

Camels in Asia and North Africa

Interdisciplinary Perspectives on their Past and Present Significance



**Eva-Maria Knoll
Pamela Burger (Eds.)**

Verlag der
Österreichischen Akademie
der Wissenschaften



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ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

PHILOSOPHISCH-HISTORISCHE KLASSE

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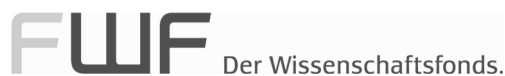
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EVA-MARIA KNOLL

The Camel at the Crossroads of Multiple Perspectives: Introduction to an Interdisciplinary Encounter

While we were collecting the articles for this publication the international community's attention was preoccupied with the so-called Arab Spring of 2011. As is widely known, this series of protests and demonstrations started on December 18, 2010, in Tunisia with the self-immolation of a desperate vegetable vendor called Mohamed Bouazizi and rapidly spread across the Middle East and North Africa. Around the globe people could follow media coverage of those events on an almost daily basis. It is not my intention to discuss the peaceful and violent aspects of this mass movement in the Muslim world here, or the socio-technical organization of the protesters, its roots and routes or its outcomes and future perspectives. Yet a small detail in those powerful media images and narratives of the protests bore witness to the strong feelings and contrasts of the Arab Spring movement, simultaneously connecting them to this volume's main topic.

I became aware of a flamboyant creature that had appeared in a remarkable number of the myriad of Arab Spring images broadcast around the world by TV stations, newspapers, cell-phones and the internet: camels – or, to be more precise, dromedaries. See for example the powerful image (picture 1) of a camel-riding supporter of the embattled Egyptian president Hosni Mubarak, taken by the American Pulitzer-Prize-nominated photojournalist Chris Hondros.¹ Hondros had captured the dromedary and its rider in the midst of a turmoil during a clash between pro-Mubarak and anti-government protesters in February 2011 on Cairo's Tahrir Square. In this picture, camel and man seem to be pursuing the same goal. Angry men in the crowd around the camel are grabbing, pushing, shoving. People are shouting and the camel roars. The camel's saddle is a nice piece, decorated with a colorful woven blanket, on which a protester is pulling fiercely. Another protester seems to be ready to use his walking stick as a weapon. Although the scene is emotionally loaded, conveying tension and danger, the encounter between people and camel seems to be self-evident and remarkable at the same time.

What was and is so particularly affective in these kinds of pictures? Why did the media channels, reporters and private protesters time and again pick the camels out of the crowds of thousands of protesters? Why did the journalists on site, the protesters and the spectators in other parts of the world as well seem to be crazy for this particular kind of camel-in-the-protest image? Why had Mubarak's supportive riders chosen to include this particular animal in their political intervention? What is the long-standing specific attraction, ongoing for thousands of years in the Orient and the Occident alike, related to this animal? What forged this special bond between human being and camel?

This volume might help to throw some light on some of these and related questions. Allow me to give a few glimpses into the human fascination with camels from the perspective of an interested social anthropologist.

First of all, camels are archaic animals, having lived on this planet for millions of years. Camels as we know them are the only surviving branch of the *Tylopoda*, the “swollen foot” suborder of “terrestrial herbivorous even-toed ungulates”, which was widespread in South

¹ Picture by Chris Hondros (Getty Images), Tahrir Square, Feb. 2, 2011, Cairo, Egypt. Hondros was killed in April 20, 2011, while on assignment in Libya.

America and Asia for about 46 million years. This would put the camel's emergence into the geological time of the Eocene. These animals are categorized as "even-toed ungulates" (*Artiodactyla*) because their weight is borne evenly between two toes – in contrast, for example, to the privileged third toe of horses. Accordingly, today's camel's taxonomic scheme reads: class: *Mammalia*, order: *Artiodactyla*, group: *Tylopoda*, family: *Camelidae* (Mukasa-Mugerwa 1981:2).

Nowadays this family of predominantly domesticated animals, the *Camelidae*, spans almost the whole planet, with living representatives in the New World (i.e. Llama, Alpaca, Guanaco, Vicuña in South America's Andes regions) and in the Old World (Bactrian or two-humped camel and wild camel in Asia; dromedary or one-humped camel in Arabia and North Africa). This book focuses on one of the two major branches, namely on Old World camelids.

A second possible argument for the continuing fascination with camels might be that this animal is particularly closely associated with one of the major steps in human history and human evolution, namely the Neolithic Revolution (Childe 1936). Based on archeological evidence it is assumed that the transition from hunter-gathering to settlement, agriculture and pastoralism through the domestication of animals and plants took place under favorable climatic conditions between 8000 to 5000 BCE (Gupta 2004). The climatic conditions that made the Neolithic Revolution possible were given in tropical and subtropical areas of southwestern and southern Asia, northern and central Africa and Central America (*ibid.*) and thus humanity's evolution at this juncture happened in several places.

In contrast to older, unilinear development models, in the 1950s anthropologists started to think about this process as a "unity in diversity" (cf. Gingrich 2010), with the alternative of a tree- or bush-model in mind instead of the older unilinear metaphor of a staircase. Simultaneously, the evolutionary process with regard to domestication is not one-directional; it should rather be thought of as a gradual adaptation of both animals and humans – i.e. as co-evolution. In marked contrast to older evolutionary assumptions, according to which pastoralism and animal husbandry was seen as the second stage in human evolution after hunter-gathering, around the turn of the 19th century anthropologist Eduard Hahn was already stressing that the development of nomadic pastoralism usually presupposes the cultivation of food plants by sedentary cultures (Gingrich 2010). As a particularly significant domestic animal the camel refers us to this kind of a long-standing human intervention in nature through taming and selective breeding. Compared to the domestication of dogs some 10,000 years ago and to the goat 8000–9000 years ago, however, at 5000–6000 years for the Bactrian and 3000–4000 years for the dromedary, the domestication of camels is relatively young, as Pamela Burger will show in this volume.

Apart from evolutionary developments, a third argument for our continuing fascination with camels might lie in the fact that this animal is intrinsically linked to mobility. The camel is the prerequisite for far-reaching transport and long-distance trading. Since its domestication the camel has developed into the most significant means of transport in arid and semi-arid areas of the Old World, making the wheel almost superfluous in some of these regions (Bulliet 1990).² In the slow and ruminant rhythms of their characteristic pacing gait, camels have been carrying people's loads for centuries – loads that range from frankincense about 5000 years ago to satellite dishes in the 21st century (see picture 26 in Chuluunbaatar's contribution to this volume), as well as to the Arab Spring intervention discussed above. Together with cats, giraffes and opossums, with whom they share this unique kind of animal locomotion, camels stand out from the majority of mammals by moving the limbs of one side of the body simultaneously (pacing gait).

² Although the camel had marginalized the wheel as a means of transportation, both camel and wheel were and sometimes still are nevertheless essential as a socio-technical and animal unit for rotating systems like irrigation, milling (see Bulliet 216–217; Gingrich this volume), and for the wells, one might add, which are often operated by a simple wheel, a pull rope and a draft animal (Gingrich/Heiss 1986:31–39, 182).

By conquering spatial distance, camels and ships provided the basis for long-distance trade and thus for the resulting wealth of cultures, in particular in Europe and China. Landscapes have developed along with the patterns of movement of this animal and its related human/animal interactions: the long-distance trading-scapes, domesticated landscapes of pastoralists and breeders, wild-scapes as the refuges of the remaining last wild camels, tourist-scapes, laboratory-scapes and so on, as many articles in this volume will show.

A fourth moment that might explain the continuing fascination camels exercise on human beings is perhaps the dialectical human-nature relationship. The cognitive distinction of human cultures between “wild” and “domestic” spheres refers to the level of human control over nature. The degree of social distance between humans and particular animals defines for example whether certain animals’ meat is categorized as edible or not, whether terms for animals are considered to be useful for verbal abuse or not (Leach 1976, 1964), or whether we hug a species as stuffed animal or not (Bendix 2002:216–217). One consequence of the dialectical human/camel relationship that becomes clear in this volume is that hybridization, the cross- or interbreeding of different species, has a domestic and thus desired and positive dimension, but also a wild and thus negative dimension. Different camel species have been interbred by humans for centuries with the goal of “improving” the animal’s characteristics and qualities (see e.g. Bulliet 1990:142–146, 168–170, Potts 2005). Robustness, the ability to carry heavy loads, and a benevolent character are favored attributes of Bactrian camels, while good milk-giving qualities, its speed and elegant, long-legged body structure are favored in dromedaries. When it is within human control, inter-breeding is a human skill, inherent in the above-mentioned process of the Neolithic Revolution, and hybrids are desired outcomes (see Faye and Konuspayeva, and Knospe et al. in this volume). Outside of human control, however, inter-breeding has a negative, endangering dimension. In several articles in this book, second generation hybrids appear as camels with a “bad” character (see the article by Faye and Konuspayeva) or as a threat to the last remaining wild camels in China and Mongolia (see the contributions by Yadamsuren, Dulamtseren and Reading, Yuan Lei, Hare, Yuan Guoying and Cheng Yun and Silbermayer and Burger).

Finally, camels not only provide material for human consumption (meat, milk, wool), they also contribute energy, mostly in the form of power and work. “Animals may therefore be ‘domestic’ in the literal sense of becoming part-members of human households and integral to their labor force” (Ingold 1996:60) – and to their protesting force, as we have seen. Beyond providing work and material for human consumption camels also have symbolic significance (as the articles by Gingrich, Fischer, Lang and Chuluunbaatar show).

There may be a hundred further arguments for the special bond between human beings and camels, and for our continuing fascination with this animal. The outstanding significance of camels for humans’ past and present is even carried over into the future: for instance, camel milk is acquiring increasing prominence for sufferers from cow’s milk allergy; in times of climatic change, when pastures are declining, camels are increasingly valued as environmentally sensitive animals, for their grazing habits and their comparably soft hooves; and antibodies from the camel’s immune system are currently being investigated as promising agents in cancer treatment.

ENVIRONMENTS HUMANS SHARE WITH CAMELS: RESEARCH TRADITIONS AND INTERDISCIPLINARITY

The histories of camels and humans have long been intrinsically linked in environments where humans would often not even have been able to survive without this unique and remarkable creature. Now, when aridity is affecting ever more areas as a result of climatic change, camels will also become increasingly important. Since its foundation more than 160 years ago there has been a long-standing research record at the Austrian Academy of Sciences into topics concerning these particularly challenging environments that human share with camels.

The genealogy of scholars who made distinctive academic contributions on these arid areas begins as early as Joseph Freiherr von Hammer-Purgstall, who was the first president of what in his days was called the “Imperial Austrian Academy of Sciences.” Hammer-Purgstall was a pioneer of Middle Eastern languages, or what formerly was called an “orientalist”. His works and translations not only inspired poetry and philosophy in German, but also the Habsburg court’s diplomatic services in the Middle East and Central Asia. As early as the middle of the 19th century, Hammer-Purgstall therefore established a research tradition at the academy that closely examined cultures living in interconnection with camels. This specifically Middle Eastern research tradition continued in the last quarter of the 19th century, with the experts in Arab and Semitic languages David Heinrich Müller and Eduard Glaser until the turn of the 19th and 20th centuries.³ Subsequently, this legacy was continued after the Second World War by the academy’s late Full Member Walter Dostal and his scholars.⁴

In 1854 Hammer-Purgstall published a book entitled *The Camel* (Das Kamel). The insights in that work were exclusively based on Arabic sources. Hammer-Purgstall understood that, because of the lack of language skills in Europe, these rich Arabic literary and scientific sources on camel breeding, camel treatment and camel trading were not accessible to the average European natural scientists, historians or commercial travelers. For these reasons, Hammer-Purgstall did what had never been done before – in fact, he did something similar to what this interdisciplinary book on the significance of Old World camels is aiming at.

As early as 1854 Hammer-Purgstall envisioned the potential of a fruitful dialog between the natural sciences and the humanities. In his compilation of camel-related terms and classic text passages he tried to overcome the lack of communication between different fields of academic research – that is, between the two major academic branches that the physicist and novelist C. P. Snow (2001) so aptly addressed one hundred years later in his famous lecture as two different “cultures” in science and the humanities. In his camel-centered invitation to bridge this divide between the academic branches the academy’s first president Hammer-Purgstall envisioned that

this [book] will set up an unprecedented example how the humanities and philology may promote natural sciences and biology: by compiling those words that belong to the same subject area, these clusters of terms will then reveal hitherto unknown facts, qualities and modalities of the animal under investigation. The same might work with horses, or with palm trees, similar to the more detailed Arab vocabulary on the camel.⁵

With a research focus on Asia, the Institute for Social Anthropology (Center for Asian Studies and Social Anthropology, Austrian Academy of Sciences) continues this established and longstanding concern with areas humans share with camels. Moreover, through the cooperation with the University of Veterinary Medicine, Vienna for this publication there is also a continuity of the subject-focused interdisciplinary dialog that the academy’s president, Hammer-Purgstall, pioneered in the mid 19th century. This volume developed out of a conference that discussed the camel in its biological and socio-cultural dimensions from various disciplinary angles. Both

³ For insights into the work of Joseph von Hammer-Purgstall see Wentker (2008), of David Heinrich Müller see Sturm (in preparation), and of Eduard Glaser see Dostal (1993, 1990).

⁴ There is a broad field of contemporary research at the Austrian Academy of Sciences in areas where humans interact with camels. Some of the most relevant AAS Institutions in this regard are the Institute for Iranian Studies (IfI) and the Institute for Social Anthropology (ISA) where scholars such as Andre Gingrich and Johann Heiss (1986) follow in the footsteps of Walter Dostal (2006) and his predecessors.

⁵ In his introductory words Hammer-Purgstall states that his publication “sich einzig und allein an die arabischen Quellen halten und ein bisher noch nicht dagewesenes Beispiel aufstellen, wie durch die Wörterkunde und Philologie die Naturgeschichte und Physiologie gefördert werden können: durch die blosse Zusammenstellung der in dasselbe Stofffach gehörigen Wörter gehen aus den Gruppen derselben bisher unbekannte Thatsachen der Eigenschaften und Gewohnheiten des besprochenen Thieres hervor. Beim Pferde und der Palme würde sich dasselbe bewähren, indem der Araber dafür auch eine grosse Anzahl von Wörtern hat, deren Zahl sich aber mit der in dem arabischen Sprachschätze über das Kamel vorhandenen keineswegs vergleichen kann” (Hammer-Purgstall 1854:1; translation by the author).

the camel conference and this resulting publication thereby followed the excellent model of a comparable endeavor that was focused on the economy of the horse in Asia and carried out by the Institute for Iranian Studies.⁶

The 2010 conference “Camels in Asia and North Africa” addressed scientific and academic camel-related research in a cross-cutting overview manner.⁷ It was organized by the two editors of this book, i.e. by a veterinarian from the University of Veterinary Medicine, Vienna and myself, a social anthropologist with the Austrian Academy of Sciences. We had the rare privilege of discussing the significance of the camel’s past and present with about 100 researchers and guests from five different continents, and from a wide range of different disciplines in the natural and life sciences as well as in the humanities and social sciences. It was an intense camel-focused dialog carried out by representatives of such diverse fields as animal science, Arabian studies, archeology and archeozoology, biology, dairy and animal production, ecology, ethnobotany, ethnomusicology, genetics, history, literature, public health, sinology, social and cultural anthropology, veterinary medicine, wildlife management, and zoology, as well as by representatives of camel-protecting NGOs, by camel owners, camel breeders, and people otherwise interested in camels.⁸

By consequence, the insights, considerations and research horizons assembled in this publication might interest scholars from all these scientific and academic fields. This book might also be of value for colleagues working in the recently emerged field of “human-animal studies” or “animal studies”, or “anthrozoology”.⁹ With roots in a wide range of scientific and academic disciplines (e.g. in history; Bulliet 2005) and with an interdisciplinary orientation from the outset this field seeks to overcome anthropocentrism in its re-reflection of human-animal relationships – including humans’ attitudes toward, thinking about and conceptualizing animals as well as treating animals. By focusing on Old World Camels this book assembles human-animal interactions in a wide range of human practices, including science, industry, tourism, medicine, consumption, cosmology and art, as well as the practice of handling wild and domesticated camels ranging from breeding, herding, trading, managing to the conservation of camel species.

THE CAMEL AS A BOUNDARY OBJECT

What we were aiming for with the 2010 conference might be described in a metaphorical way as sending the camel through an interdisciplinary eye of a needle. This pun refers to the widely known saying “it is easier for a camel to go through the eye of a needle, than for a rich man to enter into the kingdom of God”, a phrase spoken by Jesus to his disciples according to Matthew 19, 24. The “eye of a needle” might refer to a very small gate in the city wall of Jerusalem. Since the gate was so small, only humans but no camel could pass. In the vernacular of historic Jerusalem this gate was called the “eye of a needle” (Röhrich 1992:1070). Regardless of these historic roots, some scholars think the proverb may, however, be based on a translation error by

⁶ In October 2006 the Institute for Iranian Studies (Center for Asian Studies and Social Anthropology, Austrian Academy of Sciences) together with the Department for Asian Studies at the Ludwig-Maximilians-Universität, Munich, organized a conference on “The International Horse Economy in Iran, India and China” and published the insights gained from it (Fragner et al. 2009).

⁷ “Camels in Asia and North Africa. Interdisciplinary workshop on their significance in past and present”, took place from 5th to 7th October 2010 at the Austrian Academy of Sciences’ main building, Dr. Ignaz-Seipel-Platz 2, Vienna, Austria. I had the great pleasure to conceptualize, organize and chair this conference together with Pamela Burger. For the workshop program see http://www.vetmeduni.ac.at/fileadmin/v/z/english/camel_workshop_program.pdf, consulted 10 Oct., 2011.

⁸ The 2010 workshop on the significance of Old World camels was not only inter- and multidisciplinary, it was even transdisciplinary. With the attendance of interested lay persons and representatives of private camel farms and riding schools in Sweden and Austria, the workshop reached beyond the academic ivory tower.

⁹ This new field of inter-disciplinary inquiry developed over the last few decades with respective specialist journals such as *Anthrozoos: A Multidisciplinary Journal of the Interactions of People and Animals*, *Humanimalia: A Journal of Human–Animal Interface Studies*, or *Society & Animals: Journal of Human–Animal Studies*.

which the Greek *κάμηλον* (camel) was confused with *κάμῖλιον* (rope). Accordingly, the metaphorical comparison for an extremely difficult, almost impossible endeavor should read “it is easier to push a rope through the eye of a needle than . . .” (ibid., see also Bendix 2002:210). Be that as it may, tiny city gate or translation error, with this saying the camel resounds in common parlance – thus even being represented in the discourses and the vernacular of people such as Austrians, who do not share their environment with camels.

Metaphorically stating that we were sending the camel through an interdisciplinary eye of a needle in the 2010 conference and this publication of the conference proceedings means we are here trying something really challenging. We tried to push the camel through an interdisciplinary eye of a needle by assembling insights on this creature from the natural as well as from the social sciences. The camel was scratching and kicking against our efforts to shove it through. On each of our successive efforts, it looked a little different – bent and almost a little deformed by the respective disciplinary perspective. In our scrutiny from various and highly heterogeneous disciplinary angles the camel thus became a “boundary object” – as the conference’s keynote speaker Ulrike Felt from the Department of Social Studies of Science at the University of Vienna pointed out in her analysis of the dynamics of interdisciplinarity. Putting the camel center stage through a multidisciplinary approach is not an easy task. Since the 19th century, science has been increasingly preoccupied with creating and upholding disciplinary boundaries, resulting in the development of distinct “cultures” of how we know, what we know and how we communicate what we know. Every researcher and author in this volume belongs to a disciplinary knowledge community; a “thought collective” with a rather specific “thought-style” (Fleck 1979). By our efforts at knowledge exchange across disciplinary boundaries, this assemblage of contributions from multiple thought-styles in one volume reveals the camel as a boundary object, i.e. as

an analytic concept of those scientific objects which both inhabit several intersecting social worlds [. . .] and satisfy the informal requirements of each of them. Boundary objects are objects which are both plastic enough to adapt to local [or disciplinary] needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. (Star/Griesemer 1989:393).

Such boundary objects are central in the development of interdisciplinary thinking.¹⁰ As the focal point of a shared interest, camels as boundary objects enable us to link highly heterogeneous researchers since they make it possible for us to collaborate despite a plurality of research interests and methodological approaches (Wenger 1998). They allow us to make connections and share our insights – and, at the same time, they allow us to some extent to hold on to our respective perspectives, theories and methods. This volume comprises highly heterogeneous methods of generating data, including searching archives that reveal scholarly thinking on camels hundreds of years ago, shooting anesthetic darts from jeeps racing through impassable deserts, begging camel herders for blood and hair samples for DNA analysis or listening carefully to their folk songs, cutting up plastic containers to see if and how what is inside might affect the quality of camel milk, staring at the stars in the sky with farmers or wandering for months with camel-herding nomads and sharing their daily life. Yet assembling and unifying contributions from highly diverse scientific and academic thought collectives is a challenging task that requires all contributors to withdraw to some extent from their own disciplinary writing standards. Authorship for example is extremely unevenly organized between natural sciences and the hu-

¹⁰ Moreover, the camel itself is “good to think with” interdisciplinarity, argued European ethnologist Regina Bendix in her inauguration speech: With its extremely long limbs and its peculiar hump or humps, the enormous molars, and its heavy eyelashes the camel reminds us more of a combination of not entirely harmonizing images than of a singular entity – it is, in fact, as such a paradigm for a long-practiced interdisciplinarity (Bendix 2002:205–206).

manities. We thus meet standards of multiple authorship¹¹ alongside those of single authorship in this book. Giving first names is frowned upon in the natural sciences while it is courteous within the humanities. This list of obstacles that have to be overcome in working on camel matters across the borders of the major scientific cultures can be extended endlessly. To complicate things further, there are also the diverse national scientific and academic traditions and cultural differences engraved in this volume, for example according to the presence or absence of first names and surnames. And above all, the camel truly is a boundary object in many more respects. There are, for example, no scientifically defined camel breeds. The fact that almost every country with local traditions of camel breeding categorizes its own breeds, often by using local terminology, gives geneticists headaches when trying to compare camel populations around the world.

THE STRUCTURE AND ORGANIZATION OF THIS BOOK

As early as the 4th century BCE, Aristotle had distinguished two species of camel in his *Historia Animalium* and noted that “the Bactrian camel differs from the Arabian; the one has two humps, the other but one” (Bohn 2005:B.II.27). In 2010, when we started organizing our camel conference, there were still two different Old World camel species known to the scientific world. In the meantime, however, it has become clear that the two variations of the Bactrian camel are not as closely related as was previously assumed, as Pamela Burger will show in her contribution to this volume. Hence there are, in fact, three different species (*genera*) in the Old World camel habitats (i.e. the distribution area of the Old World *Camelini* tribe of the family *Camelidae*):

- a) the recently identified new subspecies of the wild camel (*Camelus ferus*), which has two humps.
- b) the two-humped Bactrian camel (*Camelus bactrianus*), and
- c) the one-humped dromedary or Arabian camel (*Camelus dromedarius*),

The organization of this book essentially follows the kinship structure of the *Camelini*, and in addition it reflects the varying degrees of scientific and academic knowledge about the different members of this camel family tree.

I – OLD WORLD CAMELS (*TRIBE CAMELINI*)

In the first part of the book we discuss the relationship between the different Old World camels, their common history and their domestication process.

Pamela Burger combines insights of veterinary medicine with molecular and population genetics in order to throw light on the domestication process of Old World camel. The understanding of this process is still limited and as such it is a missing link in the history of our livestock species. Based on genetic and archeozoological evidence, Burger argues that, contrary to the widespread assumption of a single origin of the Old World Camelids, there are separate origins of the dromedary and the Bactrian camels. Identifying centers of domestication and thus wild ancestral and closely related camel populations can help to save the biodiversity of camels, a particularly important type of livestock in Asia and North Africa.

¹¹ As a social researcher, in the course of compiling this volume I learned that a first-mentioned author of articles in the natural sciences had carried the main workload in gathering data or running analysis in the laboratory, while the last mentioned is the principal investigator who had designed the study and had been responsible for acquiring the funding for the overall investigation. The positions between the first and the last author belong to people who had substantially contributed to the study, e.g. by providing a particular sequence of the analyzing process. This is in sharp contrast to the humanities, where more than three authors are highly uncommon and – if not listed alphabetically – the last mentioned has contributed the least to the publication.

Bernard Faye and *Gaukhar Konuspayeva* scrutinize Kazakhstan as one of the few countries where the distribution areas of the two domestic Old World Camelids, i.e. the Bactrian camel and the dromedary, overlap. Since it was an important section of the Silk Road, with a high demand for stronger pack animals, it is no wonder that we encounter the human skill of cross-breeding in this country.

The first part of the book concludes with the critical empirical investigation of an almost mythical assumption on camels' development history. With reference to a frequently cited Italian source from 1879, it was assumed that the wild camel (*Camelus ferus*) was the common ancestor of both the Bactrian and the Arabian camel. By providing contrary anatomical evidence, *Clemens Knospe et al.* refute the persistent assumption according to which there is a two-humped phase in the embryonic development of one-humped camels that relates to its two-humped ancestry.

II – WILD CAMELS (*CAMELUS FERUS*)

In the second part it will become clear that our knowledge of wild camels (*Camelus ferus*) is still merely rudimentary. We know little about how these shy and timorous animals live and how they move about their territory. As mentioned above, until recently we knew so little about their genotype that this animal was described in scientific discourses as the feral relative of the domesticated Bactrian camel – or even as the ancestor of all Old World camels. It is not even clear how many of them are still out there in the unbelievably harsh conditions of the deserts of China and Mongolia, where wild camels have survived in four more or less isolated populations. With an estimated population of less than 900 animals in China's wildlife refuges, the wild camel would, in fact, be more endangered than the giant panda.

In their critical report on the conservation status of the wild camel in Mongolia, *Adiya Yadamtsuren*, *Enkhbileg Dulamtseren* and *Richard R. Reading* discuss the various threats to this critically endangered species, such as illegal mining, hunting, the decline or destruction of water resources and the wild camel's various encounters with domesticated livestock.

Yuan Lei et al. discuss the situation in China, where about another half of the remaining world's wild camels have found a fragile refuge. Both articles make clear the difficulties and obstacles that have to be overcome and the strategies and measures that would be urgently necessary to save the last remaining wild camel populations on this planet.

Learning more about the distribution, habitat needs, movement patterns and social behavior of wild camels may essentially contribute to ensure their survival. One way to gain this kind of knowledge is to track and monitor their movements via GPS satellite collars. Collaring wild camels with this device in southern Mongolia, however, is, according to the contribution by *Chris Walzer et al.* like "working in a freezer". The harsh conditions in the exceptional wild-camel environment require a precise harmonization of esthetics and hurried operational procedures.

Mating with domestic Bactrian camels is another serious threat to the remaining wild camel population. Through genetic analysis, *Katja Silberman* and *Pamela Burger* reveal a hybridization process, and based on these insights they suggest measures for the preservation of the genetic integrity of the last wild camel populations.

III – BACTRIAN CAMELS (*CAMELUS BACTRIANUS*)

Another genetic-analysis approach, this time by analyzing ancient DNA, opens the third section of the book, which deals with Bactrian camels. *Alexandra Trinks et al.* use a particular part of ancient DNA as a window into the camel's domestication process, which took place in the steppes of Eurasia in the Bronze Age. Mitochondrial DNA, passed down from mother to daughter, revealed a relatively wide distance between domestic Bactrian and wild camels but a rela-

tively limited diversity within the group of early domestic Bactrians. The authors thus conclude that a split between the two populations occurred about 700,000 years ago – long before domestication. The domestication of the two-humped camel, however, was rather a single domestication process that probably took place in southwestern parts of Central Asia.

Maria-Katharina Lang's contribution offers the view of an art-interested anthropologist on interactions and interconnections between Mongolian people and Bactrian camels. In her analysis of various descriptions and depictions of camels, such as the famous film *The Story of the Weeping Camel*, Lang reveals links between the historic past, narratives, legends and lived practices in Mongolian encounters with camels.

In *Otgonbayar Chuluunbaatar's* article it is music that contributes to our understanding of the significance of camels in Mongolian society. Through the exploration of various song texts, Chuluunbaatar points to the special place the camel has in legends, metaphors, ritual songs, everyday folk songs and modern literature. One day, she concludes, the camel may be completely replaced as means of transport, but it will probably always be an essential motif and an integral part of Mongol culture.

IV – DROMEDARIES (*CAMELUS DROMEDARIUS*)

The wide scope of the comprehensive fourth part of this book reflects the comparatively extensive research and writing available on one-humped camels – also called the Arabian camel or dromedary – in western Asia and northern Africa.

The section on dromedaries opens with an archeozoological contribution by *Margarethe and Hans-Peter Uerpmann* that focuses on camel remains excavated in the United Arab Emirates. By comparing dromedary bones from the Iron and the Bronze Age the authors are able to indicate a shift from hunting to herding camels that occurred between about 1400 and 900 BCE and which puts South-East Arabia at the crossroads of the early history of dromedary domestication.

The second dromedary text is by *Walter Dostal*, who died on August 8, 2011, at the age of 84. In his last lecture, given at the 2010 camel workshop, he was brave enough to critically reconsider some of the insights that he had made on the camel-riding positions and the development of Bedouin societies of the Arabian Peninsula. While the riding position on a Bactrian camel is more than obvious – in between, and thus safely secured by the two humps – the dromedary with its enormous one hump offers three possible riding positions. Dostal reconstructs Bedouin history by analyzing two of these possible riding positions and the corresponding saddle constructions as they developed in different parts of the Arabian Peninsula. With reference to archeological findings and contemporary dromedary-riding techniques, he shows that the sequence of different riding techniques relates to cultural exchanges. His article discusses among other things one of the most impressive artifacts of human/camel interaction, namely the more than two-meter-wide woman's saddle.

The challenging logistics of long-distance trading camel caravans are scrutinized by *Johann Heiss* with reference to a 10th-century South Arabian writer and to travel routes through the southwest of the Arabian Peninsula. For centuries, caravans of several hundred dromedaries carried goods through the challenging terrain. Heiss shows that providing this enormous workforce of animals with sufficient amounts of water and fodder, and distributing the burdens and hardships of the undertaking evenly required elaborate strategies.

Andre Gingrich discusses camel-related folk conceptions common in the *Tihāma*, the coastal plain area along the eastern shores of the Red Sea. The farmers of this area believe in the camel's sensitivity to the return of the star constellation of the Pleiades and thus to the coming of the rainy season. As animals with a specifically meaningful relationship to humans, dromedaries indicate the beginning of the rainy and thus fertile season by staring at the farmer's house. Gin-

grich relates his ethnographic analysis to the ritual significance of camels and oxen in pre-Islamic southwestern Arabia.

Daniel Martin Varisco examines the extensive lore as documented in Arabic texts about what dromedaries should and should not eat. Based on texts from the 9th century CE, his contribution on the relevant Arabic ethnobotany reveals human concerns with camel fodder ranging from plants classified as the best pasture, to those that produce superior quality milk, and others that are thought to cause harm.

Darem Tabbaa gives a broad overview on the socio-economic significance of dromedaries in Syria. This includes Syrian pastoralists' struggle for survival in modern Syria but goes also beyond Syrian borders. This especially refers, for example, to the remarkable historic event in 1856, when about 100 Syrian camels and a Syrian camel herder were shipped to the US to serve with desert garrisons in California and Arizona.

Another country-focused contribution is *Arshad Iqbal's* discussion of dromedaries in Pakistan. He sheds light on different camel production systems and points to a general increase of camel's socio-economic significance in safeguarding human nutrition.

Mohammed Shunnaq and Susanne Ramadan Shunnaq consider images and potential of camels in the tourism industry. Mediated through classical films such as *Lawrence of Arabia* and countless advertising strategies of the tourism industry, images of camels have become a vital element in popular fantasies about the Orient. The authors analyze this camel-related orientalism and explore its potential for a future marketing via desert camel tracking of attractive but not yet intensively traveled tourist sights in the northern and central parts of Jordan.

A contribution on the significance of dromedaries in folk medicine closes the cluster on western Asia. *Abdulsalam A Bakhsh et al.* discuss the use of camel urine and camel milk as medical remedies in Arab folk medicine and in contemporary biomedical settings.

Anja Fischer's ethnographic contribution on questions of prestige associated with camels opens the next subsection on dromedaries in North Africa. Fischer explores the significance of dromedaries as creatures of affection in a nomadic society in the Algerian Desert. Particular prominence is given here to the long-legged white dromedary. It is worth noting that people apply this color preference both to the one-humped dromedary and to the two-humped Bactrian camel, as we know from Maria Katharina Lang's article in the third section.

Maurizio Dioli's contribution serves as an introduction to a subsequent broader block concerned with the significance of dromedary milk in northern Africa. He presents traditional pastoralists' techniques and devices regarding milking, fostering and weaning dromedaries that he encountered as a veterinary surgeon in the Horn of Africa. The reader might feel pity for some of the camels, yet one should not forget that in an environment where camel milk is essential for human survival these techniques are meaningful to ensure the flow of milk and to avoid a calf being rejected by its mother and destined to die.

Mario Younan and David M. Mwangi explore the informal character of the camel-milk market in Kenya and Somalia, which is largely a women's business. Camel milk has outstanding keeping qualities. This allows the milk women, despite the long distance to the producers, the heat and the unfavorable sanitary conditions, to respond to the ever-growing demand for camel milk from the increasing numbers of urbanized and sedentary (ex-)pastoralists in the area.

Another milk-focused article is *Ibtisam E.M. El Zubeir's* study on the shelf life of camel milk. By comparing the efficiency of a lacto enzyme on the keeping qualities in cow's and camel milk, Zubeir points to the significance of camel milk for countries like Sudan.

The dromedaries part of this book concludes with another approach to the boundary object camel, namely in pictures. The photo-essay on dromedaries in the Nigeria-Niger corridor by

Abdussamad M. Abdussamad et al. is concerned with the topics of camel's classification according to different phenotypes, their reproduction, and health.

Richard W. Bulliet has been kind enough to conclude this interdisciplinary volume on Old World camels with an afterword. He reflects on his 45 years of studying the history of camel use and domestication as well as on two surprising limitations in relation to this creature. Firstly, the world's strongest pack animal is rather limited in its cultural manifestations – there is an elephant goddess but no camel god. Secondly, in comparison to the worldwide spread of other livestock, the camel is rather restricted in its geographical spread. The limited cultural impact of camels, argues Bulliet, has to do with their late period of domestication, and the sparse and fruitless results of experiments to export camels to exotic locations are linked to their long maturation period.

As a rough categorization of the 26 articles in this interdisciplinary volume on Old World camels according to their research focus it can be said that the contributions from the natural-science branch tend to discuss evolutionary processes. They thereby operate on a larger time frame and a 'smaller'-object of evidence, namely genes. With the aim of preserving the last remaining wild camels, this time line spans the evolutionary history of *Camelini* developments from some five million years ago through to domestication 6000 to 8000 years ago and into the future and destiny of a remarkable animal. The natural sciences interact with camel species per se. Social-science contributions, by contrast, are rather concerned with the significance of human/camel encounters in more contemporary, everyday situations. So we can identify a roughly focus in this volume either on evolution or on history and society – and we see various intersections: the contributions from the humanities, such as archeology and history, as well as the considerations from the veterinary, wild-life management and dairy farming representatives, show the limits of such an effort to group the highly heterogeneous perspectives, aims and insights of camel research assembled in this publication.

It is evident that the significance of Old World camels in the past and present goes far beyond the interdisciplinary aspects collected in this volume. Racing camels, one of the world's largest camel markets in India, the heyday of the camel caravans on the silk road, the environmentally pressing problematic of feral camels in Australia, the question of why there is no camel among the animals of the Mongol calendar, or the saying that humans know 99 names of Allah, but the 100th name is only known to the camel are topics not covered in this book, along with hundreds of further rewarding subjects. This book should therefore only be seen as a first attempt to bring together scholars from all over the world from diverse scientific and academic backgrounds and with diverging perspectives, interests and methods to share their knowledge, queries and sympathy for one of the most fascinating animal on this planet. It is therefore especially encouraging that the Vienna 2010 conference triggered a continuing dialog between specialized representatives of the humanities and the life sciences that will lead to subsequent camel conferences (a further interdisciplinary camel conference was planned for 2012 in Syria but had to be postponed owing to the difficult political situation that resulted from the Arab Spring movements in the region). Another gratifying outcome of the 2010 camel conference in Vienna was a consultation between the organizers Burger and Knoll for an Austrian TV documentary on camels and a subsequent cooperation between this film project and a genetic research project at the Veterinary University, Vienna.¹² For future research the camel will remain at the crossroads of interdisciplinary interests and perspectives.

¹² Documentary "Wüstenschiffe" (Ships of the Desert) 2012 by Georg Misch, Mischief Films www.mischief-films.com/htm/filmeuebersicht.php?id=28&PHPSESSID=e9c8536e2949f766840ac9954ff0bcd5&langswitch=e&PHPSESSID=e9c8536e2949f766840ac9954ff0bcd5, consulted 12 July, 2012).

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PART I

OLD WORLD CAMELS

(Tribe Camelini)

Genetic Traces of Domestication in Old World Camelids

When and where did modern camels evolve? These questions about the evolutionary history and domestication of dromedary (*Camelus dromedarius*) and Bactrian camels (*Camelus bactrianus*) have only recently reached the field of molecular genetics. Traditionally, fossil records are used for tracing ancient demography. For Old World camels the split between dromedaries and Bactrian camels was dated at 5 million years (myr) ago, significantly later than estimated by phylogenetic¹ studies (8 myr). Although fossils provide invaluable information they are limited and difficult to assess, particularly if there was continuity between ancient and modern camels. Based on archeological data the domestication of dromedaries took place in the south-eastern part of the Arabian Peninsula around 3,000 to 4,000 years ago. The originally assumed and eponymous center of origin for two-humped camels in Bactria (today's Afghanistan and Turkmenistan) has been replaced by possible domestication center(s) in western Asia between 5,000 and 6,000 years ago.

Genetic data collected from today's camel populations give us insight into ancient demographic events, since they have left imprints in the genetic profiles. Basically two main hypotheses are followed: The multiregional hypothesis suggests that for each camel species the modern domestic form evolved directly from several ancient wild forms in different locations in the Old World. Conversely, the single-origin model argues that only one specific population gave rise to the domestic form for each species, which subsequently expanded demographically. To test these hypotheses we use mitochondrial DNA (mtDNA) inherited solely from the mother and nuclear DNA transferred to the offspring by both parents.

By using modern DNA analysis it is possible to trace the ancestry and migration of different camel populations and thus draw conclusions about potential domestication scenarios. One hypothesis states that the high genetic diversity found in a specific modern camel population might reflect ancient diversity (before domestication) and thus could hint at a possible domestication center. This is based on the assumption that the gene pool is narrowed during domestication, since only a few animals are used for breeding. A possible domestication scenario could also be explained by the "hourglass" metaphor, which refers to the existence of a large genetic pool before domestication, which is reduced by a bottleneck during the domestication phase and is followed by a demographic expansion and breed formation after the initial domestication. An alternative hypothesis assumes that a wide genetic variation in modern camels might also reflect recently accumulated diversity due to demographic expansion after domestication. One possible way of differentiating between the two scenarios is the comparison between domesticated camels and non- and pre-domesticated animals, namely extant wild relatives and samples from extinct ancient specimens. This analysis can tell whether a modern extant population is the closest relative to the domesticated camels or if the direct ancestors are extinct today, as seen in horses (Cieslak et al. 2010).

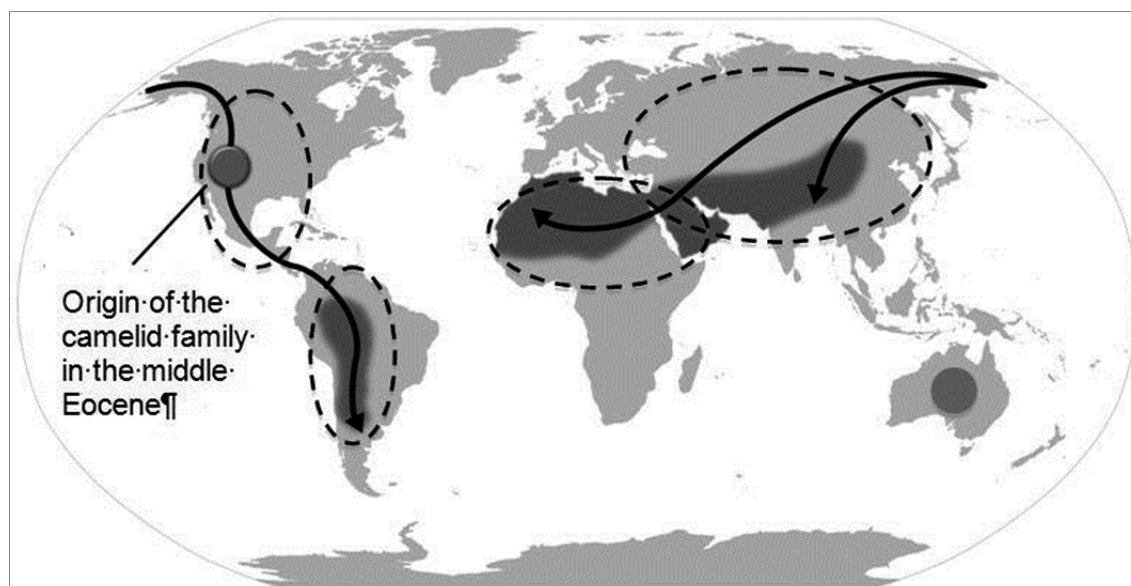
The big challenge in the study of Old World camels' domestication is that the wild dromedary is extinct and the wild two-humped camels are genetically very distant from their domestic counterparts (Silbermayr et al. 2010a, Ji et al. 2009). This is in contrast to other domestic animals, where the wild ancestors still exist (e.g. wild boar, wild goat, wild ass) and are closely

¹ In phylogenetic studies the evolutionary relationship between different (sub)species or populations is investigated using molecular data.

related (i.e. common shared mitochondrial haplotypes can be found). Moreover, in all genetic studies we observe a panmictic (globally mixed) camel population,² which is likely due to natural and human-induced migration (e.g. caravan transportation). This fact makes it very difficult to define possible domestication centers based on the genetic variation observed in modern camels alone. Intensive research on ancient DNA samples, however, has the potential to shed new light on the riddle of camel domestication.

THE HISTORIC BACKGROUND OF THE OLD WORLD CAMELS (*CAMELINI*)

The early ancestors of the Old World camelids (*Tylopoda*, *Camelidae*, *Camelini*, *Camelus*) originated from North America, where they emigrated via the Bering land bridge to the eastern hemisphere, the “Old World”. The earliest remains of camelids in Asia date to the Middle-Pliocene about 5 myr ago (Prothero/Schoch 2002, Kozhamkulova 1986). The widest distribution of camelid species occurred in the Plio-Pleistocene (2.5 to 1.5 myr ago) when they ranged from East Asia (Kozhamkulova 1986) to eastern Europe and North-East Africa (see graph 1; Howell et al. 1969, Gentry/Gentry 1969). Present-day members of the genus *Camelus*, namely the Bactrian camel (*Camelus bactrianus*), the wild camel (*Camelus ferus*)³ and the dromedary (*Camelus dromedarius*) likely descended from Plio-Pleistocene forms of *Paracamelus*, recorded from localities in northern China, western Mongolia, Tajikistan and Kazakhstan (Kozhamkulova 1986).

