated the spring moult for kulans from Akmolensk (Kazakhstan) into April or May. At Badkhyz (Turkmenistan) the kulans moulted between February and the end of April (SOLOMATIN 1962). RASHEK (1972) provided the most detailed study of moulting in hemiones, concerning the free-ranging Badkhyz kulans on Barsa Kelmes Island in the Lake Aral. Over ten years of study the mean duration of the spring moult lasted 70 days, but it could last shorter or longer depending on the temperature (frost), the sex,

[33] BANNIKOV (1948) depicted a dziggetai mare shot on 4th June 1945 near the Lake Nogon-Nur in Mongolia. Remnant patches of winter hair are conspicuous on the forehead, between the ears and on the neck. DENZAU & DENZAU (1999) photographed a yearling male dziggetai in the moult from the winter to the summer coat. The photo had been taken at Tsagan Owor (42.3° N, 104.1° E) on the 4th July 1996 (G. DENZAU, pers. comm.), when only small patches of the winter hair had remained on the flanks and on the dorsal rump.

the age, the bodily condition, and on certain individual peculiarities which had not been understood. Adult stallions needed 27-78 days (mean over nine years: 50 days), pregnant mares 42-122 days (mean: 63 days), mares without fetus 72-94 days (mean: 74 days), juveniles of two years 61-91 days (mean: 72 days), male juveniles of one year 41-111 days (mean: 83 days), and females of one year 58-98 days (mean: 67 days) to complete the moult. In most years the transition started in early April and lasted till the end of June, but it could commence in February if the weather conditions were mild. One year old kulans (late June) started to moult 30 days later than did adult stallions (May 10th to May 15th), which were the usual cohort to commence the moulting season 20 days later than adult mares (end of May to early June if pregnant), and 10 days later than juveniles of two years (mid-June). The onset of the moulting period differed between years by one to one and a half months, if frost lingered into spring-time. An undernourished specimen needed more time to finish the moult. On Barsa Kelmes the gradual growth of the winter coat started in early September and was finished during December, but depending on the climate it could begin in late August or in October. The period until the winter hair had fully grown ranged from 80-110(-140) days. MAZÁK (1962) and RASHEK (1972) described the topography of the seasonal transition, which differed among (zoo-living) kiangs and kulans: Kiangs retained the latest patch of winter hair on their belly (MAZÁK 1962). The spring moult of captive Badkhyz kulans at the zoological gardens of Prague (MAZÁK 1962) was a prolonged process of losing fields and patches of fleece in a mosaic-like pattern. Instead the winter fleece was acquired by the gradual growth of the ever denser pelage in autumn, without a moulting process proper. In conclusion, the available evidence supports the hypothesis that the specimens from the museum at Leiden were winter phenotypes from October rather than from June.

The meaning of the two different geographical origins indicated for the dziggetais at Leiden is not understood. The labels identify the origins of “Transbaikalia” and “Dahuria”. To the east of the Lake Baikal (= Transbaikalia) two tongues of steppe country penetrate from Mongolia into the south Siberian taiga: These are an area just south of the Lake Baikal towards the Mongolian border, and the Dahurian steppes in the upper drainage basin of the Amur River (CHIBILYOV 2002). If the designated origins Transbaikalia and Dahuria imply that the mounts deposited at Leiden were collected in geographically separate rangelands, the female cannot have been collected by RADDE, but it still would represent a hemione from a long-extinct population in Russia. G. RADDE had studied the museum collections of St. Petersburg before departing to Siberia, and refers to MESSERSCHMIDT and PALLAS as the only previous students of Dahurian dziggetais. There is no indication of additional dziggetai material stored in the Russian capital that early and, for that matter, before the year of the export of two Siberian dziggetais from St. Petersburg to Leiden[34]. Dahuria is located in Transbaikalian Russia, so both designations could refer to the same collection site. The travel reports by RADDE (1859, 1861 [1970 reprint], 1862, 1863) used both geographical designations to refer to sites east of the Lake Baikal indeed. The Chinese border officials had denied RADDE the entry into China (ANON. 1863), and there is no hint that he had collected dziggetais elsewhere than near Soktui (see above). If the mounts at Leiden, imported a few years

[34] POLJAKOV (1881) was aware of five dziggetai specimens kept at the Zoological Museum of St. Petersburg two decades later, but before the first big Russian expeditions had started to collect in Central Asia (see chapter 7): Two skins collected by a GENERAL POTORACKI in Dzungaria, and a mounted and two flat skins collected in the “same area where PALLAS had acquired the type specimen”, i.e. three specimens from the Transbaikalian steppes. These could have been the remaining specimens of the dziggetais collected by G. RADDE, who reported the collection of four individuals from Dahuria. POLJAKOV’s (op. cit.) report therefore would suggest that only one of RADDE’s specimens had been exported to Leiden. Where did the other originate from? GROVES & MAZÁK (1967) mentioned three Siberian skins of “north Mongolian” hemiones for the St. Petersburg museum, i.e. one mounted specimen from Abagaitu (in Dahuria), and two further mounts from “south-western Siberia”. Two female skulls were labelled with “Dzungaria” and a juvenile skull with “Desert Kirgisorum” (op. cit.). No further details could be received about the localities, the collectors, or the phenotypes (C. GROVES, pers. comm. 2006). Was there a hitherto overlooked early collector, who had delivered Dzungarian or south-west Siberian hemiones? Did a winter skin collected by PALLAS persist, or did RADDE purchase an additional skin not mentioned in his diaries? Did one of the Leiden specimens originate from “south-west Siberia” (Dzungaria)? The differentiation shown in fig. 5 remains difficult to interprete.

after RADDE's return, can rightly be traced to him, they had most certainly originated from a very restricted tract of land in Siberia (see footnote 34). The two different patterns of the posterior rump and the light borders of the eel-stripe (fig. 5) therefore seem to indicate variation contained in the Dahurian population. Taxonomically unimportant influence factors like sex, age and social rank need attention before the classificatory value of this character can be judged. G. DENZAU (pers. comm.) remembered apparently comparable polymorphism from herds in Mongolia, where the "stripe-ornamented phenotype" was however very rare. Specifically the case of the "Kobdo onager", *Equus onager castaneus* LYDEKKER (cf. chapter 8), and PRJEVALSKI' s (1988 [reprint]) and GRUM-GRIJIMAILO's (1891) "two species of wild ass" from Chinese Dzungaria need further attention in this context (see chapter 7).

5. The late Recognition of *Equus hemionus* as a Species by Systematic Zoology

The dziggetai did not find entry into the "Systema Naturae" compiled by CARL VON LINNÉ (1758, 1766)[35], which knows in the order Belluae (equids and hippopotami) only the Cape Mountain zebra (*Equus zebra*), the domestic horse (*E. caballus*) and the donkey (*E. asinus*) (LINNAEUS 1894 [reprint]). The O n a g e r figures instead as one of four synonyms of the donkey, together with asinine subcategories A s i n u s proper, and the ass-horse hybrids M u l u s and H i n n u s . However, it seems unlikely that naturalists of the mid-18th century were unaware of the existence of hemiones as a true species of wild equid. DU HALDE's (1745), MESSERSCHMIDT's (1966 [reprint]) and GMELIN's (1752) books may have been overlooked by LINNÉ, but hemiones were the first non-domesticated equids known to many classical compilers of natural history books as early as in the ancient science communities of the Greek, the Persians and the Romans (KELLER 1909, LICHTERFELD 1878, PALLAS 1781b)[36]. These ancient scholars had written on the south-west Asian half-asses, including presumably the Syrian hemippe, the Persian onagers and the Indian khurs, and on the extinct populations from Asia Minor. Despite their habit to design hemiones as free-ranging mules these naturalists were aware of their fertility and of many pertinent and fantasy characters of their ecology and behaviour (op. cit.). Hemiones were recognized as a valid species of their own, not just as species hybrids. They were hunted for venison, served as models for artwork, and were captured for the use as sires in mule breeding and as draught animals for war chariots (SCHUBERT 1879, KELLER 1909)[37]. Hemiones were mentioned in the Old Testament, and were presumably the only wild equids known to the authors of the Bible[38]. They were the only perissodactyls mentioned in the "Physiologus", which was the leading natural history textbook of the Levante

[35] LINNÈ was born at Rashult in Sweden in 1707, and he died at Uppsala in 1778. A medical doctor and botanist, he became best known for standardizing the systematic nomenclature of plants and animals. He assigned two scientific names to every kind, i.e. genus and species. Systems are centred on the genus, which are listed in a hierarchical order of ever more comprehensive groupings. Systems should be both natural and practical, but they have no phylogenetic meaning. Geographical variation in species is not considered.

[36] ARISTOTLE, HOMER, THEOPHRAST, XENOPHON, KTESIAS, AELIAN, COLUMELLA, OPPIANUS, HERODOT, PLINIUS, SOLINUS, TACITUS, VARRO, AMMIANUS MARCELLINUS.

[37] In the early 19th century efforts to "acclimate" exotic species led I. GEOFFROY SAINT-HILAIRE and other French zoologists at Paris to attempt the domestication of hemiones again. "D z i g g e t a i s " (which presumably were instead Indian khurs from Cutch; SCHREBER 1844a) could be bred, tamed and used to draw a wagon from Paris to Versailles within an hour. A mare of mild temperament accepted a saddle and a horseman. Zebroids (hemione x donkey) proved suitable for human use too (ANON. 1862).

[38] The Old Testament emphasizes the untamed ferocity and the barren living-space of the wild ass in the books of IJOB (HIOB: paragraphs 24.5, 39.5) and JESAJA (32.14). The additional character of lasciviousness reportedly attributed to the hemione by the Bible (CARUS 1872) refers to the camel mare or in general to desert-living game in the translations consulted by the present author. Neither could the hint in JEREMIA (2.24; cf. op.cit.) or the reference stating the species's supposedly impetuous character (see SCHUBERT 1879) be spotted and confirmed. IJOB reported on the land Uz in Mesopotamia, and his wild asses might have referred to hemippes. CARUS (1872) referred any biblical hint to the "w i l d a s s " to hemiones, and not to African wild asses.

and in Europe during the early Middle Ages until the 14th century (CARUS 1872)[39]. Sanctioned by the Bible, and possibly transmitted by the "Physiologus", the knowledge of hemiones found entry into several bestiaries written by medieval monks, who elaborated the facts and the fiction about the wild, diabolic and jealous onagers, and sometimes added their own fantasy. LANGLOIS (1911) drew attention to three encyclopaedias of natural history, compiled by monks in the French language: "Le bestiaire de Philippe de Thaon", which appeared between 1121 and 1135[40], is preserved in three slightly different copies kept at Copenhague, Oxford, and London. Concerning hemiones it might refer to the "Physiologus": "Onagre ou âne sauvage. Le 25 mars, à l'équinoxe, cet animal brait douze fois. C'est de tristesse, en constatant que la nuit et le jour sont d'égale longueur, car il préfère la nuit au jour. C'est le diable". The bestiary in the "Liber de Proprietatibus Rerum" written by the British-descended BARTHÉLEMY L'ANGLAIS, a Franciscan monk teaching in France, surpassed the "Physiologus" by listing 115 animal species, including the onagre. FATHER BRUNETTO LATINOI from Florence spent many decades of the 13th century writing and teaching in France. His magnum opus "Le Livre du Trésor" elaborated PHILIPPE's story on the hemiones' behaviour around equinox by the idea to use the rhythmic, hourly brays as the substitute of a clock: "Les ânes sauvages, ou onagres, que l'on trouve en Afrique[41], sont indomptables. Chaque mâle a plusieurs femelles, et se montre si jaloux qu'il a tendance à châtrer ses propres poulains. L'onagre brait régulièrement une fois par heure, jour et nuit; il peut, par conséquence, servir d'horloge". The most famous zoological treatise of the High Middle Ages, "De animalibus (libri)" by ST. ALBERT THE GREAT from the 13th century[42], repeated the story of the onager braying after every full hour on the day of the equinox, and added more details (ALBERTUS MAGNUS 1999 [reprint]): The females are so lusty that they become tedious to the males. The stallions are so jealous that mothers need to seek hiding places to deliver and to store the foal, in order to prevent the father from nipping off the testicles of a newborn son. To moderate the heat of their lust the wild ass would stand on a cliff, drawing in the wind. Persecuted onagers emit odiferous

[39] The "Physiologus" was a compilation of the knowledge of various branches of science and natural history, whose origins can be traced to Alexandrinian communities of Christian belief from the first centuries A.D. (CARUS 1872). Copied, updated and enlarged by several scholars in the following centuries it became translated from the classical Greek, Latin, Armenian and Ethiopian (Koptic) languages, and into the tongues of the developing European nations, including Old High German, Anglo-Saxon, Old English, Icelandic, Old French, and Provençal. It served as a prime source of learned knowledge of the early Middle Ages, which was tolerated under the supremacy of the Catholic Church. In systematic zoology this book enumerated the 17 mammal species mentioned in the Bible, including the wild ass. Hemiones were unfavourably jealous and vindictive, and would persecute and castrate their own male offspring. While on the day of the spring equinox human beings enjoyed to enter a brighter season of fuller daylight after winterly darkness, the jealous onager would take a diabolic stance and utter roars twelve times the night -after every full hour- in the search for lost prey (sic). The details reported about this unfavourable behaviour differ between the many editions of the "Physiologus" (in some versions the hemione roars 24 times, day and night). Hemiones are mentioned at least in the editions of the Physiologus in the Armenian, classical Greek, Latin, Old High German, Old French, and Icelandic languages. CARUS (1872) equates the wild ass of the "Physiologus" with hemiones, but he does not explain why African asses are excluded from this interpretation (the book has roots in Ethiopia too).

[40] PHILIPPE was a clergyman from the village of Thaon near Caen in Normandy during the reign of KING HENRY I. of England and Normandy.

[41] The reference to Africa need not be a hint to the African wild ass, but a metaphoric term to design an e x o t i c origin of onagers. It is uncertain if African wild asses had become known to European scholars during the Middle Ages (see footnotes 7, 38 and 39).

[42] ALBERTUS MAGNUS (ALBERT VON BOLLSTÄDT, A. VON KÖLN), a doctor universalis and a member of the Order or Preachers (Dominicans), was possibly born at Lauingen in Schwaben between 1193 and 1207. He taught in several German cities and in Paris, but chiefly in Cologne, and he became the dominant figure of scientific Latin learning of the 13th century, and one of the most influential philosophers of the High Middle Ages. ALBERT unified the ancient knowledge of animals, and he finally sanctioned it for the community of Christian scholars. His work "On animals" consisted of three books, i.e. (i) a reprint of the ARISTOTELIAN zoology, (ii) his own elaborations, small experiments and comments on many items of anatomy and physiology, and (iii) a commented systematic list of animal species elaborated from the bestiary by his disciple and fellow Dominican THOMAS DE CANTIMPRÉ. ALBERT was widely recognized as the summa zoologica of the scholastic science. He died on November 15th, 1280.

excrements, delightful to dogs, to detain them around while the equid could flee to safer places. Onagers endure thirst very poorly and require clear water to drink regularly. They avoid human company[43]. A systematic search of medieval compilations would reveal more references to hemiones almost with certainty.

Considering the popularity of the hemiones over two thousand years, or more, LINNÉ's classification of the onager as a strain of the domestic donkey presumably does not indicate his ignorance of the old zoological literature, but it might have rather rested on a premature concept of what a species was meant to be, so to distinguish equids perceived as "phenotypic intergrades" between asses and horses from true hybrids (mules). Obviously asses and horses were superior types to shape the expectation of an essentialist of how a soliped ungulate should look like, and this bipolar typology secondarily referred the (somewhat) intermediate hemione phenotype to a "connecting link" of lower diagnostic (taxonomic) value. The continued use of the designation m u l u s f o e c u n d u s A r i s t o t e l i s might have discouraged the recognition of hemiones further. The considerably expanded, post-LINNEAN 13th edition of the "Systema Naturae", compiled by JOHANN FRIEDRICH GMELIN (1788) from Göttingen, recognized *Equus hemionus* as a valid species and provided succinct differentiae to characterize its appearance and lifestyle[44]. GMELIN's correct insights into the similarity of certain morphological traits of this dziggetai with the horse, the donkey, the mule, or the zebra are of interest. However he continued to separate the O n a g r u s from *E. hemionus* within the species *Equus asinus*, and subsumed it under the wild asses (f e r u s), which were one of four synonyms within *E. asinus* besides the categories d o m e s t i c u s , m u l u s and h i n n u s . This two-species concept for hemiones continues the old conviction that the Persian onagers were the ancestors of the domestic donkeys. PALLAS (1780, 1781b), who had provided a detailed description of two north Persian onagers in the same journal volume which contained his discovery of the dziggetai (*E. hemionus*) as a new species, adhered to this opinion too, and apparently for this reason did not propose a taxonomic name for the hemiones from Persia[45].

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[43] ALBERT´s vague ideas about the identity of hemiones is emphasized by listing wild asses in two sections of his (alphabetically arranged) system, i.e. as wild asses proper (A s i n u s s i l v e s t r i s) besides the donkey, said to live in Africa, and as o n a g e r s . The latter are accompanied by the "Onager indicus" which however refers to the one-horned Indian rhinoceros, and by the Onocentaurus or ass-centaur, a composite animal with the head of an ass and a human body.

[44] *Equus hemionus* (GMELIN 1788, p. 210): Equus unicolor, pedibus solidungulis, cauda calva extremitate pilosa, cruce nulla. [Suite in italics:] Habitat in desertis inter fluvium Onon et Argun interpositis (hodiennum varius), gregarius in desertis Mongolicis, potissimum deserto Gobi ad Sinae regnique Tibetani fines usque, apricos, salsos, planos, herbosos campos amans, silvas montesque nive candidos abhorrens, timidus providusque, curse celerrimus, hactenus non cicuratus, audita et olfactu acutissimo, hinnitu magis sonoro, quam equi; in festatu lue in caballos et poves propaganda; mordendo et calcitrando pugnat; prurit Augusto; parit equa vere pullum, utplurimum unicum, caro Mongolis Tungusisque deliciosa; pellis naevium species adaptatur. Magnitudine et habitu proxima accedit ad mulum, at pulcrior, auriculis caudaque ad zebram, ungulis et reliquo corpore ad asinum, artubus ad equum; differt tamen capite magno, fronte plana antrorsum angustata, collo graciliore quam reliquis speciebus, et magis teret, pilis hieme sesquipollicaribus, mollibus, basi pallide glaucis, cetera pallidis isabellae colore, dorsi undulatus, aestate pene vaccina. Pondus circiter 560 libris medicis aequale, longitudo 5 pedes superans; cauda pedem et 12 pollicis longa, apice floccoso nigro. Dentes 34.

[45] This formal step was reserved to BODDAERT who created the taxon *E. onager* without much further research of his own in 1785. The original two-species concept for south-west Asian (*E. onager*) and Central Asian hemiones (*E. hemionus*) seems to root at least partly in the misconception that donkeys had been domesticated from south-western hemione populations, even though this error had been finally recognized with the better knowledge of the African wild asses during the late 19th century. Even PALLAS, who adhered to a species concept which could be termed a biological species concept, which was widespread in Europe before the breakthrough of the LINNEAN concept of species as abstract classificatory categories (MAYR 1984), had not considered the possible conspecificity of the hemiones from Persian and Dahuria.

The most widespread natural history encyclopaedia of its time, the "Histoire Naturelle Générale et Particulière" by GEORGES-LOUIS LECLERC, COMTE DE BUFFON[46], was well aware of the presence and the appearance of the dziggetai (termed "dsiggetai"). Reffering to MESSERSCHMID (sic) and to GMELIN & MÜLLER, DE BUFFON reviewed the available knowledge of the pre-PALLAS period[47]. An edited supplement volume (DE BUFFON 1798) included a detailed chapter which reproduced PALLAS's description of *E. hemionus* and of onagers, augmented with editorial notes and comments. The geographical divide between the dziggetai and the kulan (which was tentatively equated with the onager) was indicated as "Jaik, Yemba and Sarason" (somewhere near the Ural Mountains?). DE BUFFON's (op. cit.) work excels by his awareness of the mosaic-like distribution of similarities between dziggetais and zebras, asses and onagers. Different concepts of relationship between these species are considered at great length. Superseding the plain comparison of external traits, which had run through the literature since ancient Greek and Roman times, DE BUFFON was a pioneer of *Equus* phylogeny, opening the scientific debate about the systematic arrangement of the contemporary equid species within the clade that contains the hemiones, the asses and the zebras. This discussion shall continue for the next two and a half centuries till date, and it has yet failed to produce a robust phylogenetic classification of sister species, which does not suffer from internal contradictions among different sets of characters. In fact, the inconclusive discussion in two sections of his volume (p. 137 ff, and p. 587) suggests sister-group relationships of dziggetais with each of the three other equids mentioned, preferring sometimes the zebra and elsewhere the onager as the closest relative of the Central Asiatic hemiones. This discussion contains mutually exclusive interpretations of relationship, which are difficult to follow and to summarize. Born in the same year as LINNÉ, the COMTE DE BUFFON was the supporter of what could be termed a biological species concept: Species were perceived as being reproductive communities rather than the formal categories of the LINNEAN taxonomy (MAYR 1984). The incompatible suggestions if dziggetais were "the same species as either onagers, zebras or asses" therefore perhaps only meant if hemiones and one of the other mentioned equid species could possibly interbreed with success. Like many before him, DE BUFFON was evidently intrigued by certain phenotypic characters of dziggetais reminiscent of mules. Within a most creative chapter on domestication, mules and dziggetais served as examples to elaborate ideas about the mechanism of heredity. The speculations uttered by this "quicksilvery mind" (MAYR 1984) are not easily understood, because important terms were used with multiple meanings. E.g., the designation m u l e t (translated variously as Maulthier or Maulesel in the German version) refers to at least three meanings, including (i) the horse x donkey species hybrids usually understood by this term, (ii) species hybrids or mongrels in general, such as sheep x goat hybrids or wolf x dog hybrids, or (iii) bodily monstrosities or prematurely born offspring of all kinds of animals[48]. In fact, the respective chapter concerning equid genetics and the domestication of mammals is entitled "On the Degeneration of Animals". DE BUFFON published a plate of mule and a hinny in the modern sense (i.e. horse x donkey and donkey x horse species hybrids), but he nevertheless continued

[46] DE BUFFON was born at Montbard (Bourgogne) in 1707, and died in 1788. Head of the royal Jardin du Roi and of the Cabinet Royal d'Histoire Naturelle in Paris, which later became the Musée National d'Histoire Naturelle in the French Republic. The 36 volumes of his natural history encyclopaedia (1749-1788) were the leading source of zoological knowledge for many decades, and perhaps the most popular animal book series before "Brehm's Thierleben". It consisted of short to lengthy species monographs, including those on equids, rather then presenting a classificatory system. DE BUFFON initially denied the utility of the LINNEAN categorization of taxa, because these LINNEAN species were abstract concepts whereas in nature only individuals (and the chain of individuals through the generations) were real entities (= reproductive communities). DE BUFFON formulated the research programme of "la biologie" for comparative zoology, in deliberate contrast to the formal taxonomy adopted by most museums in acceptance of his adversary LINNAEUS. His standpoint however modified somewhat over time, and the late DE BUFFON developed less critical views on taxonomy (cf. MAYR 1984, JAHN 1998).

[47] DE BUFFON (translation of 1837) mentions the existence of "stuffed zebra and dsiggetai skins" in the natural history cabinet of St. Petersburg.

[48] The keeper of zoology at the British Museum (Natural History), JOHN EDWARD GRAY, used the term "mule" in the sense of "zebroid" to designate every hybrid of any two *Equus* species. "Double mules" were the backcrossed offspring of such mules (zebroids) and one of their parental species (GRAY 1850).

to refer to the dziggetai as the fertile mule from Tartary in the same chapter. The argument that equid hybrids were not degenerated animals was emphasized, and that mules were valuable by their own identity. Two creative speculations were developed to explain the bodily similarity of dziggetais to both ass-like and to horse-like species. First he considered a case of hybridogenetic speciation from two parental species, ass and horse, which had merged to produce the hemione[49]. As an alternative, or maybe in elaboration of this view, dziggetais could represent the surviving offspring of the feral mules escaped from the ancient Phoenicians, which afterwards had regained fertility. He quoted the case of a successful back-cross of a female mule (i.e. a confirmed hybrid of a male horse x a female donkey) with a horse stallion from Spain[50]. Hemiones (and mules) as "phenotypic intergades" among two equid species had impressed DE BUFFON sufficiently to produce his own ideas about the mechanisms of heredity[51]. The detailed statements on this subject are not relevant for an understanding of hemione systematics, but the creativity of this zoologist, obviously far ahead of his time, is most remarkable. Decades after the appearance of the "Histoire Naturelle" the German encyclopaedist JOHANN CHRISTIAN DANIEL VON SCHREBER (1775-1844) continued to enrich his chapter on the onager by citing hearsay information of two cases of fertile mules (horse x donkey) from Venezuela. Obviously, horse and ass had impressed humans (Europeans and Chinese alike, DU HALDE 1749) as memorable types over millennia, so that any intermediate phenotype could not qualify as "something equivalent" to these two notionally superior entities. The neglect of *Equus hemionus* is a good example of the pitfalls imminent in any approach to classify biodiversity from a taxonomic philosophy of essentialism (in the sense of MAYR 1984), which clusters newly discovered types into a pre-existing hierarchy that had produced type concepts for groups of organisms to which a newly discovered "pattern" is being compared. Without paying notice to biological function (e.g. reproductive communities) or to phylogenetic polarity intermediate phenotypes may easily be disregarded as being "impure entities".

There could be a second cause for missing the true nature of *Equus hemionus* by early systematics: Did the late acceptance of hemiones as a species by modern European scientists, and their neglect by the pioneer of formal classification, LINNAEUS (VON LINNÉ) from Sweden, reflect extra-scientific feelings on purity (or rather the impurity of suspected mongrels) [52]? The remarkably detailed account by the French encyclopaedist DE BUFFON about hemiones, and even more on mules (or the fairly different organisms designated by him as "m u l e t ") reads like a pleading that such "intermediates" should be valued for their own sake, rather than being degradations of more distinctive types. Concerning hemiones, it remained to the German zoolo-

[49] DE BUFFON (op. cit.) also believed that the black and white stripes of zebras had resulted from the hybridization of a dark and a light-coloured ancestor species. Such ideas of hybridogenetic speciation were not unusual in ARISTOTELIAN and scholastic zoologies, e.g. Medieval scholars believed that greyhounds had been created by a leopard which had sired a canine bitch (ALBERTUS MAGNUS 1999 [reprint]).

[50] After DE BUFFON's death so-called d z i g g e t a i s , but in reality presumably Indian khurs, were imported to the menagery at Paris, and used by zoologists of the early 19th century to produce hemione x donkey zebroids. The latter proved reportedly fertile, although "to a lesser degree" than were the matings of conspecfific parents (ANON. 1862).

[51] *Equus* mules have always inspired speculative concepts of heredity. ALBERT THE GREAT (1999 [reprint]) summarized early Greek ideas about the sterility of she-mules, and adds his own speculations. Central to these explanations were the incompatibility of sperm and ova, variously referred to their different "temperature" and "texture". The chromosomal complements of horses, asses and their hybrids became finally known only in the late 1950s and the early 1960s (BENIRSCHKE et al. 1962).

[52] This essay does not permit a discussion of the possible role of hemiones in the debate about the importance of pure types (lineages) in the early period of developing zoological systematics. Species conservationists and practitioners of wildlife breeding in zoos are however well aware of the considerable emotional conflicts aroused in debates about the relative value of animal lineages perceived as being pure-bred or suspected as being introgressed by other races (species). A deeper analysis of historical zoology than the present one might wish to trace the origins of ideas about "fertile mules", the supposed "evil character" and "lasciviousness" of onagers, and the delayed recognition of the Asiatic wild asses as legitimate members in the "Empire" of Zoology (Regnum Animalium), equivalent to horses and asses.

gist JOHANN FRIEDRICH GMELIN (1788) to arrive again at the stage of the taxonomic insight of classical writers at some two thousand years before [53, 54].

The wide circulation of textbooks like those compiled by DE BUFFON (op. cit.) and SCHREBER (op. cit.) fostered the popularity of PALLAS's hemione. The former treatise was arguably the most widely communicated popular textbook on animals before the appearance of "Brehm's Thierleben". D z i g g e t a i became a generic name to designate not only the hemiones form Dahuria, but all half-asses, especially in the German, but to a lesser degree also in the English and the French languages throughout the 19th century.

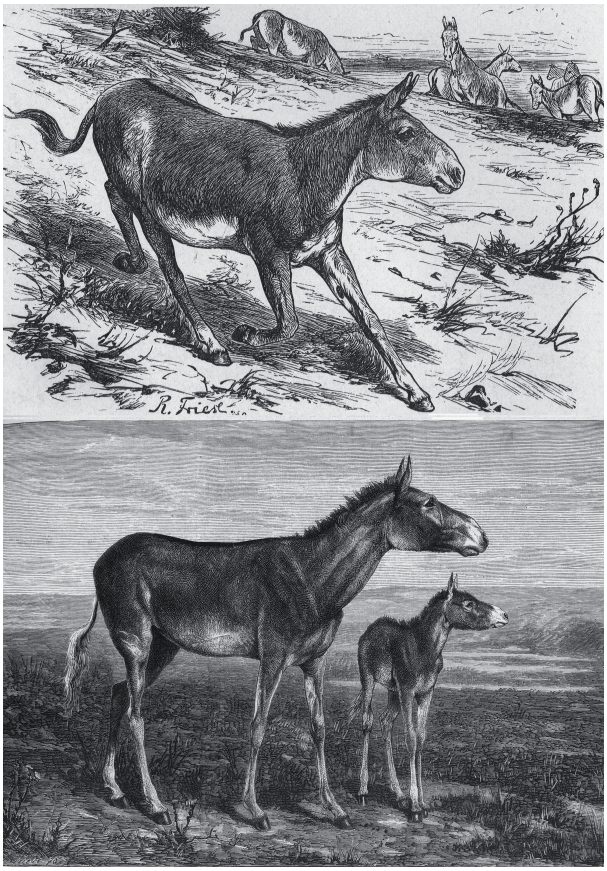

Fig. 6: Popular illustrations of "dziggetais" in the 19th century. 6a: Black and white drawing by R. FRIESE in "Brockhaus' Konversations-Lexikon" (ANON. 1892). 6b: Sketch by SCHUBERT (1879) in the "Leipziger Illustrirte Zeitung". Such barely naturalistic illustrations have paved the way to a vulgarized dziggetai concept.

The colonial expansion by the major European research nations into the species-rich countries overseas during the 19th century saw, particularly in Germany, a sharp increase of the scientific interest into the geographical variability contained in mammals. This included the hemiones, which were the first equid species described by an author of German nationality[55]. The Berlin

[53] According to DU HALDE (op. cit.) early Chinese zoologists had designated the dziggetais as m u l e s too. I am unaware if Medieval Chinese zoologists had been granted access to ARISTOTLE's manuscripts, or if their erroneous view had developed independently from a case of convergent pattern recognition.

[54] Nevertheless mystic opinions about the relationship of hemiones to horses and donkeys lingered into the 19th century. The mammal book by POEPPIG (1851) is a late example to present dziggetais as a "transition" of horses and asses.

[55] The appreciation of learned circles for his scientific achievements is a contrast to the fact that P. S. PALLAS had to emigrate from Germany to Russia to be recruited into an academic position.

Zoological Gardens, which were the major zoo in the dominant German province of Preussen, and later the national zoo of the developing Deutsches Reich, used the geographical variation in species as one guiding principle to display large mammals to the public of the new central capital of the recently unified Reich. The more or less naturalistic drawings of hemiones in general encyclopaedia (ANON. 1892) and illustrated magazines (SCHUBERT 1879) helped to popularize the dziggetai concept further (fig. 6a, 6b), and with many other popular zoological publications (e.g. "Brehm's Thierleben") they focused the interest of learned circles in Germany to the geographical variation contained in mammals. Not unexpectedly, this popularity of a complex science like evolutionary biology also fed and spread questionable, if not overtly misleading opinions, and it paved the track to a period of fairly superficial treatment of the genetic diversity of hemiones. Even the Berlin Zoo, one of the major proponents to carry these concepts into the interested circles of the German capital, did not take every detail of its self-elected mission to spread the knowledge of racial diversity too serious (footnote 90). Despite the many superficial errors created in these years in questions of large mammal systematics this remarkably favourable intellectual climate for taxonomy culminated in the recruitment of the distinguished splitter PAUL MATSCHIE as the curator of the decisive mammal collection of the Museum für Naturkunde in Berlin. This taxonomist alone will augment the number of Central Asiatic taxa of hemiones by adding four new (subspecies) names (MATSCHIE 1911, 1922; see below). This phase of a productive hemione microtaxonomy marks the climax, and the provisional end, of the scientific interest invested into the hemiones for about half a century, arguably from 1911 (1922) to 1967 (GROVES & MAZÁK 1967).

6. The extinct Kulans from Middle Asia

Historically, hemiones are known (or thought) to have ranged widely in the steppes and (semi)deserts of European Russia, Kazakhstan, Uzbekistan and western Siberia, south to the Kopet-Dag, the western foothills of the Pamirs, the northern foreland of the Tienshan Mountains, and Turkmenistan (HEPTNER et al. 1989). These populations had joined the south-western population group in Iran and Afghanistan. Today the nearest population surviving west of the Gobi and of Dzungaria are the Transcaspian kulans from the borderlands of Turkmenistan and Afghanistan. The hemione populations in the large territory between Turkmenistan and Dzungaria have been very scarcely explored prior to their complete extermination. Only single specimens are known from collections, and the few specimens imported from these lands to German zoos remain poorly documented and seem not to have been preserved.

In the west of Transbaikalian Siberia (sub)fossil bones reveal the presence of kulans in the more remote past, but the northern populations in Kazakhstan and west Siberia persisted until the 19th century (HEPTNER et al. 1989). They were long-distance migrants, which used to move over 500-600 km twice per annum to escape snow or drought. The map by BASKIN & DANELL (2003) shows seven former seasonal migration routes of kulans in Middle Asia, the longest of which spanned ten degrees of geographical latitude (45° N to 55° N), from south-central Kazakhstan to the Russian territory just beyond the Kazakh-Russian border. The forest-steppe and the northern steppe zone were apparently not populated regularly by the kulan (HEPTNER et al. 1989), but the northern range limits are insufficiently known. FALK (1786) knew of the summer range extending to the Jemba, and of concentrations near the Lakes of Aral, Balkhash, Zaissan and Aksakul, and generally in sandy deserts with stands of saxaul. GREVÉ (1898) drew the northern boundary in Russian Turkestan at 48° N, chiefly in the area of the Lake Aral[56]. Between the Ural Mountains and the Irtysh River kulans transgressed northwards until 52° N, while locally, e.g. in the Kokchetav Hills (Orenburg province), they penetrated northwards to 54° N (HEPTNER et al. 1989). Kulans were also found north and north-east of Zaissan, at Semipalatinsk, in the cis-Altaic steppes, and in the Kulunda steppe, but perhaps they were only regionally common, e.g. near the Lake Balkhash (SPÖRER 1868). LANSDELL (1885) was aware

[56] GREVÉ (1898) recorded both *E. hemionus* and *E. onager* for Russian Turkestan, obviously being uncertain of the correct affiliation. He did not separate the kiang from the eastern species *E. hemionus*.

of their existence near the Lake Alak-Kul, east of the Balkhash basin (without meeting a single specimen in summer 1882). GREVÉ (1898) listed the following records of kulan herds without referring to the sources of this information: North-western Karatau; west Tienshan (Tjanschan), presumably meaning the forelands of this mountain chain; the upper reaches of the rivers Arys, Keles, Tschirtschik, and their tributaries; Dzungaria east of Ulan-Ussu, and between the mountain chains of the Altai and the Tienshan. Their abundant occurrence was reported (op. cit.) for the Saissan Ssoitu valley, the Lake Nesamersajuschtschij, the steppes of Bekpakdala and those located between the Altai and Zaissan, the northern shore of the Lake Balkhash (herds of 1.000 specimens), and for a few more sites. By the beginning 20th century the species had disappeared from many territories in what is now Kazakhstan, lingering merely in the extreme east, in Betpakdala, in northern and southern pre-Balkhash, in the Zaissan depression and towards the Dzungarian Gate. Dziggetais were still common near the Lake Zaissan-Nor in 1876, and several of them were met during one morning by BREHM (1876 [1982 reprint]). They were "exceedingly numerous" near the Lake Balkhash in the early 20th century (MILLER 1914). By the 1930s the species was extinct in Kazakhstan, a few strayers taken apart, which continued to intrude from Dzungaria into the eastern extremity of Balkhash, and into the Dzungarian Alatau (HEPTNER et al. 1989).

Hardly anything is known about the identity and the phenotypic appearance of the kulans from these historical corelands of their distribution, except for the reports and the collections of very few short-term expeditions. This poor evidence is surprising, since Transcaspian kulans were the first hemiones outside the Near East to be discovered by a European: This first encounter might be credited to the Flemish monk WILLEM VAN RUYSBROECK (RUBRUQUIS 1255)[57,58], the author of perhaps the oldest and in any case a widely acclaimed treatise about the geography of Central Asia (e.g. RUBRUK 1925 [reprint]). The RUYSBROECK expedition to Karakorum in Mongolia departed from Constantinoples, crossed the Black Sea to the Crimea, and starting from there traversed lands within the range of kulans on horse-back, i.e. from the lower Volga and the Ural Rivers to the Karatau, the Dzungarian Alatau, Dzungaria, and the Ektag Mountains. The return route was similar, but it passed east Kazakhstan in the north of the Lake Balkhash. The steppe of the Bekpakdala plains in Kazakhstan ("monotonous wilderness") was the only territory which yielded sights of kulans on the eight days following the 31st October 1254[59]. From the route reconstructed by SCHMIDT (1885) the first encounter can be inferred for sites north of the River Tschu at approximately 46° N, 70° E, and with a daily coverage of 80 - 100 km ("the distance from Paris to Orléans", op. cit.), kulans continued to be seen until the Karatau Range had been reached. RUYSBROECK (RUBRUK 1925 [reprint], p. 58) noted that the ani-

[57] Born at the village of Rubrouck near St. Omer in French Flandres (Department du Nord), the Franciscan monk FATHER WILLEM had gained travel experience during the Seventh Crusade in 1248. In 1253-1255 he and FATHER BARTOLOMEO DA CREMONA were sent by KING LOUIS IX. to the residence of the Mongolian Emperor MANGKU KHAN at Karakorum. This place was probably located on the Orchon River, north of the Changai Mountains, in Mongolia (SCHMIDT 1885). RUYSBROECK's travel was the fourth exploratory mission to the Mongols since the year 1245, sent out to learn more about these warrior people, whose troops had started to menace Europe.

[58] SCHMIDT (1885) thought that WILHELM VON RUBRUK was the only name supported by the old sources, but several other spellings prevail for this monk of Flemish mother-tongue, e.g. GUILLAUME DE RUBROUCK, WILLIELMUS DE RUBRUQUIS, WILLIAM OF RUBRUCK, etc.

[59] Wild asses were reported even earlier in RUBRUQUIS's (1255) travel report, namely in a chapter inserted into the diary when the expedition had reached the Ukrainian steppes a few days after leaving Sodaia (= Sudak) on the Crimea: "Many forest asses, which looked like mules - Asinos sylvestres vidi in magna multitudine, qui sunt quasi muli" (BEAZLEY 1903, p. 152). However, this record is not reported in a chronological diary of daily encounters, but in a detailed description of the way of life of the "Tartaric tribes" , which had been met for the first time in the steppes north of the Asov Sea. Possibly therefore this hint to the asinos sylvestres was meant to characterize the fauna encountered by the "Tartars", rather than being a valid record for the Ukraine itself. This possibility is supported by the hint to the "Arcali" in the same context: This perhaps first record of the argali by a European cannot refer to the Ukraine, because these wild mountain sheep do not range thus far west into European territory.

mals were called a s s e s , but they appeared more similar to mules nevertheless. Too fast for persecution, any effort to hunt these kulans had failed[60].

In the 1830s EVERSMANN[61] (1840) collected hemiones in the steppe plateaux located between the Caspian Sea and the Lake Aral. A skull and two skins were deposited at the museum of Kasan University (the fate of this material is unknown). At that time the Central Asian dziggetais and the Persian onagers were regarded as two species, *E. hemionus* and *E. onager*, a classification questioned by EVERSMANN (op. cit.) on account of the "intermediate" look of his specimens. These Transcaspian kulans possessed no shoulder cross, their auricles were of intermediate length between onagers and dziggetais, and the dark dorsal stripe was framed by white margins of variable extent and intensity. A predominance of white body marks is diagnostic for the south-west Asian populations (onagers, khurs, Turkmenian kulans), but it is not observed in Gobi dziggetais. Unfortunately, the body measurements taken by EVERSMANN (op. cit.) are ambiguous, and not easily compared with the measures from other authors[62].

A few years later LEHMANN[63] explored the steppes and semideserts between Orenburg, Buchara, and Samarkand (52° N to 39° N, and 65° E to 85° E). An attentive naturalist who described the plant and animal life encountered at detail, this pioneer explorer of large tracts in Russian Turkestan had apparently failed to meet a single hemione (HELMERSEN 1852). His results on vertebrates[64] were published by the academician J. F. BRANDT (St. Petersburg), who referred the mid-19th century range of hemiones in west Turkestan to the southern Kirghiz, the Truchmenian and the Aralian steppes. Even in these days kulans seems to have been rare or localized in Middle Asia, at least outside its southern fringe.

From mid-March to November 1876 the expedition led by OTTO FINSCH[65], ALFRED EDMUND BREHM[66], and KARL GRAF VON WALDBURG-ZEIL-TRAUCHBURG[67] explored west Siberia

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[60] In illa solitudine vidi multos asinos, quos vocant c u l a m , qui magis assimulantur mulis: quos multum persecuti sunt dux noster et socius eius, sed nihil proficerunt propter nimiam velocitatem eorum (RUBRUQUIS 1255, cf. SCHMIDT 1885). The spelling of this first literary record of kulans differs between different manuscripts of RUBRUQUIS's text: c o l a n , c u l a m , c o l a u (BEAZLEY 1903).

[61] DR. EDUARD EVERSMANN was born at Hagen (Westphalia) on 23rd January 1794, and he died at Kasan on April 14th, 1860. After his studies of medicine, mineralogy and entomology at Marburg, Berlin and Dorpat he travelled to Bokhara, the Caspian Sea, the Volga steppes, and to the Caucasus. Plans to travel alone as a disguised native to Kashgar and Tibet failed after his European identity had been disclosed. He became the professor for zoology and botany at the University of Kasan in 1828.

[62] EVERSMANN had failed to see hemiones when exploring the steppes between Orenburg and Buchara in the autumn of 1820. The mammals collected during this journey were investigated by H. LICHTENSTEIN (Berlin) in an appendix to the travel monograph (EVERSMANN 1823). They comprised 26 species, but these did not contain ungulates larger than wild boars.

[63] ALEXANDER LEHMANN, born in Dorpat (Livland) on 18th May 1814, died at Simbirsk on 12th September 1842. A student of natural history at the University of Dorpat, before accompanying KARL ERNST VON BAER to Nowaja Semlja, Lapland and arctic Russia. He explored the steppes around Orenburg and in the southern Urals.

[64] LEHMANN had died from a fever soon after his Middle Asia expedition had ended on July 30th, 1842. His expedition diary was published by HELMERSEN (1852) with an appendix on vertebrate zoology by J. F. BRANDT, who had used LEHMANN's diary, his unpublished notes of encounters with animals, the skins and alcohol-preserved specimens collected during the expedition, and a list of the material deposited at the museum of Orenburg. LEHMANN's diary does not contain a record of hemiones, despite describing many minor natural treasures at some detail. Any direct encounter with a hemione would have been noted with certainty. BRANDT's inclusion of a short note concerning hemiones therefore presumably either recounts hearsay information reported to LEHMANN in 1841/1842, and written into his unpublished zoological notes, or it reflects BRANDT's own state of knowledge in 1852. In any case the range of Middle Asian hemiones in the period 1840-1850 is referred to.

[65] FINSCH was born at Warmbrunn (Giant Mountains) on 8th August 1839, and died at Braunschweig on January 31st, 1917. 1860 assistant at the Rijksmuseum voor Natuurlijke Historië at Leiden (Holland), 1864-1878 employed at the Völkerkundemuseum at Bremen. 1872-1882 scientific travels in North America, Lapland, Russia, and most intensively in Micronesia and in the west Pacific, where FINSCH helped to prepare

and Kazakhstan in a project by the "Verein für die deutsche Nordpolarfahrt zu Bremen", the later Geographical Society of Bremen (FINSCH 1879, 1899; BREHM 1876 [1982 reprint])[68]. Leaving the train in Nishnej Nowgorod they travelled in potential hemione country south to the Ala Kul, the Dzungarian Ala Tau, and the Lake Zaissan-Nor in the western forelands of the Altai Mountains, before they passed the Altai en route to Tomsk. The mammals collected by this expedition were determined by PETERS (1878). Kulans were met at only two sites (BREHM 1877, FINSCH 1879, 1880): In the city of Omsk a two year old male and a three year old female hemione ("k u l a n s ") were kept by an officer of the local Cossacks troops, APPOLON IWANOWITSCH RUSINOFF (fig. 7). These had been captured as foals by Kirghiz hunters in the steppes around Bekpakdala (midway between the Lakes Aral and Balkhash), and nursed by a lactating domestic horse[69]. Their summer coat was yellow-brown, with a white muzzle and lower cheeks, neck, belly, and legs, and with a white spot on the haunches. The dark dorsal stripe was bordered by white margins. Unfortunately, the Berlin Zoological Gardens showed no interest to purchase these tame kulans offered to them by RUSINOFF (FINSCH 1879), presumably because a hemione couple had already been kept (see footnote 90). Efforts to spot free-ranging hemiones in the steppes of south-west Siberia and northern Turkestan proved futile, although reported summer stands of this species were explored over weeks (BREHM 1877). Only in the Kazakh-Chinese borderlands around the Lake Zaissan, which only few years prior to that expedition had been finally brought under Russian sovereignty by the foundation of the military borderpost of Zaissan, and where the land use pressure still was marginal in these days, the expedition was successful. WALDBURG-ZEIL (in CANSTATT 1912) specified that the kulan habitat north-east of the Lake Zaissan and towards the Chinese boundary was a stony, waterless steppe of 30-40 wersts diameter, which could not be utilized to graze domestic stock. Two raw kulan hides could be bought from Kirghiz hunters near Zaissan (BREHM 1876 [1982 reprint])[70], and the desert steppes north-east of the Lake Zaissan-Nor produced at least 16 sightings of

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the seizure of north-east New Guinea as a colony of the German Empire. From 1898-1904 he was curator at the Museum of Leiden again, and from 1904-1917 the director of the Städtisches Museum Braunschweig. As a renowned bird collector and monographer, he became best known for his work on parrots. Not interested in the variation contained in species.

[66] BREHM was born at Renthendorf (Thuringia) on 2nd February 1829, and he died there on November 11th, 1884. After an apprenticeship of architecture he was engaged in several natural history expeditions in Africa, Europe, and Asia, and he became the director of the Hamburg Zoo, and of the aquarium "Unter den Linden" in Berlin. Best known for his popular animal encyclopaedia "Brehms Thierleben" in several volumes, which became a classic in popular scientific writing. BREHM described the behaviour of animals with terms reserved for human characters.

[67] WALDBURG-ZEIL was born at Neustrauchburg near Wangen (Württemberg) on 18th December 1841, and he died at Syrgenstein (Allgäu) on January 30th, 1890. A military officer interested in the sciences, he had accompanied THEODOR VON HEUGLIN from Stuttgart, the discoverer of the controversial African wild ass taxon *Asinus taeniopus* HEUGLIN 1861 from the borderlands of the Red Sea (HARPER 1940), and the sometimes accepted coauthor of the African wild ass *Equus africanus* HEUGLIN & FIZTINGER 1866 (GRUBB 2005), to Svalbard in the summer 1870 (KÖNIG-WARTHAUSEN 1877, CANSTATT 1912, HENZE 2005). He was accepted to accompany the west Siberia expedition by O. FINSCH if only travelling at his own cost, and if dispensing with publishing the scientific results soon after return. His Siberian diary was edited and issued only in 1912 by OSKAR CANSTATT.

[68] The endeavour was sponsored by the German Länder of Bavaria and Württemberg, and by a rich Moscow-based citizen, in order to explore the feasibility to transform the Ob River into a shipping canal to facilitate the traffic and the trade with Siberia. Much less attention was paid to this question than to zoology and botany.

[69] WALDBURG-ZEIL's diary (in CANSTATT 1912) specified the capture grounds as located on the Tschu River on the border of Turkestan and the Russian Gouvernement Akmolinsk (cf. the RUYSBROECK expedition, above). The same source also recalled a stuffed kulan in the zoological collection owned by the Polish grammar school professor STOWZOFF at Omsk.

[70] In volume 11 of his original, unpublished diaries BREHM (1892) designated the hemiones as W i l d p f e r d , presumably implying a generic meaning of this term. It was exchanged into k u l a n by the editor H. P. GENSICHEN.

living kulans (BREHM 1877)[71]. The askaris persecuted a group of three adult hemiones and one very young foal on horseback for twenty minutes, and they were able to capture the fatigued foal (FINSCH 1879, BREHM 1877, 1876 [1982 reprint]). The stress and a substitute diet of cow milk and grass killed this young kulan on the following day. BREHM (1877) was obviously deeply impressed by this encounter, and he wrote a passionate, if not emotional, essay on the life of kulans coping with the seasonal phenology of this steppe country. Apart from certain anthropomorphism typical of these days, and of BREHM's writing in particular, this essay might safely rank as one of the most detailed and precise accounts of hemione biology published before the second half of the 20th century. The information provided about kulan behaviour seems surprisingly detailed and "correct", although the essay cannot rest on authentic information: BREHM had glimpsed only a few escaping kulans for short moments, and he had not observed their social behaviour at all. BREHM (1877) also offered his opinion that kulans were the phylogenetic ancestor of the domestic horse[72]. The artist MORITZ HOFFMANN produced a black and white drawing of the kulan foal caught near the Zaissan-Nor, and of the tame pair kept at Omsk, for publication in FINSCH (1879). This drawing (fig. 7) seems to suggest comparatively marked colour contrast between the body and the light rump patch, the metapodia, the muzzle, the (incorrectly positioned) jaw patch, the belly and the flanks[73]. The carcass of an adult kulan stallion from Zaissan provided the following measures (FINSCH 1879): Body length (mouth to end of longest tail hair) 10 feet[74]; shoulder height three feet 10 inches; sacral height 3 feet 11.5 inches; head length (from nostril to front end of ear) one foot 8.5 inches; auricle length 7.75 inches; head length (from tip of the nose to occiput) two feet; neck length (from occiput to shoulder) one foot 9.5 inches; rump length (from shoulder to root of tail) three feet 9.5 inches; root of tail one foot 3.5 inches; tail length two feet 7.5 inches; longest tail hair one foot 4 inches; longest mane hairs 5.75 inches; hoof height at front 2.75 inches; and rear height of hooves 1.5 inches.

The foal skin from the Maiterek steppe near the Lake Zaissan-Nor, and the skin of an adult mare from the north of this lake acquired from local hunters were the material for PAUL MATSCHIE (Berlin) to describe a new race *Equus* [*Asinus*] *hemionus finschi* many years later (MATSCHIE 1911). He referred to the reddish salmon-pink ground colour (Repertoire des Couleurs 73) with a weak grey hue. The lips were white, and the whitish ventrum extended into an identically coloured lateral stripe field in front of the thighs, reaching upwards to one half the rump height. MATSCHIE (op. cit.) conceded that he could not check the type of PALLAS's dziggetai from Dahuria. Some authors accepted the subspecies *E. h. finschi*, e.g. to designate all kulans from Middle Asian with or without the Turkmenian (Badhkyz) population, or instead sank this taxon into the synonymy of the Dahurian race *hemionus* PALLAS (table 2, chapter 11; cf. SCHREIBER et al. 2000).

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[71] The botanist CARL ANTON MEYER had seen a kulan near the Lake Zaissan-Nor (Noor-Saisan) already on 17th May 1826, and he reported that the species was not rare in this remote part of Russia (MEYER 1830). MEYER (op. cit., p. 254) designated the species as "ungezäumtes Pferd oder Kulan (*Equus onager*)". He explored the Altai forelands as a member of the expedtion led by CARL FRIEDRICH VON LEDEBOUR, which had been organized by the Estonian University of Dorpat to describe the geography and the natural history of the Altai Mountains and the Kirghiz steppes. MEYER was born at Witebsk on 1st April 1795, and he died at St. Petersburg on February 24th, 1855.

[72] FINSCH (1880) recounted information from local people that a species of true wild horse inhabited the north-west Gobi desert across the Chinese boundary. The local Kirghiz name for this wild horse was "Surtaga". The discovery of this species is credited to the Russian explorer N. M. PRZEWALSKI (see footnote 14 for the role of French jesuits in discovering this species for western science in China).

[73] The Siberian collections of the FINSCH-BREHM expedition were presented during a touring exhibition in the cities of Bremen, Hamburg, Braunschweig, Hannover and Kassel in the years 1877-1878 (FINSCH 1899). For the exhibition at Braunschweig in 1877 FINSCH (1899) mentioned a "stuffed kulan", a photograph of which was published in the catalogue (FINSCH 1877). This document could not be obtained by the present author, neither could the site of this exhibition be ascertained. Neither the natural history museum nor the municipal archives of the city of Braunschweig were aware of this event.