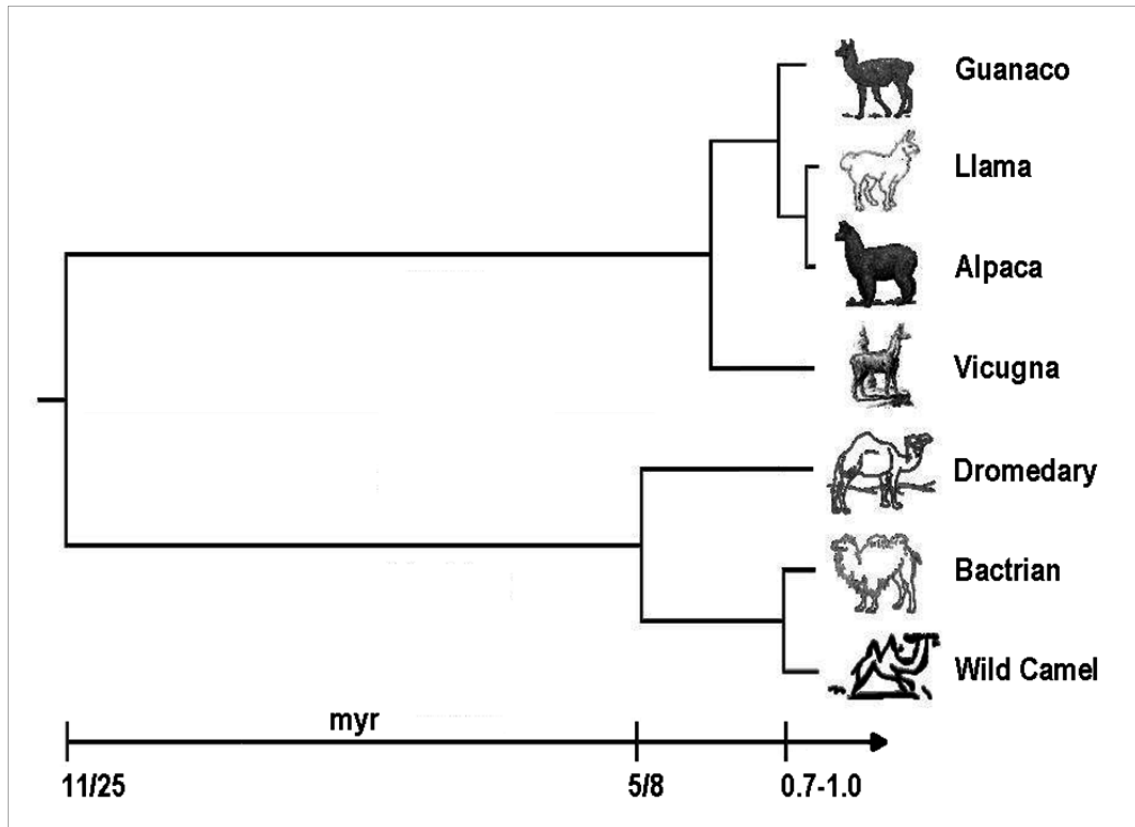


Graph 1: Early plio-pleistocene (dashed lines) and present-day (grey shaded) distribution of the camelid family. Black arrows indicate early migration routes via the Bering land bridge and the Isthmus of Panama. Dromedary camels arrived in Australia only in 1837, where they were shipped mainly from Pakistan. (http://upload.wikimedia.org/wikipedia/commons/1/16/Camelid_locations_and_migration.png; consulted 4 April, 2011; modified according to Prothero/Schoch 2002).

Molecular evolutionary studies estimate the split between Old and New World camels at 11 myr (Kadwell et al. 2001, Stanley et al. 1994) to 25 myr (Ji et al. 2009) and the separation within the *Camelini* at 5 to 8 myr ago.

² This is explained in more detail in the results and visualized in graph 5.

³ The naming of wild and domestic animal species follows the ruling by the International Commission on Zoological Nomenclature (Opinion 2027, March 2003), which fixes the first available specific name based on a wild population (Gentry et al. 2004).



Graph 2: The maximum likelihood tree of the evolutionary relationship among the *Camelidae* is based on the complete mitochondrial genomes⁴ of New World and Old World camels.

The evolutionary relationship between dromedaries and Bactrian camels has been widely discussed. The observations of one-humped dromedaries passing a two-humped stage in their embryonic development (Lombardini 1879) and the fact that crosses between dromedaries and Bactrian camels produce fertile offspring led to the widespread assumption that the one-humped and the two-humped forms descended from a single ancestor, *Camelus ferus* (Peters/von den Driesch 1997 and ref. therein). However, the osteological evidence (Gautier 1966) claiming that the extinct giant camel (*Camelus thomasi*) belonged to the lineage of two-humped Bactrian camels has been refuted: the morphological re-analysis of Paleolithic giant camel bones revealed features characteristic of the one-humped camel *Camelus thomasi* and the species is therefore considered a close relative if not the direct ancestor of the dromedary (Peters 1998, Peters/von den Driesch 1997). Moreover, wild dromedaries must have occurred in considerable numbers on the Arabian Peninsula in Holocene times, as illustrated by the recent discovery of 2nd millennium before common era (BCE) hunting sites along the eastern coast yielding large amounts of bones from this species (von den Driesch/Obermaier 2007, Uerpmann/Uerpmann 2002). Finally, the two-humped embryonic phase of the dromedary observed by Lombardini (1879) has been disproved: the Arabian camel's prenatal development is characterized by the formation of one single hump (Kinne et al. 2010)⁵. In sum, today's evidence clearly suggests a separate ancestry for the two domestic forms.

⁴ The information in graph 2 is based on Genbank accession numbers: gi:219524215 (guanaco) gi:223976134 (llama) gi:38602627 (alpaca) gi:270267350 (vicugna) gi:157394461 (dromedary) gi:157011972 (Bactrian camel) gi:157011955 (wild camel).

⁵ For a more detailed discussion about the embryonic status of the dromedary see the article by Clemens Knospe et al. in this volume.

ARCHEOLOGICAL EVIDENCE OF DOMESTICATION OF OLD WORLD CAMELS

The originally assumed *center of domestication of the Bactrian camel* in eastern Iran or southern Turkmenistan in the 3rd millennium BCE (Uerpmann 1987) is contradicted by the fact that there is no proof that the geographic distribution of its wild two-humped ancestor included this region. Presumably, the area(s) of domestication was (were) located further to the east, such as southern Kazakhstan, north-western Mongolia and northern China, where people were already acquainted with the wild species over a longer period of time (Peters/von den Driesch 1997). However, Carl von Linné (1758) designated the domestic two-humped camel '*Camelus bactrianus*' suggesting Bactria, today's northern Afghanistan and southern Turkmenistan, to be the region of its origin.

The *domestication of the dromedary* likely took place towards the end of the 2nd millennium BCE in the south-eastern part of the Arabian Peninsula (Uerpmann/Uerpmann 2002, Peters 1998, Uerpmann 1987). Domestic camels played an important role in the ancient civilizations of the Old World and even today a number of rural and nomadic societies in north-eastern Africa and in central and eastern Asia depend on these multi-purpose animals in terms of transportation and milk, wool and meat production. Today's range countries of the Bactrian camel include the semi-deserts of central Asia, whereas the dromedary is distributed over northern and eastern Africa, South-West Asia and Australia (Clutton-Brock 1999).

LIVESTOCK DOMESTICATION INFERRED FROM GENETIC AND ARCHEOZOOLOGICAL STUDIES

Domestication is not an instantaneous event in which a wild animal is suddenly transformed into a domesticated one. Rather it is thought to be a cumulative process marked by changes on both sides of a mutualistic relationship. Thus human development has been shaped by domestication over hundreds of years. To trace this complex and multi-faceted process it is necessary for geneticists and archeologists to combine collaborative efforts, as improved phylogenetic analysis complements archeozoological documentation (Vigne et al. 2005).

As summarized in table 1, most livestock domestication events occurred at the transition from the Pleistocene to the Holocene and during the Early Holocene in five principal areas: in the South American Andean region (lamas, alpacas), the north-east African region (donkey, taurine cattle), the Near East (taurine cattle, sheep, goat, pig, dromedary), South-East Asia (zebu cattle, pig, chicken) and Central Asia (yak, reindeer, horse, Bactrian camel) (rev. in Bruford et al. 2003).

Origin and Domestication of livestock species

Domestic species	Wild ancestor	MtDNA lineages	Domestication events	Years ago	Location
Cattle	Aurochs 3 subspecies (extinct)				
<i>Bos taurus taurus</i>	<i>Bos primigenius primigenios</i>	4	1	~9,500	Near East (Euphrates Basin)
	<i>B. p. opisthomus</i>	2	1	~9,500	Northeast Africa
<i>Bos taurus indicus</i>	<i>B. p. namadicus</i>	2	1	~8,000	North Indian subcontinent
Yak	Wild Yak				
<i>Poephagus grunniens</i>	<i>Poephagus mutus</i>	3 (4)	1	~4,500	Qinghai-Tibetan Plateau
Goat	Bezoar				Near East (Euphrates Basin), Zagros
<i>Capra hircus</i>	<i>Capra aegragus</i> (3 subspecies)	5 (6)	2	~10,500	North Indian subcontinent

Domestic species	Wild ancestor	MtDNA lineages	Domestication events	Years ago	Location
Sheep	Mouflon				
<i>Ovis aries</i>	<i>Ovis orientalis</i>	4	2	~10,500	Near East (Euphrates Basin)
Pig	Wild boar				
<i>Sus domesticus</i>	<i>Sus scrofa</i> (16 subspecies)	6	5 – 6	~10,000	Europe, Near East, China, Indian subcontinent
Chicken	Red junglefowl				
<i>Gallus domesticus</i>	<i>Gallus gallus</i> (5 subspecies)	6	3	~7,500	China, Southeast Asia
Horse	Wild horse, unknown (extinct)				
<i>Equus caballus</i>	<i>Equus ferus</i>	17	multiple	~6,500	Eurasian steppe, Iberian Peninsula
Donkey	African wild ass				
<i>Equus asinus</i>	<i>E. africanus africanus</i> (nearly extinct)	1	1	~6,000	Northeast Africa or Southwest Asia
	<i>E. a. somaliensis</i> (nearly extinct)	1	1		
Llama	Guanaco (2 subspecies)				
<i>Lama glama</i>	<i>Lama guanicoe guanicoe</i>	ND	1?	~6,500	Andes
	<i>L. g. casciliensis</i>				
Alpaca	Vicugna (2 subspecies)				
<i>Vicugna pacos</i>	<i>Vicugna vicugna vicugna</i>	ND	1?	~6,500	Andes
	<i>V. v. mensalis</i>				
Bactrian camel	Wild two-humped camel, unknown (extinct)				
<i>Camelus bactrianus</i>	<i>Camelus ferus</i>	ND	1?	~5,000	Central Asia (Mongolia, China, Kazakhstan?)
Dromedary	Wild one-humped camel (extinct)				
<i>Camelus dromedarius</i>	<i>Camelus sp.</i>	ND	1?	~3,000	Arabian Peninsula

ND (not defined), BP (before present); adapted and updated from Bruford et al. (2003), Hanotte and Jianlin (2005)

Table 1: Overview of the domestic species, their wild ancestors, how often (domestication events), when (time) and where (location) domestication might have taken place.

In the following I will give some examples, mainly concentrating on domestic animals that have been used for transport and human survival in extreme environments.

The history of *horse* (*Equus caballus*) domestication is still a matter of debate, with two species having been regarded as putative progenitors, namely the Tarpan (*E. ferus*) and the Przewalski horse (*E. przewalskii*). Only the latter has survived until today and has been successfully reintroduced in the Mongolian steppe (Kaczensky et al. 2004). Although very closely related to the domestic horse, the Przewalski horse can now be excluded as the direct ancestor of the domestic form (Lau et al. 2009, Olsen et al. 2006, Wallner et al. 2003). Archeozoological and genetic evidence points to a panmictic Late Pleistocene/Early Holocene horse population ranging from Alaska and the Pyrenees to the Eurasian steppe (Cieslak et al. 2010), with possible domestication centers in the Eurasian steppe (Olsen et al. 2006) and the Iberian Peninsula (Uerpmann 1990).

In contrast, the domestication of the *donkey* (*Equus asinus*) seems to have followed a simpler process. Mitochondrial studies point to the Somalian wild ass (*E. a. somalensis*; close to extinction) and the Nubian wild ass (*E. a. africanus*; close to extinction or extinct; IUCN 2006) as the subspecies of origins and ruled out the Asiatic wild ass as a possible progenitor for the domestic species (Beja-Pereira et al. 2004). Although *E. asinus* fossil records from north-eastern Africa and south-western Asia suggest that domestication took place approximately 6,000 years ago (Clutton-Brock 1999) recent morphological findings from Egypt emphasize a long-term evolutionary change in the process of domestication (Rossel et al. 2008).

For the domestic yak (*Poephagus grunniens*), endemic to Central Asia, three maternal lineages have been described, suggesting a single domestication event in the Tibetan Plateau (Lai et al. 2007). Its ancestor, the wild yak (*P. mutus*), still ranges on the Qinghai – Tibetan Plateau. Similar to the yak the domestication of the reindeer (*Rangifer tarandus*) has allowed human pastoral communities to occupy habitats which otherwise would have been largely unsuitable for human existence. Genetically very little is known about reindeer domestication, but the oldest definitive archeological evidence comes from the Altai (Siberia) and dates about 2,500 years ago (Skjenneberg 1984).

The wild origin of the South American *camelidae* was unraveled with the guanaco (*Lama guanicoe*) and the vicuna (*Vicugna vicugna*) as the ancestral species of the domestic llama (*L. glama*) and alpaca (*V. pacos*) respectively (Kadwell et al. 2001). Archeozoological work points out the Andes around Lake Titicaca as the region of llama domestication some 6,000–7,000 years ago, while the alpaca appears to have been independently domesticated in the Peruvian Andes at the same time. Today large-scale introgression between the two domestic species has been revealed (Wheeler et al. 2006).

The earliest evidence for the presence of the Bactrian camel (*Camelus bactrianus*) has been found in eastern Iran approximately 5,000 years ago, but most likely the domesticated form was introduced in this region (Peters/von den Driesch, 1997). The Arabian Peninsula is proposed as the region of origin of the dromedary camel (*Camelus dromedarius*) with 3,000–4,000 years ago as the period of domestication (Uerpmann/Uerpmann 2002, Peters 1998).

The wild camel (*Camelus ferus*), which has been considered as the ancestor of both domesticated camel forms, can now be excluded as direct predecessor of the domestic Bactrian camel (see graph 3 in the result section).⁶

HABITAT AND CONSERVATION OF THE WILD TWO-HUMPED CAMEL (*CAMELUS FERUS*)

Once extensively distributed throughout Central Asia the range of the wild camel has become severely reduced to only four locations worldwide: three in China (Gashun Gobi and Arjin Mountains in the Lop Nur desert and Taklamakan desert) and one in Mongolia (Great Gobi desert).⁷ The Great Gobi Strictly Protected Area “A” (GGSPAA) is located in the south-western part of Mongolia bordering with the People’s Republic of China. The extremely harsh environment has given rise to a unique ecosystem with particularly well-adapted species, some of which are found nowhere else in the world, namely the Gobi bear (*Ursus arctos gobiensis*), the snow leopard (*Uncia uncia*) the argali (*Ovis ammon*) and the Asiatic wild ass (*Equus hemionus*). The wild camel population is listed as endangered by the IUCN as the estimates for the remaining animals are 400 to 600 in China (Luzhang et al. 2005, Hare 1997) and 500 to 600 in the GGSPAA (Walzer et al. 2006, Reading et al. 2001). The general belief is that the population is

⁶ For a detailed discussion on ancient Bactrian camel DNA analysis see the article by Alexandra Trinks in this volume.

⁷ For a detailed discussion on the habitat and distribution of wild camels in Mongolia and China see the articles by Adiya Yadamsuren et al. and Yuan Lei et al. in this volume.

stagnating or declining due to low recruitment of calves caused by wolf predation, habitat deterioration, illegal hunting and illegal mining (Hare 1997).⁸

The genetic status of *Camelus ferus* was heavily debated, since morphological similarities with its domestic counterpart (*Camelus bactrianus*) led to the assumption that wild camels were merely descendents of domestic animals that had returned to the wild (Peters/von den Driesch 1997 and ref. therein). However, genetic (Silberman et al. 2010a, Ji et al. 2009, Jianlin et al. 1999) and morphologic differences between wild and domestic camels in body size, hair color and skull structure strongly suggested that the two-humped camel discovered by Przewalski should be considered as an original wild form (see picture 2).

A major threat to the wild camel is the *hybridization* with the domestic camel (Enkhbileg et al. 2006, Walzer et al. 2006, Luzhang et al. 2005). The wild camel population of about 1000 individuals in China and Mongolia is directly confronted at the human-livestock-wildlife interface with their domesticated relatives. The extent of hybridization within the Mongolian wild camel population is currently being investigated using nuclear microsatellite markers developed for this purpose (Silberman et al. 2010b).⁹

METHODS: MOLECULAR MARKERS IN DOMESTICATION STUDIES

Molecular markers are specific gene sequences that are used to identify different regions in the DNA. Choosing the right molecular marker to understand the origins of domestication is critical. The analysis of information based on a multitude of highly polymorphic molecular markers is essential to draw reliable conclusions about closely related individuals or populations (rev. in Schlötterer 2004). The most commonly used polymorphic markers in domestication studies so far are single nucleotide polymorphisms (SNPs) in the *mitochondrial DNA* (mtDNA) reflecting the maternal inheritance, in *autosomes* (parental), and in *Y-chromosomes* corresponding to the paternal lineages (rev. in Zeder et al. 2006). MtDNA sequence analysis of *ancient DNA* (aDNA) has proved to be crucial in resolving domestication processes (e.g. Cieslak et al. 2010, Fernandez et al. 2006). Another class of molecular markers used in domestication studies are microsatellites, short repetitive motives (e.g. ACACAC) in the *nuclear DNA* following the co-dominant inheritance. Autosomal microsatellite loci are important tools to measure population diversity (Silberman et al. 2010b), genetic variation and genetic admixture among livestock breeds or between wild and domestic animal species (rev. in Bruford et al. 2003). New SNP markers for domestication studies are being developed as complete genome data from next-generation sequencing is becoming available (e.g. Al-Swailem et al. 2010).

GENOTYPING AND POPULATION GENETIC ANALYSIS

As nuclear sequence and/or SNP data have not been available for Old World camels until recently (Al-Swailem et al. 2010), in this project we used 804 bp (Bactrian camel) and 867 bp (dromedary) of mtDNA covering parts of cytochrome b and the control region and 20 autosomal microsatellites (KS1-11, VOLP08, VOLP10, VOLP32, VOLP59, YWLL29, YWLL36, YWLL38, LCA65, CVRL07, Silberman et al. 2010b, Mariasegaram et al. 2002). The genotyping and data analysis was performed as described before (Silberman et al. 2010a, Silberman 2009). In brief, median-joining haplotype networks were constructed with Network 4.5 software (Bandelt et al. 1999) and individuals were assigned to distinct clusters using a Bayesian approach in the Bayesian Analysis of Population Structure software BAPS 5.2 (Corander/Tang 2007, Corander/Marttinen 2006). Phylip 3.69 software was used to generate a neighbor-joining

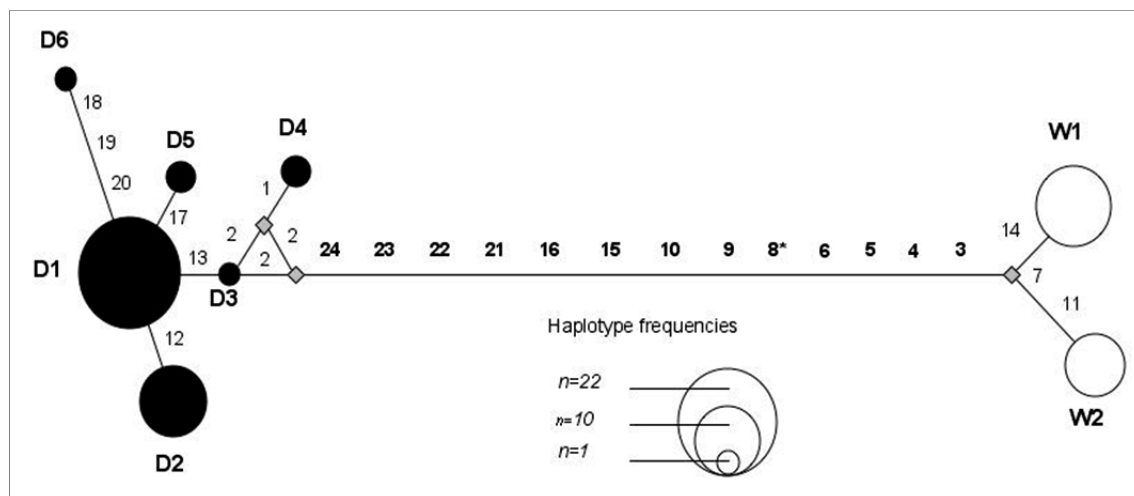
⁸ For a more detailed discussion on the census size of wild camels in Mongolia and China see the articles by Adiya Yadamsuren et al. and Yuan Lei et al.

⁹ For a more detailed discussion about the hybridization between wild and domestic Bactrian camels see the article by Katja Silberman in this volume.

tree based on the proportion of shared alleles (Felsenstein 1989) and genetic diversity parameters were calculated with Arlequin 3.11 (Excoffier et al. 2005).

GENETIC RELATIONSHIP OF WILD AND DOMESTIC BACTRIAN CAMELS

In 2003 the International Commission of Nomenclature (ICZN) fixed the first available specific name based on a wild population “*Camelus ferus*” for the wild two-humped camel (Gentry et al. 2004). Genetic analysis of the mitochondrial DNA clearly separated the wild camel from the domestic Bactrian camel, with high levels of sequence divergence ranging from 1.9% (Silbermayr et al. 2010a) to 2.4% (Ji et al. 2009). This is comparable to the divergence seen in other extant wild and domestic camelids (e.g., 1.7%; *L. guanicoe*, gi:38602627; *L. glama*, gi:219524215). The separation between the wild and domestic Bactrian camel was estimated at 0.7 myr in the Pleistocene (Ji et al. 2009), long before domestication took place (4,000–5,000 yr). Consequently, we can exclude that the extant wild camel population in Mongolia is the direct ancestor of current domestic Bactrian camels.



Graph 3: The mitochondrial haplotype¹⁰ network shows the genetic differentiation between domestic Bactrian (left) and wild camels (right). The nucleotides differentiating the two species are highlighted in bold. The circle sizes of the haplotype nodes are proportional to the number of individuals belonging to the specific haplotypes. The nucleotide difference that is discriminated in the PCR-RFLP assay as described in Katja Silbermayr’s article is marked with an asterisk.

In addition to the mitochondrial marker, which gives information about the maternal lineage, we also investigated 20 autosomal microsatellite loci (Silbermayr 2009, Silbermayr et al. 2010b). We found slightly higher amounts of average expected heterozygosity in the domestic ($H_E = 0.467$) than in the wild camel ($H_E = 0.343$) population. A significant degree of differentiation ($F_{ST} = 0.336$; $p = 0.0001$) between the wild and domestic camel populations was detected over all loci. In a neighbor-joining tree analysis based on the proportion of shared alleles between individuals (D_{PS}) all wild camels clustered in a distinct clade (71% bootstrap support; 100 iterations) and separate from their domestic relatives (Silbermayr 2009; see graph 14 in the article of Katja Silbermayr in this volume). This furthermore confirms the genetic status of the wild camel as an evolutionary significant unit, *Camelus ferus*.

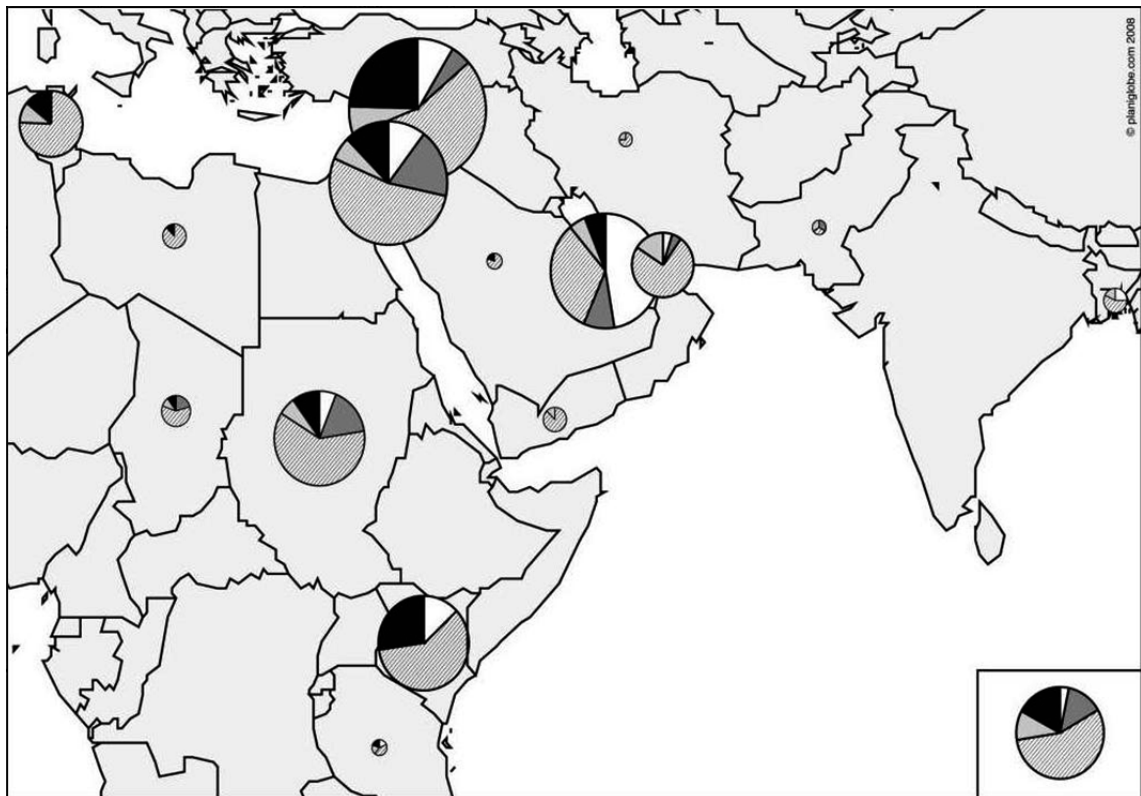
Although we can clearly differentiate between the wild and domestic Bactrian camel, the place of the domestication of the Bactrian camel remains elusive. The phylogeographic analysis of domestic Bactrian camels from Mongolia, Russia, Kazakhstan and China revealed that mitochondrial haplotypes are shared between animals originating from different countries (see graph

¹⁰ The mitochondrial DNA is solely maternally inherited, thus we also refer to a mitochondrial genotype as a haplotype.

4; Burger et al. unpublished data). This is also reflected in the fact that the paleogenetic analysis of 12 Bactrian camel bones from Late Bronze and Early Iron Age sites in Uzbekistan and Siberia resulted in the same mitochondrial haplotypes as described in modern domestic Bactrian camels. The high level of homogeneity between Bronze/Iron Age samples from Uzbekistan and Siberia and modern domesticated camels from China and Mongolia leads to the assumption of a single domestication centre rather than multiple one (Trinks et al. 2010). The study also showed that the current Mongolian wild camels are neither the descendants of Late Bronze and Early Iron Age nor the ancestors of modern domestic Bactrian camels (Trinks et al. 2010). This means that though they share a common ancestor, the Late Bronze and early Iron Age camels are genetically more closely related to modern domestic camels than they are to modern wild camels.

MITOCHONDRIAL EVIDENCE FOR PANMIXIA IN THE GLOBAL DROMEDARY POPULATION

The dromedary is one of the most important domesticated species in North Africa and South-West Asia and has been utilized for centuries particularly for transportation and for milk, wool and meat production. The intensive trading and movement of camels around North Africa and the Arabian Peninsula is reflected in the mitochondrial (maternal) genetic profile of the global camel population: in our study we found a *panmictic* (globally unstructured) dromedary population ranging from North and East Africa to Pakistan and Australia (Charruau et al. 2010). The 310 camels originating from 16 different countries were assigned to five distinct clusters with a high posterior probability (BAPS; PP=0.999). However, these clusters were evenly distributed over the global range of the dromedaries as presented in Figure 4.



Graph 4: Worldwide distribution of the mitochondrial haplogroups in the global dromedary population. The circle size is proportional to the number of individuals, the pies are colored/structured according to their assignment to distinct haplogroups. We see that the same mitochondrial haplogroups are represented throughout the dromedaries' worldwide distribution (panmixia).

It is interesting to note that the current Australian camels display the same haplotype diversity as seen in the global dromedary population (see graph 4). Australia is not a native habitat of

the dromedary, but today it has the biggest feral camel population, with more than one million individuals. In the 70 years after 1837, when the first animals were imported from Pakistan, Afghanistan (Stevens 1989) and the Canary Islands (Phillipson 1899, cited in Schulz 2010), approximately 20,000 camels were introduced to the continent, and later (after the development of vehicles) randomly released to the wild (McKnight 1969). The high mitochondrial diversity found in the Australian camel population reflects the diversity in camels worldwide and thus leads to the assumption that this level of genetic variation already existed two centuries ago and is probably even more ancient. However, this needs to be investigated using early-domesticated and pre-domesticated dromedary samples.

CONCLUSIONS

One of the missing links in the history of our livestock species is the understanding of Old World camelids' domestication. Contrary to previous assumptions of a single origin of the Old World camelids, there is genetic and archeozoological evidence for the separate origins of dromedaries and Bactrian camels. Due to the absence of phylogeographic structure in the global modern camel populations the localization of domestication in Old World camels remains a challenge. However, combined modern and ancient DNA analyses have led us to the conclusion that there was a single domestication event in Bactrian camels and that the wild camels in Mongolia and China are not the direct ancestors of their domestic counterparts. In dromedaries, modern mitochondrial DNA analysis points to maybe two domestication scenarios. However, due to the lack of ancient DNA analysis of pre- and early-domesticated camel remains, we cannot draw firm conclusions about the possible domestication centers. The effective conservation of the remaining wild camel populations as well as their domestic relatives will help to conserve the future biodiversity of the most important livestock species in (semi-) arid regions worldwide. Our special attention should be given to the world's last wild camels in China and Mongolia.

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The Encounter between Bactrian and Dromedary Camels in Central Asia

The two large domestic camelids, the one-humped dromedary (*Camelus dromedarius*) and the double-humped Bactrian camel (*Camelus bactrianus*), live in two distinct areas of the Old World. Their distribution areas overlap in a few countries such as Iran, India and Afghanistan, but the practice of hybridization is the most common in Kazakhstan. Indeed, despite being classified as two different species, the dromedary and Bactrian are interfecund.

Historically, the hybridization between the two species was associated with the Silk Road, and was aimed at producing animals combining the robustness of the Bactrian and the endurance of the dromedary, as well as an animal that was adapted to sharply contrasting climate. Nowadays, the objective is the improvement of milk production, the dromedary having a higher potential than Bactrian, but being less adapted to cold winters.

There are different forms of hybridizing, depending on the number of the hump of the genitor. Globally, in Kazakhstan, two patterns are distinguished: the *Kurt-nar* way (dromedary female x Bactrian male) and the *Kez-nar* (Bactrian female x dromedary male). Then two types of cross-breeding are carried out: by absorption or alternated. The hybridizing has important consequences on the behavior and physiology of the animals.

KAZAKHSTAN, A STEPPE COUNTRY

History and geography have meant that livestock has a central place in the culture and economy of Kazakhstan, even if the industrial developments related to the political changes of the 20th century reduced its relative importance. With a territory of 2.7 m sq. km, Kazakhstan ranks as the ninth largest country in the world. Located in the heart of Central Asia and mainly composed of steppes (80%), with only 16.7 m inhabitants it has a very low population density and a large area of agricultural activity, with livestock mainly reared extensively. If cows are reared in the most favorable areas, sheep, horses and camels occupy the most remote places. Indeed, the country is marked by its wide open spaces, mainly semi-arid, where camels are the best animal to exploit them.

The particularity of camel in Kazakhstan is that the Bactrian and the dromedary cohabit in the same areas, even sometimes on the same farm. Elsewhere, there is widespread hybridization between these two species. This practice has been common for very long time in the history of the central steppe, probably beginning under the Parthians about 2200 BCE (Bulliet 1975). This paper focuses on current hybridization practices in Kazakhstan.

THE PLACE OF THE CAMEL IN CURRENT KAZAKH SOCIETY

Camel stocks are marginal compared to the total livestock population in Kazakhstan (table 2) and represent only 3.4% of the domestic herbivorous biomass (DHB) at national level. But it has a dominant presence in steppe area and it contributes to the exploitation of the most remote areas of the country.

There was a dramatic fall in the camel population, as there was for all other livestock, after the collectivization of agriculture. Moreover, according to the Stalinist ideology, the traditional nomadic way of life was not compatible with the modernization of the rural economy in social-

ist society, leading the camel farmers to be settled. These events occurred in the years 1927–1932 and led not only to the death of the third of Kazakh population and to the total destruction of the former spatial organization, but also to the dramatic fall in the livestock population, especially among animals used by the nomads, i.e., sheep, horses and both kinds of camel, leading to a famine that intensified the effect of the collectivization by killing 1.3 million people mainly in the steppe areas (Ohayon 2006).

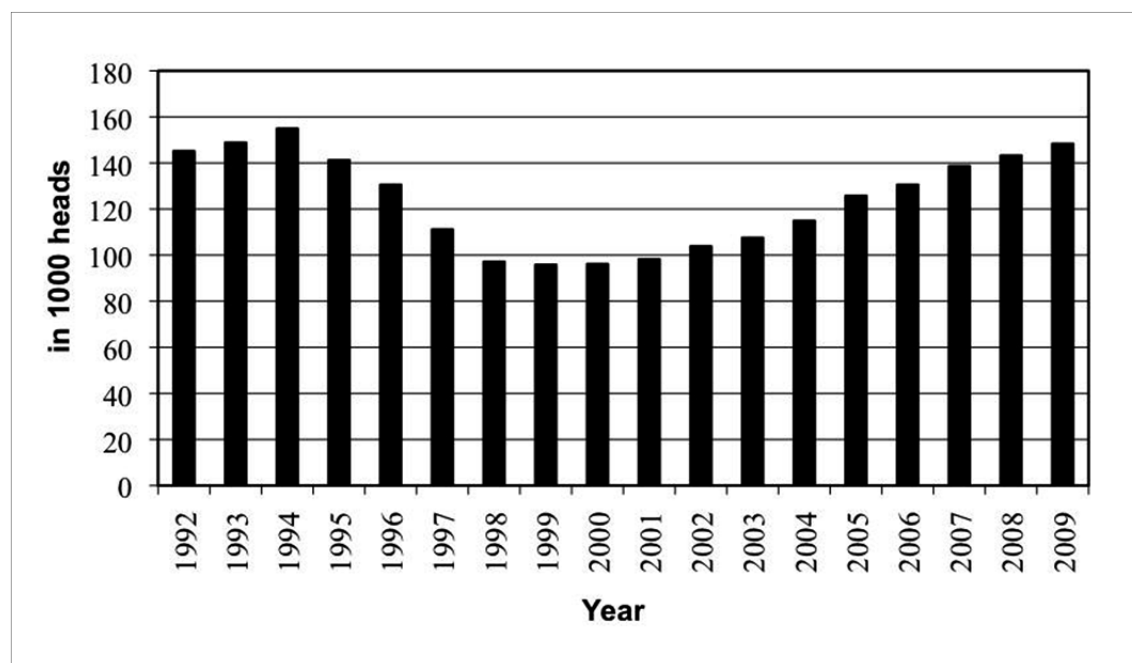
Live animals	Herbivorous Stock
Sheep	13,300,000
Cattle	5,840,000
Goat	2,600,000
Horse	1,300,000
Camel	145,000

Table 2: Livestock population in Kazakhstan for the year 2008 (source, FAOstat)

In these conditions, the sheep population fell from 18 m to 12 m and the horse from 3.5 m to 0.8 m. The camel population, for its part decreased 10 times, from 1.2 m in 1927 at the beginning of the “modernization” to less than 120,000 in 1940. This drastic change in the camel population was accompanied by an end to mobility, the camel being considered as an animal of the past, unlike the cow, which was seen as the animal of the modern farms.

However, at the same time, science-based agronomic research started in various institutes and universities, in order to promote the scientific development of agriculture and livestock.

After the crisis linked to collectivization, the camel population remained stable for the rest of the Soviet period. However, in recent decades, after a new fall linked to the privatization of collective agriculture, the camel population is now in a growth pattern (see graph 5) and the current population has regained the level it was at just after independence. The Bactrian camel makes up approximately 90% of the total camel population, but the dromedary population is increasing in the southern part of the country.



Graph 5: Trends in the camel population in Kazakhstan since 1992 (source FAOstat)

ECOTYPES OF CAMELS IN KAZAKHSTAN

Since the 19th century the Kazakh Bactrian breed has been distinguished by traditional local selection aiming to choose the more “enveloped” animals (taller and with higher wool productivity for a better resistance to the cold) for reproduction. In this population, three Bactrian phenotypes are described according to their size, their stoutness and their productivity: *Oralbokeilik*, *Kyzylorda*, *Ongtüstik-Kazakhstan*. In addition, the dromedary was imported over a longer period to produce various hybrids.

ORALBOKEILIK – THE TALLEST BACTRIAN CAMEL

This type is mainly concentrated in steppe zone in western Kazakhstan and in sandy regions in *Atyrau oblys* (an administrative region in Kazakhstan). Its population, 34.7 thousand head, is increasing. Selection to define the standard type and establish pedigree is carried out on special “pure breed” farms, which receive specific subsidies from the Ministry of Agriculture. The numbers on these farms can represent up to 8% of the total camel population of the *oblys*. This type is the tallest of the Kazakh breeds (2 m high and weighing up to 900 kg) with a coat of long, yellow-brown hair and a characteristic mane, beard and “hairy short trousers”. The aim of the selection is the improvement of wool and milk production (see picture 3).

KYZYLORDA – A MEAT-PRODUCING CAMEL

Mainly found in the *Kyzylorda oblys* and around Aqtobé city, the Kyzylorda camel population increased from 29,900 to 41,400 between 1998 and 2006. Approximately 9% are considered pure breed and selected in specific farms. They are compact, stocky animals, 185 cm high (female) to 190 cm (male) and not exceeding 750 kg. The hair coat is darker than the previous breed, but with similar distribution on the body. The main purpose of selection is for meat production (see picture 4).

ONGTÜSTIK-KAZAKHSTAN – THE BEST MILK PRODUCER

Well distributed in Almaty, Jambyl and south Kazakhstan, this type has experienced an important demographic increase since 1998 (from 40% to 70% according to the *oblys*). The pure breed represents 5% of the whole camel population. The animals are stockier than the previous one: 170–184 cm in height and 600–700 kg in weight. The coat is yellowish or light brown with shorter fibers. The selection aims to improve growth and the wool production (see picture 5).

DROMEDARY

The only dromedary breed in Kazakhstan is the *Arvana*, a Turkmenistan originate. They are numerous in the southern part of the country where they can be considered the most northern distribution of the dromedary in the world. Their numbers are increasing. The *Arvana* dromedary has a unique, long hump rather toward the back. They are big animals (185–195 cm in height, 600–650 kg in weight) sometimes with exceptional weights of more than a ton in the male (Cherzekov/Saparov 2005). They have high milk productivity and are used for hybridizing in order to improve milk production of the Bactrian breed (see picture 6).

HYBRIDS

Hybridization has long been common in the Kazakh steppe. Bactrian and dromedary camel often cohabit within the same farm (see picture 7) and there are a wide number of types of crossing (Bactrian male or female x dromedary female or male) (see table 3). These hybridizations produce a high heterosis effect for milk, meat and wool production (see picture 8). For example, the live weight of the female Iner-Maya (F1) is 128% higher than the dromedary dam, and the

wool productivity increased 192% compared to the pure dromedary breed. The milk production is 69% higher than the Bactrian and even slightly higher (2%) than the dromedary. In a within-farm comparison, a difference in the milk composition has also been observed, the hybrids being intermediate: Bactrian milk had higher concentration in vitamin C and minerals, a higher fat content but lower long-chain fatty acids (Faye et al. 2008, Konuspayeva et al. 2008).¹

After crossing the pure parental species to breed the first generation (the so called F1-generation), there are two ways of hybridization:

- Alternate crossing pathway to maximize the heterosis and increase milk production (dromedary effect), fatty matter (Bactrian effect), wool productivity (Bactrian effect) and cold (Bactrian effect) or heat (dromedary effect) resistance.
- Absorption crossing pathway for easier animal management, the hybrids, especially F2-generation Jarbai type being very difficult to rear (animals with a bad character, weak progeny or poor conformity). Absorption crossing leads to pure-breed animals after three generations (see table 3).

Type of hybrid	Kazakh name of ♂ product	Kazakh name of ♀ product	Generation rank
♀ Bactrian x ♂ dromedary	Nar	Nar-maya	F1
♂ Bactrian x ♀ dromedary	Iner	Iner-maya	F1
Nar x Nar-maya	Jarbaï	Jarbaï	F2 50/50
Nar or Nar-Maya x Bactrian	Bal-Kospak	Bal-Kospak	F2 75B/25D
Bal-Kospak x Bactrian	Myrza-Kospak	Myrza-Kospak	F3 87.5B/12.5D
Myrza-Kospak x Bactrian	Bactrian	Bactrian	F4 93.7B/6.3D
Nar or Nar-Maya x Dromedary	Jun	Jun	F2 75D/25B
Jun x dromedary	Kurt	Kurt	F3 87.5D/12.5B
Kurt x dromedary	Dromedary	Dromedary	F4 93.7D/6.3B
♀ Bal-Kospak x ♂ Dromedary	Kez-Nar	Kez-Nar	F3 50/50
♀ Kurt x ♂ Bactrian	Kurt-nar	Kurt-Nar	F3 50/50

Table 3: Main hybridization scheme achieved between Bactrian and dromedary camel in Kazakhstan

THE USE OF CAMELS IN KAZAKHSTAN AND THE PLACE OF HYBRIDS

By order of economic importance, camel products in Kazakhstan are milk, meat and wool. The camel is rarely used for riding and its role as a draught animal in agriculture is completely marginal.

THE VALUE OF CAMEL MILK

In Kazakhstan, where animals live in vast empty spaces, the possibilities of keeping products fresh are rare, so farmers have traditionally marketed fermented products. Fermented camel milk is called *shubat*, *kurt* is a dehydrated product close to camel cheese, and there is a caramelized dessert known as *balkaimak*. These products, and especially *shubat*, are typical of the country and can be considered as “territory products”, indicating a cultural identity stemming from

¹ For the discussion on the flip-side of the coin of hybridization, namely the threat to wild camel populations, see the article by Katja Silberman in this volume.

ancestral techniques and forming an important part of the tradition. This rooting in the traditional culture could be a strong commercial argument.

For the moment, most *shubat* production is small-scale, but the industrial sector for fermented camel milk is increasing in spite of the lack of standardization in production and processing conditions (Faye and Konuspayeva, 2008).

Camel milk is appreciated for its medicinal properties: anti-carcinogenic (Magjeed 2005), hypo-allergic (Shabo et al. 2005) and anti-diabetic (Agrawal 2003). A high level of unsaturated fatty acids contributes to its overall dietary quality (Karray et al. 2005, Konuspayeva et al. 2008) and more generally it is used as an energy drink for convalescents. Its anti-bacterial effects are commonly used in treating infectious diseases such as tuberculosis and the *shubat* cure has long been recommended in sanatoria (Sharmanov/Servetnik-Chalaya 1983). Patients showed a significant improvement and a restoration of blood parameters with two liters of *shubat* per day for two to four months. Similar results were reported in Libya with 1.5 l/day (Alwan/Tarhuni 2000) and in India with 1 l/day (Mal et al. 2000).

The milk for Kazakh consumers comes both from Bactrian and dromedary camels. As mentioned above, on average, dromedaries produce far more milk than Bactrians. To give just a few references (Faye 2004), the production potential for Bactrians was between 650 and 2000 liters per 12-months lactation while the dromedary Arvana breed could produce up to 6000 liters over the same period (Cherzegov/Saparov 2005). Consequently, the main reason for hybridization today is the improvement of milk production. The discriminant parameters in milk composition of Bactrians, dromedaries and hybrids are vitamin C, total protein, pH, phosphorus, calcium, iodine index and fat matter. In hybrids, vitamin C concentration is close to that in Bactrian milk, for fat matter it is close to dromedaries (Faye et al. 2008). Both the productivity as well as the quality assessed by fat content can vary according to the form of hybridization (table 4).

Type of animal	Scheme of hybridation	Live weight (kg)	12-mth milk production (L)	Fat matter of milk (%)	Wool productivity (kg)
Bactrian		610	1750	5.8	6.0
Nar-maya	♀ Bactrian x ♂ dromedary	670	2955	4.6	4.9
Iner-maya	♂ Bactrian x ♀ dromedary	605	3563	3.5	3.5
Kospak	Nar-Maya x Bactrian	643	1925	4.6	5.2
Kurt	Iner-Maya x Dromedary	535	2544	4.1	3.2
Kez-Nar	Kospak x Dromedary	650	3875	4.6	5.0
Kurt-Nar	Kurt x Bactrian	640	4565	4.5	3.7
Dromedary		557	4000	3.5	3.1

Table 4: Dairy production, fat matter and wool productivity of Bactrian, dromedary and their hybrids according to the type of hybridization (Terentjev 1975)

The quantity and quality of the milk is influenced by the breed of the mother (Terentjev 1975). If the mother is Bactrian, the milk production of F1 is lower but fat content significantly higher than hybrid F1 with dromedary mother (table 4).

CAMEL MEAT AND WOOL

Meat and wool can be considered as by-products of the milk production. The live weight of the Bactrian is on average higher than the dromedary and the hybrids can be heavier than their parents, depending on the breed of the father (table 4). Camel meat consumption is not very popular except in rural areas. Since the camel meat sector is not well organized and the main purpose of camel farming is milk, the meat market mostly uses old culled females, i.e. low quality meat that does not appeal to urban consumers. To our knowledge, unlike for milk there is no data on the difference in camel meat quality between the Bactrian and the dromedary.

The wool productivity of the Bactrian camel, an animal well adapted to the cold, is considerably higher than the dromedary. As with meat, despite the relatively good wool quality of Bactrian fur, the camel wool sector in Kazakhstan is not well organized and the commercial exploitation of this product is low compared to countries such as Mongolia, where cashmere camel wool is well developed (breed selection, modern wool-processing technology).

CONCLUSIONS

Kazakhstan is one of the main places in the Old World where the geographical distribution of the two camel species overlaps. The country was also important milestone on the Silk Road where the caravans from China using Bactrians met those from Persia using dromedaries. This meeting facilitated the hybridization practices. At that time, the hybridization was mainly used to produce stronger pack animals (Wilson 1984). In modern Kazakhstan, the demand for milk is increasing and the hybrids could again play a certain role in supplying higher milk quantity with better quality in the cold desert of Central Asia.

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Embryonic Hump Development and Ancestry in Old World Camels

Since the 1960s it has been postulated that the Arabian and the Bactrian camel originated from a single wild ancestor, *Camelus ferus*. One key argument in this respect was provided by the anatomical study by the Italian researcher Lombardini, who in the annals of the University of Tuscany in 1879 described a second hump-like structure in fetal and juvenile dromedaries. Although frequently cited in literature, Lombardini's results have never been verified. This article is intended to contribute to the discussion of Old World camels' ancestry. It is based on a study in which 33 fetuses of Arabian camels, one of a Bactrian camel and two of *Camelus dromedarius* x *Camelus bactrianus* hybrids were analyzed. No hump-like structure as such was detected in any of the dromedary fetuses with a crown-rump length below 22 cm, whereas in older fetuses only a single hump structure was observed, extending at its base from the 10th thoracic (T10) to the 5th lumbar (L5) vertebra (Kinne et al. 2010). In the Bactrian camel fetus, a two-humped stage was clearly discernable (T2–T6; T11–L5), whereas the fetuses from dromedary x Bactrian camel hybrids exhibited the largest humps (T8–L6). Based on this study and the results of recently published archeozoological and genetic analyses, the issue of a single wild ancestor for the two domestic Old World camels can finally be put *ad acta*.

ONE ANCESTOR FOR TWO DOMESTIC FORMS?

Old World camels have two domestic forms, the two-humped Bactrian camel (*Camelus bactrianus* Linnaeus, 1758) and the one-humped dromedary or Arabian camel (*Camelus dromedarius* Linnaeus, 1758). However, only a single wild camel survives to-date, namely the two-humped wild camel *Camelus ferus* (Przewalski, 1883). Once widespread throughout Central Asia, wild camels are now confined to restricted areas in south-western Mongolia and north-western China (e.g., Clutton-Brock 1987:126). The possibility that these 20th-century populations are descended from domestic Bactrian camels that have returned to the wild has repeatedly been discussed in literature (e.g., Zeuner 1967:289, Clutton-Brock 1987:126, Herre/Röhrs 1990:53). However, this now seems rather unlikely considering the genetic distance between the wild camel population actually living in the Great Gobi Strictly Protected Area A and the extant Central Asian two-humped breeds (Silbermayr et al. 2010).

Since there were no historic records of a wild population of one-humped camels living in South-West Asia, zoologists postulated a common ancestry for the Arabian and the Bactrian camels (Herre/Röhrs 1973:35, Ahne et al. 2000). Based on this assumption, Köhler (1981:128) hypothesized that the two domestic forms originated from different subspecies of *Camelus ferus*. However, apart from the absence of a wild one-humped ancestor, some other lines of evidence lend support to the assumption of a single wild ancestor for the two domestic forms.

Firstly, cross-breeding dromedaries and Bactrian camels produced fertile hybrids (e.g., Kolpakow 1935), implying – in a biological sense – that one-humped and two-humped camels constitute a reproductive community and hence a single species. This offspring, called the *Tulu*, is characterized by a single large, slightly indented hump and exhibits hybrid vigor; it is a bigger and stronger animal than either of the parental stock and is said to withstand cold conditions better than the dromedary. It was noted, however, that continued breeding rapidly resulted in loss of fertility (Kolpakow 1935). Interestingly, already in Parthian times there is evidence that

these hybrid camels were highly esteemed as pack animals (Bulliet 1975:143, 168), and their breeding seems to have been practiced on a large scale, supplying animals for the long-distance caravan trade, e.g., for the Silk Road. *Tulus* were still in demand in Iran and Asia Minor in modern times,¹ which is why Bactrian sires were introduced in western Asia as late as the 19th century (Leese 1927:133). Secondly, the osteological distinction between the Arabian and the Bactrian camel was considered problematic (e.g., Duerst 1908, Zeuner 1967:208), underscoring the close genetic relationship between the two forms. Thirdly, and the likely most persuasive argument in favor of the hypothesis of a single wild ancestor for the two domestic Old World camels, was the late 19th century anatomical study by Lombardini (1879), who described a reduced second hump-like structure in fetal and adult dromedaries. According to him, this structure would best be visible in animals with short hair and in poor condition. From his observations he concluded that one-humped animals also went through a two-humped embryonic stage, whereas later in life only the caudal hump would develop fully. He therefore considered the dromedary to be a modified breed of Bactrian camel.

Opponents of the common ancestry hypothesis, such as Lesbre (1903:135–137) and Cauvet (1925:25), based their argumentation on the differences in outer appearance, ecophysiological adaptations, zoogeographic range and gross anatomy of the two domestic forms. Comparative osteological studies by Wapnish (1984), Olson (1988) and especially Steiger (1991) lend support to their view, whereas Peters (1997, 1998) noted that *Camelus thomasi* (Pomel, 1893), an extinct camelid inhabiting northern Africa and the Levant during the Late Pleistocene, showed a close osteomorphological resemblance to modern dromedaries. Thus, although a wild relative of the domestic Arabian camel had been identified for the first time, evidence for the species' survival in post-Pleistocene times was missing, although this could be a matter of the poor archeozoological record.

To sum up, the strongest argument in support of a common ancestry of the two domestic forms at the end of the 20th century remained the study of the embryonic hump development by Lombardini, whose results had never been verified in the 130 years since their publication. In order to test his results and the conclusions based on them, a series of unborn and newborn camels was collected for anatomical study at the Central Veterinary Research Laboratory in Dubai.

MATERIAL AND METHODS

In total, 33 fetuses of Arabian camels, one of a Bactrian camel and two of *C. dromedarius* x *C. bactrianus* hybrids (*tulus*), were analyzed (see table 5). We also investigated old hump morphology and anatomy in a two-month calf. Since 1999 research has been performed on materials obtained as freshly as possible from the slaughterhouse or in the frame of necropsy work at the Central Veterinary Research Laboratory in Dubai. From these individuals, we documented either the crown-rump length (CRL) or the weight, enabling us to estimate individual ages, following Hussein et al. (1991). Also the length, height and the exact position of the hump to the spine were measured and documented in longitudinal sections, enabling us to compare the position of the cranial and caudal hump in the Bactrian and the single large hump in *Tulus* with the position and development of the hump in dromedaries.

In addition, histology of the rump was performed in some of the smaller fetuses using standardized procedures.²

¹ For a more detailed discussion of dromedary x Bactrian camel hybrids see the article by Bernard Faye and Gaukhar Konuspayeva in this volume.

² These embryos were fixed in Klotz' solution (900 ml water, 50 g sodium chloride, 90 g sodium hydrogen carbonate, 110 g sodium sulfate, 100 g chloral hydrate, 100 ml formalin), dehydrated in ethanol and embedded in paraplast®. Serial section of 4–5 µm were made with the Microm HM360 microtome and stained HE or GRA (a trichrome method according to Knospe/Mitterer 2010, with gallocyanine (G) for dark blue nuclei, chromotrop 2R

Collection Number	Crown-rump Length	Weight Sex	Age (days) notes	Hump Length	Hump Height	Hump Position
<i>Camelus dromedarius</i>						
Wani1s	3.5 cm	-	-	-	-	-
Wani1	4.2 cm	-	52	-	-	-
Wani2	6.0 cm	-	62	-	-	-
Wani3	6.3 cm	-	62	-	-	-
Wani2s	6.4 cm	-	-	-	-	-
Wani3s	6.7 cm	-	-	-	-	-
Fet7cm	7 cm	-	-	-	-	-
Fet7cmB	7 cm	-	-	-	-	-
Wani4s	7.5 cm	-	-	-	-	-
Wani5s	7.9 cm	-	-	-	-	-
Fet8cm	8 cm	-	-	-	-	-
Fet8cmB	8 cm	-	-	-	-	-
Fet9cm	9 cm	20 g/M	-	-	-	-
Fet9cmB	9 cm	-	-	-	-	-
Wani4	9.7cm	-	72	-	-	-
05-168B	11.5 cm	36 g	-	-	-	-
Fet12cm	12 cm	40 g/M	-	-	-	-
DUBCA	13 cm	-/M	-	-	-	-
05-168A	13 cm	44 g	-	-	-	-
Fet15cm	15 cm	90 g/F	-	-	-	-
Fet17cm	17 cm	120 g/M	-	-	-	-
Fet18cm	18 cm	120 g/F	-	-	-	-
Fet19cm	19 cm	130 g/M	-	-	-	-
05-847	20 cm	150 g	-	-	-	-
Fet22cm	22 cm	250 g/M	-	28 mm	5 mm	T11-L2
05-825	25 cm	300 g	-	35 mm	7 mm	T11-L2
05-s228	33 cm	-	-	50 mm	10 mm	T10-L5
07-2391f	58 cm	6,400 g	-	120 mm	30 mm	-
07-2360	70 cm	10,500 g/M	-	190 mm	60 mm	-
07-2391m	70 cm	9,300 g	-	180 mm	30 mm	-

(R) for red cytoplasm and aniline blue (A) for blue connective tissue). The sections were stained in gallocyanin solution (1.5 gallocyanin with 50g potassiumsulfate in 1000 ml distilled water) for 24–48 h, rinsed in distilled water, dehydrated in ethanol and stained for 30 minutes in chromotrop 2R (0,2 g chromotrop 2R in 200 ml ethanol (96%) with 2 drops acetic acid), rinsed in 1% acetic acid, differentiated for 20 seconds in 5% tungstic acid, rinsed in 1% acetic acid and stained for 2 minutes in diluted (1:4) aniline blue solution (0.5 g aniline blue and 8 ml acetic acid in 100 ml distilled water), rinsed in 1% acetic acid, dehydrated in ethanol, xylol and embedded. The slides were analyzed and scanned with the Olympus BX51 Dot slide system with the OlyVia-Program.

Collection Number	Crown-rump Length	Weight Sex	Age (days) notes	Hump Length	Hump Height	Hump Position
07-2222	70 cm	-	-	150 mm	50 mm	-
Main Lab	75 cm	-/F	-	120 mm	17 mm	-
05-1975	85 cm	22,000 g	300	150 mm	20 mm	T10–L5
05-594	120 cm	45,000 g	calf, 2 months	300 mm	35 mm	T10–L6
<i>Camelus bactrianus x Camelus dromedaries</i>						
07-2377	65 cm	9500 g	Tulu	200 mm	70 mm	T8–L6
07-2229	65 cm	6800 g	Tulu	200 mm	80 mm	T8–L6
<i>Camelus bactrianus</i>						
05-1876	70 cm	12,000 g	Caudal Hump Cranial Hump	50 mm 50 mm	15 mm 15 mm	T11–L5 T2–T6

Table 5: Details of the camels analyses in the frame of this study.

RESULTS

A major finding of our work is the fact that no hump-like structure could be detected in any of the dromedary fetuses with a crown-rump length below 22 cm (see picture 9 and 10). In older fetuses (see picture 11), the hump extended at its base from the 10th thoracic to the 5th lumbar vertebra, approximating the position of its homologue in the adult (Peters/von den Driesch 1997). The hump consisted of white fat tissue, which was directly connected to the subcutaneous adipose tissue, but clearly separated from the trunk muscles by the deep fascia of the trunk (see picture 12). At no time did we observe a rudimentary second cranial hump in the dromedary fetuses or calves. This is in clear contrast to the situation in the Bactrian camel, in which a cranial and a caudal hump are expressed from the very beginning in older fetuses (see picture 13). In the Bactrian specimen studied we noted that the cranial hump was situated from the 2nd to the 6th thoracic vertebra and the caudal hump from the 11th thoracic to the 5th lumbar vertebra. The position of the latter is similar to that in the dromedary. Although comparable to its homologue in the dromedary from a histological viewpoint, we noted that in the Tulus the hump was clearly more elongated; it also exhibited a slight indentation in the frontal part of the hump (see picture 14).

DISCUSSION

Our anatomical study does not corroborate the findings by Lombardini, since it clearly shows that in Arabian camels, prenatal development is characterized by the formation of a single hump. Lombardini's findings can possibly be explained as an artifact of fixation due to the poor state of preservation of the adult dromedary at his disposal. As such, Lombardini observed a thin layer of fat tissue in front of the caudal hump, but it is not argued why this tissue should indeed represent the rudimentary cranial hump. Moreover, based on our study material, one of the two fetal dromedaries he analyzed, a specimen measuring 160 mm, must definitely have been too young to show a hump, whereas in his anatomical description of the second specimen, measuring 260 mm, the presence of two humps is not mentioned explicitly. Finally, it is possible that some of the animals studied by Lombardini were hybrids. This is supported by our results (see picture 14) but can no longer be ascertained.

From our work we conclude that the domestic Arabian and Bactrian camel descend from different wild ancestors, as was already postulated in earlier publications (e.g. Peters/von den Driesch 1997 and the additional literature cited there). Recently, large numbers of osseous remains attributable to wild dromedaries have been excavated in archeological contexts in the

eastern Arabian Peninsula dating from the 5th to the 1st millennium BCE (e.g. Uerpmann/Uerpmann 2002, von den Driesch/Obermaier 2007, M. Beech, pers.comm. 2010). This implies that the wild ancestor of the one-humped camel (a descendant of *Camelus thomasi*?) was still present in this part of South-West Asia during late Holocene times. A diachronic comparison of bone size in dromedaries indicates that domestication of the wild one-humped camel likely took place at the end of the 2nd millennium or the beginning of the 1st millennium BCE (Uerpmann/Uerpmann 2002). Recent work dealing with the genetics of modern wild and domestic two-humped and domestic one-humped camels has also confirmed that the wild camel should be excluded as the ancestor of the Arabian camel. Applying the molecular clock,³ the split between the one-humped and the two-humped wild form would represent a much earlier event, estimated to have taken place some five (Stanley et al. 1994) to eight million years ago (Ji et al. 2009).⁴ However, estimates based on molecular clocks must be treated with caution, especially when dealing with domestic animals (Ho/Larson 2006).

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³ The molecular clock hypothesis is based on the assumption that genetic differences between species (or taxa) can be used to estimate their time of divergence.

⁴ For a detailed discussion about the ancestry of Old World camels see the article of Pamela Burger in this volume.

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PART II

WILD CAMELS

(Camelus ferus)

ADIYA YADAMSUREN, ENKHBILEG DULAMTSEREN,
RICHARD P. READING

The Conservation Status and Management of Wild Camels in Mongolia

Critically endangered wild camels (*Camelus ferus*) survive in just four more or less isolated populations in Mongolia and China (Reading et al. 1999). In 1975, Mongolia established the Great Gobi Strictly Protected Area "A" (GGSPAA) to help conserve the unique Gobi ecosystem and its rare flora and fauna, such as the wild camel (*Camelus ferus*) and Gobi bear (*Ursus arc-tos*). Subsequently, China created the Lob Nur Wild Camel Conservation National Natural Reserve in Xinjiang (Uigur Autonomous Region) and the Wild Camel Conservation Natural Reserve in Annanba (Gansu Province).

At present, an unknown number of wild camels inhabit these reserve areas. We have also a poor understanding of the factors limiting wild camel populations, primarily due to the difficulty of studying such wide-ranging animals that inhabit such harsh environments. That said, researchers have hypothesized that several factors may negatively influence wild camels, including poor reproduction, global climate change with increasingly dry and harsh climactic conditions and loss of water sources, predation, inter-breeding with domestic Bactrian camels (*Camelus bactrianus*) and a variety of human impacts. In this article we discuss the current status of wild camels in Mongolia, the various threats to this critically endangered species and aspects of its conservation.¹

THE CURRENT STATUS OF WILD CAMELS IN MONGOLIA

We believe that three main factors influence the demography and distribution of wild camels: water sources, foraging opportunities and lack of human disturbance. However, factors affecting wild camel distribution have not been rigorously studied and most of our observations are biased by the difficulty of accessing much of the range of wild camels.

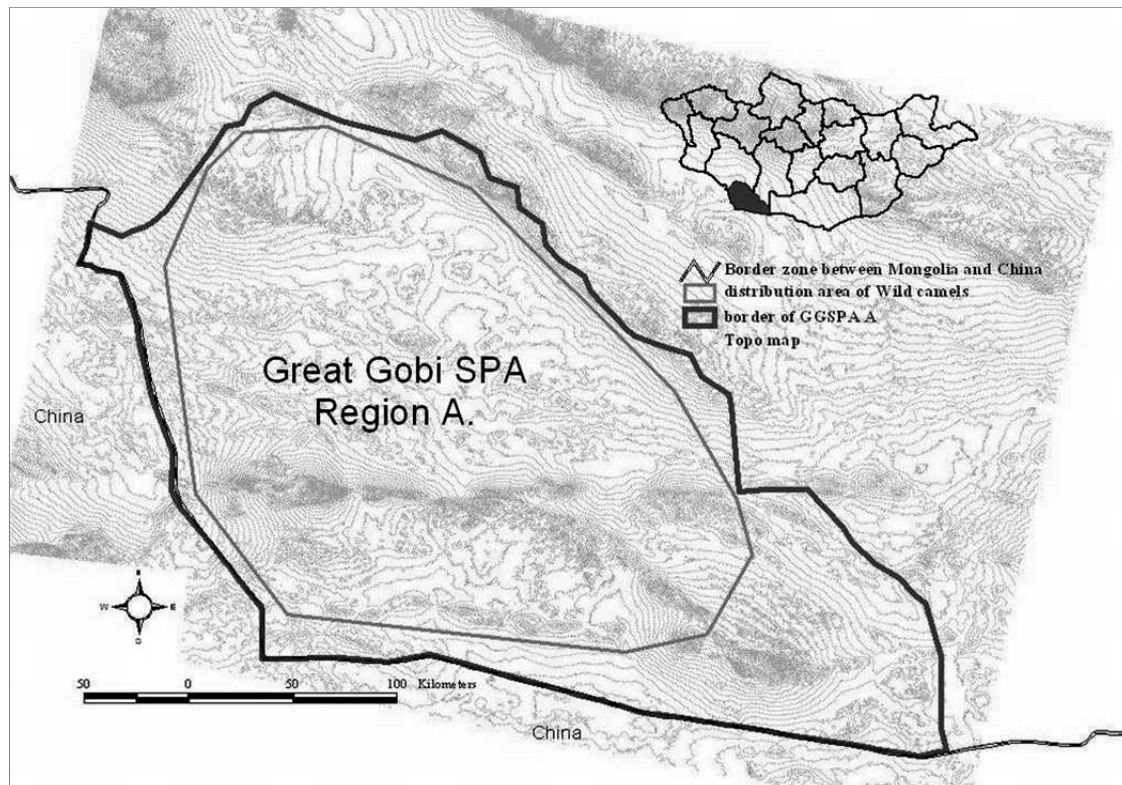
DISTRIBUTION

Given these caveats, we observed that herds congregate in and around massifs, as most springs occur there and snow cover on slopes provides a valuable water source during winter. Camels appear to shift to areas that have received recent rainfall in search of flushes of vegetation. We and others have observed herds of up to 100 individuals near mountainous areas of the Gobi, especially in October and November just prior to the rut (Tulgat/Schaller 1992, Schaller 1998).

Wild camel distribution in Mongolia today covers around 28,000–30,000 sq. km in the GGSPAA, suggesting a reduction in the wild camel habitat of about 70% since the last century. This loss in range suggests a decrease in population numbers of wild camels, although we do

¹ We would like to thank everyone who made our work possible, especially the Zoological Society of London's EDGE program, WCPF UK, Denver Zoo, the Institute of Biology at the Mongolian Academy of Science, the Great Gobi A Strictly Protected Area Park Administration staff, Chicago Zoological Society, Lincoln Children's Zoo, and also all the drivers and assistants who have helped us in the past. Special thanks are due to Mr. Choijin, who helped from our first trips to the Great Gobi "A" SPA to study wild camels and taught Adiya Ya. how to play cards during the long nights. Finally, thanks go to Henry Brown for helping with the translation into English.

not know if the decrease is proportional to habitat loss or if the population has remained stable and wild camels have simply retreated to a smaller range (Tulgat/Schaller 1992, Schaller 1998, Tulgat 2002, Guoying et al. 2002). We mostly observe camels in the southern part of the park (as we refer to the GGSPAA in this article), along the Atas and Ingis mountain ranges and also in the low-lying mountains on the northern edge of the park (see graph 6). Between these two areas, the region is more sparsely vegetated (except when it rains) with fewer water sources. Camels may gather around Atas Mountain to obtain moisture following early snowfalls in October and November. Following harem formation in December and January, males and their harems tend to move toward the center of the park while pregnant females and sub-adults remain near the mountains (Tulgat/Schaller 1992). This distribution has not changed over the past 30 years (Adiya et al. 2006).



Graph 6: Map showing the distribution (inner circle) of the last remaining wild camel population in Mongolia, in the Great Gobi Strictly Protected Area A (GGSPAA).

One way to learn about the distribution of wild camels is to monitor their movements via satellite.² Between 2002 and 2003, Reading et al. (2005) collared a female camel that covered a minimum distance of 4,527 km, moving further during the winter months (November to March) and leaving the park on one occasion for a few days. She used a home range³ of 17,232 sq. km, although her core-use area was much smaller at 8,696 sq. km. She used two main areas: just south of Atas Mountain in the southern part of the park and an elevated area in the northeast of the park. Reading et al. (2005) also collared a bull camel, but – owing to on technical problems – received only 20 locations between 2003 and 2004. That camel travelled at least 683 km. His home range covered 8,191 sq. km and his core-use area covered 7,255 km². Based on these lim-

² GPS satellite collars make it possible to track movement patterns and habitat use and collared camels may be followed over a period of one year. For a more detailed description of the process see the article by Chris Walzer in this volume.

³ The home range is the total area that an individual camel covers during the observed period, while the core area refers to the region where it stays for more than 50% of the time. A range of 17,000 sq. km is remarkable but expected in dry and harsh desert regions. It is also comparable with the home range of the Khulan (Mongolian wild ass; *Equus hemionus hemionus*).

ited data, the authors suggested that an important wild camel habitat might include the areas north and south of the Atas Mountain and the area to the northeast of Khavtsgait (“wild camel”) Mountain next to the Nariin Khokhiin Range (see graph 6). The exact knowledge about the wild camels’ distribution and preferred habitats is essential as a basis for further ecological studies and conservation efforts.

Wild camels have been recorded crossing the border in winter (Guoying et al. 2002) to reach Dacoatan Spring in China’s Gansu Province, which lies 80 km south of the Atas Mountain Range in the GGSPAA in Mongolia and 15 km from the border.⁴ However, Chinese authorities lifted a ban on mining in this area in 1990. Mining poses a considerable threat to the wild camels that use this spring, because miners use potassium cyanide to extract gold, thereby contaminating large grazing areas (Adiya/Dovchindorj 2006).

As mentioned, wild camels survive in only one population in the Mongolian Trans-Altai Gobi desert (GGSPAA) and in three groups in China, namely a small area of the Taklamakan Desert, the Gashun Gobi in the north of Lop Nur and Arjin Mountain (Wilson/Reader 1993, Reading et al. 1999). Although the populations around Lop Nur and Arjin Mountain seem to be connected, from a conservation perspective ideally all separate wild camel populations should be linked to improve genetic exchange and thus the chance to build a stable population. However, the Silk Road and later the Gansu-Xinjiang highway and the Lanzhou-Xinjiang railway have separated the Lop Nur Lake region from the Altai-Gobi Desert. In addition, a green corridor from Weili to Ruqiang, the Tarim River and Lop Nur Lake has separated camel populations in the Taklamakan Desert from populations in the Gashun Gobi Desert and the northern piedmont of Arjin Mountain (Guoying et al. 2002). Accordingly, this highly endangered animal nowadays faces the disadvantage of being dispersed in at least three isolated populations with a still unidentified number of individuals.

HISTORICAL AND CURRENT POPULATION NUMBERS

Historically, wild camels were extensively distributed throughout central Asia. Estimates of wild camel numbers in Mongolia have ranged widely from at least 300 in 1943 to about 500 in 1959-60 (Bannikov 1976, Dash et al. 1977) and up to 2000 in 1999 (Reading et al. 1999).⁵ Unfortunately, all but the last of these surveys were conducted with methods that prevent accurate population estimates. General flaws in most surveys included small survey areas and different routes/methods applied during the trips, as well as gross extrapolations from transects and point counts, which neither accounted for the distance at which animals were sighted nor for the different terrains encountered. (Reading et al. 1999). Yuan Guoying, professor at the Institute of Environmental Protection in Xinjiang, China, suggests that as few as 730 wild camels remain in Mongolia and China; 75% less than 15 years ago (Anonymous 1998). Another estimate puts the world population of wild camels at 880, making it more endangered than the giant panda (*Ailuropoda melanoleuca*) (McWilliam 1997). Hare (2000) believed 350 wild camels remained in the GGSPAA in Mongolia and approximately 650 camels inhabited Xinjiang province, China. Guoyang et al. (2002) estimated about 730–880 wild camels surviving in three main areas in northwestern China and southwestern Mongolia.⁶

⁴ Some researchers believe that when camels occasionally cross the border into China they are killed there for meat (Tulgat/Schaller 1992), although no data exist to support these allegations.

⁵ Results of other surveys in Mongolia were about 900 in 1974, 400–700 individuals in 1976, 500–800 individuals in 1980–82, 500–600 between 1982 and 1988, and 480 in 1989 (Bannikov 1976; Dash et al. 1977; Zhirnov/Ilyinsky 1986).

⁶ Including about 40–60 camels in the eastern Taklamakan Desert, 280–340 in the northern piedmont of the Arjin Mountains and Aqik Valley, 60–80 in the Gashun Desert, and 350–400 in the frontier region of Mongolia (Altai-Gobi desert) and China (Xinjiang, Gansu and Inner Mongolia province) (Guoying et al. 2002). During one survey, Adiya and Dovchindorj (2006) observed only 10 wild camels in the Arjinshan Mountain and Gumuago Desert in China.

Focusing on Mongolia, sporadic surveys and research, especially by the joint Russian-Mongolian Gobi Scientific Expedition in the 1980s, provided most of the historic information on wild camels. Results from these expeditions suggested that camel numbers were declining and camel recruitment was low (a small proportion of young observed) (Reading et al. 1999). Young camels (between six months and one year old) averaged 4.6% during the 1980s surveys, suggesting that recruitment of young individual (i.e., birth rates and/or survival rates) has been poor since 1982 (Tulgat/Schaller 1992).

Population estimates of wild camels continued to vary widely in the 1990s. Surveys conducted from 1990 to 1994 estimated 450 individuals in 1990 and 320–345 individuals in 1993–1994 (Tulgat 2002). In the only systematic survey of wild camels of which we are aware – an aerial survey conducted in March 1997 – a density of 4.98 animals per 100 sq. km or 1,985 camels in total were estimated (Reading et al. 1999).⁷ However, of these more recent surveys only the work by Reading et al. (1999) covered the entire range of the camel, used standardized routes, and accounted for sight-ability, making interpretation of the results of other surveys difficult at best.

In a nutshell, population estimates for wild camels vary widely and were determined using several different methods that unfortunately preclude direct comparisons to assess demographic trends. Few surveys used rigorous methods that permitted determination of confidence limits. Instead, most estimates represent “guesstimates” (educated guesses) based on non-systematic travels through a variable portion of the wild-camel range. As such, it remains very difficult to determine how many wild camels persist, even to the correct order or magnitude (i.e., hundreds or thousands), and whether the population is declining, remaining relatively stable, or increasing. Acquiring exact data, however, is essential for further conservation strategies and should have highest priority of all considered future measures.

DEMOGRAPHY

In addition to the unknown numbers of remaining individuals, demography also remains poorly understood and insufficiently studied. The wild camel’s 14-month gestation period and strong reproductive seasonality limited to the rut season between November and March means that females can give birth to a calf only every other year at most. Yet surveys consistently find much lower productivity. Researchers generally report that calves comprise less than 10% of the wild camel herds, often substantially less, with female-to-calf ratios varying from 1:0.06 to 1:0.18). The ratios for one-, two-, and three-year olds were even lower (Dash et al. 1977, Zhirnov/Ilyinsky 1986, Indra et al. 2002, Adiya 2005, Dovchindorj et al. 2007). Researchers also reported a higher proportion of males in camel populations than females (Adiya 2005, Dovchindorj et al. 2007). The factors preventing higher pregnancy and juvenile survival rates remain poorly studied. In addition to slow reproduction rates there are severe threats to the existing population of wild camels.

THREATS TO WILD CAMELS

Several factors threaten the persistence of wild camels in Mongolia. The most important of these include illegal mining, poaching, loss of water sources, hybridization between wild and domestic Bactrian camels and human disturbance from nomadic pastoralists. We briefly examine each of these threats.

⁷ Magash and Indra (2002) estimated around 400 ± 12 wild camels in GGSPAA between 1998 and 2000. Indra et al. (2002) observed 307 wild camels in 36 groups during surveys in 1999. A 2004 transect survey along roads estimated a wild camel density of 0.17 individual/ 1000 ha, or a population of 470 wild camels (Dovchindorj et al. 2007). The Institute of Biology, Mongolian Academy of Science, estimated 328 ± 66 camels in 2003 and a density of 0.1–0.3 animals/ 1000 ha. Studies conducted in 2004 and 2005 estimated a population of 463 ± 92 camels (Adiya et al. 2006).

ILLEGAL MINING

The rapid increase in illegal mining in Mongolia (Reading et al. 2010) has also begun to impact the GGSPAA. The park administration has reported several instances of illegal gold mining in the GGSPAA since 2008. Miners generally use potassium cyanide⁸ to extract gold, which pollutes areas where wildlife and especially wild camel forage (Hare 1997). Mining also disturbs wild camels, moving them away from vital pastures and water points. In the winter of 2008, we encountered ten illegal mining sites with small-scale mining operations extracting gold within the buffer zone and core area of GGSPAA⁹ (Adiya 2008b). Park rangers indicate that usually two to three cars filled with people enter the protected area to mine for several days. In some cases rangers catch and fine them or chase them out of the protected area. We also discussed illegal extraction of gold with herders and most of them reject this activity because of the damage it inflicts on pasture land. However, some herders stated that if they did not extract the gold themselves, foreign mining companies would come and take it.

POACHING

Hunting for meat formerly represented an important threat to the wild camel population (Zhirnov/Ilyinsky 1986). However, since the creation of the GGSPAA administration, hunting has mostly disappeared (Adiya et al. 2004). Officials reported only three instances of people entering the park to hunt without permits from 1995 to 1999 (Mijidorj 2002b).

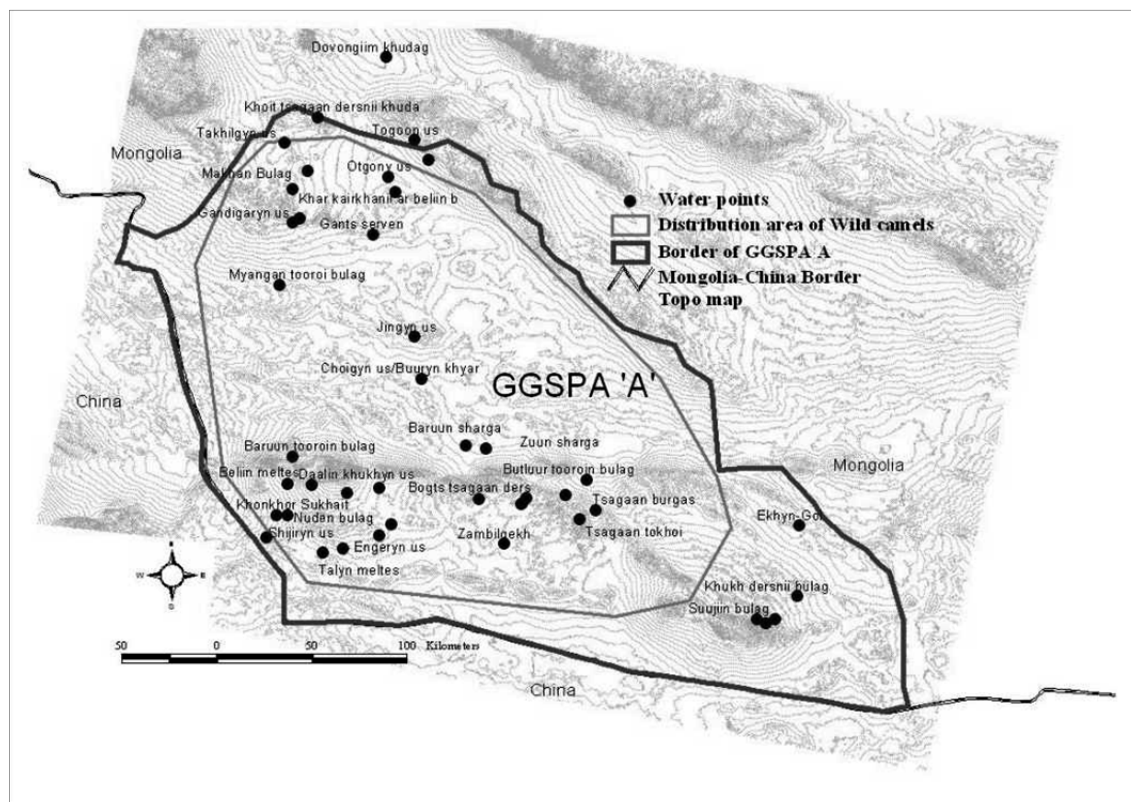
LOSS OF WATER SOURCES

Climate warming and decreased precipitation has decreased the number of springs and oases as water sources available to wild camels, which is increasing pressure on the population in the region. Sixteen springs have dried up in recent years. The decrease in water sources adds extra pressure on the remaining water points (Oyunsuren/Munkhgerel 2007, Sarantuya 2000). Wild camels must now cover greater distances to find water.

During a survey in August 2008, Adiya (2008a) surveyed a total of 35 surface water points (see graph 7). 15 of these water points had dried up and four points did not contain enough water to sampled. Not all of the remaining sources contained water suitable for drinking.

⁸ Potassium cyanide (KCN) is a highly toxic inorganic compound used to extract gold from soil. KCN damages energy production in the cell. It might be of interest that Wikipedia (consulted 8 Sept., 2011) mentions a number of prominent persons were actually killed or committed suicide using KCN, including members the Nazi Party, such as Hermann Göring and Heinrich Himmler, World War II era British agents (using suicide pills), and KCN was a popular method of murder in fiction, especially in the novels of Agatha Christie (remark ed. E.-M. Knoll).

⁹ Like many other national parks, the GGSPAA is organized in a core and a buffer zone. The core area is a strictly protected region where natural development should be uninfluenced by human activities, while in the buffer zones carefully managed activities such as agriculture, pasturing or tourism are allowed and benefit local communities.



Graph 7: Map indicating the water points in the GGSPAA. A total of 15 water points had dried up and four points did not contain enough water for sampling: Mazaalain Shand, Tsagaan Tolgoi Us, Jingiin Us, and Zuun Sharga. Samples from the remaining 16 water points found that only four sources contained water suitable for human and animal consumption: Togoon Us, Shar Hulsanii Bulag, Boodog Saiiriin Us, Maikhan Bulag. Nine sources held water suitable for animals but not humans: Otgonii Us, Shijiriin Us, Taliin Melyes, Bogts Tsagaan Ders, Tsagaan Tohoi, Tsagaan Burgas, Gandigariin Us, Tahilga, Khushuut Dund Us. Three sources provided water not suitable for human or animal consumption: Baruun Tooroi, Belin Beltes, Nuden Bulag. A previous survey by the Geo-ecology Institute at Baruun Shargiin Us, Chigiin Us and Myangan Tooroin springs found water unsuitable for human or animal consumption. During our survey in 2008, these points had already dried out. Most of the wells lie within the habitat of wild camels.

HYBRIDIZATION

Hybridization between domestic and wild camels poses a major threat to wild camels (Hare 2004, Silbermayr et al. 2010). Although genetically distinct (Ji et al. 2009, Silbermayr et al. 2010), domestic and wild camels can produce viable offspring. Tulgat (1992) suggested that herdsmen generally kill hybrid offspring due to the inferior quality of their wool, yet our discussions with local herders found that they intentionally hybridize camels to produce faster racing camels. In the second half of 2006, we recorded 44 hybrids amongst 17 pastoralist families living the buffer zone of GGSPAA: 13 males (castrated bulls), 15 adult females, six young males and ten young females. We believe that many more hybrids exist, as some families hide their hybrids. All bull hybrids we observed were castrated, as herders are convinced that second generation hybrids become weak and ill-tempered. However, hybrid females may give birth to second-generation hybrids, although we found no evidence of this during the survey, i.e. we observed no hybrid females with calves.¹⁰

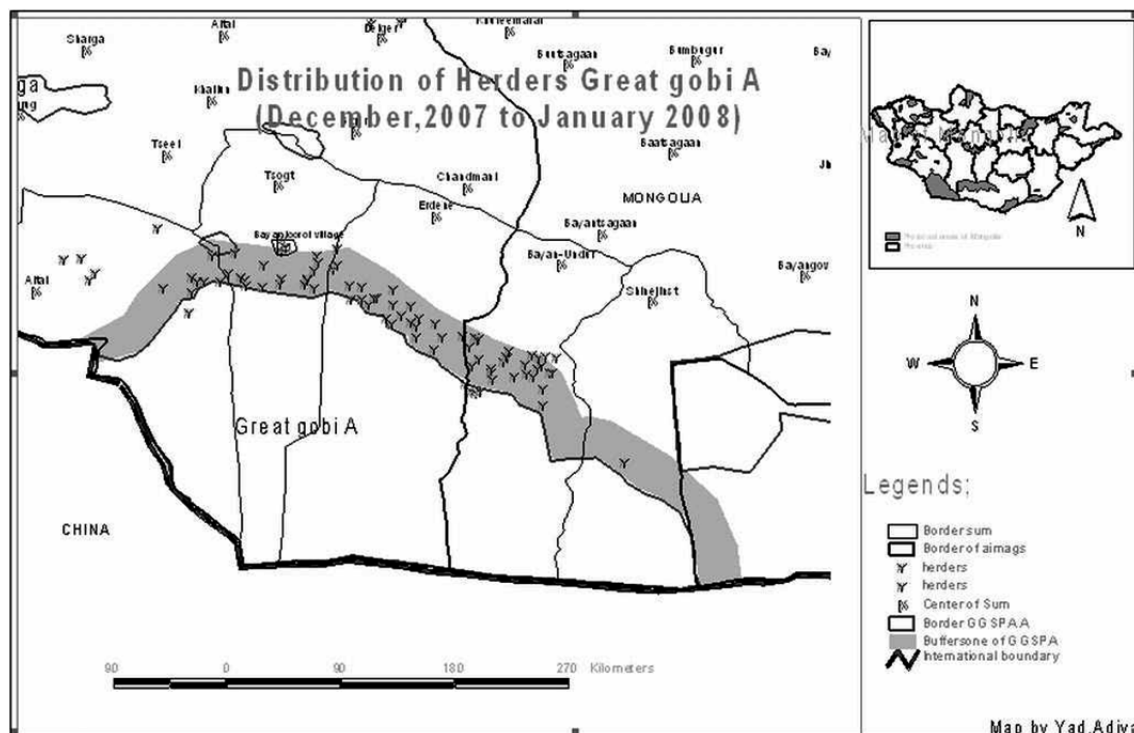
Domestic camels also sometimes join wild camel herds after becoming separated from their own herd. From 1995 to 1999, park rangers removed five domestic camels from wild camel herds to avoid hybridization. At certain times, wild and domestic camels may be attracted to the

¹⁰ For more information how to detect hybrids using genetic tools see the article of Silbermayr and Burger in this volume.

same locations. In August 1998, for example, Mijidorj (2002b) observed 43 wild camels grazing with 23 domestic camels in Tahilga Bulag, probably because the high productivity of the oases at the time attracted both species to the site. Hybrid numbers increased following the bad winter of 2000/2001, when pastoralists led domestic herds further into the park in the search of food. Finally, during the rut, wild camels become extremely aggressive and may collect domestic females without the intervention of the pastoralists who legally reside in the buffer zone of GGSPAA (see graph 8).

HUMAN IMPACTS AND LIVESTOCK

Apart from hybridization, there is human impact on wild camels and their habitat in several other ways: grazing depletes wild-camel forage, the construction of shelters for herders and their livestock disturbs habitat, poaching directly kills and disturbs wild camels, the use of freshwater springs depletes water and disturbs camels trying to access those water points, collecting saxaul and shrubs for fuel depletes forage and disturbs animals, and livestock introduces diseases into wild camel populations. Many of these factors also increase desertification in the region (Saran-tuya 2000). Further impacts include intensive agriculture in wild camel habitats, permanent human settlements near oases, feather-grass harvesting and an increase in motor-vehicle routes passing through the wild camel habitat. Basically, the simple presence of pastoralists keeps wild animals away from valuable pastures and water sources (Adiya et al. 2006). And livestock can transmit diseases as pastoralists release domestic animals such horses, cattle and domestic camels during the warm season for up to five months without active management (Enkhbileg et al. 2007b). All of these factors have led to the reduction in the wild camel's distribution during the 20th century (Tulgat 2002).



Graph 8: Map of herder winter camps in the buffer zone of the GGSPAA

Some areas of GGSPAA have to struggle with these anthropogenic impacts. For example, at the northwest boundary local pastoralists cross the buffer zone and herd their animals inside the park, causing degradation of habitat and dispersal of wildlife from the area (see graph 8). At some water points, as a further example, security posts are positioned to guard the national border with China but at the same time impacts on the habitat and the wildlife that come to drink there (Adiya et al. 2006).

WILD-CAMEL CONSERVATION AND MANAGEMENT

We propose addressing the situation of the critically endangered species *Camelus ferus* with several strategies, but focus on two strategies here: activities to conserve and strengthen the remaining population and captive breeding; while recognizing that other strategies would likely also benefit wild camel conservation. Mongolia has been employing both strategies. Two factors have saved the wild camel from extinction up to now: their extreme shyness and the fact that they inhabit one of the most remote habitats on earth (Tulgat/Schaller 1992). The large habitat requirements of the wild camel make it an ideal umbrella species¹¹ for conserving the habitat of the entire Trans-Altai Gobi (Dulamtseren 2002). The GGSPAA administration provides wild camels with active protection and a management program, but is seriously under-funded and under-staffed. The northern part of the park permits limited human use during drought periods, which enables the herders' livestock to graze around oases. Rangers conduct regular anti-poaching patrols across the northern and central parts of the GGSPAA. The remote southern half of the park contains military posts near the Chinese border, but otherwise few humans venture into this inhospitable place.