[74] Measures were provided in unspecified "Fuß (') ". The measures in inches were inferred from the symbol ("), presumably meaning "Zoll" (FINSCH 1879, p. 64 f).

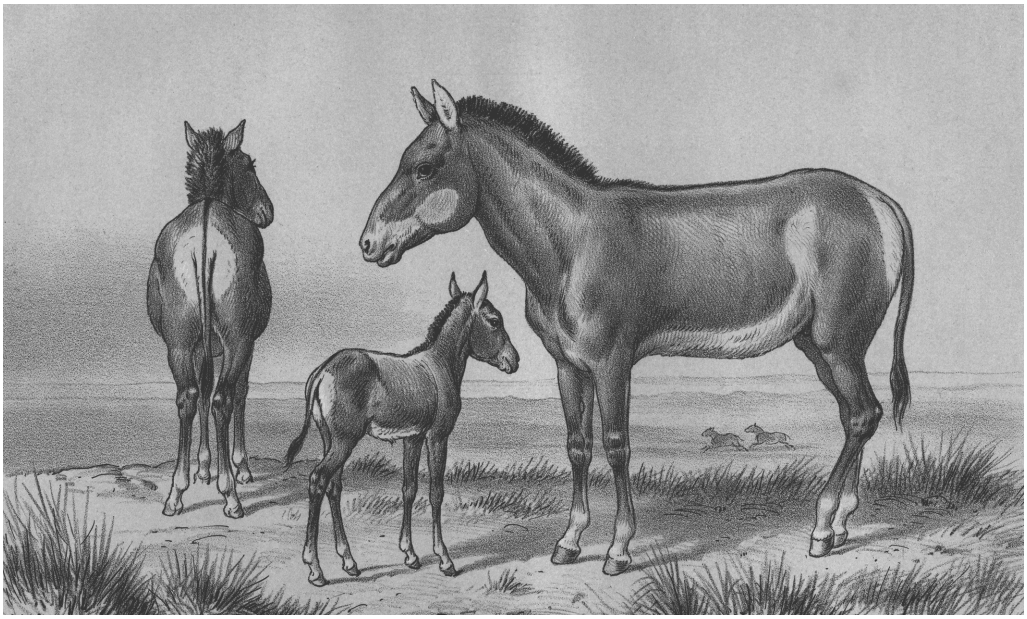

Fig. 7: Lithograph by MORITZ HOFFMANN of three kulans sketched from life by OTTO FRIEDRICH FINSCH during the west Siberia expedition in 1876 (FINSCH 1879). The adults were tame animals captured as foals in the Bekpakdala steppe, and raised in captivity at Omsk. The foal was collected by the expedition team near the Lake Zaissan-Nor in Kazakhstan. Remains of this foal are preserved at the Zoological Museum Berlin (ZMB 5216) as a syntype of *Equus* (*Asinus*) *hemionus finschi* MATSCHIE 1911.

The taxonomy of the Middle Asian hemiones remains essentially unknown, and perhaps will never by clarified, if Russian collections do not contain overlooked specimens, or bones collected in the field provide information.

7. The Distribution of Dziggetais in the Gobi Desert and in Dzungaria, and their Absence from the Tarim Depression

The early exploration of Chinese Dzungaria and the Mongolian Gobi did not add to the scientific knowledge of dziggetai systematics, but it provided records to infer the distribution and the former abundance of hemiones in Central Asia (see chapter 11)[75].

NIKOLAI MICHAILOWITSCH PRZEWALSKI[76,77] pioneered the exploration of the geography and the natural history of the Mongolian and the Chinese Gobi, of Dzungaria, and of north Tibet

[75] The French Lazrait priest RÉGIS ÉVARISTE HUC and his companion JOSEPH GABET reported on daily encounters with abundant numbers of hemiones during their wanderings in "Mongolia" and Tibet in the years 1844-1846 (HUC 1868). These mulets sauvages, also designated cheval hémione or cheval demi-âne (HUC 1932 [reprint], p. 40), were noted to breed true, with foals "from generation to generation always of the same species" (HUC & GABET 1928 [reprint], p. 146f). The reference of their observations to dziggetais in the abbridged German translation of their travel books (HUC 1966 [reprint]) is almost certainly erroneous, however, since the original version of the travel report identifies them as kiangs by conclusion: The priests had started their expedition in Manchuria (HENZE 1983), but the wild mules were viewed only after crossing the Mouroui-Oussou in "hither Tartary" (loc. cit.). This site name presumably designates the upper Yangtse River in Tibet (gazetteer in VAURIE 1972). In any case the religious mission of ABBÉ HUC and ABBÉ GABET barely touched the southernmost periphery of Inner Mongolia en route from Beijing to Lhasa.

(PRJEVALSKI 1988 [reprint], PRSCHEWALSKI 1877, PRSHEWALSKI 1951 [reprint], PRSHEWALSKI 1984 [reprint], PRZEWALSKI 1873, 1876, 1878, 1884a, 1884b). These lands were traversed in four expeditions between 1870 and 1883 (VAURIE 1972). PRZEWALSKI was accompanied by the natural historians WSEWOLOD IWANOWITSCH ROBOROWSKI during his third and fourth expeditions and by PJOTR KUZMITCH KOSLOW during his fourth travel. Both considered themselves as being PRZEWALSKI's disciples, and should pursue their own expeditions later. The first expedition lasted from 1870-1873. In November 1870 Mongolia was crossed from the Russian borderpost Kyakhta[78] via Urga (Ulanbataar) to Beijing. The 106th meridian guided the route through the Gobi. After a stage at the Lake Dalai-Nor, PRZEWALSKI proceeded to Inner Mongolia, the Lake Kuku-Nor, to the Yangtse River and to Zaidam (PRSHEWALSKI 1873, 1951 [reprint]). This trip started from Kalgan near Beijing in March 1872, and led through north-east Tibet and Zaidam, before crossing the Gobi from the Lake Kuku-Nor to Urga, and further to Kyakhta. This second crossing of Mongolia lasted from July to October 1873. Records of dziggetais were not mentioned during these trips, while other wildlife was noted[79].

The second expedition (1876-1877) explored Chinese Turkestan and Tibet. It departed from the Russian town of Kuldscha in the Ili Valley in August 1876, and passed along the Tienshan, the lower Tarim River, and the Lake Lob-Nor to the Altyn-Tag chain, which is the regional mountain range on the border of Central Asia to High Asia (PRZEWALSKI 1878, 1951 [reprint]). After a return trip on a very similar route, Kuldscha was reached again in July 1877. Keen to find wild camels, PRZEWALSKI would safely have recorded any dziggetai, but his list of the mammal fauna from the Tarim Depression did not include this species (PRSHEWALSKI 1951 [reprint], p. 92-93). The subsequent 500 wersts of foot trip in the winterly Altyn-Tag yielded the first encounter of a hemione from Chinese Turkestan. This a single "kulan (= *Asinus kiang*)" (op. cit., p. 17) demonstrated the sparse occurrence of hemiones on the northern slopes of the Altyn-Tag. Unfortunately, PRZEWALSKI has never discriminated kiangs, dziggetais, kulans, or possible intermediates between them[80]. Since kiangs were common to the south of the Altyn-Tag, a specimen migrating northwards in escape from the winter seems a safer interpretation of this record than to assume the occurrence of Gobi dziggetais thus far south-west (compare the case of SVEN HEDIN's record). The faunal list which PRSHEWALSKI (1951 [reprint], p. 116-117) had compiled for the scarce mammal fauna from the northern slopes of the Altyn-Tag supports this speculation, because his kulan (referred to as seldom in this area) shared this solitude with typical Tibetan mammals like the snow leopard, the blue sheep, the yak, and the chiru.

PRZEWALSKI's third expedition (1879-1880) into north-central Tibet departed from Zaissan in Kazakhstan in April 1879. Possible dziggetai country was visited in Zaidam, and during the return trip from Tibet through the Gobi to Urga and Kyakhta in autumn 1880, when the same trail was used as in the summer 1873. The fourth and last expedition (1883-1885) started with a north-south walk through Mongolia in winter-time, from Kyakhta (November 1883) and Urga through the Gobi to Tibet. The return trek covered Zaidam and the Tarim Basin, and terminated in Kazakhstan in November 1885.

N. M. PRZEWALSKI crossed the Mongolian Gobi four times, i.e. once in summer, once in autumn and twice in winter. He carefully recorded the sights of any game encountered in Central

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[76] Also PRSHEWALSKI, PRSCHEWALSKI, PRJEVALSKI, etc.

[77] Born at Kimborowo near Smolensk on 31st March or 12th April 1839, died at Karakol (today: Prschewalsk) on 20th October or 1st November 1888, when preparing a fifth expedition into Central Asia.

[78] Kyakhta, Kyachta, Kiakhta.

[79] As perhaps the greatest shortcoming of the present study the original reports of the important Russian expeditions (PRZEWALSKI, GRUM-GRSHIMAILO, KOSLOW) in Russian language were not consulted. However, the prolonged foot treks through the Gobi make dry if not boring reading in the translated travel reports studied (German, English, French translations), so that any translator should have gratefully included the spotting of every specimen of large game, if reported in the Russian original version.

[80] It is unfortunate that the careful observer and keen zoologist N. M. PRZEWALSKI used to designate every hemione seen as a k u l a n throughout his career.

Asia, and as a discoverer and collector of the wild horse (*Equus przewalskii*), named in his honour, and of the wild camel (*Camelus bactrianus*), he certainly paid attention to large mammals in particular. Of interest, therefore, is the lack of records of Gobi dziggetais in his books and essays for the Mongolian territory (PRZEWALSKI 1873, 1876, 1951 [reprint]). Not a single observation of the dziggetai was mentioned indeed, although the gazelles, other game and birds recorded in the diaries suggest that wild asses would have been noted too, if only met. Hemiones (dziggetais or kiangs?) were found during the first expedition in the Chinese province of Kansu, and kiangs (designated as "k u l a n s " in his notes) were frequently encountered in north Tibet (and named under their Tangutan designation of d j a n). Kiangs were particularly abundant around the Lake Kuku-Nor, near the Burchan Buddha Mountains and in Zaidam. Herds of 10-50, or in the hundreds, were seen (PRJEVALSKI 1876, 1988 [reprint]). Despite heavy persecution for their venison they proved less shy that could be expected, even curious towards humans. In the last decade of May 1884, hunting was considered unattractive, because the animals had lost their winter fat, and the quality of the skins had suffered from the moulting process (WOTTE 1971). The exploration of Dzungaria during the second expedition yielded information on three wild equid species: Apart from the newly discovered Przewalski's horse there were two hemiones species, i.e. the "d j i g e t h a i (*Asinus hemionus*)" and the "k h o u l a n (*Asinus onager*)" (PRJEVALSKI 1988 [reprint]). There is no comment to interpret this two-species concept of Asiatic wild asses in north-west China. However, PRZEWALSKI was a keen zoologist, and his opinion on Dzungarian hemiones should not be dismissed lightly. If not referring to the seasonal dimorphism of different coat colours a certain degree of phenotypic variability in the dziggetai population of north-westernmost China could be meant.

On 24th May 1879 the Swiss traveller A. REGEL[81] met large herds of "k u l a n s " in the desertic steppes on the Tallyk River in the northern foothills of the Dzungarian Tienshan (REGEL 1881). This river flows into the plains around the Lake Ebi-Nor (ca. 83°50' E, 44°20' N). The equids were observed to leave the hills at night in the search of water. Two hemiones could be shot further east (at ca. 44°10' N, 82°50' E) in a valley of the pre-Tienshan on June 19th, 1879. No other dziggetais were encountered during REGEL's west-easterly trek over eight months in the northern forelands of the Tienshan, from Kuldscha via Manas and Urumqui to Turfan and back, which included several trips into the mountain ranges themselves (REGEL 1881). These records seem to be the closest observations to the Tienshan Range ever reported, though evidently not from the high mountains proper.

The Russian Geographical Society mission of 1884-1886 under G. N. POTANIN and the zoologist M. BERESOWSKI explored the Chinese Gobi. The route passed from Beijing through Ordos to northern and eastern Kansu, which was studied intensively for two years (DEDITIUS 1897). Wildlife was found to be rare in the Chinese Gobi, but BERESOWSKI could prolong the trip for another year into the high mountains of south-western Kansu. Birds were of greater interest than were mammals, and only deer and gazelles, but no hemiones, were among the collected mammals (BÜCHNER 1892).

The zoologist GRIGORIJ JEFIMOWITSCH GRUM-GRIJIMAILO[82] and his brother M. E. GRUM-GRIJIMAILO explored the Russo-Chinese borderlands, north Tibet and Kansu from June 1889 to November 1890. They travelled from Kouldja eastwards along the Tienshan and the Manas Valley to Urumqui and Guchen. After an excursion to the oasis Gaschiun they surmounted the Tienshan at the Bujuluk Pass, and visited the Lake Lob-Nor, Sutschou, Tibet and the Hwangho River. The return journey passed the Lake Kuku-Nor and the Nan Shan Mountains to Sutschou and Kouldja. These naturalists published predominantly in Russian language. An English summary of their travel report (GRUM-GRIJIMAILO/MORGAN 1891), mentioned the occasional record of hemiones in Dzungaria, e.g. near the springs and oases in the surroundings of Guchen (44.1° N, 89.5° E), and in the lowlands east of the Ulan-Ussu mountain pass. The GRUM-

[81] REGEL was born at Zurich on 12th December 1845, he died in 1908.

[82] Born at St. Petersburg on 17th February 1860, died at Leningrad on 3rd March 1936. Also GRUM-GRISCHIMAILO, GRUM-GRZHIMAILO, GRUMM-GRSHIMAILO.

GRIJIMAILO brothers classified these Dzungarian wild asses as members of two species, *Equus hemionus* and *E. onager*. As zoologists, who had reported insightful observations of the behaviour of the wild horse (*Equus przewalskii*), their claim of seeing "two wild ass species" in Dzungaria is of interest. Of course, they could have surrendered to PRZEWALSKI's written opinion, because this traveller had become a respected if not a glorified figure of Russian science. SALENSKY (1902, p. 63-64) quoted from a report by the brothers GRUM-GRIJIMAILO in Russian language that Dzungarian hemiones grazed and drank in the forelands of mountain ranges (i.e. presumably of the Tienshan) during day-time, and returned into the shelter of the hills on sunset. Sites with "steppe vegetation" called "S y r t e " were the prefered grazing grounds. Other than the wild horses, which walked in a single file, hemiones moved and escaped in unordered packs. Horses therefore produced trodden-down tracks, which were easy to recognize, but dziggetais did not, except in the valley of the upper Glajtschshou (Chyi-Cho) River in the Tienshan (approximately at 44.1° N, 96.1° E) where, one may infer, the species had been very abundant.

In 1888 PRZEWALSKI prepared another expedition, but he died at the city of Karakol on the Issykkul in Russian Turkestan, from where the trek was planned to depart into north-west Tibet. On 26th May 1889 his disappointed team could continue the expedition under the lead of MICHAIL PEWZOW. They travelled from Karakol to the Tarim Basin, north-west Tibet, Zaidam and to the Hashun Gobi. The return route passed along the Altyn-Tag to Khotan, Yarkand and Kashgar. The military officers and naturalists ROBOROVSKY[83] and KOZLOFF accompanied this journey. The several thousand miles covered resulted in a two-volume report published in Russian language, and in rich zoological collections. The English translation of their report mentions hemiones ("w i l d d o n k e y s = *E q u u s k i a n g* = M o n g o l i a n k h u l a n ") for the Nan Shan Mountains, which were recognized as a zoogeographical outlier of Tibet (ANON. 1896)[84]. This kiang population was persecuted for venison and hides, used to prepare boots. In summer 1893 ROBOROWSKI and KOSLOW departed again form Karakol to the Nan Shan Mountains in Tibet. Pregnant kiangs, which had not yet given birth by the first week of June 1893, were seen near the upper reaches of the Tanho (WOTTE 1971). KOSLOW observed their mating ceremonies, and the hunting strategies of the native horsemen (op. cit., p. 161). In the winter 1893-1894 ROBOROVSKY saw countless hemiones (and argalis) on the fertile loess terraces of the outer foot of the Altyn-Tag Mountains, and on the edge of the Hanshu Gobi south-west of Sachu (So-tschou). These could have been Gobi dziggetais (Kansu dziggetais?, see below), or kiangs which had evaded the adjacent mountains in winter. Great numbers of hemiones (of unknown subspecies), together with wild camels and gazelles, were also observed around the lakes Khuitun-Nor, Sukhain-Nor, and Bulungin (Bargasirtin-Nor) in the same winter.

A French mission by PRINCE HENRI D'ORLÉANS[85] and (PIERRE-) GABRIEL BONVALOT[76] traversed Central Asia from the north-west to the south-east. East Turkestan was entered at Kouldja on 6th September 1889, where the Belgian missionary PÈRE DEDÉKEN joined the team. They traversed the Tienshan to Korla, and followed the lower Tarim River to the Lake Karaburn and the village Tjarchlik on the northern foot of the Altyn-Tag, from where the PRINCE and DEDÉKEN undertook an excursion to the Lake Lob-Nor. On 17th November 1889 the team ascended the Altyn-Tag via the Taschdwan Pass into Tibet, and continued their travel to Setchuan and Yunnan (BONVALOT et al. 1891). Kiangs ("k o u l a n e s = c h e v a u x s a u v a g e s " ; op. cit., p. 334) were met soon after climbing the mountain wall into Tibet, but dziggetais were not mentioned from the lowlands visited before. The two hemiones collected by the PRINCE were later exhibited to the public in Paris. ÉMILE OUSTALET (1891a, 1891b, 1891c) from the Musée National d'Histoire Naturelle in Paris presented a short report about the

[83] WSEWOLOD IWANOWITSCH ROBOROVSKY was born in 1856, and he died on July 23rd (August 5th), 1910. A military officer who had led his own expedition (with KOZLOFF) in Chinese Turkestan and in north Tibet in 1893-1895, but published in Russian language only.

[84] The Nan Shan Mountains are the highlands which also contain the Lake Kuku-Nor.

[85] D'ORLÉANS was born on 15th October 1867, he died at Saigon on August 9th, 1901. BONVALOT was born at Épagne in 1853, he died in Paris on 9th December 1933.

team's mammal collection in a popular science periodical. An ink drawing of a mounted hemione shot by HENRI D'ORLÉANS (OUSTALET 1891a) suggested a kiang rather than a Gobi dziggetai, although the animal was said to originate from a site located "south of the Lake Lob-Nor". BONVALOT (1892) refers these "*Equus kiang*" to the Lake Lob-Nor too. In reality the specimens might however have originated from the mountains of northernmost High Asia, which border on the Tarim Basin in the south[86]. This inference is supported by the anecdotal information provided about the biotope ("plateaux couverts d'herbe rase qui s'étendent au sud du Lob-Nor et s'avancent jusque ... Tibet", op. cit., p. 98); about the predators of these kiangs mentioned, i.e. snow leopards; and because the wild yaks also collected by HENRI D'ORLÉANS had reportedly been obtained "south of Lob-Nor " too (OUSTALET 1891c). The travel diary of the team did not mention any encounters with hemiones near the Lob-Nor or in the Tarim Basin, but many observations of kiangs during the later travel in High Asia (Altyn-Tag and Tibet), and it identified the sites of two successful hunts (BONVALOT 1892): D'ORLÉANS shot the first koulan stallion at Ouzoun Tchor in the Altyn-Tag on 3rd January 1889, and his local guide another specimen at a site named Balgoun Louk. Concluding from the travel itinerary these sites should be located at 310 km and 400 km to the south-east of the crossing point over the lower Tarim River respectively, i.e. they should safely reside in the plateau south of the crest of the Altyn-Tag (BONVALOT 1892). The many kiangs observed by this expedition aggregated to herds of 100-200. These groups were led by a stallion. The kiangs grew very thin during wintertime on a meagre diet of herbs and roots of a plant species named armoise. They were preyed upon by wolves, and particularly by snow leopards, but they were not shy to humans, especially not to humans approaching them on horse-back (OUSTALET 1891a).

In December 1895 the Swedish traveller SVEN ANDERS HEDIN[87] started his first of several expeditions through Chinese Turkestan and Tibet, which ended in February 1897 at Beijing (HEDIN 1896, 1900). He followed the slope of the mountain chains surrounding the Tarim Basin, and covered the north-western, western and southern rim of this inland depression. After traversing the Takla-Makan desert he followed the Tarim River to the swamp around the Lake Lob-Nor, proceeded to the Kuenlun Range, Zaidam, the Lake Kuku-Nor, and the Nan Shan Range, and he descended again to the southern Gobi, Alashan, Kansu, and Ordos on his way to Beijing. HEDIN's observations of great numbers of kiangs in north Tibet can be traced to precise localities on the maps attached to his report (HEDIN 1900). No dziggetais were noted in the Tarim Basin. However, in one of his reports submitted from the field (Kashgar, October 1895) HEDIN (1896) mentioned footprints of wild camel and marks of the "wild horse (khulan)" in a steppe zone of the Takla-Makan desert near the Khotan Daria River (op. cit., p. 270). Although impressed by this observation in an area where no wild equids had been seen before (or afterwards), HEDIN did not write how diagnostic these marks were for wild equids, nor how safely he could eventually distinguish the traces left by wild horses, dziggetais, kiangs, or domestic ponies. His local guide claimed to have seen wild equids in the Takla Makan desert before. They would descend from the surrounding mountains to the Yarkand Daria and to the Khotan Daria, and from east of the Takla-Makan desert. This record is not mentioned again in the very detailed travel accounts on the same 1899-1902 expedition through the Tarim Basin, which otherwise surpassed in every respect the essay written during that trip (HEDIN 1904b, 1905). Neither has this record been repeated or commented in any later work by the same author[88]. By contrast, the many encounters with kiangs in the Tibetan highlands are recounted in detail (e.g. HEDIN 1904c, 1907).

[86] HENZE (1978) complained that the BONVALOT expedition did not care about the precise recording of scientific information. Their travel narratives focused on the daily events and the people met. The altitudinal information about several of the visited sites proved incorrect (op. cit.).

[87] HEDIN was born at Stockholm on 19th February 1865, and died there on November 26th, 1952. He studied geology at the University of Stockholm. This Swedish expeditionist and geographer has often been regarded as the last of the famous traveller-explorers of Central Asia. Many have emphasized the quality of his maps, and the prolific writings on his travels.

[88] HEDIN's prefered research fields were geomorphology, hydrology, climatology and cartography. He explained his comparatively meagre zoological collections: "…zoology does not belong to my special field of

The British hunter and zoologist ST. GEORGE R. LITTLEDALE travelled in Chinese Turkestan twice. His chief purpose was to find the recently discovered wild Bactrian camel, and to collect specimens for the British Museum (Natural History). In 1893 he and his wife visited Kashgar and the Lake Lob-Nor, and passed the Altyn-Tag to the Lake Kuku-Nor (LITTLEDALE 1894). Hemiones, which would have safely been recorded by this naturalist, were not encountered. In January 1895 LITTLEDALE left Kashgar again, and travelled to Yarkand, Khotan, to the oasis Cherchen, and further through Tibet to Ladakh. By March no hemione had been recorded in the Tarim Depression, but kiangs were seen as soon as the north rim of the Tibetan mountain range of Akka-Tagh had been entered, which is a local chain of the Kuenlun Range (LITTLEDALE 1896). Ascending from the Tarim Depression in April the first kiang was seen in the valley of the Cherchen River, which drains the Akka-Tagh into the Takla Makan. Chirus were seen together with this first hemione, suggesting that this observation referred to a kiang rather than to a dziggetai.

The 1899-1901 Central Asia and Tibet expedition mounted by the Russian Imperial Geographical Society was the first of three expeditions led by PJOTR KUSMITSCH KOSLOW alone in the period 1899-1926[89]. It visited the Altai Mountains and Kobdo, followed the Gobi Altai eastwards, went south into Kansu, to the Lake Kuku-Nor and into east Zaidam, and continued to the country Kam in east Tibet (KOZLOFF 1902). The return route passed the Alashan Gobi, crossed the Mongolian Gobi northwards to Urga, and ended at Kyakhta in November 1901. The summer of 1899 in the Gobi Altai produced many sights of Mongolian, goitred and saiga gazelles, and of wolves, but not of dziggetais. KOZLOFF's companion B. T. LADYGHIN explored the sites named Aty-Bogdo and Koku-Tomyrty in the centre of the Mongolian Gobi, and found plenty of wildlife including dziggetais ("k h u l a n s [*Asinus onager*]"), apart from gazelles and wild camels (op. cit., p. 583). No further sight of hemiones is mentioned in the summary of the project report translated into the English language, but WOTTE (1971) recounts the encounters with Tibetan kiangs.

In 1902 the Bristish embassy officer C. W. CAMPBELL travelled from Beijing to east Mongolia. He spent two months in the steppes around the Lakes Dalai-Nor and Buir-Nor, near the Kerulen River, and in the Kentei Mountains (CAMPBELL 1903). CAMPBELL visited the district where J.-F. GERBILLON had noted a dziggetai in summer 1689, but 500 Mongolian gazelles were the only game seen apart from birdlife. The few other travellers who covered east Mongolia in the 19th century failed to record hemiones too. The British T. W. ATKINSON (1860) listed hemiones in his inventory of the mammal fauna from the upper Amur basin, but he did not mention any precise record of a dziggetai in his books about seven years of travel in Russian Dahuria, in east and central Mongolia, in the steppes of Kyrgyzstan and Siberia, and in north-west China (ATKINSON 1858, 1860). His faunal list thus does not prove the continued existence of hemiones in Dahuria by 1860. PRZEWALSKI did not meet a dziggetai during eleven days of exploration in the surroundings of the Lake Dalai-Nor in spring 1871 (PRSHEWALSKI 1873). HERMANN FRITSCHE, the director of the Russian observatory in Beijing from 1867-1883, left Beijing in the summer 1873 to trek through Chinese territory to the Argunian steppes (FRITSCHE 1885). He passed the country in the east of the Lakes Buir-Nor and Dalai-Nor, and travelled along the Argun River to Nercinsk, and further to Irkutsk. Not a zoologist, but interested in geodesy and earth magnetism, he noted w i l d g o a t s (presumably Mongolian gazelles),

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labour, and ... I made this collection more to gratify my own pleasure or fill an idle hour than with the view of satisfying the demands of the zoological specialist" (HEDIN 1904a; p. 529). Although over the decades he might have seen more Central Asiatic hemiones than almost any person before or after, and he cannot have missed the different colouration of kiangs and dziggetais, HEDIN designated every hemione as a "k u - l a n ". His low appreciation for taxonomy is mentioned repeatedly.