In the late 1990s, the Mongolian Academy of Sciences in cooperation with the GGSPAA administration and the Denver Zoological Foundation initiated a conservation project for the wild camels to assess the causes of population decline and develop ways to tackle it (Reading et al. 2005). In May 2007, the Zoological Society of London created two fellowships for a Mongolian and a Chinese scientist to study wild camels in their respective countries under their Evolutionarily Distinct and Globally Endangered (EDGE) program. This program highlights and invests in evolutionarily unique, critically endangered species, and it rated the wild Bactrian camel as the eighth most endangered mammal species in the world. A National Conservation Strategy Workshop for the wild camel in Mongolia took place in August 2010, which brought together representatives from most relevant groups, including officials from local and national governments, science and conservation experts and members of local communities.¹² During this workshop, participants followed the International Union for Conservation of Nature (IUCN) Species Conservation Planning Task Force's recommendations to develop a draft Mongolian National Conservation Strategy for the wild camel and its desert habitat. Participants examined current knowledge of *Camelus ferus*, proximate and ultimate threats to wild camels and specific actions required to reduce and reverse these threats, which the group then prioritized. Hopefully, the conservation strategy will be presented to the Mongolian Ministry of Nature, Environment and Tourism for official endorsement in 2012, so that the participants can begin to implement the planned actions. The plan calls for 1) preserving the genetic integrity of wild camels, 2) improving wild camel habitat (including both pasture and water), 3) increasing the population size and distribution of wild camels, 4) developing national and international awareness of the plight of wild camels, and 5) initiating sustainable conservation management of the species. Since we know so little about the status, biology and ecology of wild camels, more research is desperately needed, in particular, more rigorous and systematic population monitoring.

CAPTIVE BREEDING

Captive breeding began in Mongolia in 1987. Between 1987 and 1991, the GGSPAA administration captured ten male and 12 female wild camel calves and raised them using domestic Bactrian females. Unfortunately, only six males and seven females survived this experiment. The authorities failed, however, to separate the wild from the domestic camels after they had

¹¹ Umbrella species have very large habitat requirements relative to other species in the same habitat. Therefore, by ensuring protection of sufficient habitat for these organisms, other plant and animal species in the same area are usually protected as well.

¹² The Mongolian Academy of Sciences' Institute of Biology, the Wild Camel Protection Foundation Mongolia and the Zoological Society of London organized the workshop with the support of the Mongolian Ministry of Nature, Environment and Tourism.

matured, which led to some hybridization. In addition, aggressive wild males in captivity led to a number of problems, injuring both humans and other camels. The United Nations Development Program (UNDP) Mongolia Biodiversity Project tried to address this problem by establishing a more formal captive breeding program. However, the park authorities demonstrated only minimal interest in the program and possessed few resources, which aggravated the situation (Schaller 1998, Mijidorj 2002a).

In 2000, researchers from the State University of Agriculture in Mongolia tried to establish another captive breeding center. However, difficulties associated with herd management, the distance of the center from the distribution of wild camels, and hybridization problems between domestic bull camels and captive wild female camels led to the end of the program (Enkhbileg et al. 2007a). In 2003, the Mongolian government and the Wild Camel Protection Foundation (WCPF) signed an agreement to start a further captive breeding program near the GGSPAA. In October 2003, 12 wild camels from the former captive breeding program of the park were captured to initiate a new, more actively managed program (Hare 2004). The program hopes to produce enough animals for eventual reintroduction into the wild as a means of expanding the distribution of wild camels, although debate continues over whether wild or captive-born animals should be used if officials deem that reintroduction is desirable.

CONCLUSIONS

Wild Bactrian camels are critically endangered, surviving only in small areas of Mongolia and China. Despite decades of work, we still know very little about these unique animals or the reasons for their decline. Nevertheless, several factors possibly threaten the persistence of wild camels, including illegal mining, poaching, a reduction in the number water sources, hybridization with domestic Bactrian camels, and human disturbance. Recent research and conservation initiatives promise to improve our understanding of the species and the threats facing them, thereby increasing population size and distribution. We recommend undertaking several conservation-management actions, including (i) raising awareness at both the local and national levels about the plight of wild camels; (ii) conducting research and consistent, long-term monitoring of wild camel populations, (iii) establishing a trans-boundary park between China and Mongolia and creating corridors for wild camels to move between isolated habitats within Mongolia; and (iv) improving regulations and law enforcement and addressing socio-economic concerns to mitigate human impact.

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The Status of the Wild Camel in China

In 1874 the famous Russian explorer Nickolai Przewalsky first identified the wild camel (*Camelus ferus*) as being different in many respects to the domestic Bactrian camel (*Camelus bactrianus*). He took the skins and bones of two wild camels back with him to St Petersburg, where his discovery was treated with skepticism by Russian scientists. In recent years it has been proved through genetic testing that the wild camel is not only substantially different from the domestic Bactrian camel, but is indeed a separate species (see Burger this volume). Przewalsky was right.

This paper introduces wild camel distribution in China and factors that threaten them, and it puts forward methods to protect the wild camel in China against these threats.

HISTORY

The wild camel is a remarkable animal. Like all camels it has an outstanding immune system and its milk contains a high percentage of insulin (Wernery et al 2006, Al-Numair et al. 2010).

However, it is in China that its remarkable properties have been shown by its ability to drink salt water, which a domestic Bactrian camel cannot tolerate, and its ability to survive in two of the harshest environments in the world; the Desert of Lop and the Gashun Gobi. These two deserts were for centuries crossed by the Middle Silk Road and caravans of domestic Bactrian camels criss-crossed the roads from east to west and west to east taking with them the riches of China and returning with the wealth of Europe. This gave rise to the suggestion that the wild camel was just a Silk Road runaway – a feral camel.

In more recent years, China conducted atmospheric nuclear tests over parts of the former Middle Silk Road, yet the truly remarkable wild camel appears to have survived these tests without any damage to its reproductive system.

Two hundred years ago the habitat of the wild camel extended into the grassland steppes of Mongolia and the great plains of Kazakhstan. But today, due to pressures mainly from man, the wild camel has retreated into the wildest and harshest environments, which seem unlikely to be able to sustain any life whatsoever, let alone a mammal as large as the wild camel.

It has always been a timid and elusive creature, retreating at the approach of man and fearful of any close contact. The renowned Swedish explorer Sven Hedin (1889) only noted the presence of the wild camel infrequently and his references to it in his numerous books on travels through its Chinese habitat are extremely rare. He did, however, shoot two wild camels, and by taking careful measurements of their skulls he concluded that the shape of the head was different from the domestic camel. This is verified by the Mongolian word for the wild camel, *havtagai*, which translates as “flat head” and acknowledges a difference in skull shape from that of the domestic Bactrian. Another notable difference is the size of the two humps. They are much smaller and, as Hedin correctly observed, more widely spaced. Even in captivity and with access to high quality food, the humps remain small and do not flop to the side as is sometimes the case of the domestic Bactrian camel when the animal has been in a stressful situation or is deprived of adequate grazing (see picture 2 of Pamela Burger’s article in this volume which shows a “flat head” next to its domestic Bactrian relative with the distinguishable features).

THE DISTRIBUTION OF THE WILD CAMEL IN CHINA

Currently, wild camels survive only in four separate areas in the world. Three of these habitats are located in the Xinjiang Uygur Autonomous Region of China: 1) the Gashun Gobi Desert in the northern part of the Lop Nur lake region, 2) the Arjin Mountains south of Lop Nur Lake region, 3) the Taklamakan Desert to the west of the Desert of Lop, including the southern Tarim River basin. The fourth area, in part outside China in Mongolia, is located in the China-Mongolia border region, including the Outer Altai Gobi Desert in the south-western part of Mongolia.¹ The wild camel sometimes migrates across the international border from Mongolia into Gansu Province and Inner Mongolia. For the purposes of this paper, the fourth area is described as the Outer Altai Gobi Desert. All these four wild camel habitats are located in the extremely arid area of Central Asia and are characterized by varied landforms with low hills and sparse vegetation. The soil comprises brown desert soil, grey-brown desert soil and aeolian soil. The actual number of wild camels is a matter of intense debate. Estimated numbers range from less than 730 (Hare 1996) to 890 (Yuan Guoying, Zhang Li, Yuan Lei 1999) in the mid- and late 1990s in China. By 2011 it was fresh estimates suggested that there are approximately 600 wild camels in China and approximately 450 in Mongolia – a world-wide population of roughly 1000. A substantial number of these wild camels live in a Chinese nature reserve.

THE XINJIANG LOP NUR WILD CAMEL NATIONAL NATURE RESERVE

In 2000, the Xinjiang government set up the Arjin – Lop Nur Wild Camel Nature Reserve which gave protection to the prime habitat of the wild camel in the Gashun Gobi and the Arjin Mountain areas – numbers one and two of the last four areas mentioned above where wild camels live today. This largest of the three Chinese reserves comprises 78,000 sq km and was upgraded to national level in 2003 and renamed the Xinjiang Lop Nur Wild Camel National Nature Reserve (LNWCNR).

The LNWCNR is located in the north-west of China in Xingjiang Uygur Autonomous Region. As mentioned, the LNWCNR is the main habitat of the critically endangered wild camel in China and it is one of the driest areas in the world, popularly known as “Lop Nur”. In the centre of this area is a feature which viewed from space looks like a large ear, but is in fact the dried-up lake-bed of Lop Lake. The LNWCNR not only protects the critically endangered wild camel, but also protects one of the driest and most ecologically fragile desert eco-systems in China. The reserve is divided into buffer and core zones depending on (1) the concentration of wild camels and (2) areas which have been identified as prime wild camel habitat where people cannot enter. The latter are classed as core areas. Areas where the wild camel is an infrequent visitor are classified as buffer.

WILD CAMEL RESEARCH

Prior to 2010 the Xinjiang Environmental Protection Bureau, where the LNWCNR Reserve Management Office is situated, organized a number of expeditions into the LNWCNR to survey the wild camel. Eleven field surveys were undertaken and 58 herds with 318 individual camels were observed over this period.

In detail, the camels sighted in the course of these eleven surveys between 2003 and 2009 are: In 2003, a total of five groups and 38 individuals in two areas near the southern boundary of the reserve were sighted. In 2005, five groups and 55 individuals were observed in the Arjin valley, namely Bashkagung, Xiagou valley and Kum Su Spring. In 2006, two groups and six individuals were sighted at Biquan Spring and Pargang Tagh. In 2007, five wild camels were observed south of Lop Nur Lake and one camel in the Arjin Mountains. In 2008, a total of 161

¹ For a discussion of the Mongolian habitat of the wild camel see the article by Yadamsuren, Dulamtseren and Reading in this volume.

wild camels were found in three areas: the north-eastern mountains of the Lop Nur Desert, south of the Aqike valley and north of the Arjin Mountains, with the biggest group totaling 30 wild camels. In 2009, 52 wild camels were observed south of Lop Nur Lake and along an abandoned road in the northern Arjin Mountains.

Based on these eleven surveys, it has been concluded that the population of wild camels is relatively stable, neither increasing nor decreasing to a large degree. Due to the vast size of the reserve and the fact that it is surrounded by a restricted military area to the west, accurate data is extremely difficult to obtain and aerial surveys are not possible. But there has certainly not been a dramatic decrease over the last ten years.

THREATS TO THE SURVIVAL OF WILD CAMELS

Threats to the survival of the wild camel population in the LNWCNR include hunting or poaching, predation, habitat degradation, hybridization and mining.

ILLEGAL HUNTING AND POACHING

Illegal hunting was popular from the 1950s to the 1970s and was mainly conducted by local communities for food and sport. During the 1980s private guns, including those held by herds-men, were confiscated because of internal security problems in China. However, it has been observed that some armed enforcement officers – including policemen – still engage in illegal hunting.

In the northern Arjin Mountains, cases of poached wildlife including wild camels have been reported in recent years. Specific evidence of this has been recorded on the surveys made by LNWCNR staff in 1996, 2005 and 2008. In addition, there is the problem of legal and illegal miners killing wild camels for food when they approach their mining sites. In addition, survey parties have found homemade land mines positioned near wild camel water points to kill the wild camel for food.

WOLF PREDATION

A few wild camels, especially calves up to two years old, have been killed by wolves in the Arjin Mountains. Wolf predation on wildlife is part of a natural ecological balance. As long as the wolf population is not too high, it should not be necessary to control them. In the LNWCNR the habitats of wild camels and wolves overlap only in the northern Arjin Mountains. However, since this is the area with the largest concentration of wild camels, wolf predation could become a more serious problem if wolf numbers dramatically increase. Since the government stopped herds-men carrying firearms in the 1980s, wolf numbers appear to be increasing in the Arjin Mountain area and the situation is being closely monitored by the LNWCNR head office.

DESERTIFICATION AND GRAZING COMPETITION WITH DOMESTIC BACTRIAN CAMELS

LNWCNR's grazing land in general has been reduced dramatically over the last ten years due to loss of vegetation because of increased desertification. For example, there is no vegetation at all near the northern boundary of the LNWCNR. In the northern sector, grazing competition with domestic Bactrian camels is not a great problem because there are hardly any domestic camels in the area. In the southern and south-eastern sectors of the LNWCNR, however, the biggest impact on grazing occurs near the northern escarpment of the Arjin Mountains. Nearly 200 domestic Bactrian camels from Aksai in Gansu Province have been herded deep into valleys of these mountains and have been grazed near the Lapeiquan fresh-water spring, which is in the buffer zone of the LNWCNR.

Grazing of domestic livestock causes degradation of vegetation and results in competition for food. In addition, domestic camel grazing may cause unwanted hybridization between the wild camel and the domestic Bactrian camel, as discussed below.

In the past, an increase in domestic livestock grazing was responsible for a decrease in the population of wild camels in the south-eastern Gashun Gobi and Arjin Mountains. However, due to a rapid degradation of the vegetation caused by overgrazing, the pasture condition in these areas is now too depleted for domestic livestock other than domestic Bactrian camels. Numbers of domestic Bactrian camels were very high in the past, but in recent years they have dropped dramatically as there is little economic value in raising domestic camels today and domestic camel usage has been replaced by motor vehicles. Considering the huge distribution area of the wild camel, grazing activity on a small scale does not present too great a threat. However, with the increasing degradation of the vegetation, the threat in the eastern Arjin Mountain area and the south-eastern Gashun Gobi remains, even though domestic Bactrian camel numbers have fallen.

HYBRIDIZATION

Hybridization of wild camels and domestic Bactrian camels is a threat. If herdsmen release domestic Bactrian camels into the desert to graze without supervision, hybridization and thus a dilution of the wild camels' unique gene pool will occur. Mating only takes place during December, January and February, when the wild bull comes into musth. Another risk is that domestic Bactrian camels can carry infectious diseases, such as Q-fever, into the wild camel herd. If this happens it can be disastrous for wild camel populations, which in some cases have little immunity to domestic camel diseases.

OTHER HUMAN ACTIVITIES

Mining is the biggest legal and illegal human activity in the LNWCNR. Several years ago, approximately 2000 people went into or through the LNWCNR every year. Some of these were legal miners in the buffer zone mining iron-ore. Others were illegal miners in search of gold or using fresh-water springs to extract gold from rock by the highly toxic use of potassium cyanide. On the southern boundary, which is bordered by the Arjin Mountains with numerous valleys and culverts, it is extremely difficult to detect illegal miners if they operate in this rugged and sparsely populated terrain.

However, today, more and more of the mining activities are receiving government permission. South of the Tikar LNWCNR checkpoint in the north-east of the reserve, legal iron-ore mining activities have increased considerably in recent years. The volume of legal motor traffic going into the reserve can build up extremely quickly. In addition, gold mining is developing in the Gashun Gobi, north of the Aqike valley, which is a very important core area for the wild camel habitat. These activities affect wild camels considerably in what Sven Hedin has called "the heartland of the wild camel".

Other activities, such as tourism, do not occur frequently and car rallying, which did occur in the past, has now been stopped. There is some tourism from the western city of Keurla to Lou Lan ancient city, which is located to the west of the LNWCNR near the western boundary of the Gashun Gobi. There is also some tourism in the Gashun Gobi from the city of Dunhuang in the east of the LNWCNR.

REMEDIAL MEASURES FOR WILD CAMEL PROTECTION

Some effective measures have successfully been carried out but further activities are necessary to secure the survival of the last remaining wild camels.

The wild camel is the eighth most critically endangered large mammal in the world according to the Zoological Society of London (ZSL). Many organizations and individuals have given all kinds of help in order to protect the species from extinction. In 1997 John Hare established the Wild Camel Protection Foundation (WCPF), a UK registered charity with the sole aim of protecting the critically endangered wild camel. This has helped the Xinjiang government to

establish the LNWCNR, raised funds for wild camel protection, organized workshops and training programs for Chinese and Mongolian scientists and established a wild camel breeding centre in Mongolia. The Zoological Society of London (ZSL) has also contributed greatly to wild camel protection by awarding fellowships for Chinese and Mongolian scientists and jointly organizing workshops. The Chinese government has established wild camel reserves and given great support both at provincial and national levels. In addition, there are many other institutions and individuals who have given help to protect the wild camel either practically or by making substantial donations to wild camel protection.

Now the most important issue is to strengthen the environmental monitoring in the LNWCNR under the already existing Regulations of the People's Republic of China Nature Reserves Law and the Xinjiang Nature Reserve Management Regulations. Strengthening law enforcement and patrolling inspection in the LNWCNR can only be put into effect by an increase in personnel and finance.

Next it is necessary to strengthen the collaboration between the three different reserves in China, that is, 1) the Xinjiang Lop Nur Wild Camel National Nature Reserve (LNWCNR) with 78,000 sq. km, 2) the Gansu Annanba Wild Camel Nature Reserve with 3,300 sq. km, and 3) the Gansu Dunhuang Xihu Nature Reserve of about 6,600 sq. km.

It is recommended that these three nature reserves, which have contiguous borders, are linked together administratively, so that an exchange of information and the organization of joint operations are conducted to prevent illegal access to all three reserves from the outside. Public education activities to increase community awareness of biodiversity conservation among people of all ages and nationalities would be a further necessity. Finally, it is important to secure the genetic purity of wild camels by tightly controlling domestic Bactrian camels' grazing in areas where the wild camel is given protection.

CONCLUSIONS

At present, the LNWCNR is one of the last major wild camel habitats in the world. The number of wild camels in this and the two other contiguous reserves is estimated at approximately 600, with the possibility, as a 2011 survey has shown, of a further 50 wild camels in the Taklamakan Desert to the north of the end of the Keriya river. If the LNWCNR is not given enhanced protection in its competition with intensified economic development, then more than half of the wild camels in the world will eventually disappear. Despite the negative impacts, the LNWCNR staff is working hard to fulfill their mission to protect wild camels. The strengthening of the management of protected areas, enhanced inter-reserve cooperation and the protection of wild camels as outlined above are therefore top priorities.

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Working in a Freezer: Capturing and Collaring Wild Bactrian Camels

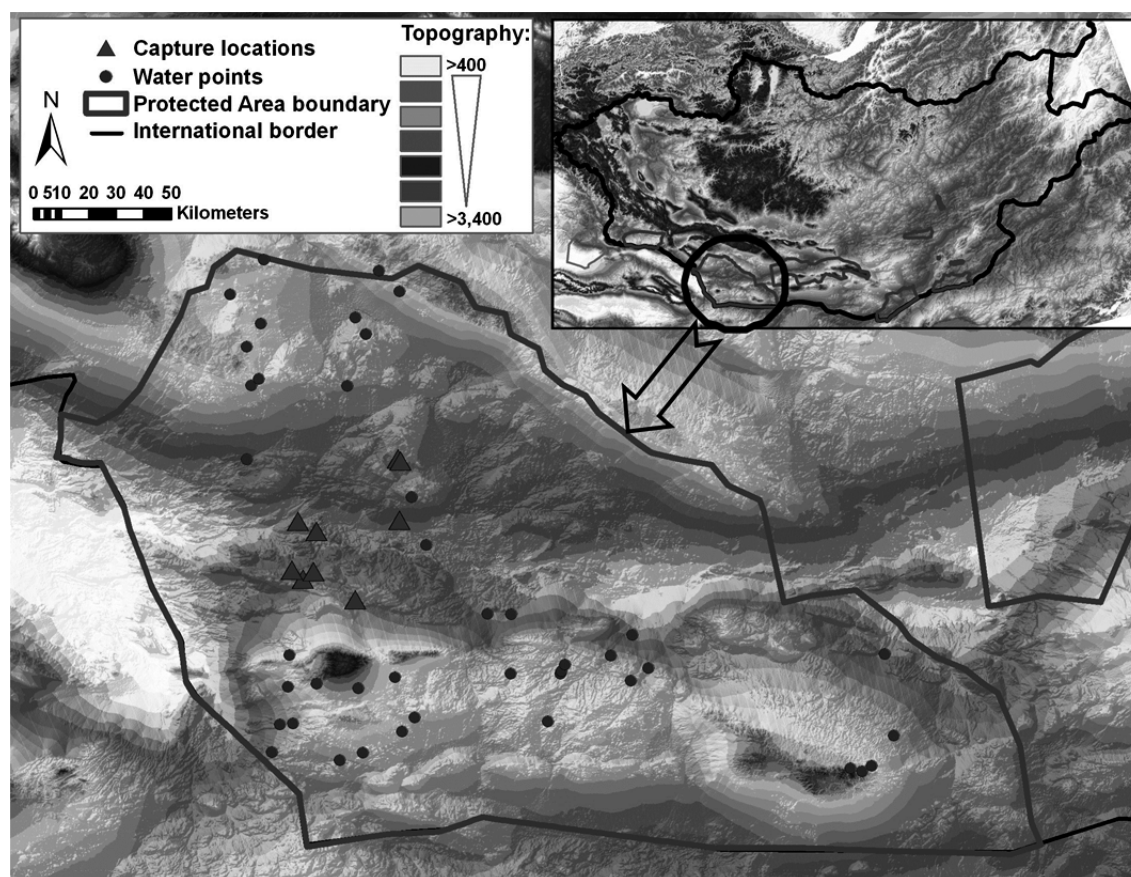
The range of the wild Bactrian camel (*Camelus ferus*) has been reduced to only four locations worldwide. The population is listed as critically endangered. To better understand the movement patterns and habitat needs of wild camels in southern Mongolia several expeditions were undertaken between 2005 and 2007.¹ Using a chase method where camels are darted from a moving jeep, eight camels were chemically captured. In seven of the camels darted, anesthesia and subsequent recovery was smooth and without complication and these animals were outfitted with satellite radio-collars. However, one camel died of undetermined causes during anesthesia. Extremely low ambient temperatures in the winter season and dry, hot and windy summer conditions greatly hampered fieldwork. This article reports on the field trips and the challenging task of providing wild camels with GPS satellite collars.

THE WILD CAMEL IN THE GOBI

The Great Gobi Strictly Protected Area “A” (GGSPAA), located in the south-western part of Mongolia bordering the People’s Republic of China, is one of the world’s great desert ecosystems (see graph 9). The extremely harsh environment has given rise to unique, particularly well-adapted species, many of which are found nowhere else in the world (Zhirnov/Ilyinsky 1986). The large mammal fauna consists of several rare or globally threatened species, namely the wild Bactrian camel (*Camelus ferus*; see picture 15), the Gobi bear (*Ursus arctos gobiensis*), the snow leopard (*Uncia uncia*), the argali wild sheep (*Ovis ammon*) and the Asiatic wild ass (*Equus hemionus*) (Zhirnov/Ilyinsky 1986, Reading 1999, McCarthy 2000). Human pressures for pastures and water on the edges of the GGSPAA and in its buffer zones have substantially increased since the early 1990s and are believed to have led to significant habitat degradation in some areas (UNDP 2004, see also Yadamsuren/Dulamtsuren/Reading in this volume). Additionally, the past two years have seen a marked increase in mining activities and there are concerns about the threat of partial degazetting for mineral extraction.

¹ We are especially grateful for the highly motivated and competent field crew – it was their local knowledge, good organization and humor that made these expeditions a success – I. Khatanbaatar, Y. Nyambayar and B. Tseveenpurev for their never ending support at camp and looking out for khulans (the Mongolian Wild Ass) and camels. Thanks for the careful but spirited driving Davaa-Ochir Avirmed, G. Enkhbold and R. Tumen-Ulzii. Without A. Gerelmaa and her wonderful cooking we would all have starved. We would like to thank UNDP staff, namely Ms. Vatucawaqa and Ms. Batkhishig for project facilitation, Mrs. Narentuya and Mr. Enkhbat for organization and support and the Great Gobi Strictly Protected Area “A” staff in Bayantooroi for their hospitality and motivation.

This contribution is dedicated to the memory of Gobi A ranger Mr. Choijim – a true Gobi man.



Graph 9: Map of Great Gobi Strictly Protected Area “A” (GGSPAA) with water points and wild camel capture sites, one of the world’s great desert ecosystems located in the south-western part of Mongolia bordering the People’s Republic of China.

The “Conservation of the Great Gobi Ecosystem and its Endangered Species” project was initiated in June 2003 by the United Nations Development Program (UNDP)/Global Environment Facility (GEF). It aimed at ensuring the long-term conservation of the Great Gobi ecosystem and its umbrella species by building the capacity of the park management authority, improving participation of local communities in the management of the protected area (GGSPAA) and supporting research and environmental monitoring activities through the development of a model conservation program using the wild Bactrian camel as an “umbrella species” (UNDP 2004). The concept of umbrella species is to use species requirements for baseline conservation planning. Conservation activities directed towards the selected umbrella species are deemed to be beneficial to a multitude of sympatric species, i.e. the animals and plants with which this umbrella species shares a specific habitat. Selecting single species as an umbrella, however, has been shown to have severe limitations as ecological factors not relevant to the (often large) umbrella species severely limit other (often smaller) co-occurring species (Roberge/Angelstam 2004).

The range of the wild Bactrian camel has been reduced to only four locations world-wide: three in China (Lop Nur, the Arshin Mountains and Taklamakan desert) and one in Mongolia (GGSPAA). The population is listed by the International Union for Conservation of Nature (IUCN) as critically endangered and there remains an estimated population of 600 animals in China and between 350 to 1,950 in the GGSPAA. (Hare 1997, Reading et al. 1999, Guoying et al. 2002, Mix et al. 2002, Weidong et al. 2002). The large range in the population estimates is due to the large size, remoteness and harsh climate of the GGSPAA. Past population estimates have often lacked a detailed description of the survey methods and more recent surveys have used different methods or lacked documentation of the search effort (Tulgat/Schaller 1992, Reading et al. 1999, Mix et al. 2002, Dorvchindorj 2005, Reading et al. 2005). These problems

are compounded by the inherent issues in estimating population size in low density, clumped populations without the possibility of aerial surveys (Kaczensky/Kramer-Schadt 2010). Thus there is still significant debate concerning population numbers and trends (Mix et al. 2002). The general belief is that the population is stagnating or declining due to low survival rates of calves, caused by wolf predation, habitat deterioration and illegal hunting (Tulgat/Schaller 1992, Mijiddorj 2002). There are also great knowledge gaps concerning the ecology of the wild camels and data on population dynamics (McCarthy 2000, Magash/Indra 2002), behavior (McCarthy 2000), habitat use (Tulgat 2002), movement patterns (Reading et al. 2005) and veterinary aspects (Blumer et al. 2002). Initial studies concerning the genetic status of the Mongolian wild camel population have revealed high levels of mitochondrial differentiation between wild and present-day domestic Bactrian camels (Silbermayr et al. 2010, Ji et al. 2010). Further genetic evidence² supports the nomenclature of the wild two-humped camels (Gentry et al. 2004) as an original wild form and a separate species *Camel ferus*.

WILDLIFE CAPTURE

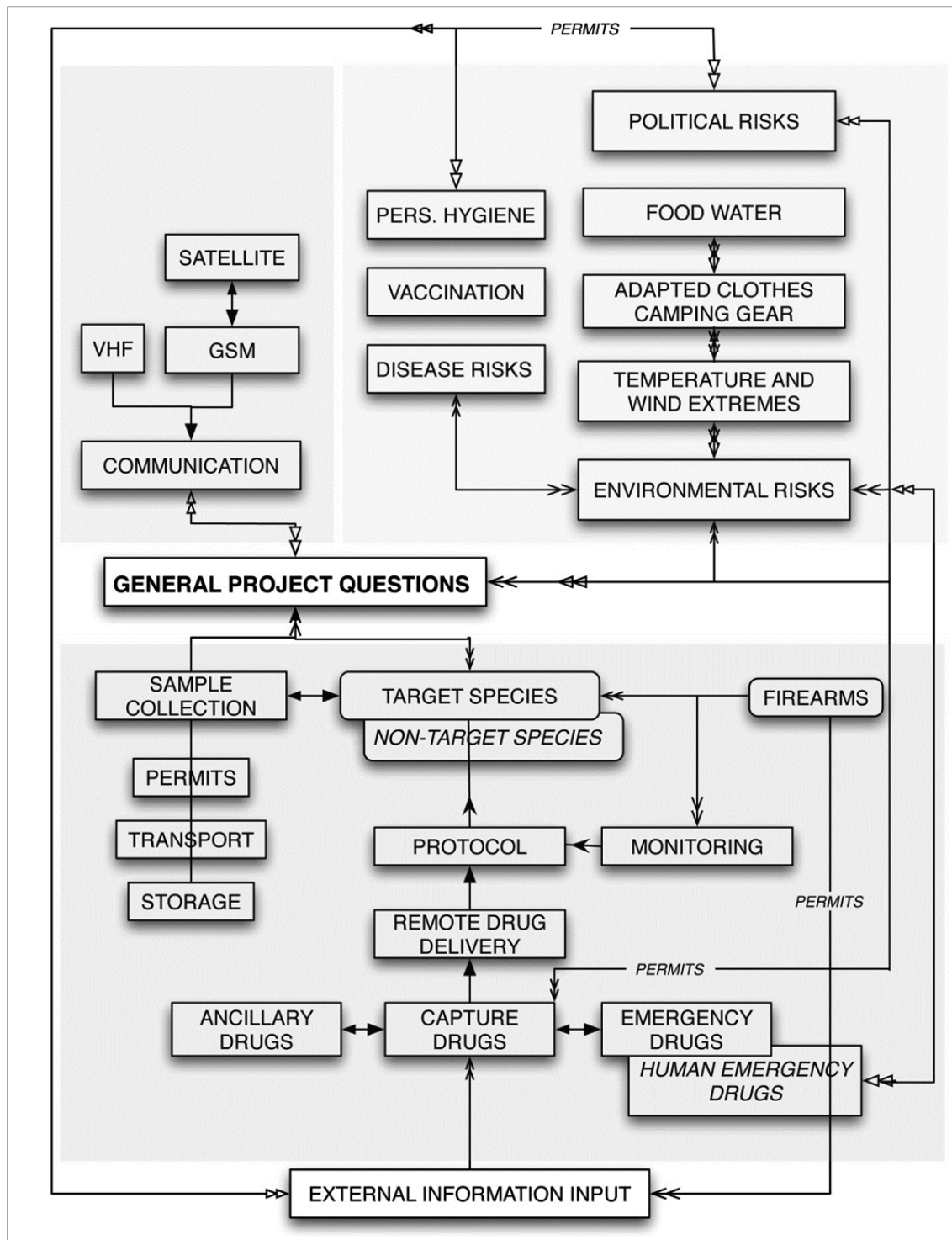
In wildlife research and management to “capture” wildlife is to be understood in the sense of “getting hands on the animal” and subsequently releasing it – not as its “removal”. Prior to any wild animal capture the purpose and circumstances of the procedure must be considered to be both practical and essential (Osofsky/Hirsch 2000), as every anesthetic event entails the intrinsic risk of significant injury and potentially death. Though this risk is for the most part very small, it must be ascertained that the procedure is necessary and that the potential gains outweigh the risks (Kreeger et al. 2002). Capture and general anesthesia can only be as safe as the acquired skills and knowledge of the person performing the procedure allows. These skills in combination with an adequate anesthetic protocol will determine the outcome of the anesthetic event. From the onset, it is important to realize that capture operations, conditioned by the use of potent drugs and severe environmental conditions, are inherently dangerous for the people involved (Caulkett/Shury, 2007, Haymerle et al. 2010).

When planning a wildlife capture event it is vital to attempt to identify the various issues and risks involved with the capture event and the field site. The entire procedure can in this author’s view be broken down into three main components: a) the actual anesthesia and capture event, b) environmental and socio-political issues and c) communication issues. Graph 10 provides a simplified outline of the individual components. This outline can be used to evaluate risk and to generate a project specific checklist. The process of risk evaluation is best viewed as a continuous and on-going adaptive process. Initial risk assessment will possibly need to be adjusted as field data becomes available. A static approach to risk assessment in the field can lead to significant and potentially dangerous misjudgments. On returning from the field trip it has proven useful to re-evaluate the checklists and adapt them accordingly for future use.

CAMELS AND THEIR VETERINARIAN – EACH HAVE THEIR OWN PLANS

In order to capture camels for radio collaring we employed a chase method where the camel is darted from a moving jeep. This method has been successfully used to dart grey wolf (*Canis lupus*), Asiatic wild ass (*Equus hemionus*), Przewalski’s horse (*Equus f. przewalskii*) (Walzer 2003, Walzer/Kaczensky 2004, Walzer et al. 2006, Walzer 2007) and a single wild camel (Blumer et al. 2002). Poachers traditionally employ this method with 12-bore shotguns, predominantly hunting for Asiatic wild ass. For remote dart firing we used a modified high pressure CO₂ dart gun (Daninject JM,TM Dan-Inject ApS, 7080 Børkop, Denmark) with a short, 4-cm barrel, as this greatly facilitates movement within the confines of the jeep.

² For a more detailed discussion about the genetic status of the wild Bactrian camel see the article by Pamela Burger in this volume.



Graph 10: The three main components of a field capture event and their interactions: communication (in the left upper part), environmental and socio-political risks (in the upper right part), and the actual capture/anesthesia (lower part).

During the winter 2005 expedition³ (Walzer/Kaczinsky, 2005; see also Walzer 2008, a popular description of this expedition) we combined drugs to anesthetize one male and two female

³ See also a popular description of this winter expedition (Walzer 2008).

camels.⁴ More specifically, we used a combination of the potent opioid etorphine 4.4 mg (M99, C-Vet Veterinary Products, Leyland, UK); 10 mg of the opioid agonist-antagonist butorphanol (Torbugesic, Fort Dodge Animal Health, Iowa, USA); 13 mg of the alpha-2 agonist detomidine (Domosedan, Orion Corp. FI-02200 Espoo Finland) and 160 mg tiletamine-zolazepam (Tilest 500; Virbac, 06515 Carros, France). Because the ambient temperatures varied between -15 and -30°C during the day, all drug combinations were supplemented with sterile propylene glycol (Sigma-Aldrich GmbH, 1120, Vienna, Austria) as an anti-freeze. Once an animal was identified, it was chased at a speed of 35 to 40 km/h until the jeep was able to approach within approximately 10 to 15 meters on a parallel track (see picture 16 and 17). It was then easily darted in the rump using standard pressure settings. It is essential to define a chase cut-off time before the chase procedure is initiated. Our experience has shown that a chase time of 15 min. is easily tolerated without a significant increase in body temperature. To ensure accuracy and reliability, only new, 3 ml darts (Dan-Inject ApS, 7080 Børkop, Denmark) were used during the captures. Once an animal was darted, we attempted to maintain visual contact, but did not disturb the animal before it was fully immobilized. Once the animal was recumbent, we approached on foot from behind and secured the head. All animals were collared with a GPS-Argos satellite collar (see picture 18). Anesthesia was reversed in all cases with 200 mg of intravenous naltrexone a full opioid antagonist (Trexonil, ZooPharm, Inc., Fort Collins, CO 80524, USA), and 25 mg intravenous atipamezole, an alpha-2 antagonist (Antisedan, Orion Corp., FI-02200 Espoo, Finland). The rapid reversal (60 seconds) of these anesthetic components enabled us to keep the down-time in lateral recumbency to a minimum, which in the face of the exceptionally cold temperatures is extremely important to reduce the risk of hypothermia in the animal.

A short anecdote might illustrate the extreme working conditions for a veterinarian in the Gobi, which are, in fact, the conditions of a freezer (see picture 19): the normally simple procedure of taking a blood sample from the jugular vein is a significant challenge at close to minus 40° C in the environment, as the body-temperature blood instantly freezes rock solid in the large gauge intravenous needle. These working conditions necessitate careful planning and a thoughtful use of available body heat to keep medications and samples in a liquid state.

During the summer 2007 expedition, six camels were captured using the method described above (Kaczensky et al. 2007). In five of six camels darted, anesthesia and subsequent recovery was uneventful. However, the first animal, an old bull of about 15 years, died during the capture.⁵ This bull was easily darted as he ran much more slowly than the other animals in his group. It took 40 min. after darting to locate the bull, which was in acute respiratory distress when approached. Intravenous naltrexone (250 mg) was immediately administered and the animal's respiratory rate and effort improved. However, cardiac arrest occurred after 10 min. and the animal could not be resuscitated. The cause of death remains unknown. Due to the lack of water and approaching sunset we could not perform a complete necropsy. The animal appeared extremely bloated and was noted to have regurgitated. We cannot exclude that it aspirated gastro-intestinal contents, leading to its death. Furthermore, we suspect that this animal possibly had a pre-existing medical condition that was also responsible for its very slow pace.

CONCLUSIONS

Based on previously published reports (Blumer et al. 2002) and subsequent to our experience, we recommend the following combination of drugs for the field anesthesia of adult wild camels: 4.4 mg etorphine, i.m., 10 mg Butorphanol, i.m. and 15 mg detomidine-HCl, i.m. Butorphanol

⁴ Excerpts from this publication have been published previously in various proceedings of the American Association of Zoo Veterinarians (AAZV) and the European Association for Zoo and Wildlife Veterinarians (EAZWV) meetings.

⁵ While Bactrian camels have been reported to reach some 35 to 40 years in captivity, a 15-year-old wild male has to be considered very old.

is a mu-opioid receptor antagonist and through its action potentially alleviates the marked respiratory depression induced by the ethorphine at the mu-receptor and potentates the sedative effect at the kappa and sigma receptors. Induction to sternal recumbency is accelerated by the addition of 160 mg, i.m. of tiletamine-zolazepam. Etorphine was reversed with intravenous naltrexone (200 mg) and atipamezole (25mg). Naltrexone has a longer half-life than the standard antagonist-agonist diprenorphine (Revivon, C-Vet Veterinary Products, Leyland, UK) thus eliminating renarcotization, which could leave recovering camels vulnerable to hypothermia, predation or injury. The depth of anesthesia was in all cases largely sufficient to place GPS-Argos collars on the animals and to collect the necessary biological samples.

Losing an animal during field anesthesia is always a painful experience. With this individual we felt that the long recovery time (and a possible pre-existing medical condition) contributed to the animal's death. Immobilizing an animal that exhibits abnormal behavior should generally be avoided. The difficulty in actually locating an animal in the steppe landscape must not be underestimated and utmost care and concentration is needed not to lose sight of a darted animal. Decreasing the ethorphine by 1mg and omitting the tiletamine-zolazepam results in standing – sternal sedation, which makes it easier to locate the animal in the steppe. However, this reduced dosage leads to a prolonged chasing phase in which the animal can cover a greater distance and potentially injure itself.

In our view, the risk and cost involved in capturing and anesthetizing these animals is outweighed by the need to base future wild camel management plans firmly on sound scientific data. Our preliminary results have shown that the animals range widely throughout the protected area. However, the satellite data is still insufficient to infer clear habitat preferences and subsequent management priorities. For an effective conservation strategy that secures the survival of these unique animals it is essential to have exact knowledge about the habitat requirements. A further collaring expedition is planned in the early fall of 2011, and this should help in providing the additional data. Some management issues are urgent and require immediate action. It is our hope that the management plan for this critically endangered species will remain a working document in order to integrate scientific field-based knowledge as it becomes available.

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KATJA SILBERMAYR, PAMELA BURGER

Hybridization: A Threat to the Genetic Distinctiveness of the Last Wild Old World Camel Species

Natural hybridization has played an important role in the evolution of many animal (Mallet 2005) and plant taxa (Baack/Rieseberg 2007). However, hybridization between wild species and their domestic congeners often threatens the gene pool of the wild species, especially if the species has become rare (Allendorf et al. 2001, Randi 2008). This is the case with the wild camel as we will show in this article.

NATURAL AND ANTHROPOGENIC HYBRIDIZATION

Introgressive hybridization between translocated or invasive organisms and local wild populations adds to a loss of genetic diversity and biodiversity. With the ever increasing encroachment of humans, their livestock and pets on the remaining natural habitats, introgressive hybridization can be observed between wild animals and domestic stock, e.g. between the domestic dog (*Canis familiaris*) and the wolf (*Canis lupus*; Randi 2008, Anderson et al. 2009), the domestic cat (*Felis catus*) and the European wildcat (*Felis sylvestris*; Beaumont et al. 2001, Randi et al. 2001) and domestic cattle (*Bos taurus*) and bison (*Bison bison*; Halbert/Derr 2007). Furthermore, massive releases of captive-reproduced game stocks have altered the gene pool of natural red deer (*Cervus elaphus*), sika deer (*Cervus nippon*; Goodman et al. 1999) and galliform species (Barilani et al. 2007).

Hence anthropogenic hybridization threatens natural populations or may even lead to their complete admixture (Allendorf et al. 2001). On the other side, depending on the influence of environmental heterogeneity, hybridization can also rescue local populations from extinction. Intentional hybridization has saved populations from inbreeding depression as observed in the Scandinavian wolf (*Canis lupus*; Edmands 2007) or the Florida panther (*Puma concolor coryi*; Johnson et al. 2010). Moreover, hybridization events can lead to an increase in species numbers (Mallet 2007) and thus, as mentioned above, plays a significant role in the process of evolution. Keeping these dual roles of hybridization on biodiversity dynamics in mind, natural populations and especially the wild relatives of our livestock species should be conserved as valuable resources of genetic diversity.

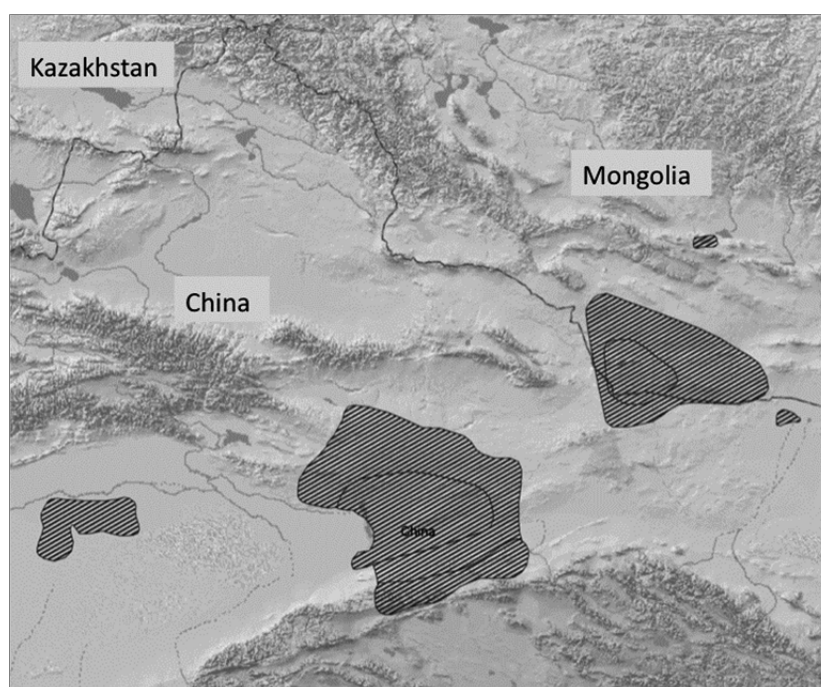
HYBRIDIZATION BETWEEN WILD AND DOMESTIC BACTRIAN CAMELS

The two-humped wild camel (*Camelus ferus*) is the only surviving wild species within the Old World camelids (*Camelini*) and is considered as “critically endangered” in the Red List of species threatened with extinction (IUCN, 2011). It is also protected under local legislation in China and Mongolia. The opinions on the genetic relationship between the wild and the domestic Bactrian camel (*Camelus bactrianus*) have been widely divergent ranging between assumptions that the wild camels are not truly wild but feral and that wild camels are considered to be the ancestors of the living domestic two-humped camel. Recent studies based on molecular clock analysis¹ of complete mitochondrial DNA sequences indicate that the separation of the two line-

¹ The molecular clock is a method of estimating the divergence time between two species/lineages based on changes in the DNA.

ages began in the early Pleistocene, about 0.7 million years ago. The archeological dating of Bactrian camel domestication is estimated at 5000–6000 years before present, thus excluding the extant wild camel populations as direct progenitors of the current domestic Bactrian camels (Ji et al. 2009). In addition to morphologic differences between wild and domestic camels in body size, hair color and skull structure (see picture 2 in the article by P. Burger in this volume), recent genetic analysis (Silbermayr 2009 and 2010a, Ji et al. 2009, Jianlin et al. 1999) identified the two-humped camel discovered by Przewalski (1878) as an original wild form, *Camelus ferus*.²

The wild Bactrian camel population appears to be in a steady decline. Population estimates are highly variable and inconsistent (Hare 1997, Luzhang et al. 2005) and the latest surveys have revealed that the population has become severely reduced to only 900–1600 animals worldwide. In contrast, there are over 2,000,000 domestic Bactrian camels worldwide. Once distributed throughout Central Asia the wild camel populations, today, have become restricted to four areas: Gashun Gobi, Lop Nur and Taklamakan desert in China and Great Gobi desert in Mongolia (see graph 11).³



Graph 11: Distribution range of the remaining wild camel populations in Mongolia and China (IUCN 2011; http://www.edgeofexistence.org/mammals/species_info.php?id=8#distribution; consulted 3 March, 2011).

The extensive livestock-wildlife interface around the Great Gobi Special Protected Area “A” (GGSPAA) is of particular concern for the conservation of the Mongolian wild camel population (Walzer 2006). The remaining population is surrounded by an estimated 10,000 domestic camels in addition to 50 to 60 already existing fertile hybrid camels in the circumjacent settlements. In some cases, the hybridization of domestic females with wild bulls is initiated to enhance the fitness of domestic camels (Enkhbileg et al. 2006). In addition, the movement of domesticated animals into the habitat of the wild population leads to the transfer of potential pathogens across this domestic-wildlife interface (Walzer 2006). The detection of hybridization between wild populations and their domestic relatives is an essential tool for the preservation and future sustainability of endangered wild populations (Hammer et al. 2008, Oliveira et al.

² For more information about this topic see the article by Pamela Burger in this volume.

³ For a detailed discussion on the situation of wild camels in China and Mongolia see the articles by Yuan Lei et al. and Adiya Yadamsuren et al. in this volume.

2008). The identification of such hybrids is difficult based purely on morphological traits. However, the analysis of the DNA genotypes reveals the relationship of individual animals to different populations.

MOLECULAR MARKERS TO DETECT HYBRIDIZATION

The principal tools of population genetics are the measurement of highly variable molecular markers and the estimation of the genetic variation and distances within and between populations. Genetic variation is measured in terms of polymorphisms and heterozygosity,⁴ which is calculated from the different allele frequencies of genes. The genetic distance is a measure of the genetic diversity between different individuals or populations (Schlötterer 1998). For the detection of hybridization and population structure hyper-variable DNA markers such as restriction fragment length polymorphism (RFLP), microsatellites (short tandem repeats, e.g. ACACAC), and single nucleotide polymorphisms (SNPs) in nuclear and mitochondrial genomes are used (e.g. Randi 2008). Therefore, by applying molecular markers on samples of wild and domestic Bactrian camels their evolutionary relatedness can be determined.

So far, polymorphic microsatellites in *Camelidae* have been developed for the alpaca (*Lama pacos*), the llama (*Lama glama*) (Lang et al. 1996, Obreque et al. 1998 and 1999, Penedo et al. 2001) and the dromedary (*Camelus dromedarius*) (Mariasegaram et al. 2002). Cross-species amplification⁵ of these markers in the Bactrian camel (*Camelus bactrianus*) has been successful, but species-specific markers, which might better reflect the genetic diversity of Bactrian camels, are still few (Edvotchenko et al. 2003, Silbermayr 2010b).

To investigate hybridization – a key issue in the conservation of wild camels – we analyzed mitochondrial differentiation levels between wild and domestic Bactrian camels and developed a diagnostic polymerase-chain-reaction restriction fragment length polymorphism (PCR-RFLP) assay to identify maternal domestic hybrids in the wild population (Silbermayr et al. 2010a). This method uses a particular enzyme to cut the targeted mtDNA fragment of domestic Bactrian camels into two pieces, but leaves the mtDNA of wild camels uncut. To further investigate population genetic structure and levels of genetic diversity in Bactrian camels and to detect hybridization between Mongolian wild and domestic Bactrian camels, microsatellite markers were isolated and characterized in addition to previously published microsatellites (Silbermayr et al. 2010b).

MATERIAL AND METHODS TO DETECT HYBRIDIZATION IN WILD CAMELS

A total of 103 specimens originating from wild and domestic Bactrian camels as well as reference species were analyzed. For the mitochondrial DNA (mtDNA) analysis we used 81 samples from 27 wild, 41 domestic and five hybrid (captive born) camels, as well as eight individuals with unknown maternal ancestry originating from Mongolia, China and Austria. As references we retrieved nine sequences from GenBank.⁶ The specimens originated from 59 blood, five fecal and 14 hair samples, one muscle and one skin biopsy, and one museum skin. They were collected either non-invasively or during routine veterinary treatment. For the determination of genetic diversity within and between the wild and domestic Bactrian camel populations, we sequenced an 804-nucleotide mitochondrial fragment comprising parts of the cytochrome b and the control region in 59 animals. An additional 22 samples were subjected to the PCR-RFLP

⁴ A gene locus is heterozygous when it contains two different alleles (forms of a gene), which are inherited from both parents.

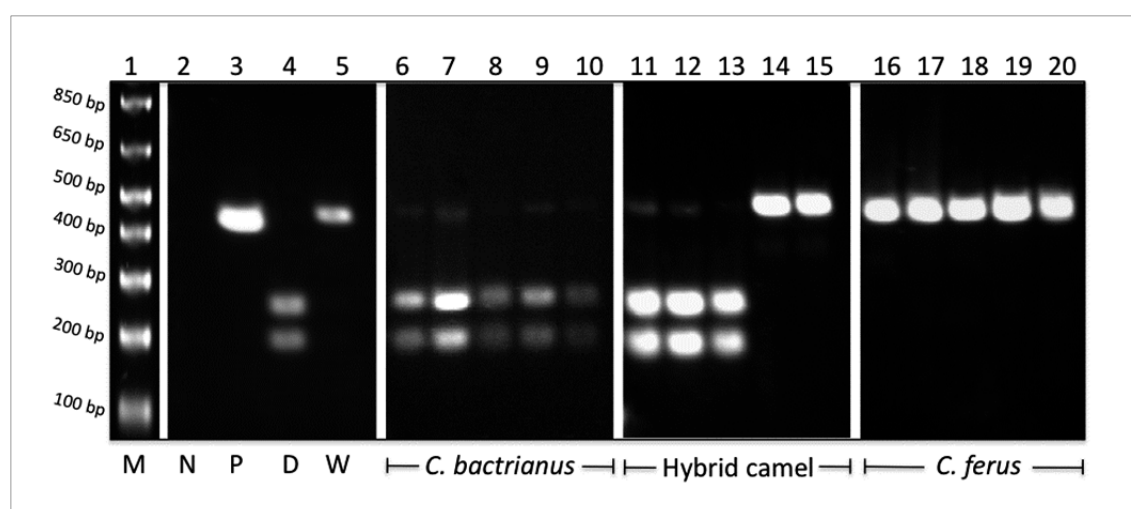
⁵ Microsatellite markers developed for dromedary or llama are used – across species – in Bactrian camels.

⁶ GenBank is an online database for genetic sequence data; each entry receives an individual accession number, like the Bactrian camel mitochondrial genomes used here (GI: 156615987, GI: 156615992, GI: 156615976, GI: 157011972, GI: 156615981, GI: 223972289, GI: 156615972, GI: 157011955, GI: 156615983).

analysis (Silbermayr et al. 2010a). For the analysis of 20 microsatellite loci, we tested a set of 42 domestic, 20 wild and four hybrid camels, in addition to three dromedaries and one alpaca for cross-species amplification and as an outgroup. The specimens originated from blood and were stored at minus 20°C. DNA isolation, PCR amplification, sequencing and sequence alignment was performed as described previously (Silbermayr et al. 2010a). Individuals were assigned to distinct clusters using a Bayesian approach implemented in the BAPS 5.2 computer program (Bayesian Analysis of Population Structure; Corander/Tang 2007). Microsatellite analysis was performed as described previously (Silbermayr 2009, Silbermayr et al. 2010b) and a neighbor-joining tree was generated based on the proportion of shared alleles with the Phylip 3.69 software (Felsenstein 1989). What we can do with the above-described methods is an initial rapid screening of wild camel samples using mtDNA followed by a more detailed analysis of their hybridization status by defining the individual genotypes with microsatellites.

RAPID SCREENING OF HYBRIDIZATION WITH MITOCHONDRIAL DNA (MTDNA)

In the field of wildlife conservation as well as in livestock management genetic monitoring has become an important tool, because it reveals information about genetic diversity, effective population size (i.e. how many breeding individuals exist) or inbreeding. For the effective genetic monitoring of a wild population it is essential to have an easy, fast and reliable screening method. Mitochondrial PCR-RFLP systems, in particular, meet these requirements and are therefore frequently used for species identification (Wolf et al. 1999, Kuehn et al. 2006). Based on the high levels of differentiation between wild and domestic Bactrian camels (see graph 13 in the article of P. Burger in this volume; Silbermayr et al. 2010a) we developed a PCR-RFLP system, which uses a particular enzyme to cut the targeted mtDNA fragment of domestic Bactrian camels into two pieces but leaves the mtDNA of wild camels uncut. With this easy and rapid method to discriminate between *Camelus bactrianus* and *Camelus ferus* we were responding to the demand for an inexpensive and reliable method to monitor the Mongolian wild camel population. To test the diagnostic value of the assay, we analyzed all collected samples including traditional (blood, skin), non-invasive (feces, hair) and museum specimen. The digestion treatment with the enzyme resulted in consistent banding patterns for domestic camel specimens yielding two bands (190/256 base-pair (bp)), while wild camels remained uncut (446 bp) (see graph 12). Captive-born hybrids with domestic mothers and the museum sample showed the domestic banding profile as expected (see graph 12; lanes 10–13). However, hybrids with a confirmed



Graph 12: Gel picture showing the banding patterns of a 446 (bp) long mitochondrial fragment digested with a restriction enzyme (XmiI; Fermentas). Domestic Bactrian camel samples are cut in two pieces visible as two bands of 190 and 256 bp, respectively (lanes 6–10), while wild camel specimen remain uncut (one band of 446 bp; lanes 16–20). The hybrid camels (lanes 11–15) show either the domestic or wild camel binding pattern depending on their

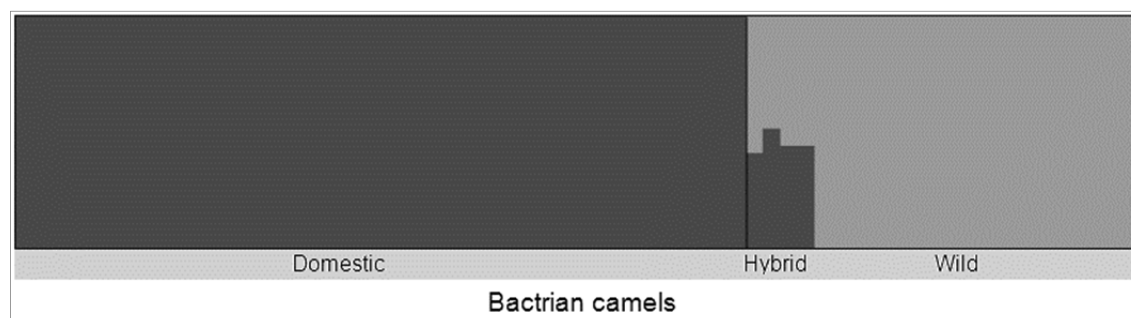
maternal origin. M: 1kb+ DNA ladder; N: negative control (without DNA); P: positive control (undigested PCR product); D: domestic Bactrian camel, cut (190/256 bp); W: wild camel, uncut (446 bp).

wild maternal ancestry as well as samples collected non-invasively during a monitoring trip in the national reserve GGSPAA showed the *Camelus ferus* pattern (see graph 12; lanes 14–15 and 17–20; Silbermayr et al. 2010a).

We applied this method successfully to non-invasively collected hair and fecal samples. Thus the system can be used for specimens collected during routine monitoring trips into the natural wild-camel habitat. Moreover, this technique can be established in a small genetic laboratory, as it requires relatively basic laboratory equipment and minimal training. In addition, we have used this marker to solve questions of taxonomy and nomenclature in a rare museum specimen, as we could assign one skin sample from the Natural History Museum Vienna as domestic Bactrian camel (Silbermayr et al. 2009).

IN-DEPTH INVESTIGATION OF HYBRIDIZATION USING NUCLEAR DNA

As mitochondrial markers give information only about the maternal genetic background, it is additionally important to use nuclear microsatellites for the investigation of paternal hybridization. The analysis of microsatellite data from 20 loci revealed the existence of hybrids between wild and domestic Bactrian camels. As displayed in the admixture analysis (see graph 13) the wild and domestic camels cluster together in separate groups while the hybrid camels harbor parts (domestic and wild) of both parental genomes.



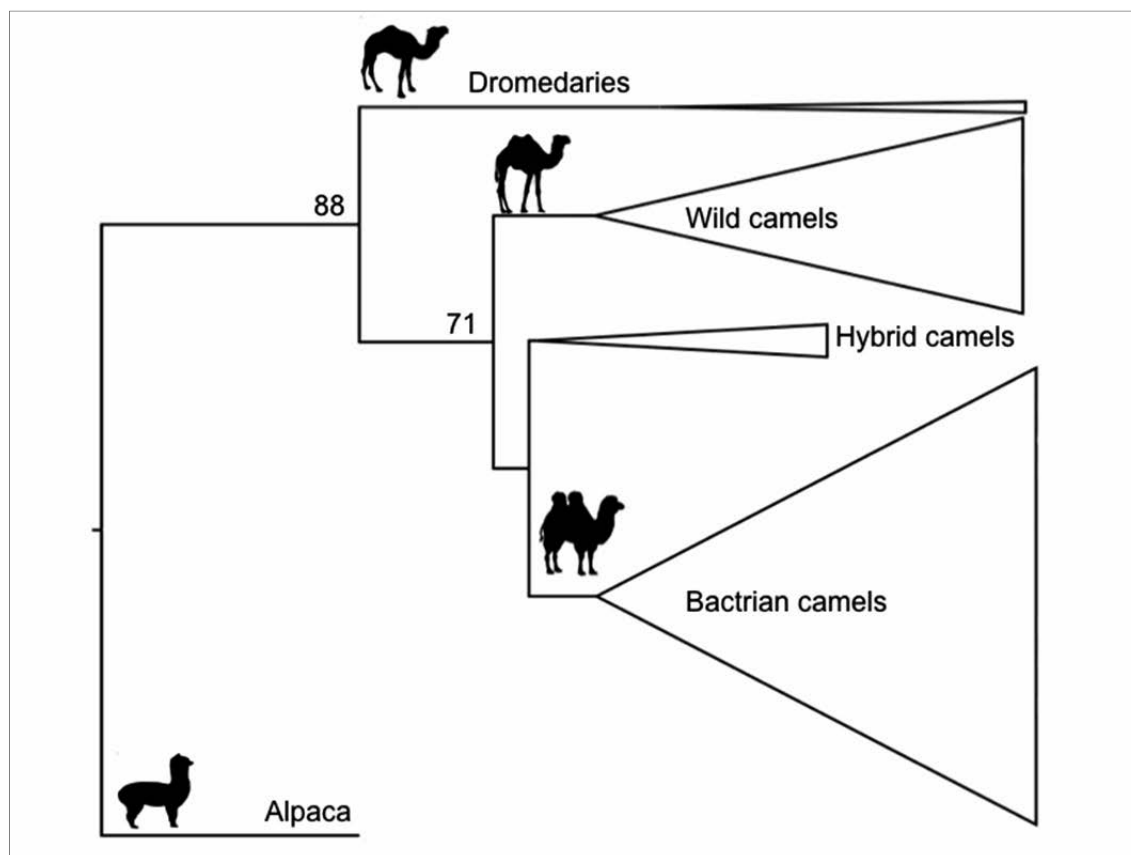
Graph 13: Admixture analysis using the BAPS 5.2 computer program. The pure domestic (left) and wild Bactrian camels (right) are assembled in distinct groups, while the hybrids show the genomic profiles of both (domestic and wild) parents.

Similar results were observed using a different (neighbor-joining tree) analysis, where the domestic and wild Bactrian camels grouped in separate branches (bootstrap support⁷ 71%) and the hybrid camels formed a specific cluster (see graph 14). The analyses were carried out in three Bactrian camels with a known history of hybridization; in addition, however, we could detect another hybrid camel, which was originally presumed to be of wild origin.

In summary, the applied molecular markers comprise a reliable method for the genetic differentiation of wild and domestic Bactrian camel samples and for the detection of hybrids in the last wild camel populations of Mongolia and China. From the results obtained in this study we recommend using mitochondrial markers complementary to nuclear markers, as evidence for introgression can vary substantially in mitochondrial and nuclear genes (Halbert/Derr 2007). Hybridization has often been studied using mitochondrial sequence data coupled with information from other loci or geographic data. This has provided convincing evidence of introgression between domesticated species and their wild relatives such as alpaca (*Vicugna pacos*)/vicuña, llama/guanaco (Kadwell et al. 2001) or domestic goat/Markhor goat (*Capra falconeri*; Hammer et al. 2008) and domestic cattle/American bison (Halbert/Derr 2007). The process of

⁷ In statistics, bootstrapping is a computer-based method for assigning measures of accuracy to sample estimates.

either anthropogenic or natural inter-specific hybridization is ongoing, e.g., as shown in hybridization frequencies of 75% in British ducks and 10% in European mammals (Mallet 2005). Similarly, a domestic horse (*Equus caballus*) mare is one of 13 founding individuals of the Przewalski's horse (*Equus przewalskii*) captive breeding program (Ryder 1994) in Mongolia. In spite of this hybridization, Przewalski's horses represent a distinct gene pool that is the object of continuing conservation efforts (Slotta-Bachmayr et al. 2004, Allendorf et al. 2001). Comparatively, the wild camels represent a genetically and morphologically (Sokolov/Orlov 1980, Tulgat/Schaller 1992) distinct population, which deserves international attention and conservation.



Graph 14: Collapsed (branches of individual camels were taken together) neighbor-joining tree based on the proportion of shared alleles between individuals. The domestic Bactrian camels are assembled distinctly and separate from the wild camels. The hybrids form a separate cluster. The tree is rooted with the alpaca as an outgroup. Numbers refer to bootstrap support (100 iterations).

CONCLUSIONS

The results of our genetic analysis highlight the importance of in-situ conservation actions for the last wild camel populations in Mongolia and China. Future hybridization assessment programs are needed to (i) record and protect the distribution range of non-hybridized wild camel populations and (ii) support the monitoring at the human-domestic-wildlife-interface in and adjacent to the national parks. This should help preserving the genetic integrity of wild camel populations and prevent a loss of biodiversity through hybridization between wild and domestic animals.

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PART III

BACTRIAN CAMELS

(Camelus bactrianus)

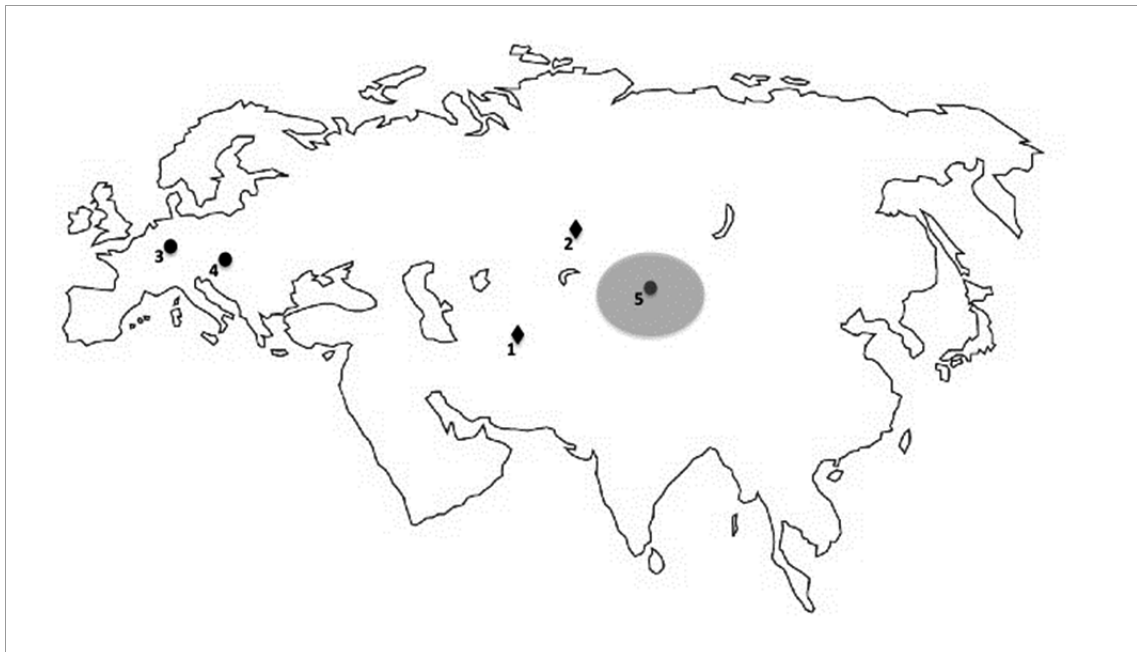
ALEXANDRA TRINKS, PAMELA BURGER, NORBERT BENECKE,
JOACHIM BURGER

Ancient DNA Reveals Domestication Process: The Case of the Two-Humped Camel

The domestication of the two-humped camel (*Camelus bactrianus*) promoted remarkable progress in cultural and economic development for ancient human civilizations in the steppes of Eurasia. However, the evolutionary relationship between domesticated and the extant wild two-humped camels (*Camelus ferus*) as well as time, place and motivations for domestication of these animals remain unresolved.

Here, a particular fragment of the mitochondrial DNA (458bp hypervariable fragment of the control region) was analyzed in 12 bone samples of Bactrian camels. The bone material was collected from Late Bronze and Early Iron Age sites in Siberia and Uzbekistan. Subsequently, ancient DNA sequences from these samples were compared to DNA sequences from 122 modern domestic Bactrian camels from China and Mongolia, eight modern domestic Bactrian camels from German and Austrian zoos and 20 modern wild camels from Mongolia (see graph 15).

Phylogenetic distances between wild and domestic populations is inconsistent with the hypothesis that the progenitors of the wild *Camelus ferus* population were ancestral both to the prehistoric the modern domestic camels. Low genetic diversity observed in all domestic populations supports the idea of a single camel domestication center, possibly in the western part of Central Asia, and indicates that it is very unlikely that the lineage of the extant wild two-humped camel is the progenitor of the domestic Bactrian camel.



Graph 15: Overview of the origin of the samples analyzed:

- 1 Late Bronze and Early Iron Age samples from Bandixon, south Uzbekistan
- 2 Late Bronze Age samples from Om'1, West-Siberia
- 3 Modern domesticated camel samples from zoos, Frankfurt/Germany
- 4 Modern domesticated camel samples from a zoo, Vienna/Austria
- 5 Modern domesticated and wild camel samples from the borderland of China and Mongolia

INTRODUCTION: THE QUESTION OF ANCESTRY IN CAMEL DOMESTICATION

Domestication of the two-humped camel facilitated the cultural and economic development of prehistoric human civilizations in the Eurasian dry zones. The Bactrian camel continues to be used today by modern rural and nomadic societies as a source of transportation, labor, meat, milk and wool. Camel dung replaces scarce firewood as fuel in the mostly treeless steppes. Despite the great economic impact of domestic camels for the inhabitants of the Central Asian deserts, the time and place of domestication remain uncertain (Benecke 1994).

The only surviving wild camel species, *Camelus ferus*, is commonly thought to be the progenitor of the domestic Bactrian camel. As we will show, however, modern investigation techniques such as ancient DNA sequencing make it possible to draw a different conclusion. During the Pleistocene, wild camels were distributed throughout the desert areas of Eurasia, but their numbers decreased over time (Benecke 1994, Peters/von den Driesch 1997, Peters 1998). The westward extent of the ancient wild camel population distribution is unknown, because of the paucity of skeletal evidence and the small number of residual modern populations restricted to four separate desert areas in China and Mongolia (Bannikov 1976, Hare 1997, Mix et al. 1997). The worryingly low number of wild camels at present makes it impossible to reconstruct their original zoogeographic distribution, particularly at the time of domestication. Additionally, incomplete knowledge about the range and variability of the wild camel population at the onset of the domestication process makes it difficult to determine the proceedings of camel domestication.

THE QUESTION OF LOCATION IN CAMEL DOMESTICATION

Archeological records show evidence of a closer relationship between humans and the Bactrian camel beginning in the late 4th and early 3rd millennium BCE (Bulliet 1975, Benecke 1994). The earliest skeletal remains come from sites in Anau and Geoksyur at the Kopet-Dagh foothills in the borderland between Turkmenistan and Iran (Kuzmina 2008). A similar situation appears at the northern edge of the Kopet-Dagh mountains, where archeological layers at Shor- and Khapuz Depe produce finds of the Bactrian camel dating to the early 3rd millennium (Compagnoni/Tosi 1978). Further, camel bones dating between 2,500 and 2,200 BCE originate from the Turkmen settlements of Altyn Depe, Namazga Depe and Kelleli (Peters/von den Driesch 1997, Kuzmina 2008). At the Shahr-i-Soktha site in south-east Iran, finds of collected camel hair and dung date to the first half of the 3rd millennium BCE. This suggests the presence of animals that lived in close association with the inhabitants of the settlement and very likely represent domesticates (Peters/von den Driesch 1997). Based on the provenience of the finds at Shahr-i-Soktha in south-east Iran, excavators have assumed that camel husbandry for meat, wool and dung production has been practiced in this region since the Bronze Age (Köhler 1981). Likewise, clay figures of cart-drawing camels of the same period from Ulug Depe imply a use of domesticated camels as draught animals (Kuzmina 2008). The presence of camel bones in Bronze Age strata from sites in Iran and southern Turkmenistan suggests that people of the Iranian Plateau and the Kopet-Dagh foothills area played a major role in the domestication process of the two-humped camel (Benecke 1994).

Contrary to this hypothesis, some archeologists and zoologists do not believe that paleontological and archeological evidence from south-western Central Asia can be interpreted as an indication for an ongoing process of domestication, as they see no proof of the presence of the wild *Camelus ferus* during early to middle Holocene times in this area. The authors argue that the center of domestication must lie further east, in areas where people were acquainted with the wild form over an extended period of time, for example in southern Kazakhstan or north-western Mongolia (Peters/von den Driesch 1997). The sudden appearance of camel bones in Turkmen and Iranian archeological layers dated to the Bronze Age, as well as missing skeletal remains of wild camels in earlier Neolithic strata in these regions convince them that people from the Kopet-Dagh foothills acquired the fully domesticated two-humped camels from eastern Asia.

However, differentiation between wild and domestic camel bone material is difficult and the earliest evidence of fully domesticated camels from southern Kazakhstan and north-western Mongolia are only dated to the 2nd millennium BCE (Köhler 1981, Peters/von den Driesch 1997, Mukhareva 2007).

THE VALUE OF ANCIENT CAMEL DNA: MATERIAL AND METHODS

To further examine the origin of the domestic Bactrian camel, we investigated mitochondrial DNA from prehistoric camel bones and compared them to extant wild and domestic Asian camels.

Archeological bone material of *Camelus bactrianus* was collected from six different Late Bronze and Early Iron Age sites (dating 1500 BCE–100 CE) in western Siberia (*Rayon Kujbyšev, Province Novosibirsk*) and southern Uzbekistan (*Rayon Bandixon, Province Suchandar'ja*). Further information about the samples is given in table 6.

Lab Code	Archeological Site	Dating
Om'1.1	Om'1, Novosibirsk/West-Siberia (Settlement)	Late Bronze Age (1500–800 BC)
Ban 1	Bektepa (Bandixon II), Bandixon/South-Uzbekistan (Settlement)	Early Iron Age (4th century BC)
Ban 2	Bektepa (Bandixon II), Bandixon/South-Uzbekistan (Settlement)	Early Iron Age (4th century BC)
Ban 3	Bektepa (Bandixon II), Bandixon/South-Uzbekistan (Settlement)	Early Iron Age (4th century BC)
Ban 5	Bektepa (Bandixon II), Bandixon/South-Uzbekistan (Settlement)	Early Iron Age (4th century BC)
Ban 6	Jalantushtepa, Bandixon/South-Uzbekistan (Settlement)	Early Iron Age (3 rd century BC – 1st century AD)
Ban 7	Kurgansol, Bandixon/South-Uzbekistan (Settlement)	Early Iron Age (4th – 2nd century BC)
Ban 8	Kindyktepa, Bandixon/South-Uzbekistan (Settlement)	Early Iron Age (4th century BC)
Ban 9	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)
Ban 10	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)
Ban 11	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)
Ban 12	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)
Ban 13	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)
Ban 14	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)

Lab Code	Archeological Site	Dating
Ban 15	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)
Ban 16	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)
Ban 17	Majdatepa (Bandixon I), South-Bandixon/Uzbekistan (Settlement)	Late Bronze Age (1400–1000 BC)

Table 6: Archeological samples.

For the specifically interested reader we shall explain the procedure of ancient DNA extraction in more detail. Two separate bone samples were cut from each individual and then powdered. Extraction of ancient DNA was carried out by incubation of 0.5 g to 2 g powdered bone samples in 3 ml to 12 ml extraction buffer (2.5 ml to 10 ml 0.5 M EDTA, pH 8; 0.25 ml to 1 ml 5% N-lauryl sarcosine; 30 µl to 120 µl 20 mg/ml Proteinase K) on a rotary shaker overnight at 37°C. Subsequently the DNA was extracted using one volume phenol/chloroform/isoamyl alcohol (25:24:1); the supernatant was concentrated by Amicon Ultra 15 (50 kDa) dialysis and finally washed several times with UV-treated HPLC-grade water.

Primer pairs for six overlapping fragments of the camelid mtDNA were designed to cover the first 458 bp of the control region (np 15436–15894; numbering as per Cui et al. 2007). Because of the poor preservation state of some of the bone samples, six additional primer pairs amplifying smaller, non-overlapping fragments were created. All likely non-variable base positions between the non-overlapping fragments were filled up with the reference sequence (NCBI accession number: NC_009629). Further information about primer sequences and primer positions are given in table 7 and 8.

For data analysis, mtDNA sequences were aligned using the MegAlign program from the DNA Star Software package (Version 7.2). The sequences of aDNA-samples were subsequently compared to 122 modern domesticated Bactrian camels from China and Mongolia, to eight modern samples of domesticated camels from German and Austrian zoos, and to 20 modern wild camels (*C. ferus*) from Mongolia (totaling 162 sequences). A reduced median-joining network was constructed using the Network 4.5.1.0 program (Fluxus Technology, Clare, Suffolk, UK; <http://www.fluxus-technology.com>).

System	Primer	Sequence (5'-3')	Primer Position	Product Position	Product with/without Primer
1	U1	ggaattctcattaaactacccctgac	15409–15435	15436–15525	137/91
	L1	gcaacgcgtgctgtgacat	15526–15544		
2	U2	tgcccaacgtgcatgaaacttc	15495–15516	15517–15610	144/95
	L2	atttgacataatgtgctatgcacgaac	15611–15637		
3	U3	atcgtgcataaattgtttgccc	15558–15580	15581–15671	138/92
	L3	ggcctggtgattaagctcgtgat	15672–15694		
4	U4	catttcagtcagtagcatatcataac	15638–15665	15664–15745	133/81
	L4	gtttagaacccccacaaatggatg	15746–15769		
5	U5	tcataacccgctcagcag	15703–15721	15720–15824	148/104
	L5	tgtctatttaagaggaaagtgtgg	15825–15849		
6	U6	ctttatcaggcatctggtcttacttc	15749–15775	15774–15894	177/120
	L6	aattataaaagtaccaaagcatgacacca	15895–15924		

Table 7: Overlapping primer pairs for mitochondrial DNA analysis.

System	Primer	Sequence (5'-3')	Primer Position	Product Position	Reference-sequence	Product with/without Primer
1	BanU1	ggaattctcattaaactacccctgac	15409–15435	15436–15499	15500–15522	117/65
	BanL1	gtcagttattgaagtttcagcacgtt	15500–15526			
2	BanU1b	cccaacgtgcatgaaactcaatact	15497–15522	15523–15563	15564–15585	90/42
	BanL1b	atgcatggggcaacaaatttatg	15564–15587			
3	BanU2	cataaattgttgcccatgc	15564–15585	15586–15618	15619–15625	81/34
	BanL2	tggaaatgattgacataatgtgctat	15619–15645			
4	BanU3	tacatcttattctgtcgtgcatagc	15599–15625	15626–15680	15681–15769	100/64
	BanL3	cacgcggcctggtgattaa	15681–15699			
5	BanU4	atccattgtgggggttctaacc	15747–15769	15770–15792	15793–15855	70/24
	BanL4	taggtgagatggtcctgaagtaaga	15793–15817			
6	BanU5	cacacttcctcttaataagacatctcga	15826–15855	15856–15887		89/33
	BanL5	agtaccaaatgcatgacaccacagttat	15888–15915			

Table 8: Non-overlapping primer pairs.

AUTHENTICITY OF ANCIENT DNA SEQUENCES

The most serious problem with ancient DNA work is contamination, which can occur within each step of ancient DNA analysis: in the phase of sample preparation, during extraction and PCR-set up, or during the amplification step.

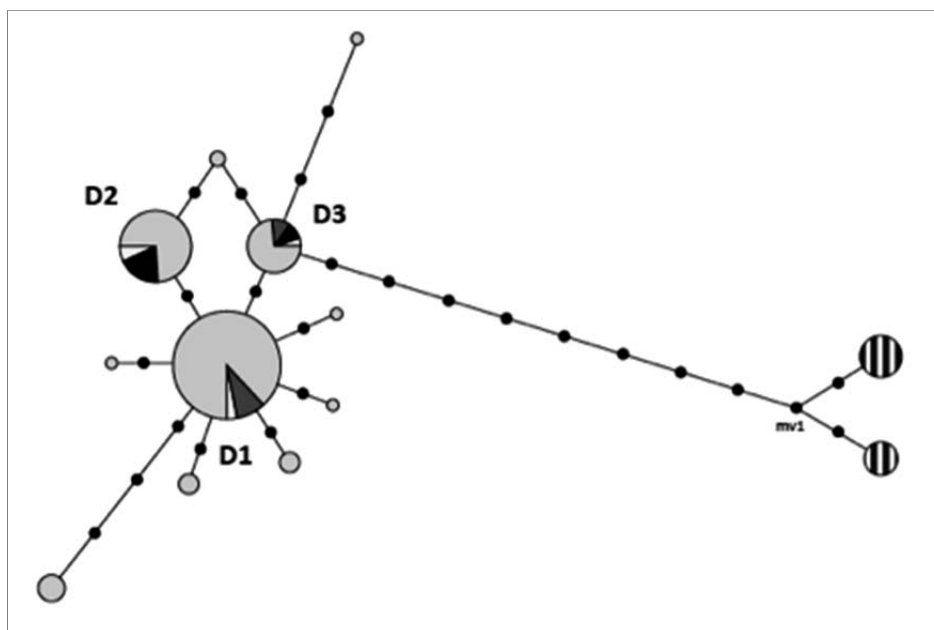
Ancient DNA is present in only small amounts, is seriously damaged and difficult to amplify. In contrast, modern DNA is ubiquitous, predominates over ancient DNA in quality and quantity, and is therefore easier to amplify. Due to the nature and degradation properties of ancient DNA, strict measures have to be applied to prevent sample contamination and to ensure the generation of authentic and meaningful data.

The ancient DNA work described above was carried out in the laboratories of the Institute of Anthropology at the University of Mainz, Germany. To avoid contamination in our study, all pre-PCR working steps including sample preparation, extraction and PCR-set up were conducted in a clean-room laboratory free of molecular work. All the following steps, including amplification and sequencing, were performed in a separate post-PCR laboratory.

Two separate bone samples were obtained from each individual and analyzed independently. In addition, specific primers were designed so that they only amplify Bactrian camel DNA. Various blank controls carried out along with both the extraction and PCR-reaction steps were always negative and did not contain any DNA. 12 out of 17 bone samples yielded DNA and gave reproducible results.

RESULTS: DIFFERENTIATION BETWEEN PREHISTORIC AND MODERN BACTRIAN CAMELS

DNA sequences between wild and domestic camels showed significant differences. To illustrate these differences and the relationship within and between the different wild and domestic camel populations, a median-joining network (see figure 2) was generated, using the Network 4.5.1.0 program (Bandelt et al. 1995). The network contains a total of 162 sequences. The size of the circles in the network is consistent with the number of samples with a particular DNA sequence, which thus carry the same mitochondrial haplotype¹.



Graph 16: Median-joining network:

light grey = modern domestic camels; black: modern zoo samples;

dark grey = Late Bronze Age;

white = Early Iron Age;

black/white cross-stripes = mitochondrial Genotype of the wild camel;

small black dots = nucleotide changes between samples, caused by mutations.

In graph 16, sequences of the modern domestic camels are represented in light grey, modern zoo samples are marked in black, dark grey segments are from the Late Bronze Age, and Early Iron Age samples are labeled in white. Haplotypes of the wild camel are depicted in black/white cross-stripes.

Nucleotide changes between samples, caused by mutations, are reflected by small black dots. Distribution of the mtDNA-sequences within the network shows a great homogeneity between all domestic Bactrian camel populations, whereas all ancient samples cluster with modern domestic camel haplotypes. The samples (listed in table 6) Ban 3, Ban 10, Ban 12, Ban 13, Ban 14, Ban 15 and Ban 17 group in cluster “D1”, while samples Om’1 and Ban 5 group in cluster “D2” and Ban 1, Ban 9 as well as Ban 11 group in cluster “D3”.

Within the domestic camel populations, haplotypes differ from each other mostly in one or two transitions. Furthermore, the star-like pattern of modern *Camelus bactrianus* haplotypes based on cluster “D1” may indicate a recent population expansion. By contrast, the sequences of the extant wild *Camelus ferus* can be distinguished into only two haplotypes, which differ from each other though two mutations, namely by a transition and by an indel (insertion/deletion).

¹ As the mitochondrial DNA is only inherited from the mother, we also refer to a mitochondrial genotype as a haplotype.

The phylogenetic network clearly demonstrates the significant difference between the Mongolian wild camel lineages and all domestic lineages, pointing to a long separate population history. This is inconsistent with the idea of the domestication of Bactrian camels from an ancestral *Camelus ferus* population.

CONCLUSIONS

Mitochondrial DNA comparison of all domestic camels (Late Bronze and Early Iron Age from Siberia and Uzbekistan as well as modern camels from China and Mongolia) revealed relatively few nucleotide differences. Considering this low diversity, especially within the ancient samples, a single domestication center seems more likely than multiple origins of domestic camels. Unfortunately, our sample size is small and skeletons mostly stem from adjacent sites in south Uzbekistan. It is thus very likely that we underestimate the actual diversity in early domestic camels. However, it is noteworthy that one of our archeological samples, which comes from a site in Siberia that is approximately 2,500 km distant from the others and dates to the Late Bronze Age, carries the same haplotype as an Early Iron Age sample from Uzbekistan. This at least adds to the picture of limited diversity in early domestic Bactrian camels.

Wild camel sequences are phylogenetically extremely distant from domestic two-humped camels, pointing to a population split long before domestication. Based on modern sequences of the whole mitochondrial genome, Ji et al. (2009) estimated the most recent common ancestor between *Camelus bactrianus* and *Camelus ferus* as being up to 700,000 years ago.

The ancient DNA sequences presented here demonstrate the high similarity between earliest domestic camel populations and modern Asian and zoo camels. The observed difference between the ancient domesticated camels and living wild camels, however, is inconsistent with the hypothesis that the progenitors of the wild *Camelus ferus* population were ancestral both to the prehistoric and recent Bactrian camels. As the extant wild two-humped camel contributed little or nothing to the domestic camel populations, another as yet unidentified wild camel population must be the ancestor of the domestic two-humped camel.

The distribution area of *Camelus ferus* during the early and middle Holocene included the East Asian steppes as far as modern Mongolia and southern Kazakhstan. We consider the sympatric, i.e. overlapping existence of another genetically distinct wild camel population in this region to be very unlikely. In the search for the ancestral wild camel population we thus assume a more western origin of the ancestral Bactrian camel population. As mentioned above, the earliest archeological records of camel bones, cart-drawing clay figures and finds of camel hair and dung come from settlements of the Kopet-Dagh foothills in the borderland between Turkmenistan and Iran and date to the second half of the 4th and the beginning 3rd millennium BCE. In contrast, the earliest evidence of fully domesticated camels in Kazakhstan and Mongolia occurs much later, in the 2nd millennium BCE.

Considering the archeological record, there is no doubt that camel husbandry gained importance in Eurasia during the Bronze Age. As a result of this palaeogenetic study, we propose that the domestication of the two-humped camel took place as a single domestication process, rather in south-western parts of Central Asia than in Mongolia or even East Asia, whereas the lineage of the extant wild *Camelus ferus* is neither the ancestor of the ancient domestic camel population analyzed here, nor of the modern domestic two-humped camels.

Although the observed genetic differences are significant, different ancestry scenarios will have to be modeled and tested by serial coalescent simulations to see whether the observed genetic patterns could also have been produced under alternative – *prima vista* less plausible – demographic history models.

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MARIA-KATHARINA LANG

The Tears of the Camel: Reflections on Depictions and Descriptions of the Camel in Mongolian Culture

In 2004 the film *The Story of the Weeping Camel* (m. *Ingen nulims*¹) was nominated for an Oscar in the “Best Documentary” category. The narrative documentary was written and directed by the German-trained Mongolian director Byambasuren Davaa and Luigi Falorni. Its protagonists are the members of an extended family of herders in the Gobi desert area, who own a herd of sixty camels. The docu-drama, combining unstaged sequences with recreations following the storyline of a prepared script, had a wide public appeal. In the view of social anthropology and Mongolian studies, the storyline has several elements worth analyzing, as they reflect cultural practices such as animal herding, human and animal interaction, music, Mongolian symbolism, natural and human landscapes. The film tells the following story:

During spring a family of herders in the Gobi desert assists the births of their camel herd. The last calf to be born turns out to be a rare and thus particularly valued white colt. The mother rejects the new born, refusing to suckle it and failing to establish a natural bond. With the help of various rites the family tries to restore the harmony between mother and calf. They call upon the services of a group of Buddhist monks (*lama*) who perform a ritual, offering of dough effigies (m. *dorom*; tib. *torma*)² and playing monastic musical instruments at an *owoo*, a sacred stone cairn (see picture 20).

This ritual does not improve the situation. The family then manage to engage a musician who plays a horsehead fiddle, the *morin khuur*. First he hangs the instrument on the first hump of the mother camel to establish a linkage between the mother and the instrument. Then he removes the instrument and starts playing, accompanied by a female family member singing a soothing melody without words but repeatedly intoning the letters “*khoos, khoos, khoos*”. After a while the mother camel starts to weep, tears running down her face, and she reconciles with her baby, allowing it to suckle, and thus the rare white camel calf is saved.

Several important Mongolian cultural markers are included in this film narrative: a white camel, Mongolian belief systems such as Buddhism and pre-Buddhist rites, and the traditional Mongolian instrument par excellence, the *morin khuur*, the horsehead fiddle. These are manifestations of Mongolian cultural and social identity and construction of identity in the context of historic and political events. In the following I will look at these markers, focusing on the relation to the camel in Mongolian art and historic descriptions. I will reflect on the background of the story, its symbolism and among other things draw a connection to the Austrian history of science. As one of the five domestic animals (sheep, goats, cattle, horses and camels) the camel holds an important place in Mongolian society. This is expressed in various ways: Camels played a role in the expansion of the Mongolian Empire, they served as a gift within the tribute system between Mongols and the rulers of the Ming and Qing Dynasties in China, music is performed especially for camels and they serve as riding animals – not only for people, as I will

¹ There is no widely shared well-established system of transcribing Mongolian. In this article I follow the transcription used by Christopher Atwood in the Encyclopedia of Mongolia and the Mongol Empire (Atwood 2004). The following abbreviations are used in the text: m. – Mongolian, skr. – Sanskrit, tib. – Tibetan.

² Torma are figures made mostly of a mixture of flour and butter. They have specific, often conical shapes and may be colored. Various forms are used as offerings in Tibetan and Mongolian Buddhism and in tantric rituals. It is believed that making and offering torma might i. a. appease spirits and remove obstacles.

show. Descriptions and depictions of camels (like some presented in this article) may contribute to the understanding of the significance of this animal in Mongolian society, history and culture.