[89] KOSLOW was born at Duchowschtschina near Smolensk on 16th October 1863, and died in the vicinity of Leningrad on 26th September 1935. Born into a poor family, KOSLOW earned his life as a worker in the vodka distillery at the village Sloboda, where PRZEWALSKI had bought a country residence. He became an intimate junior friend of the already famous traveller N. M. PRZEWALSKI, and was invited by him to join his fourth expedition. WOTTE (1971) revised this first trip, and the three journeys led by KOSLOW himself, and published a useful route map for easy reference. Also KOZLOFF, KOZLOW.

some birdlife and many wolves, but no dziggetais. Neither did he record hemiones on another trip to Dahuria from Irkutsk to Nercinsk, and further to Kyakhta, Urga and through the Mongolian Gobi (via Iche-Ude to Kalgan) in autumn 1876, nor during a previous journey through the Gobi in autumn 1867, from Kyakhta via Urga and the Tsair-Ussu to Kalgan.

P. K. KOZLOFF, accompanied by A. N. KASNAKOV and V. F. LADYGIN, traversed the Gobi in 1907-1909 in a mission by the Russian Geographical Society. They followed a north-south transect from Kyakhta to Ulanbaatar, the Gurban Sajchan Mountains and terminated south of the Mongolian border at Chara-Choto. The travel book failed to record dziggetais, but it mentioned kiangs near the Lake Kuku-Nor (KOZLOW 1925). KOZLOFF's last trek in 1923-1926 led from Ulanbataar to the Gobi Altai, the Edsin-Gol, the Lake Kuku-Nor and the Hwangho River, and backwards on a similar route to Kyakhta and the Lake Baikal (STUBBE & CHOTOLCHU 1968, WOTTE 1971). The translated short version of the travel report focused on birds, without a reference to hemiones (KOZLOVA 1932).

The Hungarian DUKE ZICHY, accompanied by the zoologist ERNST CSIKI, collected many animal species and observed gazelles during their zoological collection trip through Mongolia, which led from Kyakhta via Ulanbaatar (Urga) south to the Chinese border and further to Beijing. They failed to record a single dziggetai when crossing the Gobi for two weeks in September 1898 (HORVÁTH 1901). In 1931 the mission by the French travellers HAARDT, AUDOUIN, and DUVREUIL travelled over 450 km in the Chinese Gobi. The accompanying zoologist M. REYMOND reported the sighting of three Przewalski's horses in detail, but he failed to record a single dziggetai (REYMOND 1932).

The British zoological exploration of north-west Mongolia and Dzungaria by DOUGLAS CARRUTHERS and his fellows, the botanist M. P. PRICE, and the zoologist J. H. MILLER, in 1910 and 1911 (CARRUTHERS 1911, 1912, 1914), did not find dziggetais in the surroundings of the Siberian or the Mongolian Altai, in the lake country of north-west Mongolia, or in the Upper Irtysh valley. The following ten months in Dzungaria yielded however the sight of "droves of wild asses" on the western shores of the salt lake of Bar-Kul, a lake basin with abundant wildlife, which also fed a huge flock of 15.000 free-running domestic horses (CARRUTHERS 1912). This basin received considerable amounts of groundwater from the snow covered mountains in the south, which permitted a lusher plant growth than did the surroundings. Dzungarian hemiones were shy, but J. H. MILLER shot two dziggetai stallions of four to five years of age in the Dzungarian desert north of the Lake Ebi-Nor (45.1° N, 82.5 ° E), between the Barlik-Maili Mountains and Borotala. Their shoulder heights measured 50 and 53 inches respectively. He noted a sandy fawn body colour, white bellies and white rump patches. The face was of a dark, sandy fawn colour, and the chest was isabelline. The legs were lighter than the rump. The dark brown mane continued into a chocolate-brown dorsal eel stripe framed by dirty white or very light fawn margins. The photo of a two year old foal in winter reveals the difference to the sleeker and paler summer coat. MILLER (1914, p. 607) designated the Dzungarian dziggetais as "*Equus hemionus typicus*", which might imply the perceived taxonomic identity with *Equus h. hemionus* PALLAS. The white underside of the summer coat and the light margin of the dorsal stripe do not agree with the belly, tinged in isabelline, of *E. h. bedfordi* (see fig. 10). LYDEKKER (1916a) assigned the dziggetai skull, which MILLER had donated to the British Museum (Natural History), to a kiang. POCOCK (1947b) compared this skull with those of kiangs and khurs without conclusion.

From the end of May 1927 to early June 1928 the team led by S. HEDIN travelled from Beijing to Dzungaria through the Chinese Gobi (HEDIN 1929). From Pautou on the Hwangho River they passed through the Alashan Gobi to the south shore of the Lake Gashiun-Nor, to Hami, Turfan, and Urumqui. Three localities produced sights or traces of wild asses. The biggest herd was met at a site, Tsagan-Bogdo, in Inner Mongolia, which is not identical to the locality named Tsagan-Bogdo by the ANDREWS-expedition (cf. chapter 9). The 24th December yielded another sight, further east in the forelands of the Emir Tag in the easternmost foothills of the Tienshan. The remaining record was noted east of Hami on 7th January 1928. These few encounters com-

pare with many observations of sometimes large herds of kiangs during HEDIN's previous three-year expedition from the Pamirs via the Lake Lake Lob-Nor to north Tibet (HEDIN 1899). A member of HEDIN's crew during 1927-1930, the Swede HASLUND-CHRISTENSEN, witnessed five k u l a n s in Inner Mongolia, after crossing the Edsin-Gol in westbound direction into the Black Gobi, but before his arrival at the oasis of Bajing Bulak, on the chilly morning of November 16th, 1927 (HASLUND-CHRISTENSEN 1936, p. 134). This site might be close the location of the first Gobi dziggetais recorded by MARCO POLO (see chapter 3).

BANNIKOV's (1948) map (edited by MURZAEV 1954) shows the distribution of the dziggetais in the Mongolian Gobi, as compiled by the pioneer explorers of Central Asia (fig. 14). BANNIKOV (1948) had spent the years 1942-1945 in Mongolia to study hemiones. By the 1940s the dziggetais had lost most of their (inferred?) historical range in north-west, north and east Mongolia. They had concentrated in south-west Mongolia until 48° N in the west, and 46° N in the centre of the country. To the east the constantly occupied range terminated at 108° E. Only in some years they migrated further to 112° E or to 116° E, and rarely even continued to visit the Lake Buir-Nor on the boundary of Mongolia and Manchuria. Examples of eastward range expansions were observed in the years 1911, 1915, 1921, 1929, 1930, and 1934. Precise single records from outside the remaining core range were provided by specimens hunted at 45°30' N, 114°30' E in 1911, and at 45° N, 114° E in 1934. Hearsay information confirmed scattered hemiones near the Lake Buir-Nor and the Lake Dalai-Nor in the far east of the country (or in adjacent Manchuria) at 50-60 years before the year of publication (BANNIKOV 1948), and near the Lake Kirghiz-Nor in north-west Mongolia at 40-60 years before 1948. A last observation from the Lake Kirghiz-Nor was cited for the year 1935. In 1941 a herd of perhaps 1.000 dziggetais had been observed north of the Lake Bon-Tsagan (MURZAEV 1954). Of further note are the proposed "genetic relationship" of the (former) Dahurian population in southernmost Siberia with the Gobi dziggetais from east (south-east) Mongolia, and the much earlier retreat of the Przewalski's horse into the arid solitude of the south-western Mongolian Gobi in a period when dziggetais still succeeded to roam over considerable tracts of the country. The loss of the former eastern portion of the Mongolian range was explained by the shortage of suitable drinking sites, which had remained free of human occupation in this more densely populated area. Competition with livestock for water was identified as the principal threat to the survival of the dziggetais.

The field work of the Russian zoologist A. G. BANNIKOV in 1943-1945 may be taken as the beginning of a new phase of hemione research, i.e. the exploration of behaviour, ecology, and adaptations (BANNIKOV 1948, 1958, 1961, 1981). This new era replaced the times of the great reconnaissance expeditions. Promoted by German biologists too (STUBBE & CHOTOLCHU 1968), this phase has seen the entry of Mongolian and Chinese scientists into the quest of dziggetai biology.

8. The Role of Zoological Gardens in the Quest of Dziggetai Taxonomy

There is no confirmed evidence that Central Asian dziggetais had reached European zoos before the late 19th century (SCHLAWE 1986). A couple of zebroids bred from a hemione and one of the other equid species in the first decades of the 19th century, ascribed to dziggetais (RÖRIG 1903), were almost certainly mistaken khurs from India, Persian onagers or maybe Syrian hemippes. Every other alleged early record seems to refer to other hemione subspecies too, or to population hybrids. The "d z i g g e t a i s " exported from Shanghai to Paris (ANON. 1862, RADDE 1861 [1970 reprint]) might have been kiangs, and those imported from India to France (SCHREBER 1844a, ANON. 1862) were almost certainly khurs. KOURIST (1979) listed early Central Asian dziggetais for the Ménagerie du Jardin du Plantes at Paris (1835), for the Jardin d'Acclimatisation de Paris (1863), for the Zoological Gardens of Berlin (1874) and Hamburg (1865), for the Knowsley Menagery owned by the EARL OF DERBY in England, and for the Zoological Gardens of London (arrival in 1909, supposedly from the Altai). The specimen at London might be the type specimen of Bedford's dziggetais transferred to London from Woburn Abbey (see below), but most or perhaps all other records might refer to hemiones from origins outside of Central Asia. Those for the zoos at Berlin and Hamburg deserve continued attention, and verification, nevertheless (cf. the list of four

dziggetais kept by the old Hamburg Zoo at the turn of the 19th to the 20th centuries in SCHLAWE 1986)[90]. The supposed d z i g g e t a i at the Riga Zoo which had sired a foal with a kiang mare (GRAY 1972) was a kulan from Turkmenistan (POHLE 1991).

At the turn of the 19th to the 20th century the animal trading company owned by CARL HAGENBECK (Hamburg) and the owner of the private game park of Askania-Nova (near Charkow, Ukraine), the German-descended FRIEDRICH VON FALZ-FEIN, imported Przewalski's horses (recently discovered by N. M. PRZEWALSKI in the year 1879), hemiones, and other valuable game from Central Asia. Scientific and popular publications about the purchased hemiones were written by zoologists from London, Hamburg and Braunschweig (HAGENBECK's imports) and from Berlin and Askania Nova (imports by F. VON FALZ-FEIN) respectively (see below in detail), and two dziggetai races were described from these imports into European zoos by museum taxonomists in London (*Equus onager castaneus* by LYDEKKER 1904b) and in Berlin (*Equus* [*Asinus*] *hemionus bedfordi* by MATSCHIE 1911). Unfortunately, the ambiguous information about the geographical origin of the zoo-living type specimens of these races led most subsequent authors to sink these names into the synonymy of better-founded types (table 2).

Starting in 1896, CARL HAGENBECK and the Russian tradesman STEPAN NIKOLAJEWITSCH WERESCHIAGIN from the Siberian city of Semipalatinsk signed an agreement to promote the import of Russian and Mongolian wildlife to Hamburg. Focused primarily on the import of red deer for animal exhibits and for the "genetic improvement" of European game stocks, several other zoo animals reached Europe too. Two male and one female "k u l a n s " arrived from Semipalatinsk in Hamburg in 1896 (DITTRICH & RIEKE-MÜLLER 1998), while "perhaps in 1899" WERESCHIAGIN delivered a pair of "d z i g g e t a i s " (SCHLAWE 1986). Both statements may or may not refer to the same import. A dziggetai was present in the ele-

[90] In a note on the discovery history of the dziggetai in the "Leipziger Illustrirte Zeitung" of 19th July 1879, G. SCHUBERT published a black-and-white engraving of a supposed dziggetai mare accompanied by her foal (fig. 6b). The engraving is much less naturalistic than the plate by M. HOFFMANN in FINSCH's (1879) book published in the same year. It does not improve the understanding of hemione diversity, but serves as an early example of a vulgarized dziggetai concept. Both mare and foal are much too high-legged, such as if the body proportions of a newborn had been transferred to the adult by an artist who had never seen a fully-grown dziggetai. The models for this illustration were unspecified "stuffed specimens". The artist could have been inspired by FINSCH's recent collections (1879), and the stuffed specimens could refer to the touring exhibition of the west Siberian collection in four German cities in 1877-1878 (see footnote 73). SCHUBERT (1879) does not mention the Zaissan-Nor kulans, but he refers to two "d z i g g e t a i s " at the Berlin Zoological Gardens. These were not hemiones from Central Asia, however: The archive of the Berlin Zoo lists two hemiones for the respective time period, a mare supposedly from Asia Minor acquired from HAGENBECK in 1874, and a stallion obtained in October 1875 from the animal dealer JAMRACH with a supposed origin "Calcutta". The mare produced a hybrid foal with an African wild ass (SCHLAWE 1969), which is also referred to by SCHUBERT (1879), confirming the relation between the hemione couple at Berlin and the 1879 newspaper article beyond reasonable doubt. At the same time FINSCH's kulans from Kazakhstan are released from the likely models of the present artwork (contra SCHLAWE 1986). This detail is noted because SCHUBERT's plate differs from FINSCH's kulans by not showing light buttocks (cf. chapter 12, conclusion 9). LICHTERFELD (1878) described these (stripe-legged) hemiones from the Berlin Zoo too. GAEBLER (1883) interpreted them as the representatives of a northern and a southern race. Two generations of offspring born to this pair were designated as "I n d i a n k u l a n " or "M e r w k u l a n " (SCHWARZ 1929) in a period when the Berlin Zoological Gardens started to develop an interest in exhibiting the geographical variation of large mammals. Supposed "k h u r s " appeared in other 19th century zoos in Germany too, e.g. at the Cologne Zoo, and a stillborn supposed "d z i g g e t a i " foal presented by the Berlin Zoo to the Royal Agricultural College at Berlin in 1886 (SCHÄFF 1886) must presumably be allocated to this lineage of unidentified population hybrids too. The parental pair might have originated from south-west Asia (see fig. 11 in SCHLAWE 1969), and it can be omitted from the history of dziggetai husbandry in Europe. The erroneous article by SCHUBERT (1879) is best not further considered as a historical anecdote on dziggetai husbandry (cf. SCHLAWE 1969, 1986). SCHLAWE (1969) records another newspaper note (Spenersche Zeitung) on a "d z i g g e t a i " imported to the Berlin Zoo on 15th November 1872, which cannot be traced in the zoo archive or in the zoological museum of Berlin.

phant house of the Hamburg Zoo until the visit of KNOTTNERUS-MEYER (1902). A son bred by a couple from Semipalatinsk (SCHLAWE 1986) arrived at the Frankfurt Zoological Gardens in 1907 (GOEHRING 1908), where it was kept in the elephant house (PRIEMEL 1918).

Table 2: Acceptance (x) or rejection () of subspecific names for the classification of Central Asiatic dziggetais by various authors

Revisor	Evidence	Taxon				
		hemionus	***castaneus***	***finschi***	***bedfordi***	***luteus***
SCHWARZ (1930)	survey of zoo specimens, literature	*hemionus*			*bedfordi*[91]	*hemionus*
ANTONIUS (1932)	zoo specimens, own keeping and breeding experience	*hemionus*				
ALLEN (1940)	skulls and skins from Gobi	*hemionus*				
HARPER (1940)	literature survey	*hemionus*		*(finschi)*	*hemionus*	
GROVES & MAZÀK (1967)	literature survey, skins, limited craniology	*hemionus*				*luteus*
SCHLAWE (1986)	zoo specimens, literature	*hemionus*				
DENZAU & DENZAU (1999)	literature, field observations, museum studies	*hemionus*				
GROVES (2002)	reassessment of previous study	*hemionus*	*castaneus*		*hemionus*	
BASKIN & DANELL (2003)	not stated	*hemionus*	only Russia considered	*finschi*	only Russia considered	only Russia considered

A photograph from 1920 by Frankfurt's zoo director KURT PRIEMEL is copied as fig. 8 (reproduced from ANTONIUS 1932). It shows the presumably only living hemione from Siberia ever photographed. ANTONIUS (1932) enquired from LUDWIG ZUKOWSKY from the Hagenbeck's Tierpark (in litt.) their likely capture grounds in the steppes of the Irtysh lowlands in the north of Semipalatinsk, and he ascertained their "northern and not too far eastern" origin in Asia. This hemione appears to be more distinctively counter-shaded than are the Gobi dziggetais, and at least the rear portions of its dark dorsal stripe are flanked by white margins, which enter the rump patch. ANTONIUS (1932) noted similarities with a kiang rather than with a Transcaspian kulan kept by him at the Schönbrunn Zoo (Vienna), such as a longer muzzle, a bulkier head, a narrow croup and a finer eel-stripe. A colour plate (fig. 9) by WILHELM KUHNERT in the popular animal encyclopaedia by HAACKE & KUHNERT (circa 1901) shows two hemiones of unspecified identity and provenance against a background of conifer trees[92]. The book's publication date, approximately 1901 (not printed in the volume), is compatible with the speculative view that this hemione couple are the kulans imported from Semipalatinsk (SCHLAWE 1986). In

[91] Name restricted to Transcaspian and cis-Altaic kulans.

[92] WILHELM KUHNERT was born at Oppeln on 28th September 1865, and died at Flims in Switzerland on 11th February 1926. For the student of animal painting at the Royal Academy of Arts in Berlin the Berlin Zoological Gardens were an important training ground, facilitated by personal contacts to the zoo director LUDWIG HECK. KUHNERT paid great attention to present the animal models against a naturalistic landscape setting (GRETTMANN-WERNER 1981), but the background of some artwork proved incorrect in terms of zoogeography nevertheless. Overseas travels helped the artist to present his paintings as naturalistic as possible, but he has never visited Siberia or Central Asia.

any case these animals do not seem to correspond to phenotypes from Transcaspia, Iran, India, or Syria. They exhibit a white stripe on both sides of the dark dorsal stripe. This character is absent from most Gobi dziggetais, but it is diagnostic for many south-west Asian hemiones, probably also for the Russian dziggetai kept at the Frankfurt Zoo, for two dziggetais shot in Chinese Dzungaria (MILLER 1914), for the dziggetai (?) of unknown origin drawn by the director of the Augsburg Zoo, STEINBACHER (1952, p. 21), and for the type specimen of the enigmatic subspecies *E. h. castaneus* (see below)[93].

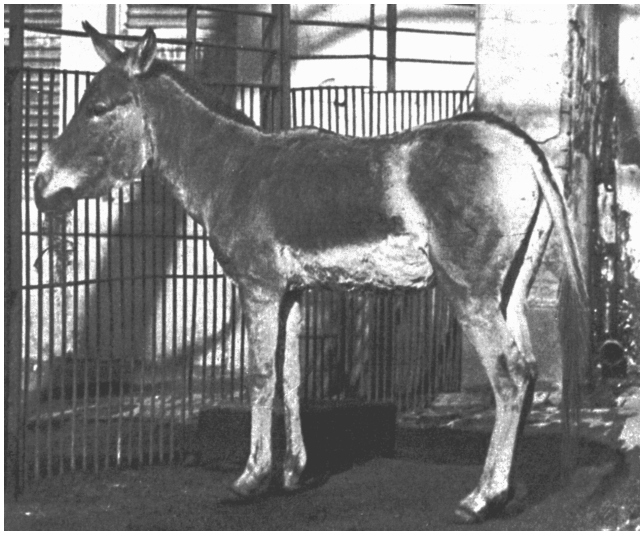

Fig. 8: Dziggetai stallion photographed at the Frankfurt Zoological Gardens in 1920 by its director KURT PRIEMEL (reproduced from ANTONIUS 1932). The specimen had been bred in the Zoological Garden of Hamburg, perhaps from the kulans imported from Semipalatinsk in Siberia (SCHLAWE 1986).

In 1896 F. VON FALZ-FEIN developed contacts to the Russian tradesman N. P. J. ASSANOW from Bijsk in the Siberian Gouvernement Tomsk (FALZ-FEIN 1930). ASSANOW organized the capture and the transport of equids and other game from Central Asia for the following six years. An unsuccessful attempt in 1896 was followed by six imports of wild horses and/or dziggetais to Europe: In the year 1899 to Askania Nova, in 1900 to Russia, in 1901 and in 1902 to Hamburg, and finally in 1903 and in 1904 to Askania Nova. The two importing institutions seem to have relied entirely on ASSANOW to identify the capture grounds, and to organize the captures and the transport to a station of the Siberian railway. The difficulties of these projects were remarkable[94]. The capture of 1896 failed because the caught suckling foals refused to thrive on the substitute milk from yaks and goats offered, and died. Afterwards, domestic horse mares had been mated in time to have suckling foals and thus milk by the planned capture date. After the destruction of their foals these mares served as the nurses for the wild equids. Therefore all captured equids were suckling foals without exception. Even so the mortality of the wildlife transported through the pathless vastness of the Dzungarian and Mongolian deserts and steppes continued to be high. Modern means of

[93] The painting by W. KUHNERT is copied in the popular animal encyclopaedia by LYDEKKER (1916b) without reference to the original source. Printed in less brilliant and thus more natural colours than the too glossy original (HAACKE & KUHNERT circa 1901), this plate of the "A s i a t i c w i l d a s s " (pages 45/46) served to illustrate the text paragraph on *Equus onager*, which was said to roam in Persia, Baluchistan, Afghanistan, Sind, Kach (sic), and in other districts of northern and western India (LYDEKKER, op. cit.). While details of the outer appearance appeal to dziggetais rather than to Persian onagers, LYDEKKER seems to have been impressed by the white flanks of the dark dorsal stripe, which also led him to classify his new race *castaneus* in the species *E. onager*, separate from the dziggetais (despite his opinion that the type of *castaneus* had originated from west Mongolia).

[94] The claims that three employees had organized as many as 2.000 Mongolian horsemen to catch the wild equids, and that the foals had been driven over 3.000 km steppe country (KADICH 1903) seem too heroic exaggerations of a truly most impressive achievement.

tranquilization able to reduce the stress to the animals were unavailable: At least two expeditions had failed due to the complete mortality of every caught ungulate (HAGENBECK 1914). Bomas permitted to assemble the wild equids at Kobdo and at Bijsk until their export (FALZ-FEIN 1930). Kobdo (Chovd) in the Mongolian forelands of the Altai served as the local project headquarters. From there the expeditions traversed the Altai Mountains to Bijsk in the Gouvernement of Tomsk in Russian Siberia, and continued by steam boat on the Bia and the Ob Rivers to the nearest railway station, where a long but perhaps less stressful journey for man and beast over another 5.000 km by rail could commence. The foot treks from Kobdo to the railway station lasted 59 days, including four days of travel by steam boat (DITTRICH & RIEKE-MÜLLER 1998).

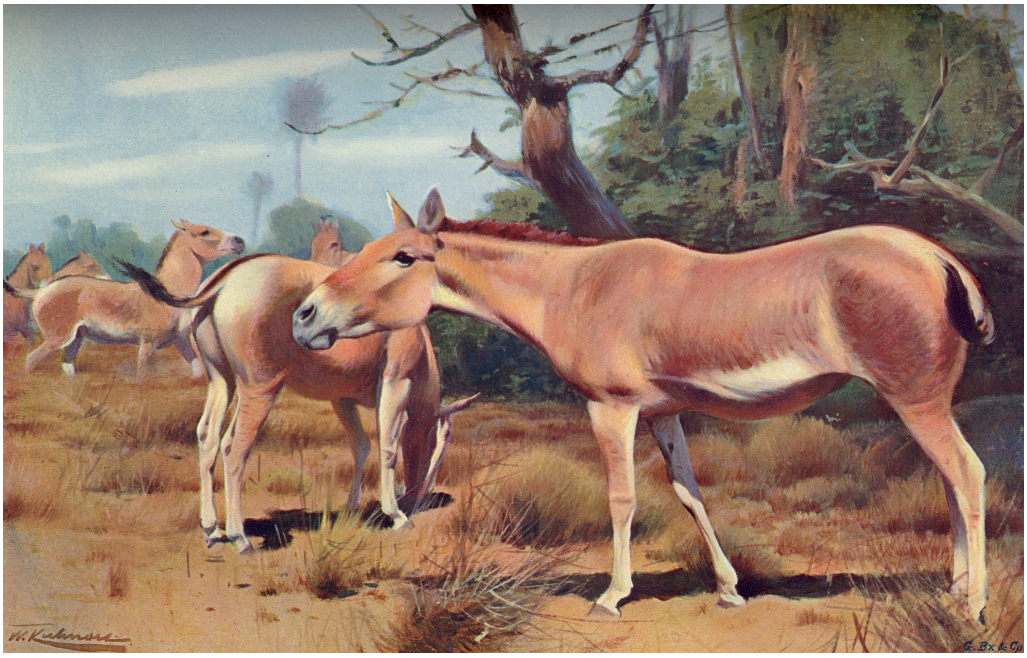

Fig. 9: Oil panting by FRIEDRICH WILHELM KUHNERT of hemiones from an unspecified origin (HAACKE & KUHNERT, about 1901). The colouration of the animals, and the conifer trees in the background seem to suggest a northern origin of these kulans. Note the white fields besides the dark dorsal stripe and the extensive white rump patch. Had these kulans been imported by CARL HAGENBECK from Semipalatinsk in west Siberia to Hamburg in 1899 (SCHLAWE, 1986), or did they come from the animal trader NEJIWOW in Kyrgyzstan ?

The numbers of dziggetais which reached Europe during these years (1899-1904), and their capture grounds, are not known with certainty. One dziggetai imported by the Hagenbeck Company was sold to the game park of the 11th DUKE of BEDFORD at Woburn Abbey in England. A colour plate of this specimen (fig. 10a), painted by the Dutch illustrator JOSEPH SMIT[95] in June 1903, was published by the curator of mammals at the British Museum (Natural History), RICHARD LYDEKKER (1904a). This male dziggetai of an estimated life age of three years had a pale sand-coloured summer coat, supposedly retained both in summer and winter alike (LYDEKKER 1904a). Like in Dahurian dziggetais the lips were white, but the muzzle and the belly were isabelline, rather than white or whitish. The inner faces of the extremities were white only in their proximate portions, but elsewhere they were pigmented like the body. This individual

[95] SMIT was born at Lisse (Netherlands) on 18th July 1836, he died on 4th November, 1929.

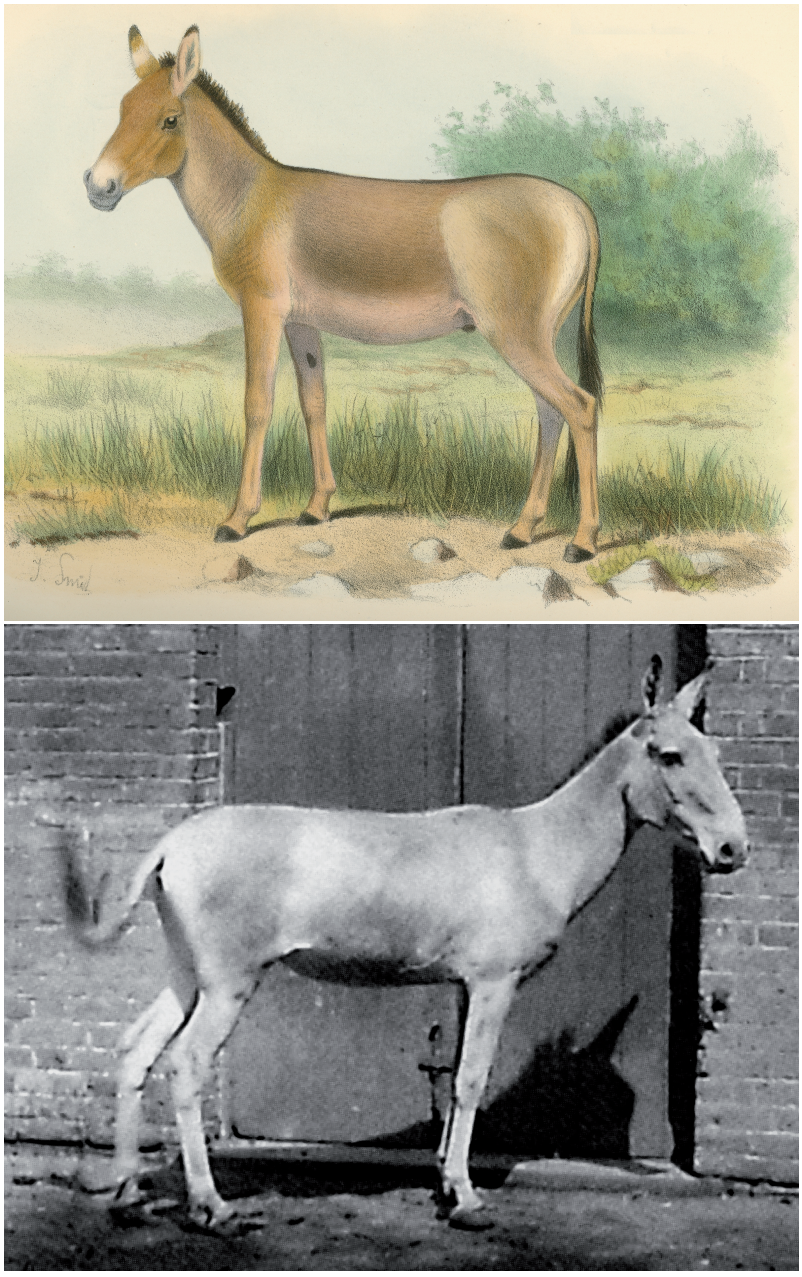

Fig. 10: Iconotype of Bedford's dziggetai (*Equus* [*Asinus*] *hemionus bedfordi* MATSCHIE 1911), imported by the company of CARL HAGENBECK as a foal, and exported to 11th DUKE of BEDFORD at Woburn Abbey (England). The geographical origin of this animal in Central Asia is uncertain, but presumably it was located in the western Mongolian Gobi or in Dzungaria (see text). Above: Summer phenotype painted by the Dutch artist JOSEPH SMIT in June 1903, when kept at the private game park of the DUKE of BEDFORD at Woburn Abbey, England (LYDEKKER (1904a). Below: The same individual photographed in 1918, after its transfer from Woburn to the Regent's Park Zoological Gardens in London (photograph reproduced from EWARTS 1996).

was transferred from Woburn to the Regent's Park Zoological Gardens in London on the 10th June 1909 (FLOWER 1929, see KOURIST 1979), and was photographed there in 1918 (EDWARDS 1996). One of these photographs is repoduced as the fig. 10b. MATSCHIE (1911) used the description and the iconotype from LYDEKKER (1904a) to propose a new taxon, *E. (A.) h. bedfordi*, to distinguish its body coloration from the "ochraceous yellow" of PALLAS's Dahurian dziggetai and from the "yellow reddish" of RADDE's specimens from the same area. HARPER (1940) criticized that P. MATSCHIE had not examined the type specimen on which he had based the designation *E. h. bedfordi*. This opinion needs not be correct however, since the animal was alive for seven further years after the species description in 1911, and it may well have been visited by MATSCHIE at the London Zoo during one of his sojourns in an English collection (M. HARMAN, Birchington, pers. comm.). In July 1918 the skull and the skin of the type specimen of Bedford's dziggetai were sold for the price of 20 pounds Sterling to the natural history museum at Tring (near London), owned by the LORD ROTHSCHILD. In 1939 they were transferred to the British Museum (Natural History) in London. In this final depository the specimen (catalogue number BM 1939.2472) is labelled as being a k u l a n from Turkmenistan (*E. h. kulan*), but the ink-written designation "M o n g o l i a n a s s " on the skull is still visible, and the skin identifies this animal as a dziggetai, and by coincidence as the type specimen of *E. h. bedfordi* MATSCHIE 1911.

A female hemione reportedly purchased by the 11th DUKE of BEDFORD from C. HAGENBECK was described by LYDEKKER (1904b) as the Kobdo onager *Equus onager castaneus*. This name emphasized the darker, richer tinged, rufous summer coat. Of note were the conspicuous, pure white ornaments, which frame the dorsal stripe, the pure white rump patch spreading over the hinder half of the thighs, and the extensive white of the muzzle which reached much nearer to the eye than in any other hemione known (POCOCK 1947b). LYDEKKER chose to classify this "K o b d o o n a g e r " in the species *E. onager*, which comprised the south-west Asiatic populations, rather than with *E. hemionus* hitherto thought to occupy the entire Mongolian territory. This decision rested presumably on the white dorsal borders of the eel-stripe, which are not typical of Gobi dziggetais, but of onagers and kulans from south-west Asia. Fig. 10 shows the "sandy fawn or rufous isabelline" *E. onager castaneus* in the summer coat painted by J. SMIT in July 1904. The winter coat was described as being full mouse-grey with a faint tinge of sandy rufous in places (LYDEKKER 1904b)[96]. The marked seasonal dimorphism was perceived as a difference to *E. h. bedfordi*, whose hair moult implied a merely subtle change of colours (LYDEKKER 1904a).

Unfortunately, ambiguity if not mystery surround many details about these dziggetais imported from Central Asia to European zoos (MOHR & VOLF 1984)[97]. Quoting information from the Hagenbeck Company, LYDEKKER (1904a) indicated that the type of the later *E. h. bedfordi* (MATSCHIE) originated from "east-north-east of Tarbogatai in the neighbourhood of the Lake Balkash in Central Kobdo, Mongolia, n o r t h - w e s t of the Gobi desert". Lake Balkhash is located, however, at a distance of 600 miles (south-) west of Kobdo in what then was Russian Turkestan. Shortly afterwards LYDEKKER (1904b) modified this statement into the phrase "n o r t h - e a s t e r n (= n o r t h - w e s t e r n) Mongolia" (sic). The capture ground of *E. onager castaneus* was "said to be Kirghis-Nor, Kobdo, west Mongolia, … if this locality be correct" (LYDEKKER 1904b, p. 590-591). Evidently LYDEKKER (1912) doubted the pertinence of this geographical information. Nevertheless Kobdo has been frequently quoted by subsequent zoologists to fix the origin of both new dziggetai races, however different their pigmentation was. HAGENBECK's (1914) autobiography did not mention the hemiones, but he stated that Kobdo was the logistic centre for the expeditions to capture wild horses in Central Asia, rather than necessarily their capture ground. Nevertheless his zoological assistant ZUKOWSKY (1914)

[96] LYDEKKER (1904b) mentioned a portrait in the possession of the BEDFORD family, painted in September 1903, by when the specimen had acquired its "long grey winter coat" (op. cit., p. 590).

[97] FALZ-FEIN (1930) mentioned competition if not rivalry between the reserve at Askania Nova and the Tierpark Hagenbeck, and accused the Hamburg-based animal trading house to have impeded competing importers by the provision of incomplete if not false information on the capture grounds of the wild equids in Central Asia.

referred the wild horses exhibited at Hamburg-Stellingen to the capture site Kobdo. MATSCHIE (1901) had only learnt from FALZ-FEIN that the imported equids were from "Middle Asia". Perhaps the most trustworthy description of ASSANOW's capture grounds was given by MATSCHIE (1903), to whom C. HAGENBECK had sent the skulls and the skins of a few wild horses deemed to differ as a colour variant from *E. przewalskii* POLJAKOV. MATSCHIE described them in honour of the donor as a new species, *E. hagenbecki*, and for this taxon diagnosis he received the information (by a Herr WACHE from the Hagenbeck Company[98]) of three capture grounds[99]: 1. The plains located at some 300 km west of Kobdo between the Ektag Mountains, the Kui-Kuius River, Lake Tussgul and Urungu in the Altai forelands. 2. The steppes in the "Altai" at some 300 km south of Kobdo. 3. The surroundings of the Lake Zagan-Nor at about 450 km south of Kobdo. NOACK (1902a) mentioned three capture sites too, and might refer to the same ones as did MATSCHIE (1903).

Not only the capture sites, but also crucial details on the identity of the hemiones that arrived in Germany, Ukraine and England remain ambiguous. On 27th October 1901 one dziggetai of two years of age reached Hamburg (NOACK1902a). Of yellow-red dun pigmentation, with but inconspicuously lighter, and by no means white, ornaments at the muzzle, the flanks and the hind legs, this young male might represent the "colt from Kobdo" (LYDEKKER 1904a) and the later type specimen of *E. h. bedfordi* MATSCHIE 1911. The life age of three years in June 1903 (LYDEKKER 1904a) suggests its capture as a suckling foal in 1900. This birth date is compatible with its arrival with the import of the October 1901[100]. It cannot be the type of the race *castaneus* (LYDEKKER 1904b), which was a female bearing conspicuously white ornaments. MATSCHIE (1901) published the photo of a young dziggetai stallion in winter or in transition coat, which had arrived at Askania Nova in the year 1900 (from "Mittelasien"; op. cit., p. 366) together with three Przewalski's horses (fig. 12). In every respect discerned this stallion seems to coincide with the phenotype of *bedfordi*, and with the specimens seen by the present author during an excursion to the south Mongolian Gobi in August 2005. Since both Askania Nova and the Tierpark at Hamburg-Stellingen had bought the equids from the same Russian trading house, both importers had likely been served from the same capture area. With some uncertainty remaining therefore the area typica of *E. h. bedfordi* might be referred an unknown site in the western Gobi desert, presumably located in the south or the south-west of Kobdo: Considering the distances from Kobdo indicated by MATSCHIE (1903), *E. h. bedfordi* could have originated from Mongolian or Chinese territory.

The origin and the trading routes of the type specimen of the "Kobdo onager" of the race *castaneus* remain doubtful. No information about this animal could be gathered during a visit to The Natural History Museum in London in September 2005. Neither did a glance into animal trade books of CARL HAGENBECK's company clarify if and when this female had been acquired from Central Asia to Hamburg, and where it could have been caught[101].

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[98] Presumably CARL WACHE, who was one of two German employees of C. HAGENBECK to accompany the equid transports from Bijsk in 1901. The new deer species species *Cervus wachei* NOACK had been based on specimens which had accompanied the wild horses to Hamburg, and which had been collected by WACHE and his colleague GRIEGER at the Dschingie River in Dzungaria, 200 km south of Kobdo (NOACK 1902). This is the most direct hint to a collection ground in China. WACHE also travelled and collected elsewhere in Central Asia, e.g. in Russian Turkestan, from where he brought "a few living species" (unspecified), and many ungulate skulls, horn and antler trophies from Prschewalsk (Karakol) in the south-east of the Lake Issikul (NOACK 1903).

[99] A guide booklet for visitors of Hagenbeck's Tierpark at Stellingen mentioned t a r p a n s (sic) from Mongolia, originating from the "region of Kobdo at the boundary to China" (FLEMMING 1914, p. 32).

[100] DITTRICH & RIEKE-MÜLLER (1998) found evidence in the archive of Hagenbeck's Tierpark of a male "kiang", which has arrived in Hamburg on October 27th, 1901. This stallion had been added (at Bijsk?) to the wild horse captures by a another tradesman P. MIRKSCH, together with Siberian roes, ibexes, a maral and raptors, which may or may not indicate a geographical source of this hemione independent from the horses. This "kiang" was sold on the 13th November 1901 to Woburn Abbey (England).

[101] The yearbooks of the final 19th century were not available in the archive of Hagenbeck's Tierpark in February 2006, but the import data for the imports of wild horses from Bijsk, and the export files to Woburn Abbey during the early 20th century, did not clarify the origin of the mysterious chestnut-coloured hemione.

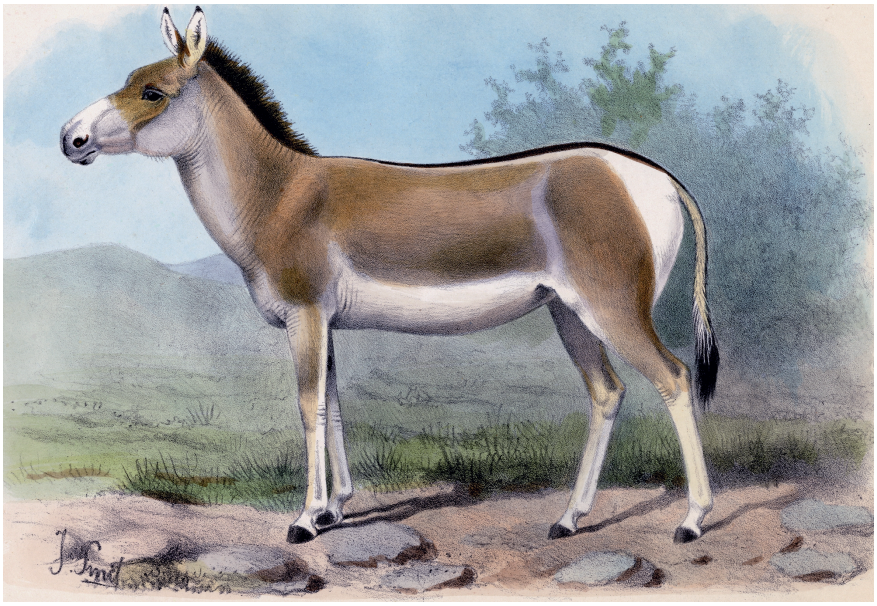

Fig. 11: Chestnut-coloured kulan or "Kobdo onager", *Equus onager castaneus* LYDEKKER 1904. Iconotype of the summer phenotype (of July 1904), painted by JOSEPH SMIT at Woburn Abbey (LYDEKKER 1904b). Note the pure white rump patch and the white stripes on the back. Reportedly collected by CARL HAGENBECKs' Central Asia expedition, and sold to the 11th DUKE of BEDFORD. The exact origin and the destiny of this type specimen remain unknown.

Fig. 12: Hemione imported to Askania Nova (Ukraine) by FRIEDRICH von FALZ-FEIN from an animal trader at Bijsk (Siberia). Reproduced from MATSCHIE (1901). The capture site in Central Asia is unknown, but it was presumably identical to the capture ground of Bedford's dziggetai, i.e. somewhere in west Mongolia or in Chinese Dzungaria (see text).

During his visit to the animal collection at Woburn Abbey in 1911, the French zoo historian LOISEL (1912) saw hemiones designated by him as " des onagres, des hémiones, des kiangs" (op. cit., p. 72, no scientific names given), apart from 15 Przewalski's horses and zebras of two species. LOISEL (op. cit., p. 77) tabulated the results of the efforts to acclimate wildlife at Woburn Abbey during the years 1892 to 1912: Four kiangs had arrived in 1894 (three of which had died or had been sold by 1911), two onagers in 1903 (one dead or sold), and four dziggetais (?) ("H é - m i o n e s ") in 1903 (three of which were dead or sold). I was unable to trace the import routes to Woburn. J. C. E. EWART, a professor of the University of Edinburgh, purchased a male hemione and a couple of Mongolian horses in 1902 for experimental hybridization with ponies, in order to test the hypothesis by the late president of the London Zoological Society, SIR WILLIAM FLOWER, that the freshly discovered and imported Przewalski's horses were nothing else than accidental hybrids between the kiang and the domestic horse. EWART (1903, 1904) bred kiang-pony zebroids to verify if they resembled the contested Mongolian wild horses, which had been introduced to Britain by BEDFORD. EWART (op. cit.) did not comment on the origin of his kiang stallion[102]. A male kiang skull donated by EWART is preserved in the Royal Museum of Natural History at Edinburgh, but there are no further data about its identity (A. KITCHENER, Edinburgh, pers. comm. 2005). The seemingly adult female type specimen of *castaneus* was painted twice, in September 1903 and in July 1904, and it should have been alive at Woburn Abbey at least that long (LYDEKKER 1904b). Since ASSANOW seems to have captured suckling foals only, the Central Asia imports of 1901 and 1902 are not likely sources for the specimen of *castaneus* anyway. FALZ-FEIN (1930) has apparently never sold his equids to England. The type specimen of *castaneus* had reportedly been lost, when the DUKE of BEDFORD had buried the carcass on his grounds without taking note of the site (pers. comm. to POCOCK 1947b). This disappearance of a type specimen is a strange incident indeed. The other "famous" hemione from Woburn, which later became designated as the Bedford's dziggetai, had been made accessible to the public by transfer from Woburn Abbey to the London Zoo, and later to the museum. Why should an enthusiastic zoologist like BEDFORD "bury the carcass and forget the site" of the type specimen of a new animal race? The new subspecies had been described from his property in the journal "Novitates Zoologicae" issued by the LORD ROTHSCHILD, who had founded a natural history museum at Tring near London, and who had entered an intellectual competition with the British Museum (Natural History), by favouring the ternary nomenclature of zoological systematics, which recognizes subspecies by giving them scientific names. BEDFORD was affiliated with the British Museum (see footnote 113). Did the BEDFORD family, deeply concerned with both zoology and species conservation, destroy the type specimen of *castaneus* after noting that LYDEKKER had erroneously described a misidentified specimen? Was this mare one of the four "hémiones" which had arrived at Woburn in 1903 (LOISEL 1912) from an unknown source? Was the type of *castaneus* one of the "kiangs" imported to Woburn in 1894, and was she related to EWART's kiang stallion at Edinburgh?

Additional hemiones of presumed Central Asiatic origin, which had been imported from unknown providers to European zoos in the latest 19th or the earliest 20th centuries, lived in the zoological gardens of Moscow[103], Halle, and perhaps Berlin and Hamburg[104]. The Halle Zoo

[102] EWART (1903) designated this animal as an "A s i a t i c w i l d a s s or k i a n g (*Equus hemionus*)". A LORD ARTHUR CECIL had cooperated in its purchase (EWART 1903). HAGENBECK's archive keep documents about the sale of a male foal of the Przewalski's horse and its domestic nurse, but not of a hemione, to a J. E. (sic) EWART at Edinburgh (DITTRICH & RIEKE-MÜLLER 1998).

[103] A single k u l a n had already been imported by C. HAGENBECK from the Moscow Zoo in 1873 (DITTRICH & RIEKE-MÜLLER 1998). The capture site and the further destiny of this hemione are unknown. OUSTALET (1902) was aware of two wild horses imported from M. (sic) ASSANOFF to the Moscow Zoo in 1901. GREVÉ (1903) met two hemione stallions in the Zoological Gardens of Moscow (year?). The older specimen was said to have been donated to the zoo by N. M. PRZEWALSKI. No details are given to infer if a kiang, a Mongolian dziggetai or a Kazakh kulan was referred to. The destiny of this specimen is unknown.

[104] A historical black-and-white photo of an adult hemione which resembled a dziggetai was seen in the archives of Hagenbeck's Tierpark at Stellingen in Febuary 2006. The stable in the background seemed to suggest that this specimen had been kept at Stellingen at an unknown date (K. GILLE, pers. comm.). The identity or origin of this animal could not be verified.

received a male "M o n g o l i a n d z i g g e t a i " in the first years of the 20th century (BRANDES 1907). It arrived presumably in the period 1902-1905 (L. BAUMGARTEN in litt.). BRANDES (1908) estimated its life age at six years. HAGENBECK had delivered a pair of Przewalski's horses and some Mongolian ponies to the Agricultural Faculty of the University of Halle in November 1901, but the origin of the dziggetai in the Halle Zoo could not be traced from the trade yearbooks of the Hagenbeck Company for the years of the wild horse imports. This stallion sired at least three zebroids with two donkey mares. A photo of this dziggetai, presumably in winter coat, was published by the journal of the Halle Zoo in 1917, and was later reproduced by BAUMGARTEN (2001, p. 78)[105] together with a micrograph of one of the newborn dziggetai-donkey zebroids. The skull and the mounted body of one of these hybrids are preserved by the Museum für Haustierkunde "Julius Kühn" of the Faculty of Agriculture at Halle University.

Perhaps apart from the breeding pair of hemiones at the Hamburg Zoo, the Russian OSIP NEJIWOW could have been a possible provider of the stallion at Halle and/or of some or all of the hitherto untraceable equids imported from the then extremely remote Middle Asian countries at the turn of the 19th to the 20th centuries. Located at Narinskoe town (Naryn) in Russian Turkestan (today: Kyrgyzstan), NEJIWOW`s company caught a multitude of wildlife, and was reported to have delivered 50.000 zoological items (live animals, furs, skeletons) from Central Asia to zoos and collectors in Russia, Germany, England, France, Austria, Italy and the United States from the 1980s to at least 1911 (ANFILOW 1911). NEJIWOW's company sent roughly 50% of his exports to Germany alone. He was a supplier of the director HECK of the Berlin Zoological Gardens, and he had contacts to Russian, German and French scientists. Using Kirghiz animal capturers who drove the animals until they fell down by fatigue, the game was transported to the Tashkent railway station, from where the transports passed Perovsk, Orenburg, Samara, Tula, Smolensk, and Warsaw. NEJIWOW delivered an unspecified number of kulans and Przewalski's horses to zoological gardens (ANFILOW 1911). The hemiones were offered at a price of 50-100 rubels per specimen. ANFILOW (1911) did not refer to the phenotype and the origins of these equids despatched from Russian Turkestan, or specify the zoos which had purchased these kulans.

Fig. 13: Dziggetai stallion at the Zoological Gardens of Halle. The animal had reportedly been caught in north-(west) China, and exported via Beijing and Moscow to the Tierpark Berlin (SCHLAWE 1986). From 28th November 1961 to 31st May 1985 it has been kept at the Halle Zoo. Its remains are preserved in the Staatliches Museum für Tierkunde in Dresden. Courtesy of L. BAUMGARTEN and J. HEUER (Halle).

[105] In my opinion this photograph does not prove the identity of the specimen as a dziggetai from Central Asia.

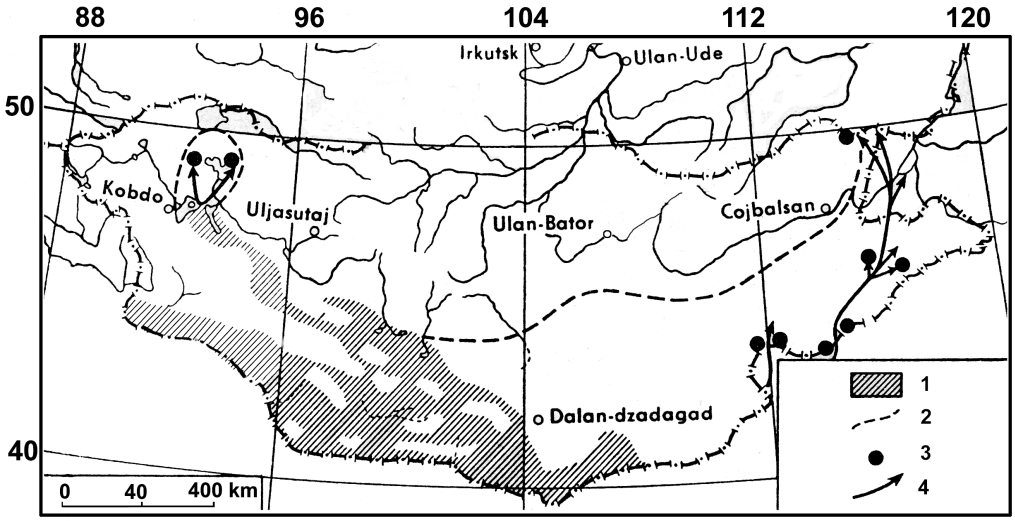

Fig. 14: BANNIKOV's (1948) map of the dziggetais' range in Mongolia in the first decades of the 20th century. Regularly occupied territories are indicated, as are migration routes for irregular range expansions. Modified from MURZAEV (1954).

After the Second World War two dziggetai stallions were imported from the Beijing Zoological Gardens via the Moscow-based "Zoobjedinenije" to the Tierpark Berlin, and forwarded to other keepers in Germany (SCHLAWE 1986, POHLE 2000). These stallions bred 25 population hybrids with Turkmenian kulans. The Zoological Gardens of Halle kept one of these dziggetais from 30th November 1961 until its death on May 31st, 1985 (L. BAUMGARTEN in litt.). This stallion had been imported from Moscow as a Turkmenian kulan, and was confirmed as such one by E. MOHR (Hamburg), but its import from Beijing Zoo to the U.S.S.R. in the year 1961 could be confirmed later by H. DATHE (L. BAUMGARTEN in litt.). The origin of these post-war imports from the Chinese territory seems to be certain (fig. 13). They were probably the Gobi dziggetais caught by a collector team sent out to the Xinjiang Province by the Beijing Zoo in the winter of 1955 to catch Przewalski's horses. This aim did not succeed, but during six months of exploring an extensive area "east of the Tsungaria basin" four "Mongolian wild asses (*Equus h. hemionus*)" could be captured for the Beijing Zoo (T'AN PANG-CHIEH 1964). A supposed west Mongolian dziggetai kept at the Prague Zoo in the period 1951-1953 (GROVES & MAZÁK 1967) was rather a Turkmenian kulan (SCHLAWE 1986). The dziggetais kept at the Beijing Zoological Gardens in August 2005 looked identical to the Gobi population from south Mongolia; they were designated by the zoo staff as *Equus hemionus bedfordi* (pers. observation)[106].