THE CAMEL IN MONGOLIA

The lives of the Mongolian herders and their traditional economy rely on the horse, cattle, sheep, goats and the camel, the “five animals or snouts” (m. *tavan khoshuu mal*). The horse provides mobility and *airag*, the fermented mare’s milk, which has been the traditional national beverage of Mongolia from ancient times until today. The sheep, goats, and cattle are the sources for food and wool, as well as providing fuel and shelter. The two-humped Bactrian camel (*Camelus bactrianus*) is used as draft animal, providing transport, fuel, fine hair, milk and meat. The Bactrian camel is better adapted to the cold, harsh climate than the dromedary. In Mongolia the Bactrian primarily live in the Gobi areas; the endangered wild camel (m. *khawtgai*) is found in the south-west.³

Early traces of the domestic and wild camel in Mongolian art are depictions on petroglyphs from the Upper Paleolithic to the Bronze and early Iron Ages and bronze figures in the animal style tradition. Petroglyphs and literary evidence depict and describe the camel drawing the then common yurt carts (a yurt, m. *ger*,⁴ is a round Mongolian felt tent). One rock engraving from Chuluut in northern Mongolia depicts a white camel. (Nowgorodowa 1980:49,179, 1989:21, Atwood 2004:75, Mongolian Art 2008:18).

WHITE CAMELS

The camel calf in the film *The Story of the Weeping Camel* referred to at the beginning is white. For the Mongols, white as an auspicious color has always been of a special significance: the Mongolian New Year is called *tsagaan sar* (white month), during the New Year’s celebration people eat *tsagaan idee* (white foods), white felt was used in context of marriage and burial ceremonies and so forth.

Camels are mentioned in various parts of the *Secret History of the Mongols*, the oldest known Mongolian chronicle.⁵ It says that during the last phase of Chinggis Khan’s life (around 1162 to 1227), when he was planning to conquer the Tangut people in north-west China,⁶ camels were used as pack animals and with their help the Tanguts were finally defeated. One might say, Chinggis Khan and his troops used the camel to make their way to conquer China, a long desired aim. After the defeat, the Tangut king Iluqu Burqan paid homage to the Mongols in form of presents such as gold and silver vessels and nine horses and nine camels – probably white ones (Rachewiltz 2006, Taube 2005). White camels were regarded as most honored animals in Central Asia in general and enjoyed special appreciation (see picture 21). There is considerable evidence for the high esteem of the camel in the period of the Mongolian Empire (1206 to 1260) and its successor states. Marco Polo describes the New Year festivities at the court of Chinggis Khans grandson Khubilai Khan (1215 to 1294), founder of the Yuan Dynasty. According to Polo the New Year celebrations were called “White Celebration” – in Mongolian until today *tsagaan sar* (white month).

³ For a more detailed discussion about the Mongolian wild camels see the article by Adiya Yadamsuren and Enkhbileg Dulamtseren in this volume.

⁴ In the Mongolian the felt tent – still used by most of rural dwellers in Mongolia and in the “ger-districts” in the capital Ulaanbaatar – is called *ger* (home). This mobile form of a residence is constructed of a collapsible wooden frame covered by a layer of felt and a layer of white cloth.

⁵ *The Secret History of the Mongols*, was probably written in 1252. It is written in epic form more like an “insider” account about the life of Chinggis Khan, his companions and his family, the Borjigid (Atwood 2004).

⁶ The Xia (Tangut) dynasty ruled north-west China from 1038 to 1227, until its final destruction by Chinggis Khan. The dynasty was founded by the Mi-nyag people, originating from the Chinese western borderlands. They were called Tangut by the Turks and Mongols (Atwood 2004:590–592).

On the first day of the year the people at the court wore white robes and exchanged white presents. Most extraordinary according to Polo was a great procession of decorated animals in front of the Great Khan.

He writes of hundred thousand beautiful white horses, 5000 elephants and following them, “a vast number of camels which were likewise covered with rich housings and laden with things needful for the feast” (Yule 1903:I.391). During the Yuan Dynasty camels were used in many ways: as beast of burden, dragging the huge Mongolian tents on carts, as food and for military purposes but mostly for transportation of supplies, and their hair was processed into the finest garments, according to Polo called *camlet* (Yule 1903). White camlets were most treasured as they were made from the wool of white camels, which were regarded as the best (Schafer 1950:191–192, Yule 1903).

The splendid art flourishing under the Mongolian Il-Khans⁷ in Iran, cousins of the khans in Yuan China, offers insights into the use of the camel and its depiction in art during the Great Mongolian Empire: book illustrations for the Great Mongol *Shahname*, the *Book of Kings* (the national epic that celebrates the ancient Iranian kings) and architectural elements with depictions of scenes of the *Shahname* show the camel as a riding animal also used for hunting.

NINE WHITES

For the Mongols, nine was and is a number of special importance: the shamanic (pre-Buddhist) heaven was believed to consist of nine layers and in the *Secret History* the number nine is reserved for the pivotal doings of Chinggis Khan (Berger 2003:48). The number nine was a fundamental organizing principle also later for the Qing – particularly in their gift giving.

During the Qing-Dynasty (1644–1911), from 1655 onwards, the Nine Whites were an annual ritualized tribute by the Khalkha khans from northern Mongolia for the Qing Emperor in China. The Nine Whites refer to nine white sacred animals: eight white horses and one white camel – flawlessly formed and perfectly white and drawn from herds all over Mongolia (Berger 2003:48).

The high lamas and Khans of Mongolia, like the last Bogd Khan, the Eighth Jibzundamba Khutugtu (1870–1924), were presented with personal gifts in exchange. Among the belongings of the Eighth Bogd Khan were items such as an ewer, today housed in the Museum of Fine Arts in Ulaanbaatar.

Three of the Mongolian five animals are part of the design of this ewer, which itself is a combination of Tibetan and Mongolian styles: a cow is on the top of the lid, the heads of two rams decorate the overhead handle, while camels with open mouths form the spouts. A vertical wall divides the interior of the ewer into two parts, so that two separate beverages could be served (Bartholomew 1995:104).

The old Qing tributary system was still echoed after the fall of the Qing Dynasty in 1911. In the early 1920s a special white camel is described by the Polish writer and explorer Ferdinand Ossendowski: according to him, during Russian Civil War, the legendary, controversial Baltic Baron Ungern Sternberg⁸ offered Ossendowski, who travelled through Mongolia in 1920/21, his own white camel to ride to the capital town Urga. Ungern-Sternberg was then fighting against

⁷ The title Il-Khan, or “*obedient khan*” refers to the status as deputy or viceroy of the great khans of the Mongol Yuan Dynasty (cf. Atwood 2004:230–232).

⁸ Robert Roman Fedorovich Baron von Ungern-Sternberg (1886–1921) was a commander of White troops who supported and won Mongolian independence from the Chinese in 1921. He was also known for acts of cruelty, for example against Bolsheviks and Jews. He was executed by Soviet authorities in 1921 (Atwood 2004:572–574).

the Bolsheviks and Red Army troops in Urga (today Ulaanbaatar) and expelled them violently from Urga. Ossendowski writes:

“I was awakened by Baron Ungern who came to ask pardon that he could not take me in his motor car. . . . But he informed me that he had left instructions to give me his own white camel and two Cosacks as servants. . . . My mount was the fastest of them all. He was a huge white animal with a splendid thick mane and had been presented to Baron Ungern by some Prince of Inner Mongolia with two black saddles tied on the bridle. He was a calm, strong, bold giant of the desert, on whose back I felt myself as though perched on the tower of a building” (Ossendowski 1922: 226, 228).

MONGOLIAN BELIEF SYSTEMS AND PROTECTION FOR ANIMALS

Alongside the so-far discussed white camel, Mongolian belief systems were further cultural markers featured in the film about the weeping camel. These belief systems are characterized by the syncretism of Buddhist and pre-Buddhist beliefs⁹ and by the integration of animals into Mongolian life in general and into religious life in particular. Amulets were and are still used for the protection of animals, including camels, and there are prayers for the five animals. A paper printed amulet from the early 20th century, protecting the house, possessions and herds of five kinds of animals against dangers such as wolves, diseases, thieves and negative influences, is described by Kelény (2003:71–73). The five animals and associated mantras are depicted on this amulet. The mantra of the Buddhist protective goddess Shridevi appears above the camel; below the camel Tibetan text reads: “Protect camels from all deadly diseases! Protect their young from every evil spirit!” (Kelény 2003:71).

MUSIC FOR CAMELS

Music, including vocal sounds as whistling, overtone singing and various instruments, forms an integral part of life in Mongolian countryside and is an essential form of communication with animals.

The instrument that is played in the film to placate the mother camel is the horsehead fiddle, the *morin khuur*. Today this two-stringed instrument is the national instrument par excellence and represents an icon of Mongolian national identity (cf. Marsh 2009).

Music and sounds are used to influence and control animals. There are different remedies for each of the five animals that reject their newborn and the musical techniques depend on the geographical region. For camels it is mostly the fiddle or the singing of a special very sad song, for example about a camel mother punished for running away. It is said that when camel mothers hear this song they weep large tears and give milk (cf. Pegg 2001: 237–239).

And it is also the music, the sounds of the wind in the strings of a fiddle (m. *khuur*), hung from one hump of the camel that may soothe the camel.

The story of the film about the weeping camel is therefore based on old Mongolian practices, tales and myths. *The Story of the Weeping Camel*, however, was not the first film dealing with these aspects of Mongolian culture. A film with a similar plot was well known even during the communist period. But in this film no Buddhist rites are carried out by monks to placate the camel mother. On the one hand, featuring religion was not possible under the communist regime, on the other hand the integration of Buddhist rituals might fit more the imagination of the

⁹ Buddhism spread to Mongolia from India through early trade routes. During the Mongolian Empire, Khubilai Khan, grandson of Chinggis Khan, established close relations to Phags pa, an eminent Tibetan lama of the then important Sakyapa sect. He converted Khubilai to Tibetan Buddhism, Khubilai promoted him to imperial preceptor and Tibetan Buddhism was becoming influential within the Empire. The often so-called “Second Conversion,” which went much further, was implemented in the 16th century under Altan Khan of northern Khalkha. Buddhism became the official state religion by this time and lasted until the communist repressions in the late 1930s.

film makers and a national Mongolian identity construction after the fall of the communist regime in 1990.

In the 20th century, Mongolian music and musical remedies to heal the camel have increasingly become associated with the horsehead fiddle. Before the destruction of monastic life in Mongolia in the 1930s, various monastic instruments used by monks and Mongolian music in general was perhaps not that much associated with the horsehead fiddle, but with a range of fiddles and other instruments such as lutes, flutes, pipes, zithers and dulcimers.

At this point I want to draw the link to ethnographic data, to the practice collected more than hundred years ago concerning the taming of a mother camel. This may represent a historic source for a film and narratives about the story of the weeping camel.

DESCRIPTIONS BY THE TRAVELER HANS LEDER

In 1892 the Austrian scientific traveler Hans Leder reached Urga (today the capital, Ulaanbaatar) the capital of northern Mongolia and organized a caravan consisting of five camels, seven horses and two Mongolian monks as translators (Lang 2010). They headed off in western direction to Karakorum, which was once the centre of the Mongolian Empire. During this first journey to Mongolia, Leder experienced and noted many details of Mongolian lifestyles and nature. When he reached the area of Olon noor (many lakes) he came across many yurt gatherings (*mail*) and animal herds of the five animals including the Bactrian camel. Leder noted:

The camel is the two-humped Bactrian, that is used here as everywhere to carry loads, but is used to pull as well; but even the meat of old and ill animals occasionally killed in accidents is relished, though even the Mongols do not call it a delicacy. Yet the possession of camels is the indicator for wealth of the possessor, even more than other domestic animals (Leder 1894:422–424; translation M.-K. Lang).

Leder observed, as he put it, “a curious practice of music, or better just sounds on animals”:

In this special case it was a female camel, that had given birth shortly before and that, be it because it was its first time or even more likely, because it felt still too weak and miserable after a just endured hard winter and did absolutely not want to accept its newborn but refused the maternal nutrition. To placate the ignorant mother, she was tied, especially evenings in short distance to her likewise fixed calf by a rope. And now a Mongolian began to blow into a cow-horn with long drawn pitiable, but very loud sounds, always in one and the same way, so that it sounded wide and feeble over the steppe.

It took quite a while unless the mother animal seemed to take any visible notice; finally it listened more and more alert and started to be uneasy. The excitement increased visibly and the musician, on his part, used his best endeavors to take advantage of and increase this fortunate atmosphere with his most beautiful tooting.

The camel even started gurgling itself and to roar, whereby it tried to bring its voice in accordance with sounds of the horn and taking all efforts to break free at the same time. After its excitement had reached the highest grade, it was released, whereupon it hastily ran to its calf, caressing it and willingly offering its udder (Leder 1894:244–246; translation M.-K. Lang).

This account contrasts to many stories about camels and “weeping” camels, where a string instrument and the human voice are usually used to influence the mother camel. The cow horn, witnessed by Leder might have been used more frequently for example in central Mongolia.

Leder, who started his scientific career primarily as an entomologist, changed his collecting focus increasingly from insects to ethnographic objects, mainly Mongolian Buddhist art. Part of his collection is now housed in the Museum of Ethnology in the center of Vienna.¹⁰ There I

¹⁰ Research project (2010–2012) “Mongolian Ethnographica of the Austrian Collector Hans Leder at Museums across Europe”, forMuse – research at museums: a program funded by the Austrian Federal Ministry of Science and Research (www.forMuse.at). Probably the most extensive collection(s) of Mongolian ethnographica in Europe goes back to the Austrian explorer Hans Leder (1848–1921). The collection is unique as it represents a snapshot of religious everyday culture in northern Mongolia at the turn of the 19th century. This part of Mongolian

recovered a small thangka (Buddhist scroll painting) among other items in the museum depository that is of relevance for the subject of this article.

THE WINTER GODDESS

The thangka of the Winter Goddess (inventory number 74.984; see picture 22) was collected by Hans Leder in 1905 during his last stay in Urga. Unfortunately, it is extremely darkened as for some time it was part of an altar place and hung above butter lamps. It was collected as “used object”, taken from daily life, so that – according to Leder – it still had a special “authentic” aura.

This depiction shows the Winter Goddess or Queen of Winter riding on a camel. This wrathful deity is one of the four goddesses associated with the four seasons who usually accompany Shridevi (m. *okin tenger*, lam *burkhan* tib. *Lhamo*), the only feminine divinity among the Protectors of the Law of Buddhism (tib. *dharmapala*), a group of fierce deities who usually became protectors of Buddhism after having been converted to the faith. Her body is blue/black and she is holding her attributes, a human skull cup filled with blood (skr. *kapala*) and a mace (skr. *gada*), and riding a camel. Usually, the Winter Goddess is depicted on thangkas as part of the ensemble of Shridevi and her retinue. In this thangka she is shown on her own, possibly owing to a special veneration of this goddess in some areas of Mongolia.

CONCLUSIONS

Film as a documentary source offers additional access to specific cultural constellations and imaginations. Artifacts and museum collections are also conveyors of knowledge and provide a link between the historic past, narrations, legends and lived practices. Combined with descriptions in various accounts, depictions and images of the camel may thereby contribute to a better understanding of the significance of the camel in Mongolia. As illustrated in this article, a popular film such as *The Story of the Weeping Camel*, taken as a starting point to reflect on the camel in Mongolian culture, can be read and connected to (the memory of) the historic past in various ways – thus it widens the view on the interactions and interrelations of humans and camels.

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culture was increasingly repressed and mostly destroyed in the late 1930s. In the course of this project, the various parts of the collection are recorded, analysed in detail, catalogued by object groups and combined in one comprehensive viewing. Field studies in the course of the project intend to contrast the locations and monasteries described by the collector and to conduct interviews regarding the history of sacred objects and locations.

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The Camel and its Symbolism in the Daily Life of the Mongols with Particular Reference to their Folk Songs

Animals are an essential aspect for the survival of a society characterized by nomadic traditions. It is little known that for Mongolians the performance of music, and especially chanting, has been an indispensable factor in livestock-breeding itself. This article shows how the camel has its established place in legends, parables, metaphors, ritual songs and everyday folk songs, as well as in modern literature. All these art forms often also impart knowledge pertaining to the camel or its significance for Mongolians.

THE CAMEL IN THE DAILY LIFE OF THE MONGOLS OVER THE CENTURIES

In the Mongol non-sedentary breeding communities, a symbolism has evolved that directly relates to this feature of their existence. This symbolism already existed among pre-Mongolian ethnic groups, as can be concluded from numerous camel petroglyphs such as those at *Bičigtiin xad*, *Bayanlig* and *Čulūt*. Further indications of this are the still-preserved cave paintings of the “Northern Blue Cave” (*Xoit cenxeriin agui*) in western Mongolia, which, estimated to be 15,000–20,000 years old, date back to the Upper Paleolithic period and thus show the world’s earliest illustrations of a camel (see picture 23).¹

The importance of the Bactrian camel becomes apparent from a tradition that has been kept alive to this day: apart from horses, only camels have been identified by a *tamga* (um. *tamay-a*).² A *tamga* is a brand (see picture 24), a “clan emblem” or a seal (cf. Chuluunbaatar 2009:10). Moreover, the design of the nose-peg (*buil*), a utensil used in camel husbandry, was adopted as a brand in its own right (see picture 25).

In 1206, after the foundation of the Mongol empire, *Činggis Xān* issued the *Yasa*, a code of law for the entire empire. According to many scholars, the *Yasa*, which no longer exists in its original form, is not a uniform, systematically structured body of law, but merely a collection of regulations and instructions that *Činggis Xān* issued over the years if needed for concrete occasions (cf. Ratchnevsky 1974). It specified, among other things, that the theft of a camel had to be compensated by returning the camel plus nine similar animals (cf. Lane 2006:216). In the *Oirat* Mongol code of 1640, the punishment was increased to “15 nines of livestock” (i.e. 135 animals) and hence exceeded the value of a horse, even of a stallion (cf. Buyanöljei 2000:141).

Over the centuries, camels, particularly the rare white specimens, were of special importance to the then rulers, as they were in ritual folklore. In the second half of the 13th century, Marco Polo, for example, reports on a procession of white horses and camels at the New Year’s celebrations in front of the *Xubilai Xān* (cf. Knust 1983:156). In the 17th century, Mongol rulers had to pay an annual tribute of “Nine Whites” (um. *Yisün cayan-u alba*) to the Manchurian-Chinese emperor. This tribute consisted of one white camel and eight white horses (cf. Perdue 2005:139).

¹ The cave was added to the Unesco World Heritage Tentative List on August 1, 1996 in the cultural category, see <http://whc.unesco.org/en/tentativelists/935/>, consulted 4 Nov., 2010.

² Mongolian is not a unified language. Unless stated otherwise, the *Xalx*-Mongolian dialect was transcribed. The following abbreviations are used: um. – Uigur-Mongolian, skr. – Sanskrit, tib. – Tibetan. With the exception of transliterations adopted from the authors cited, the transliteration schemes of Chuluunbaatar (2008) were applied both for the Uigur-Mongolian script and the Mongolian Cyrillic script. This is particularly important for the bibliography at the end of the article.

and was of a purely symbolic nature, as white was associated with highly valued qualities such as good fortune and health. These qualities were also important in traditional weddings. Thus the bride was taken to the yurt of the groom by a white horse and a camel of the same color. This custom with the same symbolism can also be found among some Turkic ethnic groups (cf. Blackwell 2001:151).

These animals, horses and camels, also played important roles in the life cycle. In “*Erdeniyin tobči*” (um.), which is translated as “Precious Summary: A Mongolian Chronicle of 1662”, written by *Sayang Sečen* in that year, the author reports that, for burials of persons of high standing, a horse or a camel was killed as animal sacrifice and then buried together with the deceased (Elverskog 2007:72). Even today, linguistic taboos regarding camels can be observed, especially associated with situations of death or pregnancy – and often gender-specific (Chuluunbaatar forthcoming). Joseph Kler (1938:59) reports of the *Ordos* Mongols: “Should a pregnant woman make fun of a camel or eat hare meat, her infant will be born with a hare lip, and other people will say that she has made fun of a camel or hare or of some person with a hare lip.”

During his visit to the *Ordos* Mongols, the scholar Schuyler Cammann (1951:167) saw a holy yearling camel with a necklace made of sheep’s shoulder blades (scapulae) and that men were therefore not allowed to ride. The significance of this animal, however, is not only apparent in folk belief. Starting with the second “Buddhisatation” of the Mongols at the close of the 16th century, Buddhism in its Tibetan form played a substantial role, which continued into the following centuries. Interestingly enough, the camel left several traces in the representation of some deities of the Mongolian Lamaistic pantheon, which distinguishes itself at times from the Tibetan form. An example of this is the camel-riding deity, the “Queen of the Winter” (um. *Ebül-ün okin tegri*, tib. *dGun-gyi rGyal-mo*, skr. *Hemantadevī*),³ one of the goddesses of the four seasons in the retinue of *Baldan lam/Oxin tenger* (um. *Okin tegri*, tib. *dPal-ldan lha-mo*, skr. *Śrīmatī Devī*). The popularity of the “Queen of the Winter” in Mongolia is apparent from the fact that they also like to depict her as an individual figure, whereas scroll paintings (tib. *thang-ka*) in Tibet only show her together with her three companions and just as one of the secondary figures surrounding the main figure *Baldan lam*.

Much of the color symbolism as well as the aureole-like radiance of the manes in certain paintings turns up again in the modern paintings of the former Mongolian People’s Republic. An example of such art is the painting “The Black Camel” by the artist A. Sengezoxio from 1962 (Museum of Modern Art, Ulaanbaatar). Camels, horses, cattle, sheep and goats are of such great importance for Mongolian animal husbandry that all together they were – and still are – called the “five snouts” (*tavan xošū mal*). In spite of the influence of the Soviet Union at that time, their significance for the Mongols was even visible in the corresponding state symbolism. This might also be due to semantic reasons because of the association with the five-pointed Soviet star (cf. Stolpe 2006). Despite having a social system that primarily depended on animal husbandry, the Mongolian People’s Republic considered itself a modern state. Illustrations with camel themes from that time are mostly connected with progressive achievements such as oil rigs or electricity pylons. Moreover, the camel was part of the Mongolian coat of arms and was hence shown on banknotes and other official emblems from 1940 until 1960. In the globalized age, however, camels are now used to transport satellite dishes to keep camel nomads up to date on news and to provide them with a kind of diversion unknown until recently (see picture 26).

³ An example of the “Queen of the Winter” of the 19th century is part of the collection of the Zanabazar Museum of Fine Arts in Ulaanbaatar. Shelley and Donald Rubin Foundation, <http://imageserver.himalayanart.org/fif=fpx/50122.fpx&obj=uv,1.0&page=image.html&rect=0,0,1,1&hei=400>, consulted 5 Nov., 2010.

THE CAMEL IN MONGOLIAN EVERYDAY MUSIC

Apart from the herdsmen's calls, which are very important in human-camel interactions, the imitation of animal sounds is considered to be one of the earliest forms of musical expression. The camel as motif, however, is also used in all other later musical categories in Mongolia. The following gives examples of some of these categories, which can be regarded as part of everyday music or ritual music, since the distinction is not always clear.⁴ Only a comparatively small number of such songs are directly related to religion in Mongolian culture.

The herdsmen's calls are used as a herding technique to communicate with the livestock, to take them to the pastures, and another particular form is employed during animal births. There are numerous variations of camel signals used on the pastures, far exceeding those commonly used for other grazing animals. These include:

<i>dūr dūr</i>	–	come here
<i>xōs xōs</i>	–	an imitation of the sounds produced by camels used for soothing a motherless camel calf
<i>xā xō</i>	–	attention
<i>xā xōž</i>	–	go away
<i>sōg sōg</i>	–	lie down
<i>xōž xōž</i>	–	get up
<i>xai xeg</i>	–	everything is all right
<i>xoig xoig</i>	–	more slowly
<i>xii xoig</i>	–	forward/move on!

Caravanners in particular use such commands, but traditionally they do not sing any of the so-called “long song” (*urtyn dū*) genre during their journey (Ceren 2008:95), because they might create the impression that it lasts even longer.

The camel has its established place in legends, parables, metaphors, ritual songs and everyday folk songs, as well as in modern literature. All of these art forms often also convey knowledge of the camel or its significance for the Mongols. Performing music has several important functions in Mongol culture. It does not just constitute a mobilizing process at social gatherings, but is also a manifestation of established symbolism and a display of identities (Kuutma 2006:7, cf. Chuluunbaatar 2010:166). In rural areas, herders' songs related to everyday activities (e.g. milking) are an example of the social function of music. The following custom shows how closely the songs and related work activities are intertwined and how essential they are for the survival of nomadic cultures.

First it should be explained that, strangely enough, the female camel sometimes abandons her newborn. Mongolian camel herders assume that this is because camels often go through severe pain while giving birth (see picture 27). By playing the *morin xūr*, the horsehead fiddle (see picture 28), and by singing special rhythmic *bogino dū* (short songs), and in exceptional cases the not very rhythmic *urtyn dū* (long songs), they attempt to encourage the mother to accept her rejected calf or another camel's orphan. This custom – also used with other animals – is called *tōlō golox*. These practices are deeply rooted in an ancient time, as numerous early reports such as one by Peter Simon Pallas (1776:177–178) indicate. It shows an aspect of maternal care provided to their animals that is uniquely Mongolian and that only became known to the wider public through the Oscar-nominated film *The Story of the Weeping Camel*. Despite the fact that this kind of music is performed in everyday life,⁵ its actual performance in this case has a certain ritual character. For example, before playing the fiddle, the *morin xūr* is hung over one of the humps of the mother camel. This establishes a connection between the person playing the instrument, the camel and the “eternal blue sky”, which is considered sacred by the Mongols. Other instruments, such as the

⁴ While this is self-evident for Mongols, who are concerned with music, it at times contradicts the etic thought of some scientists, who have a certain tendency towards definitive categorization.

⁵ Mongolian herders use this kind of music in animal breeding almost on a daily basis for each of the five groups of animals: camels, horses, cattle, sheep and goats.

aman xūr (jew's harp) or the *limbe* (flute), are also used for this purpose. Just as important as the playing itself is the soft chanting of the words *xōs xōs* by the herdsman, as in the first stanza of the following song. In transcription and in literal translation the stanza reads:

Inge xōslōx učir:

*Angir šarga ūrgiig čin',
amltan šimex ūr n' bolson;
aldrāi byacxan botgō yūnd
andū sanan golson yūm be?
Ōglō bosōd ōmōlzōn zogsōno,
ōtgōn sūgē šimūlē č dē.
Xōs, xōs, xōs,
Xōs, xōs, xōs*

Song to soothe a mother camel:⁶

Your first milk, reddish-yellow like a Mandarin duck,
the young one was born to suck your milk.
Why are you abandoning your little baby?
In the mornings the newborn wakes up and trembles,
please, feed it with your creamy milk.
*Xōs, xōs, xōs,
Xōs, xōs, xōs*

In the context of nomadic life, the above stanza reveals a profound meaning. While the literal meaning of the word *xōs* in the title is any kind of foam, froth, lather and so on, in this case it acts as a metaphor for the froth produced when the camel calf is drinking milk. In the first line of the text, the “reddish-yellow” (*angir šar*) hints allegorically at the color of the first milk (*colostrum*) of a camel cow after giving birth (we find the same metaphor in the song *Ōčīn cagān botgo*). Both the color and the name of this particular milk are metaphorically connected to the Mandarin duck (*angir šuvū* in Mongolian). These migratory birds live in pairs on many lakes in Mongolia and their ducklings follow the alert Mandarin ducks everywhere.⁷ All this is conveyed by mentioning the color *angir šar* to the camel mother.⁸

Another song, “The orphaned white camel calf” (*Ōčīn cagān botgo*), conveys in a lachrymose form how a motherless camel misses its mother. The lyrics deal with the lament of the camel calf and the female singer imitates the agonized cries of longing in the song. Because of this imitation of the cries, the song cannot, musically speaking, be classified as one of the common Mongolian song genres. The result is an uncommon and therefore rare mixture of the musical forms of the *bogino dū* and *urtyn dū* genres, which I would call *boginovtor urtyn dū* (shortened long-song).⁹ A drawn-out but rhythmical melody (which is typical of *bogino dū*) is complemented by elongated vocal ornamentations of the lyrics typical of *urtyn dū* singing, which influence the rhythm accordingly. As far as its content is concerned, the song also assumes the character of an intense lament, which in this case rather takes on the nature of *urtyn dū* singing.¹⁰ In this song, the camel calf wants to cross the mountains to get to its mother. Thus it can be assumed that the mother camel is alive, but beyond the calf's reach. Although not explicitly stated, according to similar epic motifs the mother was probably sold by the herder. The same theme of the White Orphan Camel Colt is known from several Mongolian epics (*tūl*) as well as from various different fairytales. This may be the main reason for the unusual seriousness of the theme and

⁶ For an audio sample of this and other camel-related songs see <http://bit.ly/M6TUJn>.

⁷ As a migratory bird, the Mandarin duck is also often used as a metaphor for the seasons in Mongolian folklore (see e.g. the cited passage of the ritual text *Temēnii dallaga*).

⁸ A song with a different text, but with the same metaphor of the Mandarin duck, is also used in sheep husbandry (cf. Hasumi 1980:142–143).

⁹ *Bogino dū* (short songs) are strophic, syllabic in structure, highly melodic and have precise rhythms, whereas *urtyn dū* are performed by interpreters with an expansive range, plenty of characteristic ornamentation, vibrato and tremolos. In *urtyn dū* the vocal range spans up to three octaves and demands considerable artistic sentiments and skills from the singer. The internationally common use of the literal translation “long song” for the *urtyn dū* genre does not particularly correspond to what it actually means in Mongolian. These songs are not called *urtyn dū* in Mongolian because of their length, but because each sung syllable is stretched (vocally elongated). A translation of this song category closer to the Mongolian meaning would be “extended song”.

¹⁰ A different term for such songs is used by ethnomusicologist Carole Pegg (2001:49). She labels them “lengthened short-song” (*urtavtar bogino dū*). In my opinion, however, this term does not do justice to the song. The famous Mongolian *urtyn dū* singer N. Norovbanzad also places this song in the *urtyn dū* genre (cf. Norovbanzad 2004, liner notes).

the expression of a song that is actually regarded as belonging to the genre of songs of everyday life. In *Xalx*-Mongolian transcription and in literal translation the lyrics read:

Önčin cagān botgo:

*Önčin cagān botgo n
ölsöxiin erxēr builna
öl xalzan ēžiigē
sanaxyn učir builna*

*Xulsny möčriig
xūlan xūlan builna
xurūn činē mōmō
ügüilexiin erxēr builna*

*Dersnii namiag
xemlen xemlen builna
delentei ēžiigē
sanaxyn ixed builna*

*Āvtaixan botgo n
āvygā dagād togloṇo
āv ügüi botgo n
arār tenēd builna*

*Ēžteixen botgo n
ēžē dagād builna
ēžgüixen botgo n
ergēr tenēd builna*

*Övdögnii min zogdor
urgasan č bolōsoi
Övör Xangaig davād
ēždē tavargād očixson*

*Šiliin min zogdor
urgasan č bolōsoi
šiliin xangaig davād
ēždē güigēd xürex yumsan*

*Zögör dūren
zūn olon temēnēs
zūxan langiin ünetei
minii ēž xaičiv*

*Tašügār dūren
tavin ulān temēnēs
tavxan langiin ünetei
minii ēž xaičiv*

*Talyn olon temēnēs
ta min yünd baixgüi ve
engeriin olon temēnd
ēž min yaagād baixgüi ve?*

*Žalga dund belčērtei
žaran šarga ingenēs*

The White Orphan Camel Colt:

The orphaned white camel colt
cries out for he is hungry.
He cries for he misses
his white-faced mother.¹¹

He cries nibbling and
nibbling the bamboo branches.
He cries for he is missing
the finger-sized nipples.

He cries nibbling and
nibbling the tufts of the feather grass.
He cries for he is missing
his mother with udders.

The calves that have fathers
follow their fathers and play.
The fatherless camel colt
wanders behind and cries.

The calves that have mothers
follow their mothers and bleat.
The motherless camel colt
wanders along the ravine and cries.

The hair on my knees,
I wish it had grown.
I would gallop to my mother
crossing over the southern *Xangai* Mountains.

The mane of my nape,
I wish it had grown.
I would run to my mother
crossing over the back of *Xangai* Mountains.

From among the hundreds of camels
filling the ridge.
My mother sold for a hundred pieces (lans) of silver,¹²
where did my mother go?

From among the fifty chestnut camels
filling the side of the hill.
My mother sold for fifty pieces (lans) of silver,
where did my mother go?

In the steppe there are several camels,
why are you not among them?
On the southern mountain slope there are camels,
why are you not among them?

From among the sixty female camels
grazing in the middle of the ravine.

¹¹ The Mongolian text refers to a “small white blaze” on the forehead of the camel mother, which is very rare.

¹² In earlier times, people frequently paid with silver coins or bullion from which different sized pieces were cut off as needed. *Lan* (*liang, tael*) is a Chinese weight unit that was also used in Mongolian settlement areas during the Qing Dynasty (1644–1911).

*žaran langiin ünetei
minii ēž xā yavā bol?*

My mother sold for sixty pieces (lans) of silver,
whereto did my mother go?

*Xailāstyn davāg n
davsan č bolōsoi xō
xalūn xōrxōn mēmē
xōxsōn č bolōsoi*

I wish I could cross
the *Xailāstyn* pass.
I could suckle at
warm lovely udders.

*Burgastain davāgar n
davsan č bolōsoi xō
bulag bolson mēmē
xōxsōn č bolōsoi xō*

I wish I could cross
the *Burgastai* pass.
I could suckle at udders
like from a spring.

*Ar šandyn usnās n
amssan č bolōsoi xō
angir šar ūrgā
amtalsan č bolōsoi*

If I had tried
the water of the river on the southern side.
If I had tasted
the milk colored like a Mandarin duck.

*Dalan cagān tēmē n
talā dagan belčixed
dalai bolson sūgē
sanān sanān builna xō*

Seventy white camels
are grazing on the steppe.
How I miss and cry for the
the ocean-like milk.

Several stylistic characteristics typical of traditional Mongolian music can be observed in the above lyrics. The song is composed of four-line stanzas and shows an alliteration of the initial sounds of the lines. In addition, the words at the end of each verse are often repeated.

The significance of the rich world of sounds in Mongolia, with its basic forces of nature and its ever-present fauna, is represented through the wide range of song genres. Very frequently these songs give accounts of the various gaits of a camel, which are imitated in a rhythmic way both vocally and with stringed instruments, particularly among the western Mongolian *Oirats*.¹³ An example of such a (dance) song is *Žūrā geldene* (The Prancing Camel) (cf. Chuluunbaatar 2007, Track 15)¹⁴. The numerous references to animal gaits in Mongolian folklore are also reflected in different proverbs, as for example in “A three-year old male camel comes prancing along / The grass of the plain is falling”, which stands for “cutting the hair” (Taylor 1954:327).

In an *Oirat-Mongol* song called “The Rendezvous” (*Bolzō*), which can be classified as part of rare genre of the dialog song (*xarilcā dū*), a herdsman uses the camels’ behavior as an explanation or excuse to his lover for not showing up at several rendezvous. In this example, we also encounter the color symbolism that is so important in everyday Mongolian culture (cf. Shukowskaja 1996). With each missed rendezvous, a male camel of another color is brought up, while color adjectives are even attributed to geographical names. Despite all obstacles for the people involved, the song has a positive finale, which is characteristic of *Oirat* chants and by which they can often be distinguished from songs of other Mongolian ethnic groups. As in *Ōnčīn cagān botgo* described above, *Bolzō* also shows alliteration of the initial sounds of the lines. In *Oirat-Mongolian* transcription and in literal translation the lyrics read:

Bolzō

*Ulān būrtai temēgē
xurāna gesen čin yalā dā*

The Rendezvous

Female lover:
You wanted to round up your red male camel and his herd,
that is what you told me, what happened?

¹³ Numerous Mongolian melodies imitate camel paces: walking (*alxax*), gentle trotting (*vergōx*), trotting (*šogšix*), fast trotting (*xatirax*), slow galloping (*tsogix*), galloping (*davxix*), fast-paced galloping (*tavrax*), prancing (*devxrex*) and so on. Some *bii* dances also imitate camel paces, such as the *bii* dance of the *Zaxchin Oirats* called *Bulgan šaryn yavdal*.

¹⁴ For an audio sample of this and other camel-related songs see <http://bit.ly/M6TUJn>.

ulān xürengiin zax dēr
ülzana gesen čin yalā dā

At this red-brown edge of the valley,
we would meet, you said to me, what happened?

Ulān būrtai temēnūd
usand orōd sātālā dā
ulān xürengiin zaxār
üyerlež ursād očsongui

Male lover:
The red male camel and his camels
went into the water to drink, that is what held me up.
At this red-brown edge of the valley,
there was high water, that is why I could not come.

Xar būrtai temēgē
xurāna gesen čin yalā dā
xatū zōlōngiin zax dēr
xargaldana gesen čin yalā dā

Female lover:
You wanted to round up your black male camel and his herd,
that is what you told me, what happened?
At this smooth-hard edge of the valley,
we would meet, you said to me, what happened?

Xar būrtai temēnūd
xargana rū orōd sātālā dā
xatū zōlōngiin zax čin
xar anxui bolōd očsongui

Male lover:
The black male camel and his camels,
they went into the pea shrub to eat, that is what held me up.
At this smooth-hard edge of the valley,
it suddenly got dark, that is why I could not come.

Xüren būrtai temēgē
xurāna gesen čin yalā dā
xüren xürengiin zax dēr
xürnē gesen čin yalā dā

Female lover:
You wanted to round up your brown male camel and his herd,
that is what you told me, what happened?
To this brownest edge of the valley,
you would come, you said to me, what happened?

Xüren būrtai temēnūd
xövōgōr garād sātālā dā
xüren xürengiin zaxār
xüiten bolōd očsongui

Male lover:
The brown male camel and his camels,
crossed the steppe, that is what held me up.
At this brownest edge of the valley,
it got cold, that is why I could not come.

Tormon šartai temēnūd
toglon cuvād baina dā xō
tanxil xongor bīd xoyor
tārād sūx n damžigui

Together:
The two-year-old yellow male camel and his camels,
they play and walk one after the other.
My spoilt darling, we both,
belong to each other and will no doubt be together.

THE CAMEL IN MONGOLIAN RITUALS

In spring, special rituals for camels are performed that can be traced back to the fire cult.¹⁵ Mongols worship fire in the form of a nature deity, which belongs to one of their oldest religious beliefs. This ritual is performed with varying intensity, in various ways and on different occasions. It is also celebrated in spring, when it is necessary to bless the weakened camels when they have overcome the hardest season. Such good fortune rituals are part of the *dallaga* (um. *dalaly-a*) rituals. *Dalaly-a* (to beckon) is the term applied to any ritual beckoning good fortune. In it, the participants move their stretched out arms horizontally in a clockwise direction and try to propitiate the spirits by shouting “*xurai, xurai, xurai*”. There are some slightly different text versions of varying length for this camel blessing ritual (um. *Temegen-ü dalaly-a*).¹⁶ The titles of two of the

¹⁵ Even the fireplace, which is traditionally located in the center of the yurt, is considered sacred by Mongols and is protected by various taboos. It is not allowed to pollute the fire or bring it into contact with pointed objects. The sacrifice of first fruits that are offered to the fire before each meal is an indication of a very intense fire cult. The belief that the fire has to be worshipped is among the oldest religious beliefs of the Mongols and was later adopted as by Buddhism. For a more detailed discussion of the fire cult see Poppe (1925).

¹⁶ A manuscript from the 19th century in Uigur-Mongolian script entitled *Temegen-ü yalun taily-a orosibai* ([Here] is the Fire Offering for Camels) is kept at the Library of the Hungarian Academy of Sciences (The Mongol-Manchu Collection, MS 215). Another document written in the *Oirat* “Clear Script” (*todo bičig*) entitled *Temēnī*

manuscripts contain the Mongolian word *sudur*, a polysemous word that means “collection of texts”, but also “*Sūtra*” (skr., teachings on or commentaries of individual rules in Buddhism) in the Buddhist context. Clearly originating from folk religion, this ritual was integrated into the Buddhist belief system as a local particularity, or they tried at least to influence its original character. This is especially demonstrated by the version of the manuscript in which both the country of Tibet and the holy residence of the Dalai Lama are called upon for a blessing (Rintchen 1959:52). Thus the two titles can be literally translated as “*Sūtra* of the Virtue and Fortune of the Camels”. In addition to the above-mentioned alliteration of the individual initial sounds of the lines, the poetic analysis of the following example shows a vertical alliteration of different syllables that are repeated in various lines.

In *Xalx*-Mongolian transcription and in literal translation the lyrics of the first four stanzas read:

Temēnii dallaga:

*Cagān cen šuvū irexüid
cast ūl gesxüid
cagān šaragč inge botgoloхuid
caglašgüi ix buyant dallaga avnam
xurai, xurai, xurai*

*Xun šuvū irexüid
xur casan gesxüid
xuagčün inge botgoloхuid
xutagt ix dallaga avnam
xurai, xurai, xurai*

*Angir šuvū irexgüi dor
atar gazryn nogō urgaxui dor
atigar xaragč inge botgoloхui dor
aldal ügüi ašdyn ix dallaga avnam
xurai, xurai, xurai*

*Nugasan šuvūn irexüi dor
nūryn us gesexgüi dor
nomxon zant temē botgoloхui dor
nomyn ix dallaga avnam
xurai, xurai, xurai*

The Camel *dallaga* Ritual

While the white tundra swans are arriving,
while the snow-covered mountains are melting,
while the yellow-white camel is having its young,
we ask for timeless great prosperity.
xurai, xurai, xurai

While the swans are arriving,
while the snow is melting,
while the old camel is having its young,
we ask for prosperity rich in blessing.
xurai, xurai, xurai

While the Mandarin ducks are arriving,
while the virgin land is thawing,
while the small black camel is having its young,
we ask for flawless prosperity.
xurai, xurai, xurai

While the ducks are arriving,
while the ice on the lake is thawing,
while the gentle camel is having its young,
we ask for great educational prosperity.
xurai, xurai, xurai

Camel rituals are also performed for other purposes. The written text (Rintchen 1975:58–59) of such a ritual (*Temegēni jaṣal kekü sudur ene bui*) contains Buddhist elements such as corresponding mantras (invocation formulas for meditation).

THE CAMEL IN MONGOLIAN RITUAL MUSIC

The camel also has its place in ritual music. Here, above all, the musical genres of the *yerōl* (wish-praying), the *magtāl* (praise-song) and the *tūl* (epic) should be mentioned. *Temēnii yerōl* are sung to support camel herders in camel breeding, especially in the number of births and against the loss of young animals, against harsh weather, against the loss of animals to wolves, against animal diseases etc. *Temēnii magtāl* are performed less often and primarily as thanks-giving rituals, for example if a motherless camel calf was accepted by another mother camel or

buyan xišgīn sudur can be found in the Institute of Language and Literature of the Mongolian Academy of Sciences (Oirat Manuscript No. 70). Two other versions entitled *Temegen-ü dalaly-a sudur orosibai* and *Temegen-ü yalun takily-a orosibai* were published by B. Rintchen (1959:49–50, 1975:20–21). The photograph of another manuscript (um. *Temege[n]-ü buyan kesig-un sudur orosibai*) shows a very abbreviated version with mistakes in the handwriting (http://www.flickr.com/photos/erdeni-yin_sang/461941122/in/photostream#/, consulted 25 Sept., 2010).

if no or only few animals were lost in winter. As far as the content of these two musical genres is concerned, the special qualities of the camels are described and represented in the performance.

As in everyday music, the great significance of white camels among the Mongols is also evident in ritual music (cf. Fedotoff 1997). The following example shows that this has its origins in very early times. In the epic *Sarig cagān ingenii önčin cagān botgo* (The orphaned white camel calf of the snow-white female camel), the blind camel herder dazzled the female camel and cut her tendons so that she could not escape (Katu 2005:182). While stamping around on the newborn camel, he already feared its eventual revenge. The camel calf wept for his mother and subsequently watched over her. Because of his intelligence, she finally recovered. At three years of age, the white male camel was indeed thirsting for revenge. So the scared camel herder asked the hero *Bičin Mičin Gerel Xān* for help. Endowed with magical powers, he transformed the herder into a rat so that he could hide more easily in a pile of ashes. But when the male camel caught sight of him, he crushed the rat by trampling on the ashes and could then live his life in peace.