9. The Central Asiatic Expedition of the American Museum of Natural History

The Third Asiatic Expedition of the American Museum of Natural History (New York) to the southern Mongolian Gobi in 1922 visited the Övörkhangai Aimak and the western Ömnögov Aimak. It was one out of a series of such trips led by ROY CHAPMAN ANDREWS, curator in chief of the Department of Asiatic Exploration, to investigate the palaeontology, geology, archaeology, and the animals of the Mongolian Gobi in the early 1920s (ANDREWS 1924, 1927, 1932, 1933). Mammalogy was a subordinate aim of this project, but dziggetais were to be collected for the museum's exhibition rooms. With seven cars, 125 camels, a fair number of scientists (Americans, British, Mongolian, Chinese), modern photographic equipment, and relatively comfortable camps, this expedition was much better supported than any previous project in Central Asia, and in many aspects it was far ahead of its time. This generous technical support

[106] J. DOLAN saw 1.1 dziggetais when visiting the Shanghai Zoo in December 1979 (POHLE 1984).

facilitated the collection and the export of a more comprehensive population series of dziggetais than had ever been compiled, and in fact the largest series before the present Mongolian-German project. The presumably first photographs of Gobi dziggetais from Mongolia were taken too (ANDREWS 1932, 1933)[107], and can be compared with a micrograph of a stallion from near the Sachui-Somon in the Gobi Altai Aimak taken by N. CHOTOLCHU in 1960 (STUBBE & CHOTOLCHU 1968). The equids were also filmed (perhaps the first movies produced from a wild hemione), and their speed during escapes from the persecuting motorcars was documented[108]. The expedition route passed from Kalgan in China to the base camp located in the northern forelands of the Gobi Altai, from where exploration trips started into the surrounding desert, but also into the trans-Altai Gobi. Many dziggetais were met in the area around the Tsagan-Nor (Tsagaan Nuur) in the north of the eastern Gobi Altai, where a lot of green grass was available at that time, and where small depressions dug by hand in the sand rapidly filled with ground water (ANDREWS 1927, 1932, 1933). The largest herd encountered contained 1.000 asses (ANDREWS 1933)[109]. Tsagan-Nor (45.1° N, 101.5° E) is located at a distance of some 20 miles north of the Gobi Altai, and is separated from it by a belt of sand dunes. A single herd was seen near Artsa-Bogdo, and in the desert north of the Boga-Bogdo Peak. From this peak a fan of alluvial sediment sloped down into the desert plain, dissected by the occasional rainstorm into deep canyons and ridges. The area was covered by short grass, and the dry river canyons were dotted with aged elm trees (ANDREWS 1927). The paper by ANDREWS (1927) provides photographs of these sites. By contrast the species was very rare in the then dry and barren desert south of the Altai range, though some were met just south of the Gurbun Saikhan (Gurvansaikhan) in the eastern Gobi Altai (43°30' N, 105° E). Newborn colts were observed from the last week of June until July 10th. Attempts to export young foals to America failed, because the captured specimens succumbed to a diet of cow milk (ANDREWS 1933).

Twelve adult and five juvenile hemiones were collected in the Tsagan-Nor basin, around a base camp located at Loh, and in the north of Bago Bogdo (ANDREWS 1932). Fourteen summer skins from Tsagan-Nor and Loh in the New York Museum displayed a Fawn body colour (RIDGWAY Plate XL) with a somewhat darker rump, and Light Vinaceous Buff (RIDGWAY Plate XL) lower parts, buttocks, hind parts of forelegs, and inner parts of hind legs (MOTOHASHI 1930). The ear tips, mane and the dorsal stripe were Carob Brown (RIDGWAY Plate XIV). A ring of brown hair above the coronets was observed in older animals. MOTOHASHI (1930), who also studied the skulls[110], and ALLEN (1940), the first monographer of the Mongolian and Chinese mammal fauna, designated these Gobi dziggetais as *E. h. hemionus* PALLAS. ALLEN (1940) did not discuss the name *bedfordi* MATSCHIE 1911. Further he erroneously referred the race *castaneus* (LYDEKKER 1904) to a winter skin of the same population as *luteus* MATSCHIE 1911, which would represent its corresponding summer phenotype. ALLEN (1940) ignored that (i) the type specimen of *luteus* was collected in spring-time, not in summer (see chapter 10), that (ii) the geographical origin of the race *castaneus* was unknown or at best questionable (see above), and that (iii) the race *bedfordi* had conserved its sandy fawn coat the year round (LYDEKKER 1904a), and only *castaneus* was described as being seasonally dimorphic (LYDEKKER 1904b). ALLEN (1940) did not discuss any detail of the only study of the New York Museum series by MOTOHASHI (1930), who had been this museum's own student of the relevant material. Obviously this experienced mammalogist did not take dziggetai nomenclature very serious.

[107] The cover page of the journal "Natural History", i.e. the popular magazine of the American Museum of Natural History (New York), from January-February 1933 (Volume 33) depicts the colour painting of a herd of Gobi dziggetais persecuted by a wolf, against the background of the snow-covered Gobi Altai. This painting by ARTHUR A. JANSSON may be the only artwork on Gobi dziggetais in situ ever published.

[108] For details, compare DENZAU & DENZAU (1999, p. 114).

[109] MURZAEV (1954) reported a herd of not less than 1.000 dziggetais from slightly further west, in the plains on the northern shore of the Lake Bon-Cagan.

[110] SALENSKY (1902) published skull measurements of dziggetais from the Gobi and from Dzungaria (collection of the Zoological Museum of St. Petersburg), albeit for comparison with wild horse skulls rather than for purposes of subspecies taxonomy.

10. The southern Range Boundary of the Gobi dziggetais

The contact or the transition zone between the Gobi dziggetais and the Tibetan kiangs has hardly been studied. One even ignores if they meet (met) at all, hybridize(d), are (were) connected by character clines, or if they are or have been confined to disjunctive distribution ranges in recent historical times. The characters to distinguish dziggetais from kiangs in the field are discussed by LECHE (1904), GROVES & MAZÁK (1967), and DENZAU & DENZAU (1999). The shortest field diagnosis possible refers to the white underside of the kiangs, which displays a distinctive contrast to the vividly red brown dorsum, and to the larger body size of the populations from north Tibet (LECHE 1904).

PRSCHEWALSKI (1877) met wild asses designed as "k u l a n , c h u l a n , or by their Tangutan name "d s c h a n (*E q u u s k i a n g*)" at the Tetung-Gol, the Lake Kuku-Nor, in Zaidam und in north Tibet. They abounded in the vicinity of the Lake Kuku-Nor, where mating was observed in September. These equids measured 149 cm (soil to croup), 130 cm (body length), and weighed 180-216 kg. The muzzle, throat, breast, the lower portions of the rump and the lower legs were pure white, the front parts of the forelegs and the outer sides of the ears light brown. Many other travellers confirmed the ample occurrence of kiangs in the Nan Shan Mountains, especially near the Lake Kuku-Nor (chapter 7). Likewise several authors spotted kiangs (of unknown subspecies) in the western Kuenlun Range, bordering on the Tarim Depression. The identity of the "k u l a n s (*A s i n u s k i a n g*)" seen by PRZEWALSKI (1884b) in high valleys on the northern slope of the Nan Shan Range, where the southern extension of the Gobi desert zone ascends to altitudes of 7.500–11.000 feet, is unknown, but the hemiones seen in the Zaidam depression were presumably kiangs (PRZEWALSKI 1876; dorsum light-brown, ventrum white).

Fig. 15: PROF. Dr. KARL FUTTERER (Karlsruhe) at an estimated age of 35 years. Leader of the Central Asian expedition which discovered two hemione subspecies, and possibly the collector of the type specimen of the Kuku-Nor kiang, *Equus hemionus (Asinus) kiang holdereri* MATSCHIE 1911 (see footnote 111). Reproduced from HOLDERER & FUTTERER (1897 - 1899).

Fig. 16: Overview map of the Central Asian route of the FUTTERER expedition. From HOLDERER & FUTTERER (1897 - 1899).

The knowledge of the southernmost dziggetais from north China, and about the north-easternmost kiangs from Tibet, is largely due to the Tibet expedition led by KARL FUTTERER (FUTTERER & HOLDERER 1898a, 1898b, 1899; FUTTERER 1902, 1903; FUTTERER undated), a professor for geology at the Technical University of Karlsruhe (fig. 15)[111]. This journey

[111] KARL JOSEF FUTTERER, born at Stockach in Baden on 2nd January 1866, died at Karlsruhe on 17th February 1906. He studied natural sciences at the universities of Heidelberg and Berlin, doctorated at Heidelberg in 1889, and after a short period at Freiburg University worked until his habilitation in geology and palaeontology in 1892 at the Königliches Museum für Naturkunde (Berlin). He became an extraordinary (1895) and an ordinary professor (1897) for geology at the Technische Hochschule Karlsruhe. His interest in Central Asian geography had been aroused by F. VON RICHTHOFEN (Berlin). The Tibet expedition was supported by FRIEDRICH I., the GRAND DUKE OF BADEN, who also refunded the geological expedition collections with 10.000 Marks, and upon his return in 1899 awarded FUTTERER the directorship of the Department of Mineralogy and Geology at the Großherzogliches Badisches Naturalienkabinett. FUTTERER's expedition survived an attempted assassination, when Tangutan lamas had presented the scientists a kettle with poisoned milk. They survived by chance, because their dogs died immediately after drinking from this donation, soon enough to prevent the team from enjoying the refreshment too (NARCISS 1978). FUTTERER's mental disease and his early death prevented the full scientific documentation of the expedition's results and collections. The various files at the Landesarchiv Baden-Württemberg (Karlsruhe) contain an unpublished, partial expedition diary (FUTTERER undated), and a fine collection of photographs (HOLDERER & FUTTER 1897-1899), which presumably was a present to the sponsors (GROSSHERZOG FRIEDRICH?). It contains many black-and-white photos of landscapes (including

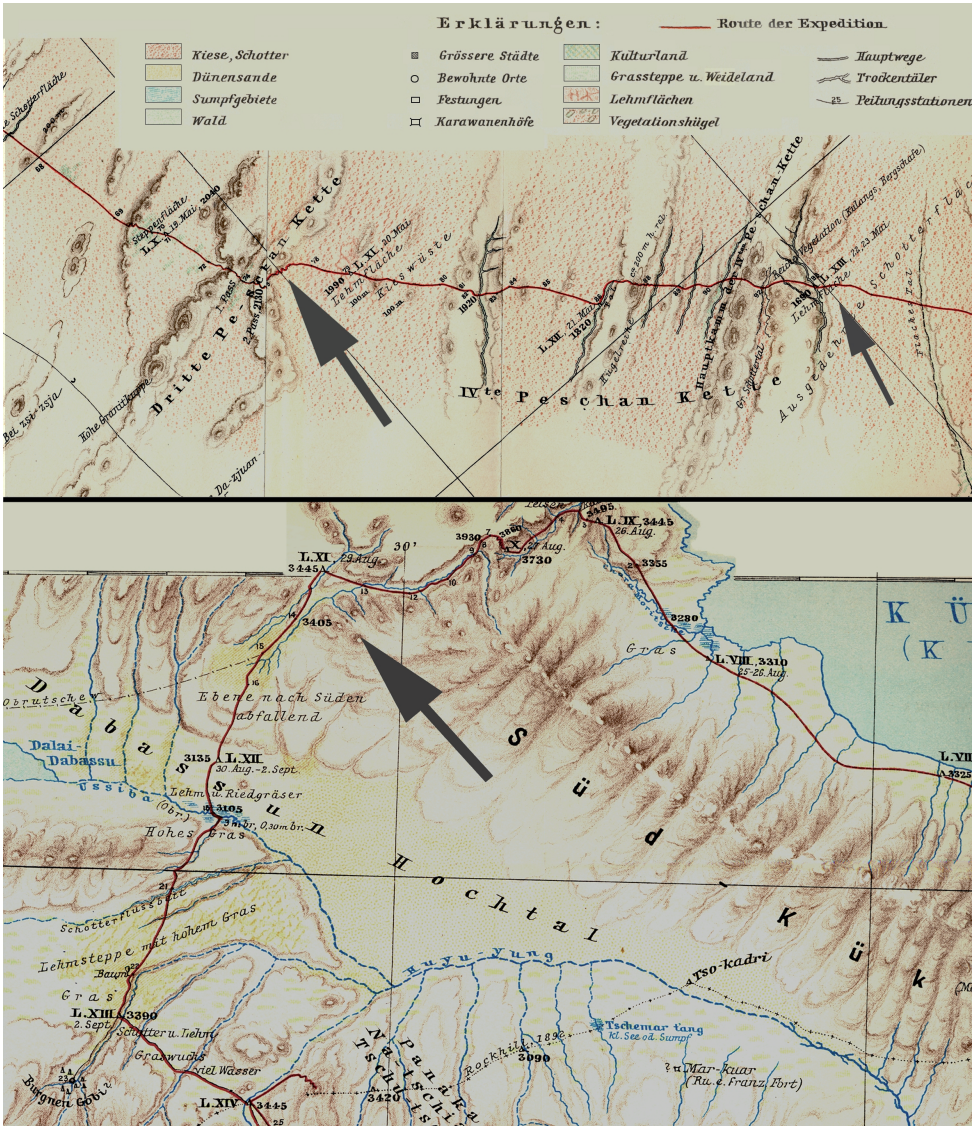

Fig. 17: Collection sites of the Kansu dziggetai, *Equus* (*Asinus*) *hemionus luteus* MATSCHIE 1911, near Suzmigal, located between Chalmi und Sotschou in Inner Mongolia (fig. 17a), and of the eastern or Kuku-Nor kiang, *Equus* (*Asinus*) *kiang holdereri* MATSCHIE 1911, in a valley between the Kuku-Nor Mountains and the Semenow Mountains, south-west of the Lake Kuku-Nor in Tibet (fig. 17b). The terrae typicae were identified from the collection dates of the museum types, from the route sketch 1:1.000.000 for the travel route in Kansu by B. HASSENSTEIN (FUTTERER 1902), and from the map 1:500.000 of the trek through north-east Tibet by B. HASSENSTEIN and C. SCHMIDT (FUTTERER 1903).

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the collection regions of the types of two new hemione subspecies), of people and ethnographic objects, mounted on 50 cardboard plates and assembled in a leather case (HOLDERER & FUTTERER 1897-1899). Wildlife photography has not been included in this photo gallery. MAYER (1985) provided a list of obituary notes published to honour K. FUTTERER.

departed from Karlsruhe to Baku, Samarkand and Kashgar, and traversed Chinese Turkestan and north-east Tibet (fig. 16). The expedition focused on aspects of geomorphology and geography, but nevertheless five hemiones were collected at two localities, and deposited at the Königliches Museum für Naturkunde at Berlin and the Großherzogliches Naturalienkabinett at Karlsruhe. Two new subspecies, the Kansu dziggetai, *E. h. luteus,* and the Kuku-Nor kiang, *E. h. holdereri*, were described from this material several years later by MATSCHIE (1911)[112]. Since zoological notes or a publication by the two leading scientists of this expedition, K. FUTTERER and J. HOLDERER, have not been found, the collection sites of the type specimens can only be inferred from the specimen labels at the Zoological Museum of Berlin (ZMB), and from the route maps and diaries of the expedition (fig. 17).

The FUTTERER expedition had left Hami on 6th May 1898, and traversed desert plains poor in wildlife until the Peschan Mountains, whose northern foothills produced the sights of very shy wild asses designated by the Turkish (sic) designation "kulangs" (FUTTERER 1902, p. 11). The vegetation of this area was sparse, but runoff had collected in depressions to create shallow water pools surrounded by stands of grasses and spiny plants. On the 18th May 1898 many kulangs were met on these plains at 41°30' N, 95°50' E. Other wildlife included "antelopes" (in other contexts FUTTERER mentioned gazelles, so what were these "antelopes"?), argalis, hares, foxes, and partridges. The area was largely devoid of human occupation and use. The type specimen of *E. h. luteus*, a stallion whose skull is kept at Berlin (ZMB 32173), was collected by J. HOLDERER (fig. 18) on the 20th May 1898. On the evening of this day the campsite was erected in a loamy basin in the gravel desert east of the Third Peschan Mountain Chain, in an area which had already been explored and described by GRUM-GRSCHIMAILO (op. cit., p. 19). Assuming that the type specimen had been hunted half-way between this campsite and the rest camp of the previous night, the terra typica of the Kansu dziggetai *E. h. luteus* MATSCHIE 1911, defined by the museum label as being "Suzmigal between Chalmi and Su-tschou", is assigned to 41.2° N, 96' E (fig. 17a). A female syntype (ZMB 32175) was collected on 23rd May 1898, also by J. HOLDERER, immediately to the east of the main crest of the Fourth Peschan Range (41.5°N, 96,3° E), on the edge of a plain dotted with boulders (map in FUTTERER 1902; cf. HARPER 1940). GROVES & MAZÁK (1967) accepted *E. h. luteus* as the valid name to designate the dziggetais from the Gobi desert in general.

Fig. 18: Portrait of DR. JULIUS HOLDERER, in whose honour the Kuku-Nor kiang, *Equus* (*Asinus*) *kiang holdereri* MATSCHIE 1911, had been named, at an estimated age of 35 years. Participant of the FUTTERER expedition, who also collected the type specimens of the subspecies *Equus* (*Asinus*) *hemionus luteus* MATSCHIE 1911. Reproduced from HOLDERER & FUTTERER (1897 - 1899).

[112] In addition the same short article by MATSCHIE (1911) introduced the name *Equus (Asinus) hemionus finschi* for the kulan collected by FINSCH and BREHM in Kazakhstan, and *E. (A.) h. bedfordi* for the Gobi specimen imported by HAGENBECK, and published without formal description by LYDEKKER (1904a).

The type mare was moulting from the dense, curly winter coat to the summer pelage, both of which were of a similar loam-yellow colouration, intermediate between "Clay" or "Cream buff" in RIDGWAY's standard colours, and which matched the "Bürbraun" colour of another compilation of standards, the Repertoire des Couleurs, most closely (MATSCHIE 1911). From PALLAS's Dahurian dziggetai the type of *luteus* differed by a lighter, almost white throat and by a white lower breast and inguinal region. The white field on the ventrum extended as a stripe onto the flanks of the rump. In this character *luteus* was perceived to approach the body ornaments of the kiangs. The muzzle was not white like in Dahurian dziggetais, but it contained a blackish-brown median patch in the middle of both the upper and the lower lip.

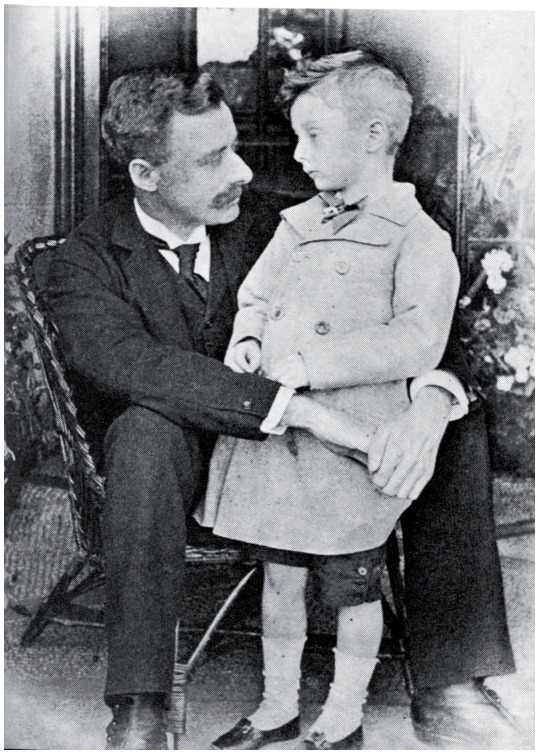

Fig. 19: HERBRAND RUSSELL, 11th DUKE of BEDFORD (Woburn Abbey), with his son HASTINGS, the later 12th DUKE of BEDFORD (reproduced from BLACKISTON, 1980). Bedford's dziggetai, *Equus* (*Asinus*) *hemionus bedfordi* MATSCHIE 1911, has been named to honour HERBRAND's contributions to zoology.

In this context MATSCHIE (1911) noted that the Gobi dziggetai imported by HAGENBECK, whose painting had been published by LYDEKKER (1904a), exhibited a pale sandy fawn rump colour, an isabelline belly - instead of the white ventrum of the new race *luteus* - and a white muzzle devoid of a dark median patch. To account for these differences he proposed the name *Equus (Asinus) hemionus bedfordi* for this specimen (fig. 10a) and thereby honoured the name of its first keeper, the 11th DUKE of BEDFORD from Woburn Abbey (England), who was an important supporter of the zoological sciences[113] (fig.19). MATSCHIE (op. cit.) did not comment

[113] HERBRAND ARTHUR RUSSELL, 11th DUKE of BEDFORD. Born in London on 9th Febuary 1858, died on August 27th, 1940. The DUKE owned an outstanding game park at his principal residence, Woburn Abbey, in Bedfordshire. A pioneer in species conservation by captive breeding, best known for establishing a world herd from the few Père David's deer imported to European zoos. He also imported the first Przewalski's horses to Great Britain, and supported zoological collectors in China who procured animals for the British Museum (Natural History). Collections in his service in Kansu in 1909 did not obtain equids (THOMAS 1911a). Numerous animal species and subspecies were named in his or his wife's honour, including among the larger mammals the golden takin (THOMAS 1911b), the Manchurian roe, the West Himalayan goral, and a few controversial variants of moose, isubra deer, dziggetai, and leopard from east or Central Asia. President of the Zoological Society of London (1899-1926), Member of the Trustees of the

on the type specimen of *bedfordi*, which was still alive in 1911, the year of description, in the Zoological Gardens of London. He may or may not have seen this only individual on which we had founded a subspecies (cf. chapter 8 for a discussion of its geographical origin).

A few months later the FUTTERER expedition followed the southern shore of the Lake Kuku-Nor in westward direction, until the mouth of the small stream Chara Moritsche. At this south-westernmost position of the lake the team ascended to the South Kuku-Nor Mountains, and surmounted them at 3.780 m altitude (FUTTERER 1903). In the south of the summits of the South Kuku-Nor Chain the campsite XI was erected in 3.445 m altitude on the evening of 29th August 1898. The sparse vegetation cover consisted of scattered grasses on a loamy soil affected by wind erosion. "Countless numbers of wild ass herds", which were very shy, were seen around the water holes on the lower slopes (op. cit., p. 5). Only the male specimen of the two adult syntypes of the Kuku-Nor kiang, *E. kiang holdereri* MATSCHIE 1911 (ZMB 32159), the one collected by J. HOLDERER, is labelled with a collection date, the 29th August 1898[114]. The designated type skull proper, from a mare referred to the collector name of K. FUTTERER (ZMB 32156), is undated. The terra typica of *E. h. holdereri* is therefore assigned to the campsite of 29th August 1989, at approximately 36°45' N, 99°25' E (fig. 17b). Gazelles were the only other wildlife mentioned for this territory. On the following morning the expedition descended into a broad valley feeding the now dry Ussiba river bed, which ran north-westwards into the Lake Dalai Dabassu. A campsite XII close to the river bed was occupied from August 30th to September 1st, 1898, but no kiangs inhabited these soft, saline terrains. Many were encountered again when climbing the southern slope of this valley towards the Semenow Mountains on 1st September. The expedition maps (FUTTERER 1902, 1903) indicate the further occurrence of kiangs ("k u l a n g s ") for the surroundings of the campsite XVIII on the 11th September 1898, when the team had left the south-eastern edge of the Semenow Mountains. Most likely therefore the type skull ZMB 32156 originated from close to the proposed locus typicus too.

The three hemiones obtained by the expedition from the vicinity of the Lake Kuku-Nor in north-east Tibet were deemed sufficiently different from the Ladakh kiangs, *E. hemionus kiang* (MOORCROFT 1841), to justify the description of the new race *Equus (Asinus) kiang holdereri* MATSCHIE (1911). This designation honours the name of one of the collectors[115]. The skull of the five-year old mare (ZMB 32156) was the designated type. MATSCHIE (1911, 1922) investigated the skin of the subadult, and the skulls of all three kiangs. The skins of the two adults

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British Museum (1906-1927), fellow of the Royal Society (1908), and President of the Imperial Cancer Research Foundation (1899-1936). The 11th DUKE of BEDFORD became a honorary doctor of law at the University of Edinburgh (1906), and succeeded to the titles of MARQUESS OF TAVISTOCK, BARON RUSSELL OF THORNHAUGH, BARON HOWLAND OF STREATHAM, and EARL OF BEDFORD (COKAYNE 1912, MOSLEY 1999). He married MARY TRIBE, the daughter of the Archdeacon of Lahore (BLACKISTON 1980). DUCHESS MARY shared her husband's love of animals, and kept meticulous records of all animal purchases, births and deaths at Woburn. Therefore the disappearance of the type specimen of the *castaneus*-hemione from the Woburn estate, after the prestigious creation of a new taxon, is even stranger (see chapter 8).

[114] The third specimen (ZMB 32158) of the type series is a subadult female collected on 21th August by a DR. STOLTEREZ. No information about the identity of this collector could be found.

[115] JULIUS HOLDERER was born at Muckenschopf in the Ortenau (Baden) on 6th August 1866, and died at Schriesheim near Heidelberg on 1st March 1950. Studied law at the University of Heidelberg as a student friend of K. FUTTERER (the file about his doctoration has been lost [Universitätsarchiv Heidelberg, pers. comm.]). His career started as a judicial officer in the district administrations of Waldshut (1894) and Lörrach (1896), which granted him a leave to join the FUTTERER expedition to East Asia from 1st August 1897 until 31st July 1899. He continued his public service in the Bezirksämter of Heidelberg (1899), Bretten (1902), and Kehl (1906). In 1913 he was promoted to a Geheimer Regierungsrat. From 1920 he served as Amtsvorstand of the Bezirksamt Pforzheim, and from 1924 until retirement in 1931 as a Landrat at Pforzheim. HOLDERER was honoured by awards for bravery in the First World War. The biography reported by STIEFEL (2001) is considered incorrect when deviating from the file by the financial administration of Baden (Generallandesarchiv Baden-Württemberg, Karlsruhe, GLA 466/9242), which calculated HOLDERER's pension (see also ANGERBAUER 1996, BREITKOPF 1997).

were mounted for the exhibition rooms of the Naturalienkabinett Karlsruhe (fig. 20), and depicted in the guidebook (AUERBACH 1904). They were destroyed in a fire during the Second World War (H.-W. MITTMANN, pers. comm.). MATSCHIE (1911, 1922) pointed to a few differences between the crania of Ladakh kiangs, *E. h. kiang*, and the new, larger-sized subspecies from the mountains between the Lake Kuku-Nor and the Semenow Range in north-east Tibet, e.g. distinctive proportions of the anteorbital skull breadth, a shallow groove in front of the molars, and to a few more details. The skin of the foal missed the light reddish chestnut-brown tinge of the specimens from Ladakh. The dorsal rump looked brownish yellow ("Laubgelb" = Repertoire des Couleurs 321) and backwards darker brown ("Krappbraun" = Rep. d. Coul. 334) instead, growing lighter from the head over the dorsum to the shoulders, while the flanks were darker. The front faces of the legs were of a saturated yellow-brown ("sattes Maisgelb") with a hue into salmon-pink, and not white like in kiangs from Ladakh. A white ring surrounded the eyes. The race was taller than were the dziggetais, had broader nasal bones, and a distinctive planum nuchale.

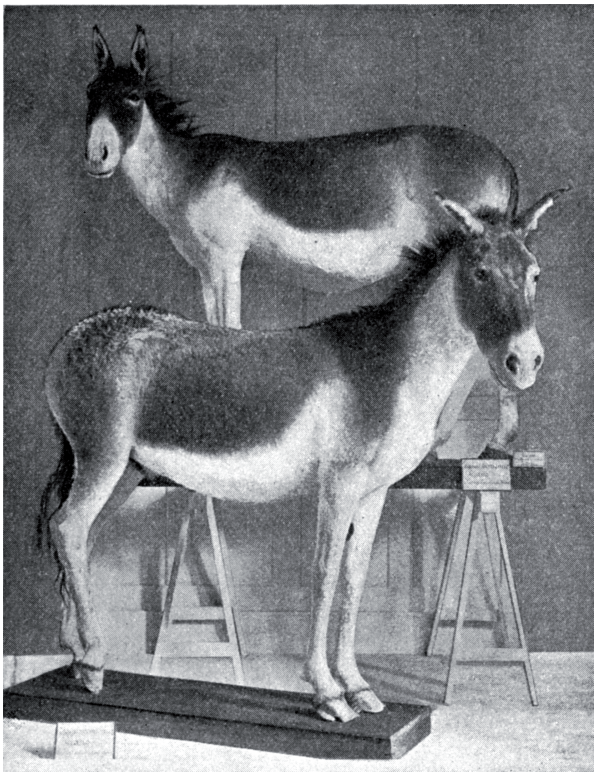

Fig. 20: Mounts of eastern kiangs (Kuku-Nor kiangs), collected by the FUTTERER expedition, at the Badisches Naturalienkabinett, reproduced from AUERBACH (1904). One of the animals (a female) is the taxonomic type of the subspecies *Equus* (*Asinus*) *kiang holdereri* MATSCHIE 1911, whose skull is stored at the Zoological Mu-seum of Berlin (ZMB 32156). These mounts were destroyed by a fire during the World War II.

ALBERT TAFEL (1914b, c) frequently encountered kiangs ("T s c h i a n g , K y a n g ", p. 193) during his expedition through north-east Tibet. On 21st June 1906 he hunted a stallion of 130-140 cm shoulder height out of a herd of 100 kiangs in a region of north-east Tibet which borders on Tsaidam. The site was located at 4.000-4.500 m altitude in the southern Wahon Mountains, north-east of the Lake Tossou-Nor, and at most 150-200 km south-east of the terra typica of *Equus hemionus holdereri*. Separated from the latter place by the Semenow and the Wahon Mountains, these ranges reach heights that should be accessible to kiangs. Nevertheless MATSCHIE (1922) described Tafel's kiang as a new species *Microhippus tafeli*[116] to honour

[116] DR. ALBERT TAFEL, born at Stuttgart on 6th November 1877, died at Heidelberg on April 19th, 1935, studied the earth sciences and human medicine at the universities of Freiburg, München, and Berlin. A

the collector (fig. 21), using a series of five skulls and seven skins collected by A. TAFEL. However, the travel books of this collector (TAFEL 1908, 1914a, 1914b, 1914c) recorded only one hunted specimen (fig. 22), which may ore may not represent the type specimen (ZMB 32161)[117]. The complete series included six adults (and an unborn foal), which were nearly Tawny in RIDGWAY's standard colours[118].

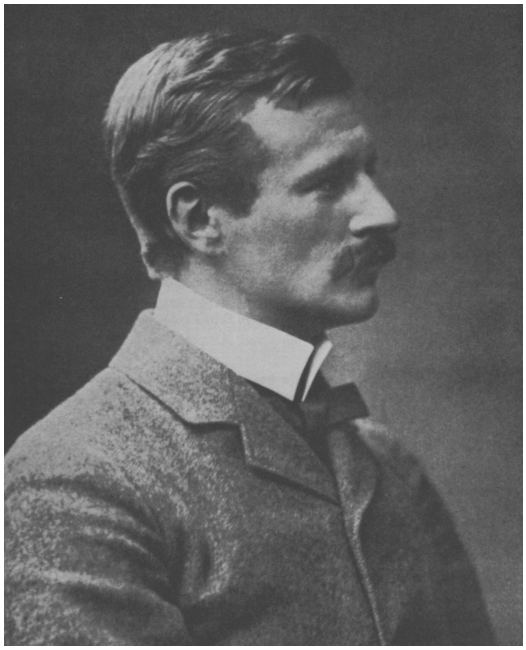

Fig. 21: ALBERT TAFEL (Stuttgart), who collected the type specimen of the Tossou-Nor kiang, *Equus hemionus tafeli* (MATSCHIE 1922). This subspecies was the last hemione taxon proposed for Central Asia. Portrait reproduced from BECK (1971).

mountaineer and a favourite disciple of FERDINAND VON RICHTHOFEN, he was recommended by him to accompany the Tibet expedition led by the geographer WILHELM FILCHNER and his wife as a medical advisor and a geologist. The group trekked from Shanghai to east Tibet and to the sources of the Hwangho in 1904-1905. Returned to Shanghai in January 1905 TAFEL separated from the FILCHNERs and organized his own expedition (1905-1908) to Ordos, the upper reaches and sources of the Yellow river, Inner Mongolia, the Lake Kuku-Nor, the Tsaidam Basin, and the Marco Polo Mountains. The project pursued primarily aims in cartography and geology. Was assaulted and ransacked three times by brigands, and seriously hurt. TAFEL complained on the poor support by the German Embassy, which had refused to facilitate his travels by issuing a proper passport and letters of recommendation, so that he had to move without official protection. He failed to reach Lhasa. Detailed maps resulted from this expedition (TAFEL 1912), and the rich collections were donated to museums (animals to the Königliches Museum für Naturkunde, Berlin; fossils and stones to Tübingen University, ethnography to the Linden Museum, Stuttgart; plants to Berlin-Dahlem). TAFEL was honoured by many scientific awards, and by a honorary professorship at the Technische Universität of Stuttgart. After another geographical research stage in China he worked as a medical doctor in the Dutch Indies. His last expedition to China in 1934 had ended prematurely due to severe illness (PENCK 1913, CHARLES 1916, FICKELER 1935, BECK 1971, SCHLEIP 1999). TAFEL's grandchildren, T. TAFEL at Stuttgart and C. FRANK at Sandhausen near Heidelberg, were unaware of further materials which could enhance the knowledge of his collection of the Tossou-Nor kiang (pers. comm., September 2006).

[117] The locations of the hunting grounds are not specified precisely by TAFEL (1914a, b, c), who mentions only a single hunt. Seemingly unaware of collecting a new race TAFEL (1914b, c) confined his narrative to mention the sightings of many kiang herds in the Lake Kuku-Nor area and in the mountain refuges bordering on Tsaidam. Some of these sites are presumably located in the range of the Kuku-Nor kiang, while others could be closely adjacent to supposed occurrences of dziggetais. Since TAFEL also travelled in Inner Mongolia to the north of the highlands, continued efforts into the verification of his collecting grounds seem worthwhile.

[118] TAFEL estimated a foal from September as three weeks old, proposing a birth date in August (MATSCHIE 1922; cf. SCHREIBER & ZIMMERMANN 2006).

In this period MATSCHIE used to adopt a very liberal use of the LINNEAN hierarchy, sometimes switching in one and the same publication either to a species or a subspecies designation for the same taxon (e.g. *Equus kiang holdereri* and *E. holdereri*). The use of the generic designation *Microhippus* for the new race ("species") *tafeli* followed the palaeontologist REICHENAU (1915), who had transferred all hemiones into this genus. The rational to place specimens of the same Formenkreis from two geographically very closely adjacent areas into different genera reveals MATSCHIE's names (in this case) as being entirely utilitarian: Clearly the subtle discriminatory characters mentioned at best justify intraspecific taxa (demotaxa), let alone a new species. Only one skin of *tafeli* represented the summer phenotype, and the others various stages in the seasonal moult. TAFEL's Tossou-Nor kiangs were distinguished from the other kiangs (MATSCHIE 1922) by a Tawny ground colour ("Oranocker") of RIDGWAY's standard colours (plate XV), by front faces of the forelegs tinged in light isabelline ("Maisgelb mit farbigem Anflug"), and by Light Buff front faces of the hindlegs (RIDGWAY plate XV). In addition MATSCHIE (op. cit.) noted the poor prominence or the absence of the white eye ring, and the extension of the darker crown coloration on the entire upper half of the neck. The rump colour of the winter skins was isabelline with a brownish hue. A detailed analysis has to reveal if the lighter body colours compared with the Kuku-Nor kiangs suggest a genetic affinity of the Tossou-Nor kiangs to the Gobi dziggetais. The indicated skull characters are too subtle or too vaguely defined to be recounted here, but not of a surprise the crania of this kiang race resembled those from the vicinity of Lake Kuku-Nor more closely than did skulls from Ladakh (MATSCHIE 1922).

Fig. 22: Kiang hunted by ALBERT TAFEL at 4.000-4.500 m altitude north-east of the Lake Tossou-Nor in the southern Wahon Mountains (a border region of Tsaidam), on 21st June 1906. Type specimen (or syntype) of the later *Microhippus tafeli* (MATSCHIE 1922). The hills in the background are part of the Burkhan Buda Chain. For details, see text.

MATSCHIE (1911) used colour standards as an external reference. Therefore his perception of differently pigmented kiangs, however subtle, might be reasonably supported. By contrast his perception (MATSCHIE 1922) of (up to three) further races gained from (i) the photograph of a kiang foal taken by W. FILCHNER near the Lake Oring-Nor (MATSCHIE 1908), (ii) from PRZEWALSKI's (1877) narratives about the herds at the Tatung-Gol, and (iii) from LYDEKKER's (1904a) colour plate of a Ladakh kiang devoid of the white eye ring and with yellow front faces of the forelegs, are clearly useless exaggerations from these hardly informative sources. The subtle differences among populations, stocks, and perhaps herds of kiangs in Tibet remain to be assessed in detail, because the current taxonomy has founded a new subspecies on virtually every (small) series of specimens from High Asia investigated by a museum zoologist[119]. The other extreme view, gained from the only recent long-term field study of the Tibetan large mammal fauna (SCHALLER 1998), of the absence of any phenotypic differentiation in Tibet and her borderlands, seems not to be pertinent either. The colour differences of the reddish Ladakh kiangs and the more brownish eastern kiangs from north-east Tibet have strangely escaped SCHALLER's (op. cit.) attention during many years of zoological work in Tibet.

11. Synopsis

The exploratory history of the dziggetais reflects the penetration of Central Asia by Europeans. Being landlocked, secluded by high mountains, and by sheer expanses of geographical distance, and being shielded by the influence zones of Russia, China and India, the thinly populated and arid lands of Central Asia had never become a target for European colonial imperialism during the ages when large mammal taxonomy was an intensively pursued field of the zoological sciences. Instead, the exploration proceeded by land bound expansion from Russia and China, and therefore slowly. Dziggetais happened to inhabit the perhaps most extensive tract of tribal lands which had remained by the mid-20th century worldwide. Russia, the leading zoological research nation in the area, only gradually succeeded in exploring the unbroken frontiers, and she had initially employed foreign (chiefly German-descended) experts for the early scientific inventory of Middle and Central Asia until the latter half of the 19th century. The short British interregnum in Tibet in the early 20th century was insufficient for deeper scientific progress, and it did not cover territories occupied by dziggetais. This background might explain the poor development of an agreed classificatory synthesis of hemione diversity in part. Worse for our current understanding, the exploring pioneers found many populations already wiped out by human persecution. On the other hand the absence of a powerful central administration permitted the relatively unrestricted access for the work of those expatriate scientists who travelled on their own account or in the service of nations without access to their own overseas territories. In fact the freedom of the Central Asiatic terrae liberae, and the absence of most of the fatal diseases which prevailed in tropical countries, had attracted a fair number of short-term researchers and collectors, chiefly German, Russian, and French, but also Swedish, British, American, Hungarian, Swiss, and Italian citizens. Most were students with a generalized interest in natural history (often with a preference for either botany or birds), geographers, missionaries, military officers on leave, rich and courageous laymen ("sportsmen") or even plain adventurers in the search of wilderness and challenge. Specialized mammalogists were rare. The typical explorer stayed for a short time in Central Asia only. Nevertheless the multitude of expatriate researchers, and their ambition and obligation to justify the expedition by collecting scientific items, almost guaranteed the record, and the occasional collection of further data and of specimens in an area inhabited by scarce wildlife. The swift-footed dziggetais were among the rarest animals collected by such casual explorers, but on the whole hemiones are better represented in museums than are many other large-bodied ungulates. French priests, and German-speaking biologists working in the service of the Russian crown, were among the most important early contributors to hemione

[119] The sometimes remarkably elevated altitudes grazed by hemiones in Tibet made BARTZ (1935) wonder if kiangs grew darker by adaptation to an extreme climate, like in the case of other Tibetan mammals too. Examples are provided of different colour phases of some mammals within different territories of Tibet (op. cit., p. 133). The frequently subtle or non-existent seasonal dimorphism reported for Tibetan mammals has been explained by the meagre snowfall in these arid ranges.

biology. Russians-by-descent took over the scientific lead in the second half of the 19th century, after a renowned Tienshan geographer had become the president of the Russian Geographical Society. Even in the early 20th century Americans, Germans, and the occasional Swedish and Hungarian explorers remained important, before Mongolia and China have entered the scene as research nations in zoology.

The negative consequences of this unsystematical progress in hemione research include (i) the lack of representative population series of museum specimens and (ii) the absence of more time-consuming analyses. The comparatively long list of authors who commented on the genetic diversity of hemiones provides a striking contrast to the incomplete database on which they chose to base their comments. There is no other equid species, and few other ungulates indeed, whose microtaxonomy has produced so many written opinions on the fundament of an insufficient database. The scientific synthesis of the scattered and non-systematically collected hemione material by GROVES & MAZÁK (1967) has arguably started only almost two centuries after the first taxonomic description of the dziggetais.

11.1. Distribution

Most expeditions mounted to explore Central Asia pursued many aims, and the search for the elusive dziggetais was not a priority for a single one of them. Neither can one exclude that these fleet-footed equids were ignored, or misidentified as feral ponies, if shortly glimpsed in the distance[120]. Still the combined evidence from 100.000s kilometres of trekking (see the chapters 6, 7, 9, and 10) characterizes the historical distribution range of the hemiones in Central Asia.

Travellers in the Mongolian Gobi, Chinese Dzungaria, Kansu, and generally in Inner Mongolia, have met either numerous dziggetais, or have missed to find a single one during lengthy treks. Herds could be large, but they were localized. In Mongolia, the small number of intensely exploring naturalists met numerous dziggetais in the south-central and in the south-western Mongolian Gobi. Other travellers failed to spot a single hemione despite crossing this desert for long distances, and sometimes repeatedly. Virtually all explorers of the Gobi reported on gazelles and birds, and some enjoyed hunting to enrich their monotonous menu by venison. These expeditions might have recorded any encounter with dziggetais to add interest to their travel reports about these barren lands, if these had been around. The historical evidence therefore likely indicates that Gobi dziggetais have always concentrated in certain areas (at certain times?), and have avoided others. The main traffic route from China (Beijng, Kalgan) to Urga (Ulanbataar) seems to have never produced a single record. Dziggetais were abundant in Dzungaria. They have been met in the northern foothills of the Tienshan, but these mountains themselves produced no record. The northern distribution boundary of dziggetais in the steppe zone, or in the ecotone of steppe and taiga, is not evident from the early expeditions. The 18th century reports from Dahurian Siberia claimed that these ranges had been visited by dziggetais herds seasonally. The report by WLASOFF (in DE BUFFON 1798) may however suggest a previous range in the lusher zones and, by that matter, a refuge nature of the (semi)desertic biotopes which continue to be inhabited. RADDE's collections in the late 1850s are the last records from Dahuria, but there are a few more observations from far eastern Mongolia until the early 20th century (BANNIKOV 1948). BANNIKOV's (1948) map suggested that dziggetais had evacuated the Mongolian territory east of 108° E before the 1940s, ranging there only irregularly (fig. 14). The same map indicates their scarce occurrence in the north-west Mongolian lake country till 1935 (visiting migrants?). I failed to spot a museum specimen from north-west Mongolia, which is one of the proposed terrae typicae of the races *castaneus* (LYDEKKER 1904) and perhaps of *befordi* MATSCHIE 1911, or from the Mongolian-Siberian borderlands (except the seasonal visitors to Dahuria). Did a "north Mongolian" race (GROVES & MAZÁK 1967) ever exist?

[120] As an illustration to this problem, HASLUND-CHRISTENSEN (1936, p. 165) met many k u l a n s in the Altyn-Tag, and with the help of a Mongolian hunter he was able to shoot two of them. Admiring "the first k u l a n s of his life", the traveller noted that they had been domestic ponies, but only from the fact that one of these equids was castrated.

The south-western extension of the Central Asiatic semideserts into the Tarim Depression had not produced a single confirmed record of a dziggetai. The "marks of wild horse (k h u l a n)" from HEDIN's first Turkestan expedition in April 1895, and the hearsay information by his local guide (HEDIN 1896), have never been confirmed. Museum specimens are absent too, and a fair number of naturalist travellers failed to obtain records from the Takla Makan desert although they commented on wild camels, tigers (in the Lob-Nor swamps) and other wildlife. A number of additional reports on Chinese Turkestan were not reviewed in this essay, because written by travellers with a focus on ornithology, archaeology, or linguistics etc.; those consulted did not provide records either[121]. Kiangs were confirmed for the high mountains bordering on the Tarim Basin in the south (PRZEWALSKI 1878, BONVALOT 1892), e.g. from the Cherchen River valley which descends into the Tarim Depression (LITTLEDALE 1896). HEDIN (1896) himself recounted hearsay information that hemiones would descend from the adjacent ranges. PRZEWALSKI (1876) noted that the Altyn-Tag was a faunal barrier, with a large mammal fauna poor in species and individuals on the northern slope towards the Tarim Depression, but with a rich abundance of game on the southern plateaux, where typical Tibetan mammals (chirus, blue sheep, yaks) reached their regional northern range limit. Only HENRI D'ORLÉANS seems to have collected kiangs thus far north-west in High Asia, but the racial identity of these specimens has not been identified. The taxonomic identity of the kiangs from the adjacent Kuenlun Range is unknown too. The westernmost kiangs in museums are those from Ladakh in India. The presently safest conclusion is that dziggetais have not occured in historical times in the wider Tarim Depression. There are no obvious natural factors to explain their absence from this desert. Other than the Gobi however the Takla Makan desert contains river oases and inland deltas of snow- and glacier-fed rivers from High Asia, which have permitted irrigation agriculture since early human history. Cities in ruins testify the previous presence of a sedentary human population. Despite a low population density in the desert itself, a more intensive human pressure than in the riverless Gobi, where land use is confined to nomadic herdspeople, seems out of question.

There is only the scarcest information about hemiones from the meridional mountain chains, which divide the Central Asian semideserts into a western (formerly Russian Turkestan, i.e. Kazakhstan, Kyrgyzstan, Uzbekistan, Tadzikistan) and an eastern portion (formerly Chinese Turkestan, i.e. parts of China and Mongolia). A single hemione record from the Chinese Karakorum was published by the DUKE OF SPOLETO, PRINCE AIMONE OF SAVOIA-AOSTA, who shot a "k y a n g" during the Italian Karakorum expedition in 1928/1929 (AIMONE 1929). This kiang ranged in the Shaksgam Valley close to the Mount Gasherbrum, which drains northwards into the Tarim Basin. This locatation is not too distant from northern Ladakh, where western kiangs (*E. h. kiang*) climb to very high altitudes (PFISTER 2004). SCHALLER et al. (1987) cited local people, who had remembered the survival of kiangs in the upper Yarkant and Oprang River valleys before 1950. These valleys are located in the Taxkorgan Nature Resere, southwesternmost Xinjiang Province (China), where the Pamirs, the Karakorum and the Kuenlun Ranges meet. There are no records of hemiones for the high Tienshan proper (HUNTINGTON 1905, SCHULTZ 1920), the Pamirs (SCHULTZ 1916, 1920, REINIG 1929), the Hindukush and for the adjacent ranges of Tadzikistan and Afghanistan (PRINCE D'ORLÉANS ET BRAGANCE 1906). A specimen collected in 1882 from the Sham Plains in central Pakistan (29°20' N, 69°40' E) was described as a distinct subspecies, *E. h. blanfordi* POCOCK 1947. It seems to be the geographically closest record of a presumable khur or an intergrade between currently recognized subspecies[122].

[121] Kashgar, Yarkand, Khotan and other places in Chinese Turkestan were visited by many adventurous travellers of British, Russian, German and French nationalities, including bird collectors arriving from India (names in MEARNS & MEARNS 1998), archaeologists, military officers, and alpinists, e.g. MARCO POLO, FRANCIS YOUNGHUSBAND, and AUREL STEIN.

[122] GROVES (1963) interpreted this phenotype as being intermediate between the kiang and the khur.

The absence of records from the meridional ranges to the south of Dzungaria implies that the eastern population groups (dziggetais, kiangs) and south-western populations groups (onagers, Turkmenian kulans, khurs) have not met along a broad front, as has been pretended by some published distribution maps, which proposed a former range continuum over the whole arid core of the Asiatic continent. Confirmed records suggest that the exchange between the Middle Asian kulans and the Chinese/Mongolian dziggetais had been concentrated on the river valleys which connect Kazakhstan and Chinese Dzungaria. The formerly common Zaissan population of kulans in Kazakhstan, designated as the subspecies *finschi* MATSCHIE 1911, presumably connected the populations from Dzungaria and the Kazakh, Transcaspian and Turkmenian kulans. Of pertinence, glaciers and periglacial biotopes might have sequestered such a narrow range corridor in the southern forelands of the Altai Mountains (Porta Dzungarica) whenever periods of climatic cooling (or pluvials) had seen humid biotopes expand from the northern and southern flanking mountains. The zoogeographical divide, which separates the steppe- and desert-living biota of Middle Asia and Central Asia, likely rests on such periodical interruptions of the gene flow. The saiga antelope and the goitred gazelle are taxonomically distinguished in the districts which had previously been termed Russian and Chinese Turkestan (the latter including Mongolia in terms of zoogeography), and the Bactrian camel (now extinct west of these mountains) has failed to recolonize Middle Asia after such an event.

The contact zone, if any exists, of the Gobi herds with the kiangs is insufficiently known. The few records of hemiones from the northern foot of the Kuenlun, and from the south of Inner Mongolia (chapter 10), may refer to dziggetais or to kiangs, or to phenotypic intergrades.

11.2. Population Status

The seemingly patchy concentration of dziggetais at certain sites, separated by vastnesses devoid of these animals, has been explained by the scattered availability of water and forage (e.g. CARRUTHERS 1912, ANDREWS, 1932, 1933). Regional foci of abundant occurrence include the surroundings of the Lake Kuku-Nor (kiangs), while the plains around the Lakes Zaissan and Balkhash were well-known sanctuaries for Kazakh kulans (SPÖRER 1868). Insufficient records from Mongolia prevent the identification of such sites of constant occupation by dziggetais. Probably there were none, but rather unstable aggregations. Such a distribution pattern precludes inferences of the abundance of the dziggetais in historical times, since any unsystematic count had likely missed the true population densities. However, the several explorers who had covered both the Gobi and Tibet recorded some to very many kiangs, as soon as they had ascended to High Asia, after they had failed to see dziggetais in Mongolia and Kansu. One explanation of this difference might be the tendency of the Gobi hemiones to group temporarily into big aggregations of up to 1.000 specimens (BANNIKOV 1948, MURZAEV 1954), which necessarily implies huge intervening areas devoid of any dziggetai. However, kiangs were met with such greater regularity throughout the last 200 years to conclude their more abundant occurrence since historical times. The largest local concentration of kiangs ever reported also numbered 1.000 specimens in a single valley (BARTZ 1935). Usually fewer were seen together, but kiangs were no exception to the rule that the high-altitude pastures of northern and eastern Tibet retained one of the biggest concentrations of plains game worldwide in the days of the first exploration by Europeans (BARTZ 1935, SCHÄFER 1937). PRZEWALSKI (1884a) explained this faunal wealth by the steady supply of water from mountain streams, by the availability and proximity of pasture at different altitudes or expositions that could be sought whenever unfavourable climatic conditions had degraded the resources of a given locality and, most importantly, by the low flight distance of the Tibetan game, which permitted humans to view them much better than elsewhere. BARTZ (1935) consented in principle, and also referred to a higher nutritional value of high Alpine meadows, to the less dense human occupation of the highlands, and to the respect of Tibetan Buddhists for living organisms[123].

[123] BARTZ's (1935) assertion that Tibetans did not appreciate kiang venison would, if generally true, explain an important difference to other people in Central Asia.

The heavy human persecution of hemiones is mentioned by authors from as early as the 18th century, but also the difficulties of killing such vigilant and fast escaping game. The approach on horse-back, ambush hunting near a water pool visited for drinking (PALLAS 1781b), drive hunts into morass (FALK 1786) or into deep snow (MEYER 1830) were promising hunting strategies. The mimicked voice of a stallion would attract both male and female hemiones during the rutting period (KOSLOW in WOTTE 1971). RADDE (1861 [1970 reprint]) reported the use of a horse mare as a decoy to attract Dahurian dziggetais. The hunter used a yellow-coloured pony to approach wild dziggetais, riding without saddle against the wind to a hill top, where the pony was left free to graze while the hunter was waiting in ambush. A dziggetai stallion, which had confused the pony with a hemione mare, approached, and could be shot at a suitable range. Prolonged waiting in ambush, e.g. on the slopes of a narrow valley which forced the hemiones to pass by closely, could also be a successful strategy. The breast was the best target to shoot at, but sometimes five bullets were required to kill a dziggetai (op. cit.). The delicate taste of venison from hemiones has been emphasized by many authors, as well as the use of hides for warm pelts (FALK 1786) and leather to prepare boots and sandals. RADDE (1861 [1970 re-print]) observed the medical use of Dahurian dziggetais: Burnt on a charcoal fire, the smoke from the tail tuft hair cured sick domestic animals (ANON. 1863)[124]. According to a fable from Dzungaria (HASLUND-CHRISTENSEN 1936, p. 164) the tail of a dziggetai would continue to beat after flies even when the skin of the hunted specimen has been taken off the carcass. Hunting for local consumption prevailed, but PRSHEWALSKI (1984) reported the commercial exploitation and trade of dziggetai products by Dzungarian tribes, who used such goods to pay the taxes imposed by the Chinese administration.

According to MARCO POLO the Emperor of China KUBLAI KHAN, a grandson of CHINGIS KHAN, used trained tigers[125] in hunting chases of wild asses and other game. These tigers were transported to the hunting sites in a cage loaded on a car, and in companion with a small dog. For the chase the predator was released in the direction opposite to the wind, so that the game could not scent it. Tigers were said to be “active in seizing boars, wild oxen and asses, bears, stags, roebucks, and other beasts“ (op. cit. p. 205). Felids might be unable to run down an un-restrained dziggetai or kiang. Therefore this report seems hardly trustworthy if not referring to animal fights in enclosures rather than to true chase hunts[126]. YULE (1871a) referred to ancient sources that trained tigers had been used in Persia for game hunting too.

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[124] Products from wild asses were recommended for medical use in the European Middle Ages too (AL-BERTUS MAGNUS 1999 [reprint]): Their flesh removed pain in the hips, an anointment with marrow cured gout and pains. Drinks of dried dung mixed with wine helped against the sting of scorpions, and dung mixed with the urine of oxen was smeared into the hair for curling them.