Elements of this story can also be found among the *Oirat Zaxčin* of western Mongolia in a *tatлага* entitled *Sarig cagān inge* (The snow-white female camel), which the Mongolian musicologist Ž. Enebiš recorded in 1971 (Cerensodnom 1982:68–69).¹⁷ Examples mentioned are the attempt of the camel mother to get up without her Achilles tendon and the camel calf's grief for his mother expressed in a special form. This particular grief is also reflected in the song *Önčin cagān botgo* (see above). For a *boginovtor urtyн dū* or an *urtavtar bogino dū*, a genre that is concerned with everyday music, this has to be considered very rare.

In consequence, it can be assumed that the epic described here and the *tatлага* cannot just be traced back to the same origin, but that they probably stem from an early form of handed down Mongolian epic. The Mongolist D. Cerensodnom (1982:66) assumes that the epic and the *tatлага* are somehow connected, since the *tatлага* as a musical form preserved characteristics of a uniform art. These art forms (dance, music and poetry) – separate today – originally had a uniform character and only later started to diverge (Cerensodnom 1982:64–65). Here the *Oirats* of western Mongolia should be mentioned, since they are the only group who dance the *bii-dance* (also *biyelgē* dance) to the *tatлага* melody, while other Mongolian ethnic groups do not know this art form.¹⁸ In this early version of a folkloric text, the color white in connection with the camel is already apparent as a formative element of the Mongols.

THE CAMEL IN MONGOLIAN FOLKLORE

While the motif of the enmity of the camel and the rat known from the epic *Sarig cagān ingenii önčin cagān botgo*, it also appears in a popular Mongolian legend (*domog*) called *Temē yagād ünsen dēr xörvödög ve*, where the camel has another reason for rolling in the ashes. This legend explains why the camel is not part of the twelve-year Buddhist calendar and why it looks the way it does today. This story is told in numerous similar versions and is also depicted in the visual arts (cf. Zhambaldorzh 1997:86):

How it came about that the camel rolled in the ashes

A long time ago the Buddha created the Mongolian twelve-year calendar whose cycle is based on the names of 12 animals. Many animals offered their names. The camel and the mouse fought over the

¹⁷ The term *tatлага* commonly designates the instrumental rendition (mostly with the *morin xūr* or the *Oirat ikil*) of a dancing song. Thus recorded versions of performances of the lyrical texts of legends or epics set to the tunes of a *tatлага* are very rare. The melody of the *tatлага* (without text) as recorded on CD by Altai-Hangai (1999, Track 13) serves as a sound document.

¹⁸ Today there are 27 ethnic groups (*yastan*) of Mongol or Turkic origin in Mongolia (Dashbadrax 2006:135). Nine of these groups belong to the *Oirats*, who represent a minority.

last empty place, the one at the beginning of the cycle. As the Buddha left it up to them to decide, they made a bet. The first to see the rising morning sun would win. The camel waited for the sun in the east. The mouse that had climbed up on the camel's hump, however, looked at the snow-covered mountaintops in the west and was the first to see the reflected rays of the sun. So the mouse won the bet and at the same time the place in the Mongolian calendar. The camel, confident of victory, was so furious to have lost the bet that it wanted to trample the mouse to death. The mouse ran for cover and quickly hid in a pile of ashes, whereupon the camel tried to crush the mouse by rolling on the ashes. And even though the camel was not accepted into the calendar, its body has the special features of those animals that belong to the calendric cycle. These features are: the ears of the mouse, the stomach of the cow, the paws of the tiger, the lips of the hare, the body of the dragon, the eyes of the snake, the mane of the horse, the wool of the sheep, the hump of the monkey, the comb of the rooster, the legs of the dog and the tail of the pig.

Since camels like to roll in ashes to protect themselves against insects and parasites, herders always relate this to that legend, which they then pass on to their children.

While the frequent subject of rolling in the ashes supports the conclusion that it is of an earlier origin, the appearance of the camel with the features of the twelve other animals also found its way into other art forms, such as the rhythmic hymn (*col*), as the title *Temē collox üg* (Song of praise for the camel) shows (cf. Zhambaldorzh 1997:216–217). A story that is similarly popular among the Mongols and that also has many variations is the story of the camel that was cheated of its antlers by a deer:

One day, when the camel went to the river to drink, a deer came by. The deer admired the beautiful antlers the camel had at that time in contrast to the deer, who had none. So he asked the camel to lend him the antlers for a wedding he had been invited to. Since the camel was friendly and ready to help, he agreed, on condition that the deer would return the antlers the next day at sunset. The deer was very happy and proud to present his antlers at the wedding celebration. When the camel came back to the river the next day, he looked for the deer, but he did not show up. That is why today camels still lift their heads after each drink of water and look around in the hope that the deer might keep his promise after all.

Mongolia's nomadic herders have developed social and economic values that are different from those of settled agricultural communities (Campi 1996:94). Although the effects of migration to urban areas can now be seen, Mongolian pastoralists' relationship with the camel can be seen as one of the oldest, most diverse and endearing relations in human history.¹⁹ One day the camel will be completely replaced as a means of transport, but it will probably always be an integral part of Mongol culture. This can also be concluded from the examples of symbolism provided in this paper and from the music that Mongolian nomads love. In the catalog of motifs comprising love of the family, the homeland, nature and the horse, the camel can be said to be one of the essential motifs of Mongolian folklore.

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¹⁹ While in 1989, a year before the political transition from a communist state to a democratic government, the livestock population comprised 558,000 camels (Source: Ministry of Food and Agriculture, Sheehy 1996:46), this fell to 260,600 by 2007 (NSO 2007:198). As Mongolian herders mostly breed several different kinds of animals, the number of herders living exclusively on camel husbandry is not known.

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PART IV

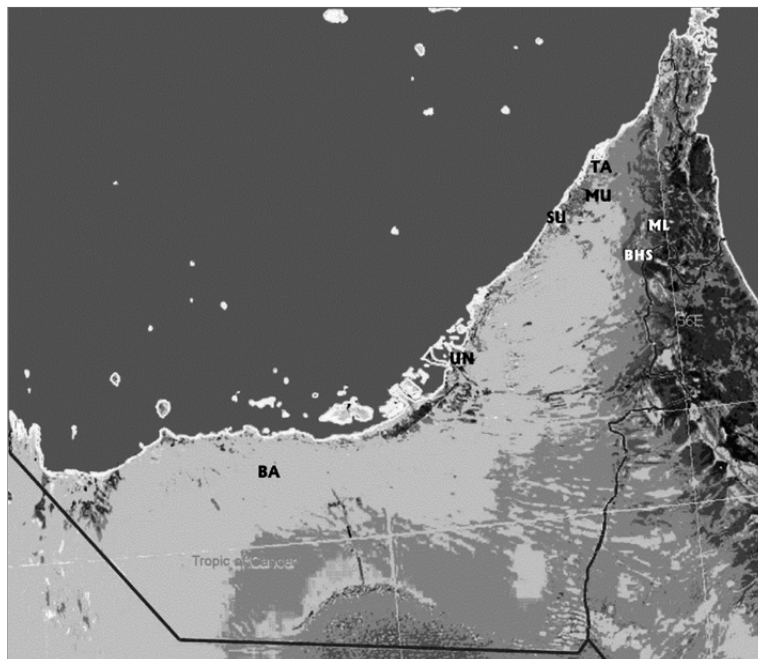
DROMEDARIES

(Camelus dromedarius)

Archeozoology of Camels in South-Eastern Arabia

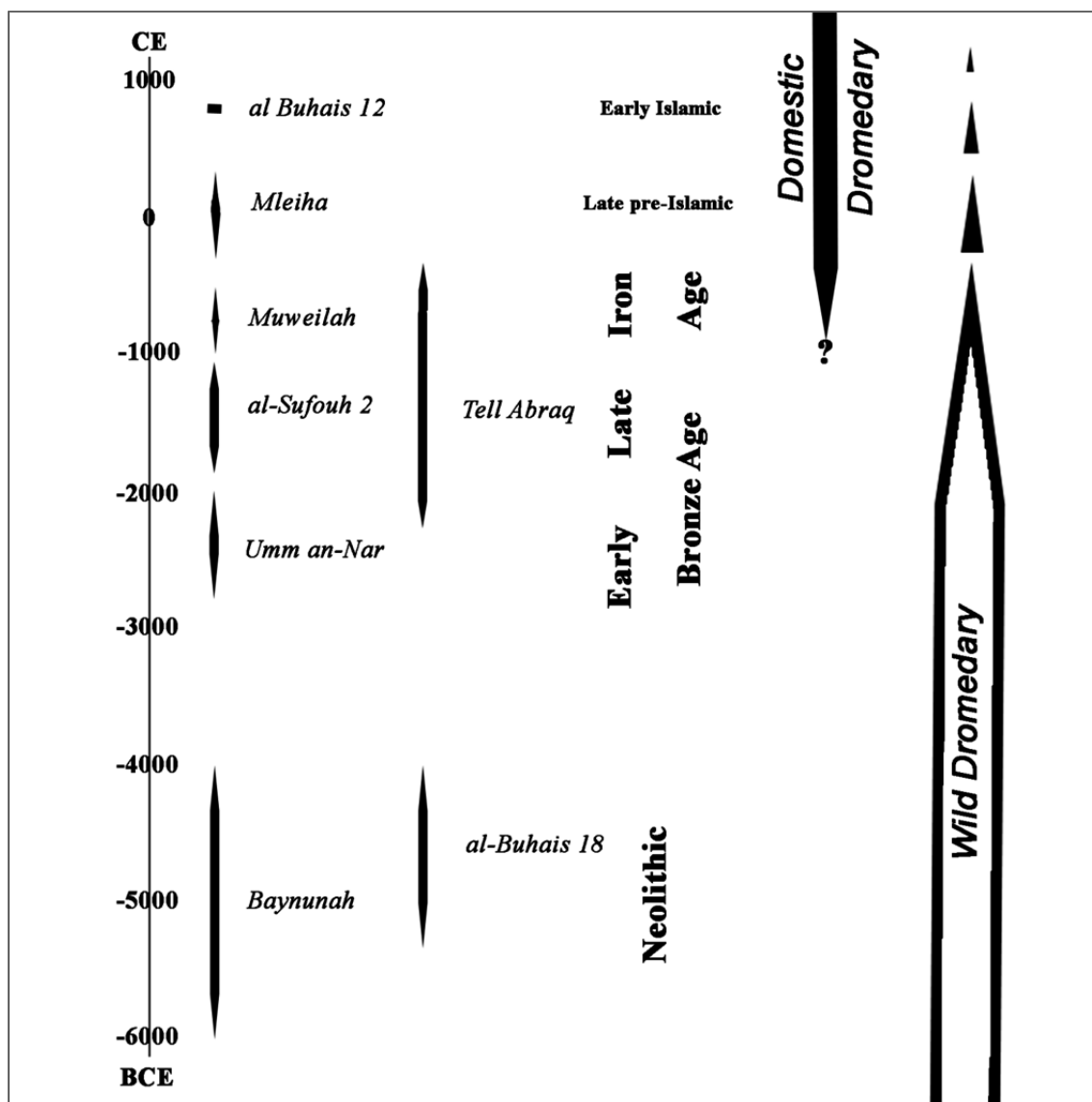
In the western world when we talk about the desert we immediately imagine camels as well. The camel as “ship of the desert” is a well-known topos in many languages. In the Arab culture, in the world of the Bedouins, the notion of camels evokes much more. Apart from a means of locomotion and transportation, camels represent an aid to survival, a lifestyle, and objects of admiration, poetic inspiration and cult. The camel’s significance is emphasized in the Holy Quran and in Islamic literature in general: the twenty-three camels of Prophet Muhammad are proverbial. The Arabic language includes many different words for camels.¹ Because of these deeply rooted alliterations it is not surprising that most people – including many archeologists – have difficulty in imagining human life in the desert without the camel. Thus all sorts of speculation and assumptions about the very early development of the close relationship between humans and camels in pre- and protohistoric times have been put forward.

This is also true of SE Arabia, where archeology as such has a fairly short history – just a little more than 50 years (Potts 2009:14). Archeozoology, the scientific evaluation of faunal materials from archeological excavations, has an even shorter history in this part of the world. As an additional difficulty, bones and other organic materials are generally not well preserved in sandy soils. Nonetheless, recent archeological activities have meanwhile produced sufficient numbers of camel bone finds from several archeological sites, dating from the Neolithic to early historic time (see graphs 17 and 18). It is therefore now possible to join the ongoing discussions about man and the camel in South East Arabia from the standpoint of archeozoology. This seems essential, as up to now there has been extreme disjunction between the extensive discussions of the camel question from the historical side – that is, from textual and pictorial evidence – and the archeological side based on actual findings from excavated contexts. The available



Graph 17: Location of the archeological sites in the United Arab Emirates mentioned in the text:
BA = Baynunah,
BHS = al-Buhais 12+18,
ML = Mleiha,
MU = Muweilah,
SU = al-Sufouh 2,
TA = Tell Abraq,
UN = Umm an-Nar

¹ For a more detailed discussion about Arabic camel names see the article by Darem Tabbaa in this volume.



Graph 18: Chronology of the archeological sites and periods mentioned in the text and of the disappearance of the wild and appearance of the domestic dromedary

archeozoological evidence from SE Arabia comes almost exclusively from the territory of the United Arab Emirates. Although archeological research is also progressing in the Sultanate of Oman, not much new information on camels has been put forward recently. This paper will therefore concentrate on findings in the UAE. Fig. 1 indicates the locations of the respective sites.

THE WILD ANCESTOR OF THE DOMESTIC DROMEDARY

So far the domestic dromedary does not have an “official” ancestor. There is no valid scientific description of the Holocene² wild dromedary in Arabia. The name *Camelus* “arabs” was proposed by the present authors (Uerpman/Uerpman 2002), but at that time the available archeozoological materials were insufficient for a meaningful description of a “new” species. Meanwhile there have been enough finds of Holocene wild dromedaries, but a formal description still needs to be published in order to provide a valid scientific name for the wild ancestor of the domestic dromedary – unless, as assumed by von den Driesch and Obermaier (2007), the Pleis-

² Holocene: the present geological period, which began ca. 10,000 years ago at the end of the Pleistocene or “Ice Age”.

tocene North African *Camelus thomasi* (Pomel 1893) is considered identical to the Holocene wild dromedary of the Arabian Peninsula. If generally accepted, *Camelus thomasi* must then be considered the wild ancestor of the dromedary.

Contrary to earlier assumptions, there is no doubt that *Camelus thomasi* was more closely related to one-humped camels than to two-humped camels (Peters 1998). Given the geographical and ecological separation of the potential areas of distribution, however, complete zoological species-identity of the wild camels in South West Asia and North Africa should not *a priori* be taken for granted. In our opinion this question should be left open for the time being, because paleogenetic research might soon find means of quantifying the relationship between the fossil species involved. If the Late Pleistocene camels of North Africa (between 100,000 to 10,000 BCE) turn out to be genetically identical to the Holocene wild dromedaries of Arabia (from 10,000 BCE to around 100 CE), then these last ones must be included into that species.

The ancestry problem of the dromedary was further complicated by the findings of a Pleistocene “giant” camel from Syria (Schmid in Le Tensorer et al. 2007). The name “*Camelus moreli*” was proposed for these finds, but their description is too incomplete to be considered a valid denomination of a new species. Apart from the “giant” specimens, “normal” sized camel bones were found in the same contexts. The available documentation raises the question of whether the observed size differences do not simply represent sexual dimorphism within a Pleistocene population otherwise closely related to the Holocene wild camels of the area. In any case, the presently available knowledge about these finds does not help to better define the wild ancestor of the Arabian dromedary.

ARCHEOLOGICAL EVIDENCE

Even without having a proper scientific name, the Holocene wild Arabian dromedary is meanwhile a well-known animal. An initial result derived from excavations at a site called BHS18 at Jebel al-Buhais in the interior of Sharjah Emirate (UAE, see graph 17). BHS18 is a Neolithic graveyard surrounded by many fire-pits and other indications of the repeated presence of nomadic herders. Obviously the site was visited seasonally during several centuries from the end of the 6th to the beginning of the 4th millennium BCE (Uerpmann, H.-P. et al. 2006, 2008). Although animal bones were badly preserved at the site, some 45 bone fragments could be identified as camel remains. These finds were attributed to the wild dromedary on the basis of the Neolithic date of the site. The bones were so fragmented that no measurements could be taken, but luckily it was possible to reconstruct the diastema part of a mandible (Uerpmann M. et al 2000, Uerpmann/Uerpmann 2008a:103, fig. 3). Its morphological features indicated the one-humped rather than the two-humped camel. This observation was quite important at the time of this discovery, because the earlier assumption that both kinds of domestic camel – the one-humped and the two-humped variety – had a single wild ancestor, namely the Central Asian *Camelus ferus* (Przewalski 1878), was still favored by some researchers at the time.

The knowledge about wild Arabian dromedaries in the Neolithic period was further increased by the subsequent discovery of the “camel site” of Baynunah, some 130 km south-west of Abu Dhabi in 2003 (see BA in graph 17). Baynunah is located in an interdunal area on the northern fringes of the Rub al-Khali. A substantial number of camel bones were found there, eroding out of the modern ground surface (Beech et al 2009). Subsequent fieldwork revealed a thick layer of flood deposits, including numerous camel bones covering an area of about 100 X 90m. The bones obviously derive from many individuals, some of them preserved as relatively complete skeletons. They show no signs of pathology and no butchery marks. The lower part of the section indicates repeated wet episodes at the site. During these periods the site was a good water hole for the local wild fauna. Radiocarbon dates suggest that the accumulation of the bones started in the early to mid 5th millennium BCE, ending during the 4th millennium BCE. Apparently camels died there naturally during hyperarid phases (Beech et al 2009). The end of

the 5th millennium marks a significant climatic change towards a dryer climate (Parker/Preston 2008).

Another important “camel site”, in this case belonging to the Late Bronze Age (see graph 18) *Wadi Suq* period, is Al Sufouh 2, found by rescue excavations in Dubai Internet City, about 1 km inland of the present coastline (Gruber et al. 2005; see SU in graph 17). Here again the main finds were camel bones, some 18,000 specimens deriving from at least 60 individuals. The faunal material was studied by Von den Driesch and Obermaier (2007), who concluded that there are still no signs of domestication (compare graph 19) and that the animals were wild dromedaries. The non-anatomical arrangement of the finds and many butchery marks on the bones suggest that the camels were hunted and slaughtered at the site. Hearths in the vicinity of the bones indicate that they were also eaten there (Gruber et al. 2005). Obviously the site was visited seasonally for camel hunting. Apparently the animals were attracted to the area by the halophytic plants in the salt marshes and in particular by the rich stands of *Avicennia* mangrove.

Wild camels in coastal environments close to lagoons do not easily fit the popular imagination of “camel and desert”. It is even more difficult to imagine wild camels existing on small islands in a lagoon environment. This is one of several reasons for the interpretation of the camel bone finds from Umm an-Nar Island as remains of domestic dromedaries (Hoch 1979, see UN in graph 17). This site is the famous eponymous harbor site of the Early Bronze Age (c. 2600–2000 BCE) off the Abu Dhabi coast. The high number of camel bone finds was interpreted by some authors as indication of domestication of this species (e.g. Dobney/Jaques 1994: 113–114). Another reason to assume domestication was their demography – including a remarkable amount of juvenile and infantile individuals, as already mentioned by Hoch (1979: 613) and again by Rosen/Saidel (2010:74). A further argument (Tosi 1989:139) was the iconographic representation of one-humped camels on the outer facing stones of the famous Umm an-Nar tombs (see picture 29). An additional argument is based on far-reaching trade connections, which could not be imagined without the possession of dromedaries as beasts of burden (Frifelt 1975:366).

Based on new faunal studies, the present authors (Uerpmann, H.-P./Uerpmann, M. 2002, Uerpmann M./Uerpmann H.-P. 2008b, Uerpmann, M./Uerpmann, H.-P. in press) argue that these assumptions are not sufficient to prove a domestic status of the Umm an-Nar camels. This is not the place to discuss all arguments in detail. Apart from the fact that the bones from Umm an-Nar are within the size-range of wild dromedaries (graph 19) one has to focus on the special ecological situation of the Umm an-Nar site. It is on a fairly small island near the landward end of the lagoon north of Abu Dhabi Island. The island is much too small to keep a herd of domestic camels all year round – in particular if there were sheep, goats and cattle as other domestic ungulates as well.

Apparently the main function of the site was as a harbor (Frifelt 1995, 240–241), and it must have been quite difficult to sustain the human population of the site in that particular environment. The nearly exclusive use of wild resources from on and off the island, ranging from fish, turtles, dugongs, dolphins and whales from the marine environment to oryx, gazelles and the wild dromedary from the mainland was the predominant means of achieving (Hoch 1979, Uerpmann M./Uerpmann H.-P. 2008b). With regard to the camels, human predation strongly influenced their demography. Heavily exploited, the wild camels – although replenished by animals from the desert hinterland – would soon have undergone a demographic change of their population structure towards an increase in the proportion of young animals. This is a known reaction of wild ungulate populations to heavy hunting pressure (Koike/Ohtaishi 1987). The wild status of the camel finds from Umm an-Nar is also underlined by the fact that during the same period important sites in the interior such as Hili 8 and Maysar – sites with a stable subsistence economy based on animal husbandry – have no or only single finds of camel bones (Uerpmann M./Uerpmann H.-P. 2008b).

PROBLEMS OF DETECTING CAMEL DOMESTICATION IN ARCHEOLOGY

From a biological point of view, domestic animals are defined by exhibiting typical inheritable differences from their wild ancestors. From an archeological viewpoint, domestic animals are characterized by a particular man-animal relationship, which makes them available for different purposes required by humans, who keep the animals at their disposal. Recognizable differences between wild and domestic animals are not necessarily required by the archeological definition. This is why many archeologists can easily imagine an early phase of animal domestication, neither recognizable in the outer appearance nor in the skeletal morphology of these animals. The related problems cannot be discussed here in detail. In the case of camels, however, it is obvious that adult wild animals could not be tamed to the extent that they might have been handled by people. This is still difficult enough with adult domestic camels today.

The people who first brought camels under human control – both the two-humped and the one-humped species – already had a long tradition of handling domestic animals, including cattle as animals of comparable size and strength. They would have known that taming had to be started with very young animals and that selection of appropriate individuals was crucial. Under human control both the biological and social environment of the animals will have been very different from natural conditions. In spite of the slow reproductive cycle of camels, the resulting biological changes within the small populations, first brought under human control, would therefore have been comparatively fast. Ten generations or a time span of between about 50 and 100 years were most probably enough to produce a visible diminution of average body size – a common indicator of early domestication in populations of medium to large mammals (H.-P. Uerpmann 2008). None of the archeological sites discussed above as “camel sites” in SE Arabia were short-lived enough *not* to have produced recognizable remains of early domestic camels – if an incipient domestication process would really have happened at these sites. Empirically, about five to ten generations (in camels not more than 50–100 years) would be long enough to cause size diminution. This does not contradict the statement that the nature of particular relationships between camels and humans must also be determined by archeological observations (e.g. Rosen/Saidel 2010). Nevertheless, even incipient domestication profoundly involves the animals as well, and their biology would have reacted correspondingly. If the animals did not react, this means that human control over the animals did not go beyond normal prey-monitoring to the extent needed by all hunters in order to find their prey.

In any case, the period without recognizable morphological differences between the wild and domestic status of camel bone finds would have been quite short – certainly shorter than the millennium that passed between the end of the Early Bronze Age and the Iron Age – the time when the domestic dromedary appears in the archeological record of SE Arabia. The obvious lack of remains of domestic dromedaries at al-Sufouh (Wadi-Suq-phase of the Late Bronze Age, see graph 18 and above) and their presence at Muweilah (Iron Age II, see below) indicates that dromedary domestication (or introduction of the domestic form) must have happened in the transitional period from the Bronze to the Iron Age or during Iron Age I (around 1000 BCE). This may have been influenced by the presumably earlier domestication (or introduction) of the two-humped camel in southern Iran. However, to our knowledge there is so far no biological evidence available for the early domestication of the Bactrian camel. An osteological indication comes from the appearance of bone finds from two-humped camels in Late Bronze Age levels at Tell Sheikh Hamed in northern Syria prior to the appearance of dromedary bones in Iron Age levels of that site (Becker 2008). The observations at Shahr e-Sokhta in south-eastern Iran (Compagnoni/Tosi 1978) might also point in that direction.

EVIDENCE FROM TELL ABRAQ (EMIRATES OF SHARJAH AND UMM AL-QUWAIN)

Tell Abraq is situated on the borderline between the Emirates of Sharjah and Umm al-Quwain. It is one of the few Tell sites in SE Arabia, which means that it was inhabited during several archeological phases over a long time-span (see graph 18). It is situated near the former south-

ern shore of the Umm al-Quwain lagoon. Its ecology during the Bronze Age was probably similar to that of Umm an-Nar or al-Sufou 2 (see TA, SU and UN in graph 17). The shells found in the early layers of the site clearly indicate a mangrove environment. The site is remarkable for its long settlement sequence covering the time from about 2200 BCE to 300 BCE (Potts 1993, 2000).

During the Early Bronze Age the animal economy of Tell Abraq, as reflected by the faunal remains, resembles that of Umm an-Nar with regard to a low proportion of domestic animals and the substantial use of wild resources. Wild camels contributed a lot to the meat supply of the early inhabitants, but their share decreased over time and camel bone finds disappear at the end of the Bronze Age – probably due to over-exploitation of the local wild camel population. There are no camel remains at all in the sample studied for the Iron Age I period. However, the sample size is quite small for this period and thus not completely conclusive (see picture 30).

In the Iron Age II (c. 1000–750 BCE) sample, the dromedary re-appears among the animal remains. However, these bones are clearly different in terms of size from those of the Bronze Age. Thus they provide evidence of the domestic status of the animals (Uerpmann M. 2001, Uerpmann H.-P./Uerpmann M. 2002). The small bone sample from the Iron Age III does not contain camel remains, but is generally dominated by medium-sized animals (sheep and goats) reflecting a different economic status of the inhabitants of the site at that time just before Tell Abraq was abandoned as a major settlement in the following ed-Dur phase. On the whole, the stratigraphic sequence of Tell Abraq gives clear evidence for a gradual disappearance of the wild dromedary during the Bronze Age – probably due to over-exploitation – and a reappearance of this species as a member of the domestic fauna during the Iron Age. Unfortunately, the faunal samples from the Iron Age layers are too small to provide detailed insight into the role of camels at Tell Abraq during this period.

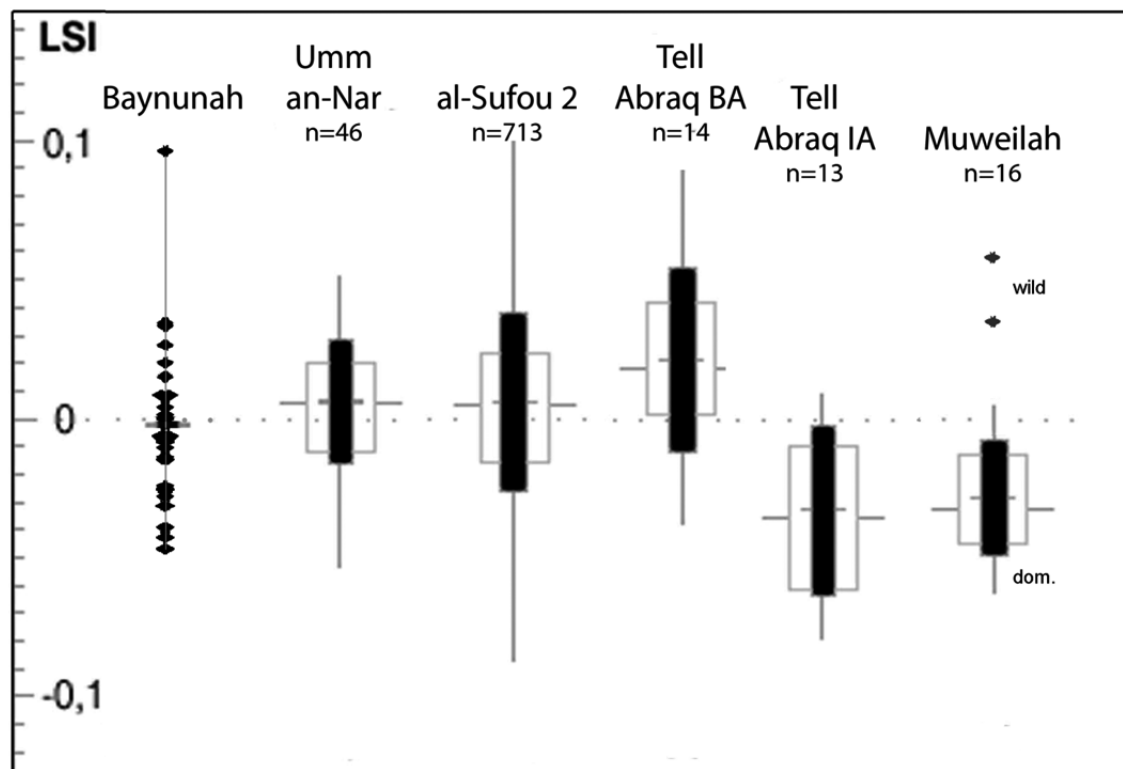
THE IRON-AGE II DROMEDARY REMAINS FROM MUWEILAH (EMIRATE OF SHARJAH)

Muweilah is a large Iron Age II site situated in the eastern outskirts of Sharjah City (MU in graph 17). It is dated by multiple radiocarbon determinations to around 850 BCE (Magee et al. 2002). Several thousand animal bones have already been studied by the authors and faunal analyses are still continuing. The domestic dromedary played an important role in the economy of this site (Uerpmann M./Uerpmann H.-P., in press). According to the weight proportions of the bone finds almost 30% of the meat eaten at Muweilah was from dromedaries. Only sheep were more important as meat producers. However, this does not necessarily indicate that the dromedaries were domestic animals. At al-Sufou2 almost 100% of the mammal bones are from wild dromedaries (Von den Driesch/Obermaier 2007). The two sites are less than 30 km apart. Although Muweilah is a little farther from the coast, the environmental setting of the two sites is very similar. The chronological difference is more difficult to define, because the camel bones from al-Sufou yielded a wide range of radiocarbon dates (Von den Driesch/Obermaier 2007:144), however, there will not have been more than 1000 years between the two assemblages. From what is known about environmental changes within that millennium, the environmental differences should not have been able to cause much morphological difference between the wild dromedary populations of both sites. Nevertheless, the dromedaries at Muweilah were statistically different in terms of body size from those of al-Sufou 2.

As a general rule, animals in the size-range from cats to cattle became smaller when they were first domesticated. This does not exclude the possibility that they could later become larger again through selective breeding. An overall reduction in size can also be observed in the Iron Age camel finds from Muweilah and Tell Abraq in comparison to the earlier finds, not only from al-Sufou 2 but also from Umm an-Nar and Baynunah. It is interesting to see that the large sample from al-Sufou 2 includes some small individuals, indicating that domestication does not “create” small animals but simply selects the smaller ones from the wide natural range. Two

finds in the upper size range from Muweilah are considered to represent hunted wild dromedaries. Hunting scenes in the Arabian rock art – stylistically attributed to the Iron Age – also indicate that the wild one-humped camel still existed during that period.

As skeletal dimensions are directly related to the size of the respective animals, comparison of bone-measurements is a simple means of obtaining evidence for the size-ranges of animals found at archeological sites. The calculation of the “Logarithmic Size Index” (LSI) is a simple means of producing comparable indicators for bone sizes deriving from different skeletal elements. It is generally applied in order to scale breadth and depth measurements of weight-bearing skeletal elements of the legs and allows direct comparison between different assemblages of bone finds. Graph 19 represents the size ranges of archeological dromedary finds in the form of “box and whisker plots”, where the black box represents the standard deviation of the LSI values around the mean of the respective assemblage, while the whiskers indicate minima and maxima. The open box comprises the inner quartiles of the values and the position of the horizontal whiskers indicates the median of all LSI values.

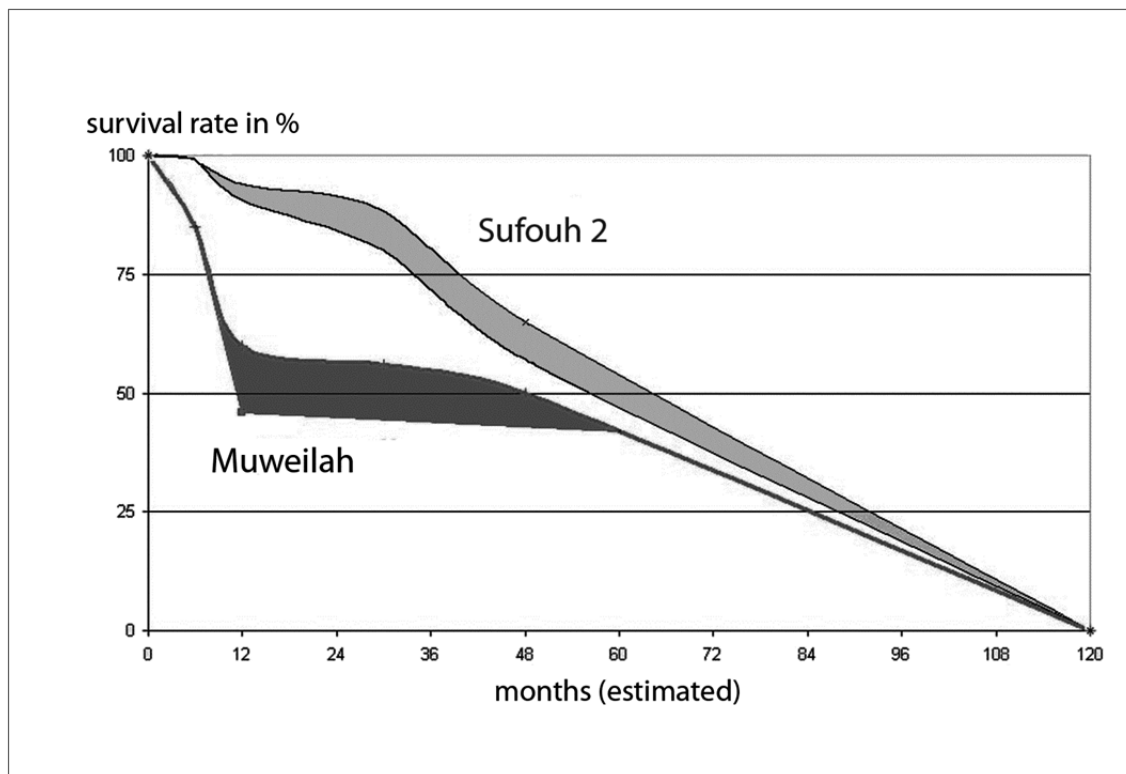


Graph 19: LSI distributions of dromedary bone finds from Neolithic to Iron Age sites in the UAE

Interestingly, the LSI values for the Neolithic dromedaries from Baynunah, transferred directly into graph 20 from the graph published by Beech et al. (2009), indicate that most of these animals were comparatively small. There is only one really large one among them, but about a third of the LSI values are in the range of the Iron Age domestic camels. This observation can be explained by the nature of the Baynunah site, where wild dromedaries died of natural causes when there was not enough rain to flood the interdunal basins and when water and vegetation there were insufficient. Only the larger and stronger individuals would have had the energy to leave the area for somewhere better before it was too late to escape. This was certainly one of the mechanisms that selected for the large body-size of the wild camels.

Conversely this also explains why domestic dromedaries can be smaller than their wild counterparts: herders would have recognized early enough when it was time to leave a desiccating area with their animals. On the other hand, to minimize the risk of loss they would have preferred to have more of the smaller than fewer of the larger animals, which in addition may have

been more difficult to handle. It is therefore the mutualistic relationship between man and domestic dromedary that caused the biological changes in the latter. Once this relationship started it created particular conditions to which both partners had to adjust accordingly.



Graph 20: Approximate survival rates of the dromedary populations at al-Sufouh2 and Muweilah

Additional evidence of the respective status of the dromedaries at Muweilah and al-Sufouh 2 comes from demographic data obtained from the rates of fusion of long-bone epiphyses. In young animals one or both ends of the large bones of the legs are separated from the shaft by a layer of cartilage which is responsible for growth. The cartilage is not preserved in archeological finds. Thus the articular ends of bones from young animals are found separate from the shafts, whereas in adult animals they are fused to the shaft. As fusion in particular bones happens at different periods during growth, counts of fused versus unfused epiphyses provide evidence of the ages before or after which the animals were slaughtered or hunted. Unfortunately, not much is known about the ages at which particular epiphyses fuse in dromedary skeletons. However, according to the available comparative skeletons, the sequence of fusions is similar to that in other artiodactyls. Percentages of fused versus unfused epiphyses can therefore be plotted in a relative order from young to old (graph 20). While the time-scale in this figure can only be a rough estimate, the relative difference between the two camel bone collections is quite obvious: at Muweilah only between 45% and 60% of the “early” epiphyses (fusing between about 12 to 18 months) are fused, while the respective figure at al-Sufouh 2 is around 90%. For the “late” epiphyses (fusing around 48 months) the difference is less obvious: they are fused in about half of the observed cases at Muweilah while the figure at al-Sufouh 2 is about two thirds of the respective specimens. Obviously, almost half of the dromedary offspring was culled at Muweilah during the first year. Later culling was modest, indicating that the surviving animals were mostly raised to adulthood. Contrary to this, around a third of the animals killed at al-Sufouh 2 were between about one and four years old, which accords well with the normal yield of non-selective hunting of wild artiodactyls.

Both the diminution of body size and the demographic differences between the camels from al Sufouh 2 and Muweilah indicate a domestic status of the latter. Disarticulation and fragmentation of the skeletal elements, as well as chop-marks on the bone finds from Muweilah indicate

that dromedaries were slaughtered there for meat. The early culling of young dromedaries (graph 20) might also indicate that camel milk was used for human consumption. This is in good agreement with the remarkable flattening of the demographic curve between the ages of 12 to 48 months, indicating that animals older than one year were spared for later use. As clearly indicated by several finds of camel statuettes, this later use included riding and transportation of goods (see graph 21).



Graph 21: Camel figurine from Muweilah (Maggee 1996:210, fig. 28).

Although the flat saddle on top of the camel's hump does not seem appropriate for riding at first sight, there are known recent examples of the use of such saddles, in particular by women. Nevertheless, the increase of the remains of fish and shellfish at inland sites in SE Arabia from the Iron Age onward can also be considered as an effect related of the use of dromedaries as beasts of burden. Rapid transportation of fresh fish from the coast to the interior remained an important function of the domestic dromedary till the advent of motorized transport in the 20th century.

CAMEL GRAVES OF THE LATE PRE-ISLAMIC PERIOD

The importance of domestic dromedaries for the emergence of the Arabic culture and way of life from the Iron Age onward cannot be discussed here in any detail. The domestic use of the camel induced substantial changes of many facets of daily life. It permitted wide-ranging mobility and was of great significance for economy, trade, and warfare (e.g. Rosen/Saidel 2010, Cleuziou/Tosi 2007:293–294, Retsö 1991).

There is also extensive pictorial evidence for dromedaries and their use from the period following the Iron Age, which is usually called the "Late Pre-Islamic" in the terminology of Arabian archeology. Camels depicted in different ways and on different materials are characteristic traits for the iconography of this period (Daems 2004). Two famous sites of this period in the region under concern are Mleiha (Mouton 1999, 2008) in the interior of Sharjah Emirate and ed-Dur (Haerinck 2003) at the coast of the Umm al-Quwain Emirate. The study of the faunal re-

mains of both sites (Van Neer/Gautier 1993, Gautier/Van Neer 1999) clearly indicates the ongoing importance of the dromedary during this time, even after the later arrival of the horse (see graph 22).



Graph 22: Fragment of a plate from Mleiha with warriors on camel and horse.

A new feature of this period with regard to the archeozoology of camels is the occurrence of camel graves. Camel skeletons may occur together with those of humans in the same grave or as individual burials in the context of a necropolis. This custom is interpreted as “*baliya*” – the sacrifice of an animal. It is assumed that this was an immolation for a deceased individual in order to be used in the afterlife. The sacrifice of camels can also be seen in relation to tokens of prestige and indications of rank (Daems/De Waele 2008, King 2009).

The dates of the camel graves found at Mleiha (H.-P. Uerpmann 1999) range from 300 BCE to 200 CE. These graves are important in various respects. The detection of camel-hybrids, cross-breeds between one-humped and two-humped camels, is one of these particular features. Hybrids can be identified by their particularly large size and by specific morphological traits, which are usually intermediate between the characters of the two parental species. The occurrence of camel hybrids, however, is not an exclusive feature of SE Arabia.³ They are known from the eastern Mediterranean area in the west to Bactria in the east and throughout the Arabian Peninsula down to Yemen. Recent observations by the authors on faunal remains from Dhafar, the capital of the Hymarite kingdom (Yule 2007), indicate the presence of both dromedaries and hybrids in this area around 500 CE.

Another important feature of the camel graves excavated at Mleiha in the early 1990s (Jasim 1999) is the fact that they represent a conceptual entity of animals offered simultaneously in the context of the burial of an important person or of a noble family. At a greater distance from the central graves – which were robbed and therefore empty – there is a row of eleven dromedary graves and one grave with single dromedary and a horse, whereas one camel hybrid and a horse with golden adornments on its bridle were found in the corridor of the noble grave chamber. Other bones of camel hybrids – not in anatomical order – are from a robbed grave shaft near the central grave. Thus the hybrids seem to have been highly esteemed, judging by their position in the graveyard. From the position of the complete camel skeletons it could be observed that the animals entered the graves alive and were put to death there. Altogether the value of the animals offered at the Mleiha graveyard must have been quite high. The dromedaries had reached the ideal age when they would have started to breed and when they would first have been ridden.

³ For a detailed discussion of camel hybridization see article by Bernard Faye and Gaukhar Konuspaveva in this volume.

The hybrids were somewhat older and had reached their full size and strength. Their value as beasts of burden was probably at its highest during this part of their lives.

As a last remark on the archeozoology of camels in SE Arabia we should mention that our first experience with a camel grave in that area turned out to be an anachronism. A camel skeleton found in grave BHS12 of the Middle Bronze Age at Jebel al-Buhais (BHS in graph 17) was the incentive for our ongoing involvement in the archeology and archeozoology of that particular area. Very soon during the excavation it became obvious that this camel skeleton was a later intrusion into the Bronze Age grave. It was not clear, however, how much later. A human burial, also intrusive and potentially representing the rider of the camel, contained iron arrowheads but no further indication for a reliable archeological dating. The bones of the camel were very fragile and not well enough preserved for radiocarbon dating, but the stomach content was still there. It contained large numbers of the durable seeds of a plant of the genus *Lithospermium*. These provided a radiocarbon date for the camel's last meal, which it ate between 655 and 670 CE (Uerpmann H.-P./Uerpmann M. 1999). This was after the initial spread of Islam in this area. The *baliya*, the offering of a camel with the burial of its owner, was against Islamic rules (King 2009). Thus the buried camel at al-Buhais 12 might provide archeozoological evidence of the historically known resistance in eastern Arabia against the spread of Islam and its attempt to free itself from Islamic rule after the death of the prophet Mohammed.



Graph 23: Dromedary skeleton in grave 12 at al-Buhais (Sharjah, UAE) during excavation

CONCLUSIONS

Timing of dromedary domestication remains the central problem of camel archeozoology in SE Arabia. The osteological differences between the dromedary remains from the Iron Age and those from the Bronze Age and older periods clearly indicate that the shift from hunting to herding camels occurred between about 1400 and 900 BCE. Whether domestication happened locally in the little-known transitional phase from the Late Bronze to the Early Iron Age or whether the domestic dromedary was introduced to the area from a hitherto unknown center of camel domestication elsewhere in Arabia is unknown. More evidence will probably come to light when further archeological sites in the United Arab Emirates and Oman have been evaluated with regard to their animal remains. Large areas of the Arabian Peninsula, where the wild dromedary also occurred during the Early Holocene and where its domestication may have happened,

are still completely unexplored in archeozoological terms. An exception is the Yemen, where thanks to the work of Francesco Fedele (2009, and in press) we know more about the early presence of domestic dromedaries. Fedele provided evidence of the use of domestic dromedaries at around 850 BCE in the Sabaeen town of Yalā. This date is in accordance with the appearance of domestic camels in SE Arabia in the Iron Age II contexts of Tell Abraq and Muweilah.