[125] MARCO POLO wrote of lions, but from the description (“streaked lengthways with white, black and red stripes“; WRIGHT 1892, p. 205) no scholar has ever doubted that tigers were meant. Lions and tigers were often confused by Medieval European writers, who sometimes designated serpents as tigers (CHARIGNON 1926).

[126] MARCO POLO’s interest in natural history is obvious from his many reports on domestic animals and game species (OLSCHKI 1960). However, the authenticity of many details has been doubted by historians (see footnote 6). In the present context his credibility is lowered further by his assertion that apart from tigers and cheetahs the grand khan had used trained lynxes for chasing deer (op. cit., p. 205). The interpretation that these supposed lynxes could have been hyaenas instead (YULE 1871a, CHARIGNON 1926) does not appear much more convincing either. Ancient Arabian rulers used diverse felids for hunting too, e.g. cheetah, lion, leopard, caracal, serval, and swamp cat, which however served to hunt smaller and less fleet-footed game (EISENSTEIN 1991). The English (YULE 1871a) and French translations (CHARIGNON 1926, p. 87) of Polo’s books recount the story of hunting hemione with felids, e.g. “ils [= the lions = tigers of KUBLAI KHAN] sont si bien dressés à prendre sangliers, ours, â n e s s a u v a g e s , cerfs et autres bêtes grandes“, while the German translation omitted the wild asses from the list of the chase-hunted game animals (RÜBESAMEN 1963). PALLAS (1781b) collected stories from Kirghiz hunters that confirm a certain pugnacity of dziggetais, up to the killing of other wildlife species which had elicited their aggression.

SIEVERS (1782) recorded the perhaps only published case of a succesfully tamed dziggetai. In the fortress of Dschindan-Turuk of Dahuria he had met a dziggetai captured and tamed five years before his visit which accompanied domestic horses to the pasture. Though tolerating a saddle, the behaviour of this hemione proved capricious, by forcing its rider to step down when standing still abruptly in refuse to proceed. Put to the carriage unexpected outbursts of bad mood could endanger the load. The behaviour of this tame hemione resembled a donkey rather than a horse. The Roman VARRO (in PALLAS 1798) maintained that tamed onagers could be handled more easily than mules.

Mass mortality of dziggetais by infectious disease is only reported by a single author (WLASSOF in DE BUFFON 1798). The possible role of introduced livestock epidemics, which accompanied the penetration of Central Asia by Europeans, for the survival of game, which had never been exposed previously, has not been well explored in Asia. By contrast introduced diseases are known to have devastated the large mammal fauna in many parts of Africa, and some African ungulates have never regained all territories which had been emptied by the advent of new viruses and bacteria from imported livestock. Mass mortality of kiangs (and of argalis, yaks, chirus and ghorals) was observed by BONVALOT (1892) in a Tibetan valley covered with countless bony remains of these animals. He speculated that a disease, a devastating thunderstorm or a severe winter had killed the herds.

A perceived incompatibility of human land use, even by nomads, and the long-term survival of kulans were reported, or implicit, in the writing by a number of authors, and in greatest detail by BREHM (1877).

11.3. Palaeontology

Almost all fossil hemiones from north and Central Asia are partial remains, often confined to tooth fossils, which do not clarify the subspecies taxonomy of the extant populations. Nevertheless a few relevant conclusions emerge from the fossil record (GROMOVA 1955, KAHLKE 1975, KOCHENOV & KOSCHTSCHAMKULOWA 1987, FORONOVA 2006, V. EISENMANN pers. comm.).

Some teeth and limb bones of North American equids resemble hemiones, but the evidence is inconclusive and could rest on plesiomophy. Old World hemiones have appeared in the (Early to) Middle Pleistocene of Eurasia, doubtfully identified fossil limb bones from Turkana in East Africa taken apart (EISENMANN 1991). The remains of hemiones, including kiangs, from China can be derived from hydruntine-like equids over a series of “chronospecies” (DENG & XUE 1999). This temporal series resembles the character transition from hydruntines to hemiones in Transcaucasia and Iran (EISENMANN & MASHKOUR 1999). In recent years the west-Eurasian *E. hydruntinus* has been confirmed as a plesiomorphic relative of the contemporary hemiones, or as an early population stratum of them (BURKE et al. 2003, ORLANDO et al. 2006). The upper time window for the autochthonous evolution of the hemione Formenkreis in east-Central Asia spans at least the last 100.000 years, or more[127].

The earliest fossil hemiones from Central Asia, from the Late Pleistocene Chinese sites of Upper Dingcun and Sjara Ossogol (see below), are antedated by (Early to) Middle Pleistocene slender limb bones and cheek teeth reminiscent of hemiones from west Europe, many parts of west and south-west Asia, the Middle East, and perhaps north Africa. The earliest Central Asian fossils originated from sites in China, but Mongolia may well have been occupied by hemiones through this period too, including at least the Last Glacial Period. Palaeo-climatic dynamics

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[127] The phylogenetic analysis of *Equus nalaikhaensis* from the quarry of Nalaikha, in the Tola Valley in the vicinity of Ulanbataar, suggested a mosaic of osteological characters of the hemiones, the asses and the Grevy’s zebra, and a taxonomic position after the divergence of the caballine horses, but before the radiation of the clade which contains the hemiones, asses and zebras. If correct, Mongolia may well have been home to the last common ancestor of all recent equids except the horse. The age of this Nalaikha fauna from alluvial sands has been tentatively referred to the Late Lower Pleistocene, not younger than 900.000 years (EISENMANN & KUZNETSOVA 2004).

have permitted the expansion of the hemiones' range into Siberia and east China, and perhaps repeatedly so. The tendency of hemiones to evolve geographical populations is probably reflected in the fossil record too, although the osteometric differentiation among temporal strata is insufficiently explored.

Sediments on the Kokkija River (south-west of the Karatau Chain) yielded kulan teeth from the Lower Pleistocene (KOCHENOV & KOSCHTSCHAMKULOWA 1987). Caves on the rivers Tcharya and Khankar in the Russian Altai yielded bones and teeth from Upper Pleistocene hemiones, which were larger than contemporary "onagers" (no dziggetais skeletons were at disposal for comparison), and which coexisted with woolly rhinos, mammoths, and cave hyaenas (GROMOVA 1955). Fossils from west Siberia suggested a "very large kulan", which may represent a different taxon or instead members of a polymorphic population with dental similarities with the much smaller *E. hydruntinus* (i.e. the extinct wild ass from the Pleistocene and Holocene of Europe and the Near East). Palaeolithic remains from Afontova Gora near Krasniarsk and from Kipiermylog on the Ienissei indicate "typical kulans". Fossil hemiones from the late Siberian Pleistocene had stronger metapodia and broader teeth, while some details of the enamel folds reminiscent of *E. hydruntinus* indicate plesiomorphic similarities with the extinct European wild ass.

Up to twelve proposed species of *Equus* have been unearthed from the Chinese territory (DENG & XUE 1999). The earliest certain half-ass has been produced by the Upper Dingcun fauna from Shanxi, vaguely estimated into the late Last Intergacial Period at 127.000 to 70.000 years b. p. (FORSTEN 1986, TAO 2006). In Xujiayao (Yanggao in Shanxi), hemiones dominated over Przewalski's horses in a controversially aged fauna estimated at 110.000 to 50.000 years b. p. (op. cit.). There follows the wild horse/hemione assemblage from Banjingzi (80.000 years b. p.) from the Late Last Interglacial, while the faunas from Laochihe (70.000 to 60.000 years b. p.), Longgugou, and Loufangzi (ca. 60.000 years b. p.) in Shanxi yielded hemione and wild horse bones from the early Last Glacial Period. It is unknown if these southerly locations were inhabited by kiangs or instead by dziggetais whose range had been granted a southward expansion by a favourable climate. The Shiyu site in Shanxi preserved at least 88 hemiones and 120 Przewalski's horses aged at 28.000 to 16.000 years b. p. (op. cit.). Hemione bones are also contained in the desertic Hutouliang fauna from Yangyuan in Hebei (11.000 years b. p.). The latter three sites are located in the west of Beijing, at a considerable distance from the present desert belt. The Manchurian site of Qingshantou (ca. 20.000 years b. p.) delivered hemiones from the Last Gacial Period too.

Fossil hemiones from within the current range of the Gobi dziggetais were collected from the Upper Pleistocene loess from Sara Osso Gola (Sjara Ossogol) in the district of Ordos in China (BOULE 1928). They coexisted with rhinos, wild camels, auroxen, and ostriches. Preliminary dating suggested a Late Pleistocene age. This site produced the entire skeleton of an adult mare. It was distinguished from extant hemiones by having more gracile extremities, indicating an even more cursorial life in arid plains. Presumably it represented a different taxon (it seems however that no bones from Gobi dziggetais were available to the investigator for comparison). The Würm-age Salawusu fauna from Mongolia (50.000 to 35.000 years b. p.) yielded hemiones with larger skulls and slenderer limb bones than are found in extant dziggetais (FORSTEN 1986). The 20.000 years old Wurji fauna from Balinzuo in Inner Mongolia produced the bones of hemiones, wild horses and many other ungulates from a cold-arid climate (TAO 2006). Further sites in Inner Mongolia revealed Late Pleistocene hemiones too.

The northward shift(s) of the Central Aisan arid climate zone during the Pleistocene into Transbaikalian Siberia permitted steppe fauna (gazelles, ostriches, kulans) to thrive in currently forested lands (GROMOVA 1955). The southern and the eastern range boundary of hemiones expanded in the Pleistocene (KAHLKE 1975, TAO 2006) to include at times Manchuria, Chaotsun (Hopei), the Pacific coastal plain near Beijing, Kansu (Kingyang and Sochinssu), and Shanxi[128]. Rather humid biotopes if not inland waters in the west Siberian lowlands should have

[128] FORSTEN (1998) refuted the controversial occurrence of a Late Pleistocene-Holocene wild ass "*E.* (*hemionus*) *nipponicus*" in Japan (Honshu), and redetermined the respective tooth fossils as being from a

isolated the Pleistocene hemione populations in Central Asia from those persisting in the western Eurasian steppes, and in the hot arid refugial areas of southern Middle Asia. The palaeoecological data are insufficient however to infer eventual patterns of range vicariance of disjunctive dziggetai populations in the Pleistocene and in the Early Holocene, or periods of geographical isolation of dziggetais and kiangs, whose fossil remains can barely be distinguished, if at all. There is no knowledge whatever if e.g. Mongolia had been (re)colonized by hemiones from more than one palaeoclimatic refugial territory.

11.4 Taxonomic Classification

The nomenclature of the hemione populations from Central Asia has not been agreed, and a trend towards a stable taxonomy is not obvious (tables 1, 2). This is caused by

- unavailability of material from many areas located between the surviving populations
- absence of population series from any samples (skins, skulls, molecules) in collections
- insufficient revision work, concerning only partial character sets chosen and insufficient depth of analysis in any one character level (except the skin colours)
- absence of molecular data

On a more principle level, the Formenkreis seems to represent a population genetic system which is not easily represented by qualitative, equivalent types. Especially the geographically intervening populations between named populations might reveal, as far as is known, transitory combinations of characters. Therefore the election of different characters for taxonomic delimitation might result in different subspecies boundaries, and sometimes it is known to do so.

Of the five subspecies names proposed for dziggetai diversity in Central Asia proper (table 1), most authors have accepted only one or two (table 2), most frequently *hemionus* PALLAS (HARPER 1940, 1945, DENZAU & DENZAU 1999). SCHWARZ (1929) dissented by extending his concept of "*Asinus hemionus bedfordi*" to comprise all kulans from origins spaced as widely apart as are Askabad, Mary (Merw), and Zaissan-Nor. This taxon lumps the subspecies *bedfordi* MATSCHIE, *finschi* MATSCHIE, and the later *kulan* GROVES & MAZÁK, i.e. it inhabits the entire Transcaspian region north and north-east of the highlands of Iran, including Turkmenistan, Uzbekistan, Tadzikistan and Kazakhstan to the w e s t e r n slopes of the Altai Mountains. This opinion, based on a limited literature study, strangely excludes the geographical origin of its type specimen from e a s t of the Altai. Even more intriguing, SCHWARZ (1929) published the photograph of a supposed *bedfordi* stallion from the Berlin Zoo which does not fit the iconotype of the race *bedfordi* well[129]. The archives of the Berlin Zoological Gardens identify this supposed Bedford's kulan as a geographically unspecified hemione whose parents had been acquired from the animal trade (see footnote 90). An import from north- or east-Central Asia seems very unlikely, and might be excluded (cf. SCHLAWE 1969).

GROVES & MAZÁK (1967) accepted two names, i.e. *hemionus* PALLAS for hemiones from Dahuria and north Mongolia (now extinct), and *luteus* MATSCHIE for the Gobi dziggetais. DENZAU & DENZAU (1999) argued that all Mongolian dziggetais should be named *E. h. hemionus* PALLAS. More recently GROVES (2002) combined these two races under *hemionus* PALLAS too, but in addition he accepted *E. h. castaneus* for west Mongolia, Chinese Dzungaria and the lands formerly thought to be inhabited by populations of *finschi* MATSCHIE. The data to justify this departure from his previous own scheme are not well explained. The location of the contact or the transition zone to *E. h. hemionus* proper has not been explained.

(domestic) caballoid horse. Equid remains have even been proposed from the seabed off the island of Taiwan from the latest Last Glacial Period (TAO 2006).

[129] The photo had been taken in winter-time, but the iconotype of *bedfordi* MATSCHIE had been painted in summer.

12. Conclusions

The present study of the historical concepts for the classification, and of the distribution, of Central Asiatic hemiones does not arrive at a firm conclusion on the proper nomenclature for all of these populations. Clearly, hitherto taxonomies had a rough classification at the macro-geographical, continent-wide scale in mind. Since species conservation operates with real, local populations, which have to survive in the very biotopes with which these desert-living equids have to cope (SCHREIBER & ZIMMERMANN 2006), a considerably expanded database, and a refined and much more detailed approach is warranted if taxonomy is to be taken serious in wildlife management. To this aim this analysis has identified a number of questions, and has arrived at certain conclusions for the ongoing research programme of our research team to understand the population structure of these equids.

1. In any polycentric species composed of core populations and intervening transitory phenotypes the population genetics of the contact populations determines the taxonomic status of the core types. On an even more principal level it decides the suitability of the subspecies concept to explain the genetic diversity in a (former) range continuum. There is hardly any knowledge of the extent and the nature of the gene flow between the populations which represent the named hemione taxa. The ignorance of the degree of genetic isolation between geographical populations is considered the biggest obstacle to a real progress in hemione systematics. In hemiones the population contacts could be (i) secondary zones with or without hybridization (compare the hints from the fossil record, and the non-identical chromosome numbers within and among some hemione taxa), or (ii) primary disruptive differentiation belts, or (iii) continuous clines. Hybridization can proceed symmetrically or asymmetrically. The possible existence of a transition belt between the dziggetais and the kiangs is of particular interest, because both population groups survive in fair numbers, and their ranges perhaps meet or overlap till date. The distinctive countershading between a (red)-brown dorsum and the white belly and muzzle readily identifies the Lake Kuku-Nor population of *E. h. holdereri* as true kiangs, with no external affinities to the colouration of the Gobi dziggetais. By contrast the colouration of *E. h. luteus* characterized a dziggetai in principle, however with a few proposed external similarities to the kiangs, and the taxon *Microhippus tafeli* perhaps denotes a kiang with certain external affinities to the dziggetais (chapter 10). The hemiones from north China may thus represent another example of an “intermediate phenotype”, which connects the typical desert-coloured dziggetai and the populations from the alpine ranges of High Asia[130].

2. Representative material is still insufficient, particularly from the south-west Mongolian Gobi, Kansu and Dzungaria. Very few specimens from Dahuria are preserved in museums, and the few specimens of the extinct autochthonous kulans from Kazakhstan cannot be augmented. Overlooked material may turn up in Russian collections. The continued sampling from dried carcasses or bones in the areas no longer occupied by hemiones (north-west and east Mongolia, Dahuria, Kazakhstan) would be welcome to complement the available samples.

3. Different character sets need to be analyzed in parallel, rather than to base the judgements exclusively on the pigmentation and on the few qualitative cranial measurements hitherto considered. The comparison of multiple characters, which evolve at a different rate, permits a deeper insight into the population genetics of any contact population, because different morphological and molecular characters can introgress with a different efficiency and speed. A broadly based analysis of the gene flow might be able to decide the question of how to subdivide the gene pool best into taxa, or if those can be demarcated in

[130] *E. h. blanfordi* POCOCK, and perhaps *E. h. hamar* HAMILTON-SMITH, and *E. h. castaneus* LYDEKKER have been considered as intermediate hemione phenotypes in other parts of Asia (SCHREIBER et al. 2000).

every contact region at all. At the continent-wide scale the skin colours seem to be the only character set assessed with satisfactory breadth (e.g. DENZAU & DENZAU 1999).

4. The cranial evidence is incomplete as long as the variation of skull shape by age (growth) and perhaps sex are assessed as inadequately as they are in any equid species. The recent collection and preparation of a few hundred skulls from the Mongolian south Gobi by M. STUBBE, A. STUBBE, and N.M. BATSAJCHAN, deposited at the Kühn-Museum of the Halle University (J. WUSSOW), is truly remarkable in this context. Their study by a Mongolian-German team is providing the first broad database about cranial variability in a hemione population, to which the cranial differentiation of single skulls from several named populations can be referred to.

5. The identification of two mounts of Siberian dziggetais in winter coat in the Museum Naturalis at Leiden (Netherlands) augments the discussion on the subspecific distinction of the Dahurian from the Gobi dziggetais (cf. GROVES & MAZÁK 1967, DENZAU & DENZAU 1999). The Leiden specimens are *E. h. hemionus* PALLAS by definition of their origin, even if one of them had not been collected by G. RADDE (cf. chapter 4). The winter phenotype of the Mongolian Gobi dziggetais is inadequately known, as is their moulting phenology. The photograph of a yearling stallion from Tsagan Owor (42.3° N, 104.1° E) from the south-central Gobi in Mongolia by GERTRUD DENZAU (DENZAU & DENZAU 1999, p. 132) suggests a very similar pigmentation to the mounts from Siberia. This young male, photographed on 4th July 1996 (G. DENZAU, pers. comm.), retains patches of the winter fleece on its flanks and on its dorsal rump. The reddish-brown hue of this remnant patch of wavy to woolly winter fur compares best to the “Snuff Brown” of RIDGWAY’s standard colours (plate XXIX), like in the winter phenotypes from Transabaikalia and Dahuria exhibited at the Museum Naturalis. Clearly, the moulting process needs careful evaluation in different populations, in order to ascertain if the topography of the hair change proceeds like in kulans or like in kiangs (MAZÁK 1962), and if the moulting phenology distinguishes herds from climatically different biotopes (altitude). Taking note of the climatic and the individual modifications of the spring moult in hemiones (RASHEK 1972) broad data series are required to recognize population-wise patterns or trends, or to exclude them.

   P. S. PALLAS, J. G. GMELIN, and G. RADDE stated that Dahuria had received seasonal immigrants from Mongolia, rather than containing the species constantly (chapter 3). Certainly visiting migrants are not a basis for an endemic taxonomic entity restricted to Dahuria, but their source herds in Mongolia must be consubspecific. At the moment there is no valid argument to support the racial distinction of the dziggetais from Dahuria and the south-central Mongolian Gobi. The conclusion by GROVES & MAZÁK (1967) of a darker and more reddish north Mongolian race (*hemionus* PALLAS), and a yellowish Gobi race (*luteus* MATSCHIE) seems to rest on the comparison of summer phenotypes from the Gobi with autumn/winter phenotypes from Dahuria. Darker summer phenotypes in more humid northern ranges may still be possible, but material from north or north-west Mongolia, and Siberian territories other than Dahuria is unavailable. The regular occurrence of dziggetais in the steppe/taiga ecotone has apparently never been confirmed, and the precise identification of specimens from the former seasonal ranges in Russian Siberia continues to pose problems (chapter 4).

6. Of the two other names for Gobi wild asses, Bedford’s dziggetai, *E. h. befordi* MATSCHIE 1911, represents the summer phenotype of the Gobi population. Its type specimen, preserved at the British Museum (BM 1939.2472), had been imported as a zoo animal approximately three and a half years after the collection date of the type of *E. h. luteus* MATSCHIE 1911, and its “iconotype” had been published in 1904 (LYDEKKER 1940a). Both races were formally described only in 1911, in one and the same paper (MATSCHIE 1911). In this manuscript *E. h. bedfordi* has been described first. The rule of priority would favour this subspecific name over *E. h. luteus*. However, the exact collection grounds of

the *bedfordi*-type specimen could not be proven, even though the (partly contradictory) records from the Hagenbeck Company indicate an origin from south-west Mongolia or Chinese Dzungaria. The previous conclusion proposes that *E. h. bedfordi* is a synonym of *E. h. hemionus* anyway.

7. *E. h. luteus* has a well-documented collection site in north China (see chapter 10). MATSCHIE's (1911) sparse description seems to suggest certain phenotypic affinities to the kiangs which are not seen in the Mongolian Gobi herds. This observation needs verification as soon as the cranial variation of the dziggetais has become better known. If a transitional contact among dziggetais and kiangs can be confirmed (cf. the pigmentation of *Microhippus tafeli* MATSCHIE 1922, chapter 10), any subspecies limit in Inner Mongolia could prove arbitrary, depending on the random effect of where within the transition zone remnant populations happened to survive the human persecution, and which phenotypes had been selected by the collectors.

8. The taxon *E. h. castaneus* LYDEKKER (1904), although recognized recently by GROVES (2002) again, rests on the colour painting of a single zoo specimen. The supposed geographical origin of this individual in west Mongolia is doubtful, and the carcass of the type seems to have been destroyed. The purchase of this hemione from C. HAGENBECK at Hamburg-Stellingen, as has been indicated in several reports, seems questionable if not doubtful. This specimen is best not considered as defining a valid taxon until the mystery around its origin and destiny has been clarified. A few hints for further queries are proposed in chapter 8.

9. The conspicuous diagnostic character of *E. h. castaneus*, however, the very light rump patch extending as whitish borders besides the dorsal eel stripe, is of continued interest. A few museum specimens, old photographs and travel reports suggest that these body ornaments are more common in some regional populations (e.g. in Dzungaria, and perhaps in Siberia and north-west Mongolia, see chapter 4 and GROVES & MAZÁK 1967, GROVES 2002) than in others (e.g. in the south Mongolian Gobi). The two Siberian specimens at Leiden differ in the conspicuousness of the rump patch, and do not confirm the statement by GROVES & MAZÁK (1967) that the clear borders of the eel stripe are a qualitative taxonomic marker of a north Mongolian race in Dahuria. If this character reveals a process of genetic introgression from western kulan populations into the dziggetais from Central Asia, or the reverse influence from the dziggetais into the kulans (cf. the "Kobdo onager", fig. 11), some Siberian and perhaps the hardly documented, speculative north-west Mongolian hemiones would qualify as transition populations. Though very rare in the herds from the Gobi desert this trait could be polymorphic in some populations (G. DENZAU, pers. comm.). Therefore the frequency of the light dorsal border stripes needs to be counted in population samples, rather than to take a note of their presence only[131]. At present the taxonomic (population genetic) information of these ornaments cannot be judged, even though this character might be the easiest population marker to explore by field biologists in larger population samples. Even the fairly diffuse, poorly demarcated buttocks patch of the dziggetais from the south-central Gobi permitted the author to spot escaping specimens in the distance from this cue alone, suggesting a function of visual recognition in the open desert. Skull biometry will reveal if functionally unrelated osteological characters assign the ornamented populations closer to the south-western population group too, so to confirm that the rump patch really indicates a process of genetic introgression.

[131] The dorsal border ornaments became narrower with age and eventually disappeared during ontogeny (TRUMLER in GROVES & MAZÀK 1967). This observation needs attention, and possible further physiological influences (e.g. sex dimorphism, social rank) have been considered inadequately too. At present foals and juveniles would be the most interesting population cohort to study the geographical distribution of these ornaments.

Zusammenfassung

Die Erforschungsgeschichte, die Verbreitung und das Vorkommen, die Taxonomie und die Haltung der zentralasiatischen Halbesel (Mongolei, Norwestchina, daurisches Siberien, Kasachstan, Nordtibet) in Zoologischen Gärten wurden zusammengestellt und interpretiert. Die zahlreichen Reisenden in den von keiner politischen Zentralmacht kontrollierten Weiten Zentralasiens und die von ihnen belieferten Wissenschaftler äußerten zwischen dem späten 18. Jahrhundert und 1922 mehrere Auffassungen über die systematische Einordnung der Populationen dieser Einhufer. Eine befriedigende genetisch-systematische Revision steht trotz der umfangreichen Literatur weiterhin aus. Die fragliche Identität einzelner Typusexemplare wird herausgearbeitet. Halbesel spielten in der Diskussion um die beste nomenklatorische Wiedergabe der geographischen Variabilität von Säugetieren traditionell eine besondere Rolle. Die zahlreichen Kommentare zu dieser Frage spiegeln die Entwicklung der zeitgenössischen zoologischen Konzepte wider. In Zeiten der Bestandsbedrohung der meisten Vorkommen ist die breite Merkmalsanalyse auf der lokalen Ebene dringender denn je, inklusive einer Entscheidung der Frage, wie mit phänotypischen Übergängen zwischen Unterarten nomenklatorisch zu verfahren ist. Das Vermögen der ternären Nomenklatur, einen Formenkreis wie den der Halbesel präzise abzubilden, bleibt nachzuweisen. Wird die eindeutige taxonomische Unterteilung durch Übergangspopulatonen erschwert bzw. verhindert, müssten die jeweiligen regionalen Populationen statt der Unterarten die Hegeeinheiten für den Artenschutz (Reservateplanung, Erhaltungszucht) begründen.

Da es eine eigenständige daurische Population in jüngerer historischer Zeit offenbar nicht gab, gehören sowohl die in früheren Jahrhunderten jahreszeitlich ins transbaikalische Sibirien eingewanderten Dschiggetais ebenso wie ihre Quellpopulationen aus der südlichen mongolischen Gobi demselben Taxon, *Equus hemionus hemionus* PALLAS, an. *E. h. bedfordi* MATSCHIE ist ein jüngeres Synonym zu dieser Unterart. Die vermutete genetische Introgression von mittelasiatischen Kulanen in die westlichen Dschiggetaivorkommen der Dsungarei, eventuell der nordwestlichen Mongolei und Sibiriens, oder umgekehrt von den Dschiggetais in die mittelasiatischen Kulane, ist unzureichend dokumentiert, aber wahrscheinlich. Die Körperfärbung einiger Halbesel aus dem geographischen Kontaktgebiet kann als Hinweise für den genetischen Austausch zwischen Dschiggetais und Kiangs gelten. Diese verdienen verstärkte Beachtung und Prüfung. Die Identität von einigen historisch wichtigen Individuen in Zoologischen Gärten und Museen wurde geklärt.

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