The introduction of the domestic dromedary into an area where its wild ancestor did *not* exist beforehand was recently described by Cornelia Becker for Tell Sheikh-Hamad on the Khabur River in NE Syria (Becker 2008). Remains of dromedaries were discovered at Sheikh Hamad in layers of the Neoassyrian Phase, the beginnings of which correspond to the Iron Age in SE Arabia. The domestic dromedary is well documented by the palace reliefs of this period in Mesopotamia. Textual evidence reports its contemporaneous presence in the Levant. It will be interesting to critically review the dating evidence for the appearance of this animal in the coastal areas of the eastern Mediterranean, which in the Holocene were outside the natural range of the wild dromedary.

Even more interesting than the dromedary finds from Tell Sheikh Hamad are other findings by Cornelia Becker at this important site: there are remains of the two-humped or Bactrian camel in layers below those which yielded the dromedary finds. As the wild ancestor of the Bactrian camel is not known to have occurred in the Djazirah area of Syria or in Lower Mesopotamia, the finds also indicate an early introduction: in this case of the domestic two-humped camel from its hitherto unknown area of original domestication. This area may well have been in the dry steppes and deserts of the Iranian Highland, where the wild two-humped camel may have existed (Uerpman 1987) and where it may have been domesticated during the Bronze Age – as possibly indicated by the early findings at Shar-e-Sokhta (Compagnoni/Tosi 1978). If domestic Bactrian camels existed in south-eastern Iran at the end of the 2nd millennium BCE, dromedary domestication in Arabia might have been inspired by contacts across the Gulf. Such contacts are well documented by finds from Muweilah (Magee 1999, 2002). It should, however, also be mentioned that the site also yielded evidence for contacts with South Arabia in the form of an inscribed name on a large jar using the Old South Arabic alphabet (Magee 1999). Thus SE Arabia is clearly on the crossroads of the early history of dromedary domestication. However, only a major intensification of archeozoological research throughout the Arabian Peninsula will provide a solid answer to the most interesting question of when and where dromedaries were tamed and domesticated for the first time.

A rapid spread of early domestic dromedaries over the Arabian Peninsula and the adjacent areas of Mesopotamia and the Levant can easily be imagined. This spread may even have occurred so fast that a precise localization of the initial center of domestication may remain difficult because of the inaccuracy of archeological dating. The influence of the possession of large animals as beasts of burden and for riding would in any case strongly have influenced the further development of the economy and culture in general. The origin of what can now be understood as the “Arabian cultural complex” would have been impossible without the domestic dromedary.

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WALTER DOSTAL †

Riding Camels in Arabia: Outline of a Revised Cultural History

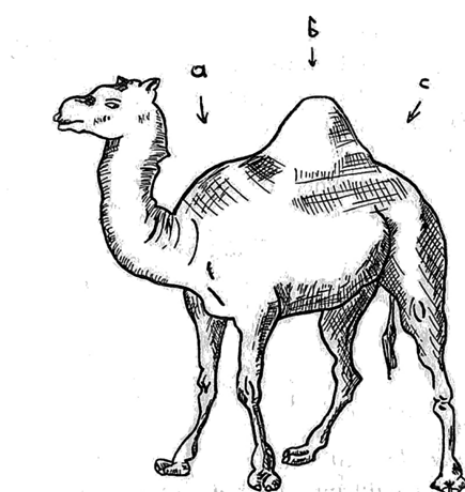
Cultural and historical analyses today are able to outline the various patterns of interactions between humans and domesticated animals that have evolved throughout history in Arabia. Among dromedaries, different forms of saddle construction and various forms of using and riding them are key criteria of those varying patterns of interaction. Elements of material culture and their practical association with camel herding thus provide important clues for the analysis of specific developmental periods. This is why, ever since the 1960s and 1970s, the question of camel-riding techniques and their roles in history have played an important role in the respective subfields of academic research.

The following article discusses various forms of camel riding techniques as indicators of developmental stages among the Arabian Bedouin, and it explores the interdependent role of the Bedouin within their wider social environments of pre-Islamic and Islamic societies on the Arab Peninsula.

RIDING THE HUMP OR RIDING THE CRUPPER?

My contribution to this volume will reconsider my publications from the years 1959, 1967 and 1979, where I proposed some interpretations of my results on the development of the Bedouin. As the starting point I would like to express my deepest thanks to my Bedouin teachers in camel-riding of the Al Adjman and Al Mutayr tribes, both living in the territory of the Emirate al-Kuwait, where I started with my field research in Arabia in 1956 as a guest of Shaykh Abdullah B. Salim B. Al Subbah. These introductions into camel riding enabled me subsequently to analyze archeological artifacts. In turn, this led me on to examine the development of Bedouin groups and their interactions with the outside world.

Let me first raise three fundamental questions for these considerations: 1) Where can one sit on a camel? 2) Which of the possible seats offers the best riding position, and 3) which of these riding positions is the oldest in use?



A dromedary's back has three possible seats: the withers, the hump and the crupper (see graph 24). In the Arab Peninsula, camels' withers are used only for short stretches, e.g. generally inside the herd during grazing. We can therefore move straight to consideration of the crupper and the hump seating positions.¹

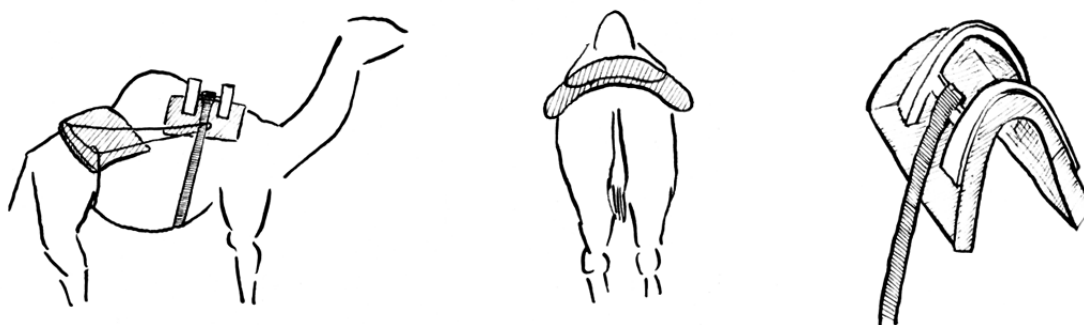
Graph 24: A dromedary's back has three possible seats or riding positions: a) the withers, b) the hump and c) the crupper (all drawings by W. Dostal).

¹ While Arab Bedouin prefer the hump and the crupper as riding positions, tribal nomads in northern Africa ride on the dromedary's withers. The rider thereby controls the animal by applying foot pressure on the camel's neck. Among Algeria's Touareg, a woman's sedan, called a Tachawit, is fixed directly on the camel's hump (for a more detailed discussion of north African Touareg see the articles by Ines Kohl and Anja Fischer in this volume).

The material culture of dromedary breeders in the Arab Peninsula reflected two different types of saddle construction in the 1950s:

First, the *shadād* construction, used for riding the hump, based upon the principle of the saddle bow (see pictures 31–34). In this case, both saddlebows (*zlāf*) have a corresponding knob elongation (*rās*) and are connected by two lateral crossbars (*mislābain*). These wooden parts of the saddle are connected by strips of gazelle leather, cut and applied in wet condition to ensure a certain elasticity (Dostal 1967:12). The stable forms of the *shadād* construction allowed the elaboration of special and particularly impressive women's saddles. With their widely protruding wing-shaped balancing bars that span up to 3.8 meters (Dostal 1967:48; see pictures 35 and 36) these women's saddles optically reinforce the dromedaries' typically swaying mode of walking. A camel with a female rider on this saddle is a breathtaking sight and becomes conspicuous from a long distance anywhere in the desert. Basically, all kinds of women's saddle indicate their special position in most Bedouin societies. The predominant part of Arab tribal camel pastoralists used this *shadād* saddle construction (ibid:12).

The second type of saddle construction used in the Arab Peninsula in the 1950s was the *hawlāni* type, used for riding on the crupper. This was done on a cushion or pad (*hawiya*) put in behind the hump (see graph 25 and 26). It was fastened by a rope to two saddle arches which were kept in place by a girth around the dromedaries' withers (see graph 27).



Graph 25, 26, 27: The *hawlāni* saddle construction makes use of the camel's crupper and is used in the southern parts of the Arab Peninsula: the saddle rests on a cushion behind the hump, is fastened by a rope to two saddle arches and kept in place by a girth around the dromedary's withers.

This *hawlāni* principle, which made use of the camel's crupper, was applied to the man's saddle, a pack saddle (*ketab*) and a corresponding woman's saddle called a *tōma* (see picture 37). The *tōma* is an uncovered female sedan. Contrary to the impressive women's saddle of the *shadād* construction as discussed previously, the *tōma* is merely assembled into a quadrangular shape by several wooden bars. It is decorated with a woven ribbon at the front (Dostal 1967:48). The *tōma* is positioned on the cushion without any specific supporting device and fastened by a girth around the camel's belly, which corresponds to the rather simple *hawlāni* principle. Historically, the *tōma* seems to correspond to the *taw'ama* women's saddle as mentioned in the *Lisan al'Arab*.² An archeological equivalent is represented by a class of dromedary statuettes from Syria (10th to 8th century BCE) with a similar superstructure (Dostal 1967:154–155).

It was only among the Al Rashid of eastern Arabia that I found certain parallels to women's saddle construction elements of the *shadād* tribes: here the *tōma* included bows of balancing

² The *Lisan al'Arab* is the most widely known, late medieval dictionary of Arabic terms and includes – to some limited extent – ethnographically valuable explanations. According to Al-Naqa'Id in the *Lisan al'Arab*, women's saddles are frequently mentioned in old Arab poetry, although not as often as terms for male saddles. Other terms for women's saddles are for example *qatab*, *kifl*, *kur* and *rahl*. The partial descriptions explain: the *kifl* was a cushioned saddle put around the hump (ibid:107–108); the *kur* was especially used for riding on mares.

bars – a typical element in the *shadād* women's saddle type called the *ghabiye* (see picture 35 and 36). The Al Rashid most probably took over these cultural elements in the course of their contacts with *shadād* tribes, resulting from their especially far reaching grazing range (Dostal 1967:49–50). These cultural contacts shall be discussed in the following.

Until about half a century ago the *hawlāni* type of saddle was mainly used among the south Arabian tribes (as an example, see picture 38), whereas the *shadād* construction was mostly used by the tribes living in central and northern Arabia. In short, southern Arabian Bedouin rode on the dromedary's crupper while their counterparts in the adjoining areas to the north were riding on the hump. These two different riding positions and their corresponding saddle types, *shadād* and *hawlāni*, point to a difference in the development of riding techniques among camel-breeding tribes.

By investigating the saddle types shown in archeological findings from the Ancient Near East I have tried to give some idea of this development (cf. Dostal 1967). In an anthropological perspective these findings represent important evidence from different periods of Mesopotamia's civilizational centers and their immediate surroundings – evidence of contacts between their populations and the camel herders of the Arab Peninsula. From the point of view of source criticism, however, I have to remark that the available material was not produced by the dromedary herders themselves. Thus, the material only speaks for those dromedary herders who came into contact with the centers of complex sedentary civilizations.

I have shown that these archeological artifacts suggest that dromedary herders rode on the crupper in the northern regions of the Arabian Peninsula during the 3rd and 2nd millennia BCE. This riding position also became evident in findings from the Sabaean-Himyaritic Empire³ in the south during the 1st millennium BCE (Dostal 1967:15). We have to note that the Arabization of the southern parts of the Arab Peninsula began during the history of these empires, as the Himyaritic rulers hired Arabs as mercenaries.⁴ Using the crupper as a riding position was obviously the older riding technique in the northern parts, which was later substituted by a technique that was new to the region.

ON THE SEQUENCES OF RIDING TECHNIQUES

The older crupper riding technique is testified for northern Arabia by two important findings. This concerns a limestone relief from Tell Asmar (in today's Iraq) from the 3rd millennium BCE and likewise the statue of a man riding a dromedary from Tell Ta'anakh (in today's Israel) around the 2nd millennium BCE (see Dostal 1967; Abb. 4 and 5). The regionally new forms of riding, making use of the dromedaries' hump, resulted from the transformation of riding techniques from the crupper to the hump. This enabled the rider to get the maximum speed out of his camel. From then on, camel riders in the north of the Arab Peninsula could cover larger distances much faster. In turn, this opened up new pastures for them much more easily. In addition, they could keep and watch over larger herds than before. In this context, a report dated 854 BCE may be recalled, about the help given by a certain Arab called Gindibu to a ruling prince of one of the Syrian towns, putting 1,000 dromedaries at his disposal (Petraček 1959).

The next archeological evidence to be considered is a chalk stone relief from Tell Halaf (in today's Syria; see Dostal 1967; Abb. 6) from the 9th century BCE. This shows a cushion saddle as previously discussed, with a girth around the dromedary's belly. An Assyrian relief from about the same time, however, includes a number of new elements: these are the saddle cloth

³ The Sabaean-Himyaritic empires characterized the late phase of the pre-Islamic history in ancient southwest Arabia and collapsed at the end of the 6th century CE.

⁴ Compare the chapter on Qaryat al-Faw by Abdulrahman Muhammad Al-Tayeb al-Ansari in the catalogue of the exposition *Routes d'Arabie: Archéologie et histoire du royaume d'Arabie Saudite* (al-Ghabban et al. 2010:310–364).

and the functionally connected straps around the breast and tail of the dromedary (see *ibid.*; Abb. 7). These additions probably reached camel breeders through their contacts with equestrians from complex sedentary civilizations. By pursuing the topic of horsemen's equipment and their influence we are thus also able to demonstrate the camel herders' version of the chariot principle.

This is the crupper rider, who sat behind the rider proper and fired arrows at the enemy (see Dostal 1967; Abb. 8). In Ancient Arab poetry this crupper rider is called the *radif* or *zamil*. The *radif* had undergone a change of function. At an unknown date, riders began to use dromedaries only to reach the scene of battle, where they then mounted horses they had brought with them to use in combat (*ibid.*:15). This historical fact points at an earlier and still hypothetical transition, when camel herders had also begun to keep horses.

The next important event in the sequence of riding techniques in Arabia is the emergence of the *shadād* saddle in the north, where so far the *hawlāni* type of riding the crupper was common. As mentioned in the first part of this article, the *shadād* construction is based on the principle of the saddle bow (see graph 27), which allows riding on the dromedary's hump. It is documented from the Palmyra area in today's Syria since the 3rd and 2nd centuries BCE, and by way of other findings from contemporary markets there.

The *shadād* construction seems to be influenced by the fundamental construction principle of the arch saddle invented by horsemen in Central Asia. Judging from the available material and its respective interpretations, it was probably the Parthians⁵ who introduced the arched saddle into the borderlands of Arabia. The *shadād* saddle in Arabia can thus be seen as the result of cultural contacts between representatives of the two largest linguistic groups in the region, Iranians and Semitic speakers. Moreover, it is remarkable that the first archeological appearance of the *shadād* saddle coincides with the same period for which the earliest representations of the Near Eastern horsemen with arched saddles are available (Dostal 1967:18–19).

THE BEDOUIN ROLE IN WARFARE AND TRADE

It is important to say something here about the significance of dromedary nomads within the various Semitic-speaking groups of nomads and semi-nomads. In his book “*Über Lebensraum und Lebensformen der Frühsemiten*” [*The habitat and way of life of the early Semites*] (1968) the German social anthropologist Joseph Henninger brushed aside older assumptions about the mythical Semites' material subsistence as being exclusively nomadic. In addition to certain varieties within nomadism itself, he made it abundantly clear that agriculture also must be taken into account as a main source of livelihood for early Semites.

Indeed, nomadic life covers a wide spectrum of different forms. Some of them are based on the breeding of a) cattle and sheep, b) donkeys and sheep, c) dromedaries, sheep and goats and d) cattle and goats. These four formulas in fact more or less follow a chronological order in a wider sense, but without being significant in any specific sense as a timetable of regional evolution. In the latter sense, the situation has to be understood in terms of multiple sequences instead, with various ways of adapting to different ecological conditions in the peninsula.

As a main result of our critical scholarly assessment, we distinguished two cultural types among dromedary herders: the “progressive” and the “conservative” type. The ‘progressive’ type developed through certain decisive impulses received by these camel herders from multiple contacts with the zones of complex sedentary civilizations. In the course of my interpretations of the progressive type (Dostal 1959, 1979), however, I originally made a great mistake: while

⁵ The Parthians were located in the northeast of today's Iran and founded the Parthian Empire (also known as Arsacid Empire; 247 BCE to 224 CE from today's southeastern Turkey, to eastern Iran). This empire was a center of trade, since it was located on the Silk Road and thus on the trade route between the Roman Empire and China.

trying to give a clear definition of what I understood by using the term Bedouin,⁶ I over-emphasized their factual dimension of being rider-warriors. This conclusion was completely wrong and I have to revoke it. In the scholarly discussions of the 1950s, 1960s and 1970s the riding warriors played a great role for the emergence of complex civilizations. They were considered to have represented a remarkable causal factor in those processes (I refer here to the works of Caskel 1953, Clénova 1956, Henninger 1943, Ingholt/Seyrig/Stayrck 1955, Jettmar 1966, Johansen 1956, Kupper 1957, Moshinskaja 1953, and Rudenko 1953). These works by German and Russian scholars created a mode and determined a certain *Zeitgeist* of academic reasoning about the topics in question.

Meanwhile, however, I have had the chance to analyze a number of reports from antiquity, and their interpretations. These sources allow the outline of a completely different picture. Camel breeders needed their dromedaries primarily for transportation to the battleground, as already indicated. Either they then used the horses they had brought with them, or they were prepared to fight on foot. Fighting as warrior riders on camels thus played no decisive role during the formative and early phases of nomadic camel herding in Arabia. It is only from Neo-Assyrian times that we do have clear evidence of the crupper-rider, the *radif* or *zamil*, fighting while mounted.

These facts lead me back into my own biography. In the final analysis, what has been said requires a new definition of the term 'Bedouin' that is not restricted to camel-riding warriors. The usage of camel riding for violent purposes gained its own decisive momentum and influence only in the process of relatively late cultural contacts with complex sedentary civilizations, and accordingly with the development of the *shadād* saddle construction.

The Bedouins were not only warriors, they also controlled the transportation of goods and provided security for goods but also for convoys. These agreements between complex sedentary societies and Bedouin were often set down in the form of legal contracts, i.e. the *ilaf*.⁷

References to their material culture demonstrate that they themselves did not practice iron forging, pottery work, stone-masonry and complicated woodworking. Instead, they relied on exchanging these products of sophisticated craftsmanship with sedentary populations or merchants. *Ilaf* contracts helped reciprocally to ensure the mutual exchange of pastoral goods against these and other products and to provide rights of residence if needed.

We have seen that Bedouin and sedentary Arabs were mutually dependent on each other in economic terms. In addition it is useful to distinguish semi-nomads, who lived partly sedentary lives while engaging more or less intensively with pastoralism, from full nomads. If we look at the socio-economic units of full nomads, we have to acknowledge a number of distinctive social features. First, at least in Arabia's southern regions, patrilinearity and cognatic features are the constitutive kinship elements of their societies.⁸ The structure of their production units was determined by nuclear, fraternal joint and extended family forms. The founder of a patrilineal production unit and its local society had the claim of property on the central means of production (i.e., on herds, pastures and wells). In predominantly cognatic organizations this claim was divided up between the sexes. Even in patrilineal contexts, however, women also owned private property such as wool (see picture 39), which was generally respected by men. Tribal social

⁶ In my 1967 publication I did take into account the local classification of *badw* as people who live outside of sedentary settlements. Yet I suggested narrowing down this concept and confining the definition of Bedouin to Arab warrior pastoralists (1967:11).

⁷ Well known among the *ilaf* is one that was concluded by Hashim b. 'Abd Manaf (5th century CE), the great-grandfather of the prophet Muhammad, for the caravans of the merchants of Mecca. As the progenitor of the Banu Hashim clan of Mecca's noble Quraish family, he is attributed with the initiation and establishment of the two great trade caravan journeys of Quraish from Mecca to the Yemen in the south and to north-west Arabia and further on to Palestine and Syria (Armstrong 1991:66).

⁸ In cognatic or bilateral kinship systems, descent relations are traced through both the mother's and father's side.

organization represented the foundation of society. In their ideology, two patterns characterized these full nomads – the conception of pure blood (*'asil*) and the conception of honor (*sharaf*). The conception of pure blood elaborated the idea of the necessity of demonstrating descent equality among descendants of a common ancestor.

CONCLUSIONS: THE BEDOUIN IN THE ISLAMIC PERIOD

Up to this point our discussion was focused on the pre-Islamic development of the Bedouin and its reconstruction through the sequence of riding techniques. At the end of this contribution, let us also consider the more recent phases of Bedouin development in the Islamic era.

Scholarly discussions about the role of the Bedouin in Islam are inspired by two conceptions: one is represented by Muhammad Asad's book "The Message of the Quran" (2009), the other by Sara Binay's study on "The Bedouin Figure in Arab Literature", 9th – 12th century (2006).

Muhammad Asad's starting point is the linguistic fact that to understand the Qur'an, a very detailed knowledge of Arabic is necessary in order to understand the ideas of the Prophet's messages. In his arguments he refers to the central and eastern Bedouin of the Arab Peninsula, who considered themselves as linguistic representatives of old Arabic. In Asad's perspective, eastern Arabia's Bedouin language therefore provided especially good access to understanding the Qur'an. Yet in view of processes of transformation and modernization during the 20th century, many aspects of this linguistic legacy were lost or damaged (Asad 2009; footnote 3).

By contrast, in her analysis of relevant Arabic literature Binay discovered an ecological factor that may have influenced scholars of the early Islamic periods. According to Binay, the peripheral remoteness of the Bedouin from the centers of scholarly learning led to several forms of stereotyping and bias in early Arab literature of the Muslim era: the Bedouin were said to mostly ignore the unity of Allah and to be full of hypocrisy. Their emotional empathy was seen as limited, and they allegedly ignored the commandments of Allah. In Binay's analysis these statements were an expression of the social discrimination against the Bedouin by the urban centers of Islamic society.

One of these contrasting views therefore sees the Bedouin as especially close to the language of Islam, whereas the other view sees them as marginalized from Islam. My own suggestions to understand Bedouin evolution during the earlier history of Islam is closer to that of Asad, but builds on what I have already outlined in the preceding sections of this article.

The Bedouin of the Arab Peninsula basically continued their established positions as acquired in pre-Islamic times under the new conditions of Islam. In spite of and partly also because of their separate and remote ways of life, they were important for long-distance trade, for providing the sedentary population with particular goods. The Bedouin were also important innovators, providing contact with the outside world, as argued in the case of adopting new saddles and riding techniques.

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Caravans from South Arabia: Roads and Organization

In his contribution to the famous volume *The Invention of Tradition*, the historian Hugh Trevor-Roper observed that “the sea unites rather than divides” (Trevor-Roper 1983:15). The same could be said of deserts, provided there are sufficient pack animals – in our case camels – and enough wells, reservoirs etc. In consequence, under certain circumstances the bleak surfaces of deserts may become rather advantageous highways.¹ The different nature of the regions – deserts, towns, agricultural areas – through which camel caravans traveled imposed different constraints and necessities on animals and humans. In the desert, there is usually room enough for the animals and people to travel alongside one another, at least to some extent, but at the watering places there had to be some kind of organization, of sequence, because understandably not all animals could drink at the same time. Moreover, there had to be animals to carry the caravan’s fodder: thus, a certain number of the camels could not be used to transport goods. In addition, few inhabited places along the way through deserts offered any chance of trade. Consequently, desert routes were ideal for fairly fast travel with only the most necessary interruptions. Thus caravans of pilgrims to the holy cities of Islam or the transport of goods such as incense destined, for example, for the Mediterranean region presumably tended to use these rather direct ways. Examples of long-distance routes of this kind are the Basra-Mecca route, the Syrian route to Mecca and the Kufa-Mecca route (cf. Al-Rashid 1980 for research on the “Darb Zubayda”, as the Kufa-Mecca route was called; Halm 1991:174).

Yet not all camel caravans traversed deserts: in the south-west of the Arabian Peninsula they used routes through relatively densely populated, intensively cultivated areas, entailing their own special problems, needs and advantages. Few historical sources address this matter in detail. Fortunately, there is a description of the organization of caravans from South Arabia to the north originating from the 10th century.

In the first part of the following contribution, I shall try to characterize the different possibilities to travel from the southernmost parts of today’s Yemen to the south-western provinces of Saudi Arabia (in short: south-western Arabia). I am concerned here with land-based travel only, the important possibility of using boats on the Red Sea will not be included. In the second part of my paper, al-Ḥasan al-Hamdānī, a South Arabian author who lived in the 10th century, will be my main point of reference, and I shall let him speak about the organization of South Arabian caravans using the highland route in south-west Arabia.

TRADE AND PILGRIM ROUTES IN THE SOUTHWEST OF THE ARABIAN PENINSULA

As early as pre-Islamic times, the Incense Road – mainly a trade route – led through the Arabian Peninsula running roughly from north to south (Groom 1981; esp. 165–188), thus traversing the region of south-western Arabia. It was already mentioned in antiquity by Eratosthenes of Cyrene (around 225–195 BCE, cited by Strabon), Agatharchides of Cnidos (2nd half of 2nd century BCE, cited by Strabon), Strabon (around 63 BCE–23 CE) and Pliny the Elder (around 23–79 CE). Since Islamic times, these north-south routes gained additional importance through the annual pilgrimage: pilgrims traveling to Mecca used the same roads as traders, scholars and diplomats. The old Incense Road at least in south-western Arabia had used the western fringe of

¹ I would like to thank the organizers of the conference and editors of the publication, and Andre Gingrich (Vienna) for his helpful comments on a previous draft of this text.

the central Arabian Desert, touching Mārib and Najrān (de Maigret 1997, 2003). By contrast, in a process of hundreds of years, by the 10th century the core area of the south Arabian populace had moved to the west, roughly to the Yemeni highlands, where the population density remains the highest until today. The main north-south roads largely followed this western movement. By the 10th century at the latest there were three main routes from north to south (apart from the Red Sea), each with its own advantages and dangers. A fourth road seems to have gained importance slightly later.

Arab authors dealing with geography, administration and postal routes mention a few places along these southern roads, but usually give no detailed descriptions, no information on distances or the organization of caravans (e.g. Ibn Ḥurdaqbiḥ, Ibn Rusta, Qudāma, al-Yaʿqūbī). Only two South Arabian authors described these roads in more detail: the younger was Najm al-Dīn ʿUmāra b. ʿAlī al-Ḥakamī in his *Kitāb al-Mufīd fī aḥbār Ṣanʿāʾ wa-Zabīd*; written 1167/68 CE). In a chapter on the South Arabian ruler Ḥusayn b. Salāma (reigned 100–1018 CE) he wrote about the construction projects this governor of the Yemen carried out along the roads leading from south to north.² The other author was Abū Muḥammad al-Ḥasan al-Hamdānī (who lived around 893 until 950/60 CE) in his *Ṣifāt Jazīrat al-ʿArab* (Description of the Arab Peninsula), where he dedicated a chapter to the roads he calls maḥajja or pilgrim's road. Both authors describe several routes that could be used in their time to travel from south to the north or vice versa.

One of these trade and pilgrim roads through the Arabian Peninsula (see graph 28, road no. 2) followed the Red Sea coast as closely as possible and was called *al-ṭarīq al-sāḥiliyya* (ʿUmāra 1979:76) or *ṭarīq al-sāḥil* (al-Hamdānī 1974:341) or *ṭarīq Tihāma* (al-Hamdānī 1974:341, ʿUmāra 1979:76). It touched villages and harbor towns such as al-Muḥā and the now abandoned Ṣarja. These settlements offered the additional advantage of trading possibilities, as well as the interchange with the flow of goods transported via the Red Sea, but in summer this coastal area is too hot to travel, at least in the daytime.

The second route led through the highlands, where most of the Yemeni people lived in al-Hamdānī's time, as they still do today. There, principal administrative centers and important markets present possibilities for trade; there is enough water for the animals of a caravan as well as fodder. Along routes in the desert or – to a lesser degree – on the coast of the Red Sea (the Tihāma), some of the animals of a caravan had to be used to carry fodder. By contrast, the use of the upper, highland or mountain road (see graph 28, road no. 4) – *al-ṭarīq al-ʿulyā* (ʿUmāra 1979:76) or *ṭarīq Najd* (al-Hamdānī 1974:339) or *ṭarīq al-jibāl* (ʿUmāra 1979:72), as it was called – minimized this additional necessity. In contrast to desert routes, the mountain road (and roads with similar characteristics) were advantageous for rather slow travel, for doing additional business on the way, and for the “search for knowledge” that many scholars/pilgrims undertook.

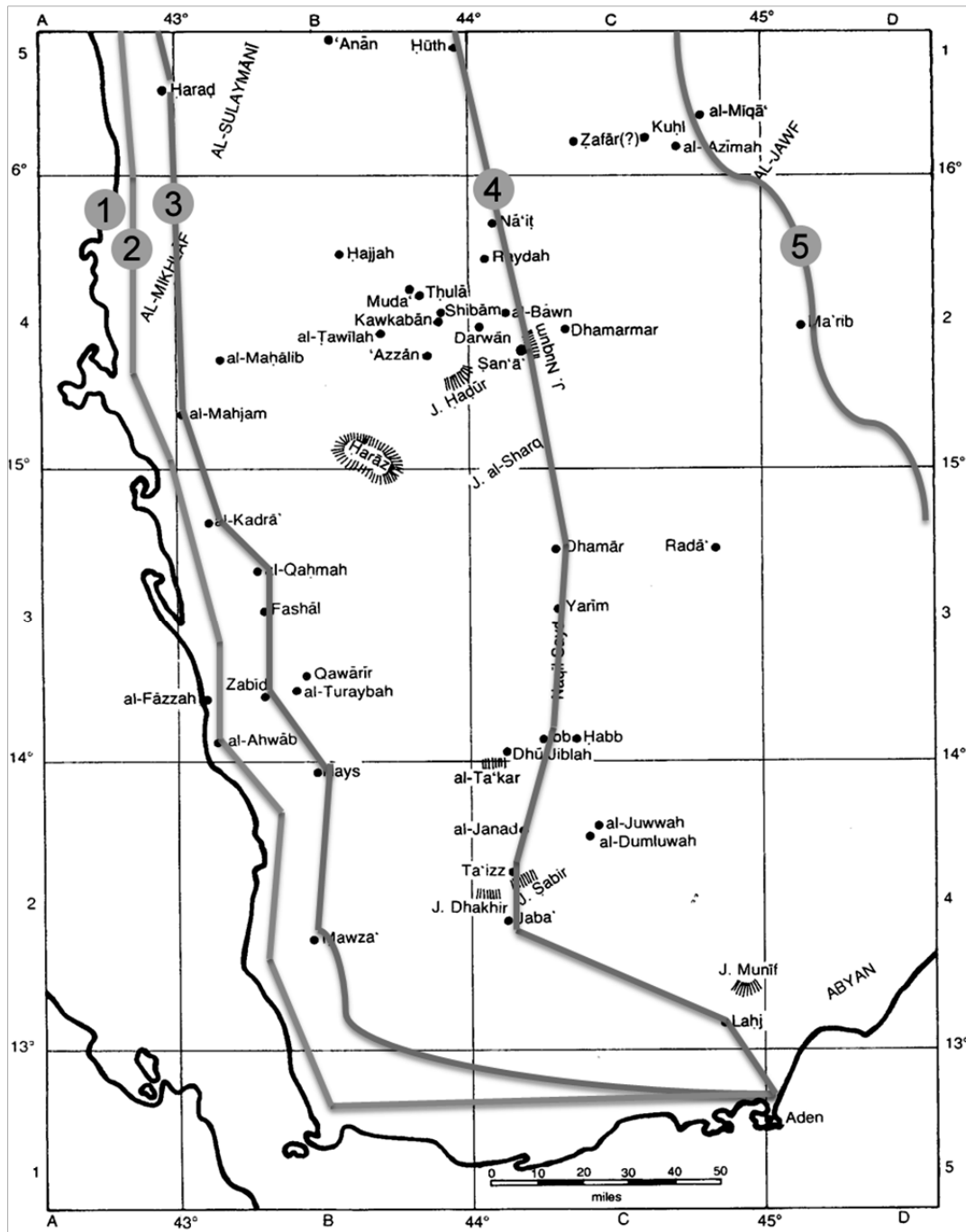
A third route, the lower road or *al-ṭarīq al-suflā* (al-Hamdānī 1974:342; see graph 28, road no. 5) led along the fringe of the desert in the east, thus at least in the south having the characteristics of a desert road. It touched on the former South Arabian population centers and possibly constituted the main course of the Incense Road in pre-Islamic times.³

An additional route, called *al-jādda al-sultāniyya* (the Sultān's highway, see graph 28, road no. 3) or *al-ṭarīq al-wuṣṭā* (the middle way; ʿUmāra 1979:72), was not yet mentioned by al-Hamdānī in the 10th century. It appears for the first time in the *History of the Yemen* by ʿUmāra b. ʿAlī al-Ḥakamī (who lived from 1121 to 1173/4). This road seemingly was therefore estab-

² Bulliet (1990:228) states quite categorically: “References to the upkeep of roads are almost nonexistent”, a statement which contradicts mentions of construction and restoration of roads not only concerning South Arabia, cf. Al-Rashid 1980:8; 11–12; 375, Plate XIII,2; 376, Plate XIV, 2; 385, Plate XXIII, 1, to name just a few examples. In Yemen, the pre-islamic ruler Asʿad al-Kāmil is said to have built roads, cf. Ibn al-Mujāwir 1986:203.

³ The old Incense Road led from ancient Qana (Biʿr ʿAlī in today's South Yemen) to Ṣabwa, the capital of the old kingdom of Ḥaḍramawt. “From there, passing through the capital cities of the kingdom of Qatabān, of Sabaʿ and of Maʿīn (Timnaʿ, Mārib and Qarnāw respectively), it reached Najrān, beyond the northern border of today's Yemen” (de Maigret 1994:316; cf. Groom 1981:165–188).

lished slightly later than the other three. Like the first, the *ṭarīq al-sāhil*, it went through the Tihāma (the coastal plain of the Red Sea),⁴ but on its eastern fringe near the steep mountain slopes leading up to the central highlands. Towns and marketplaces (e.g. *Zabīd* or *al-Mahjam*) could be touched there, but the climatic difficulties are nearly the same as on the coastal road.



Graph 28: Sketch of trade and pilgrim routes in South Arabia (from left to right):

- 1 coastline
- 2 the coastal road, *al-ṭarīq al-sāhiliyya* or *ṭarīq al-sāhil* or *ṭarīq Tihāma*
- 3 the Sultān's highway, *al-jādda al-sultāniyya*
- 4 the upper road, *al-ṭarīq al-'ulyā*, *ṭarīq Najd* or *ṭarīq al-jibāl*
- 5 the lower road, *al-ṭarīq al-suflā*

⁴ For a more detailed discussion of human/camel interaction in the Tihāma region see the article by Andre Gingrich in this volume.

Between these four main possibilities of north-south travel through the Arabian Peninsula and vice versa there were east-west connections, for instance between the city Ṣan‘ā’ and the coast of the Red Sea or in the north between Ṣa‘da and Najrān. These east-west routes were certainly not only necessary to find additional trading possibilities but also to avoid stretches of the north-south connections that were impassable or unsafe because of wars, floods and other incidents. Thus a grid of routes was constituted, parts of which are still in use today as roads for motor vehicles. Consequently, the route to take seems to have been largely a strategic consideration for the caravans’ leaders, owners or investors. Ecological-climatic problems such as the heat in Tihāma, or rain and floods in the highlands had to be taken into consideration as well as possible political obstacles such as war and unrest, and, last but not least, economic negotiations about the kind of goods or people transported influenced decisions over the route.

MEASUREMENT OF DISTANCES: MILES, DAYS AND POST-STATIONS

In his *Description of the Arabian Peninsula* al-Hamdānī tells us a great deal about traveling on these roads, e.g. about how distances were measured. In describing the routes, al-Hamdānī uses three different units of measurement: the first is *marḥala* (pl. *marāḥil*), a day’s journey, whereby a *manzil*, pl. *manāzil*, or “stopping place”⁵ is the locality at the end of a *marḥala*. The second we all know, because the word is a very common Latin loanword and therefore in use in many regions; it is the mile (arab. *mīl*, pl. *amyāl*). The third is *barīd*, pl. *burūd*, the post-stations, where official messengers changed horses. al-Hamdānī divides the way between Ṣan‘ā’ and Mecca into 22 *marāḥil* (day’s journeys), which correspond to 35 *burūd* or postal stations and to 420 *amyāl* or miles. From the information about distances one can derive two fixed measurements: one *barīd* corresponds exactly to 12 miles (between 23 and 24 km; cf. W. Hinz 1991 in: EI2, 2:232; s.v. *dhirā’*). But understandably, the *marāḥil* or day’s journeys differ with respect to the terrain. On average, one *marḥala* corresponds to 19 miles or 1.6 *burūd* (around 37 km). But in spite of that it remains unclear to me how far in terms of modern measurement the distance of a mile really was for al-Hamdānī. Richard W. Bulliet (1990:227) mentions that “a regular daily stage of travel for a caravan does not exceed twenty miles”, resulting in 31 km, but he gives no consideration to terrain. On the south-west Arabian highland road it could have well been less.

When traveling north, stars could be used for orientation. Between Ṣan‘ā’ and Bīṣa (today Saudi-Arabia), the caravans were guided by a constellation called *al-dubb al-akbar* (Ursa Major), especially by the three stars called *Banāt Na ‘š* in Arabic, making up the drawbar of what in English is called The Plough. The issue of the use of stars for orientation in historic camel caravans would be a rewarding topic for further investigation.

THE ORGANIZATION OF THE SOUTHERN CARAVANS

Members of al-Hamdānī’s own family were experienced in handling camels, as the author reveals (Iklīl 10, 199). His father traveled far, e.g. to Baghdad (ṣifa 197), to Kūfa, Baghdad, Basra, Omān, Egypt, and Mecca (al-Hamdānī 1974:200). In all likelihood, he either accompanied merchants’ caravans or was a merchant himself (cf. Jāzim/Leclercq-Neveu 2001:4–9). In any case he traveled on exactly the long-distance routes that are described here. Consequently one has to assume that al-Hamdānī had some knowledge of camels, too, a fact that is clearly shown by the quotation I will give later. When he decided to write a book on *The Two Precious Metals Gold and Silver*, he had already written a volume on agriculture and another one on animal husbandry (called “*kitāb al-ibil*” or “book of camels”), both of which unfortunately are no longer extant. To complete this trilogy on property, he wrote *The Two Precious Metals Gold and Sil-*

⁵ The Arabic term *manzil* for a stopping place for camel caravans corresponds exactly to the Latin term *mansio*, which Pliny the Elder uses in describing the way from Thoma in southern Arabia to Gaza on the coast of the Mediterranean: “quod diuiditur in mansiones camelorum LXV” (Plinius Secundus 2002:397 = book 12, c.32, 64).

ver, and in this, where one least expects it, he dealt extensively with the organization of a southern caravan. His descriptions are exact to a degree that sometimes they border on fussiness, but in most instances he gives the necessary explanations himself and leaves little to explain. I therefore want to cite the text for the larger part in my translation (al-Hamdānī 1969:48a–50a). The pieces of gold constituting the standard and other pieces to be weighed to the standard weight and to be thus prepared for minting are alternately arranged and compared with one another, because all should have the same weight: similar to the situation in Europe, coins were weighed at that time in South Arabia. This arrangement of the pieces of gold reminded al-Hamdānī of the organization of the South Arabian caravans, which he is setting out to describe as an example. In the process of writing, his description turned into a longer digression, in which the author could show his knowledge about camels and caravans embedded in an exhibit of his knowledge on minting:

What resembles the sequence of the row of the standard measure in the (melting) pot is the line up of the camels of the people of Yemen on their journeys. This is the case because most of their ways lead through plains full of thickets, brushes, fields, tangled trees and standing water or rugged ground full of discomfort and narrow passes.

al-Hamdānī characterizes the upper or highland route here quite convincingly: in changing from one fertile plain (e.g. al-Bawn north of the Yemeni capital) to the next one, the caravans had to traverse stony mountain passes (e.g. Naqīl al-Ġūla to the north of al-Bawn). On some of them one can see from the modern road that great efforts were made to construct passable roads there in earlier times.

The number of animals in such a caravan becomes clear in the following passage, since the author indicates it in his examples. At least one may presume that these numbers were not implausible for him.

They [people of Yemen] cannot arrange the rows of the camel-trains like the travelers from Iraq to Mecca and from Syria (in the desert), but their beasts of burden are always in a row, one camel after the other. Sometimes the length of a row reaches four or six miles according to the multitude of men and camels. For every thousand camels the space from the front and the space of the rows of men has an extent of two miles, two thousand (camels the extent of) four miles and three thousand six miles.

Consequently, a caravan made up of 1000 camels with the men leading them made up a continuous row nearly 4 km long; the author obviously wants us to imagine the men leading the camels walking between the animals. This length adds a special problem for caravans from the south: when the beginning was already at the station, the end of the caravan still had some hours more to travel:

And when the length of the camel-train brings it about, then the front is already in the *manzil* [stopping place], and the tail still has to travel there one *marḥala* [distance of a day]. And when the front is at the *manzil* in the morning, the tail reaches it at noon, and when it is at the *manzil* in the evening, the tail reaches it at night time.

The organizers of these kinds of large trading caravans had to deal with what we would nowadays call logistic problems of traveling, transportation and supplies:

Concerning water, it [the tail] then finds only spittle and concerning fodder only waste, and sometimes it finds even nothing like that, in conjunction with the suffering it gets through thieves and raiders of the road and through indigent Bedus, who take advantage of it in the morning, following the company and their rear-guard closely.

The head of the caravan has the advantage of finding the best supplies of fodder and water at the stopping places, whereas the rearguard gets only the rest or nothing and is additionally molested by thieves, raiders and Bedus. This unequal allocation of risks and advantages calls for organization to establish a balance between the people, as al-Hamdānī comments:

Consequently, they find the request inevitable to establish equal circumstances between the people or to work justice⁶ concerning their circumstances.

So they divide the caravan in four quarters, i.e. a multiplication of four with four. They do this according to the number of camels. Every day they let one quarter go first. On the next day, the rear guard precedes, and the first one from the day before becomes the second, the second one the third and the third one the rearguard. Then on the third day the third quarter, which was the rearguard of the second day, goes first, and the first of the day before, which was the rearguard, will become the first on the next day and the first of the first day becomes the second, and the second becomes the fourth, the rearguard. Then this rearguard precedes on the fourth day and becomes the first, whereas originally it was the second. Correspondingly, each quarter is further divided according to this system.

An example of this: “If a caravan consists of 1600 camels, the quarter is 400, the quarter of that 100 and the quarter of the quarter of the quarter 25. Then the men of one quarter meet and cast the lot. To whom the first lot is assigned, is the first. Thereafter the rest casts the lot, and to whom the first lot is assigned, is the second. Thereafter the men of the other two quarters cast the lot, and to whom it is assigned, is the third, and the fourth is the rear guard.”

1st station	2nd	3rd	4th	5th	6th	7th	8th	9th
A	P	K	H	A	P	K	H	A
B	M	L	E	B	M	L	E	B
C	N	I	F	C	N	I	F	C
D	O	J	G	D	O	J	G	D
E	D	O	J	G	D	O	J	E
F	A	P	K	H	A	P	K	F
G	B	M	L	E	B	M	L	G
H	C	N	I	F	C	N	I	H
I	H	C	N	I	F	C	N	I
J	E	D	O	J	G	D	O	J
K	F	A	P	K	H	A	P	K
L	G	B	M	L	E	B	M	L
M	L	G	B	M	L	E	B	M
N	I	H	C	N	I	F	C	N
O	J	E	D	O	J	G	D	O
P	K	F	A	P	K	H	A	P

Table 9: Schematic presentation of the organization of caravans by al-Hamdānī: the systematic change of quarters (indicated by different shades of gray) and quarters of quarters (letters A-P) at the caravan stations provided a fair distribution of the dangers and advantages of traveling in a caravan.

Following this example, the author makes an interesting digression about how the lots were cast to appoint the starting order of the groups on the first day of traveling, an advantageous day for the leading group and a rather dangerous and difficult one for the last:

There are some who write on four stones or on four sticks for making fire or arrows on one QDD, the sign for the leading one, on the second TNN, the sign of the second, on the third TLL, the sign of the third, and on the fourth SQ, the sign of the rearguard, or RBB, the sign of the fourth.⁷ Sometimes they discern among them stones, or the people of each quarter bring an arrow without feathers and head, which is recognized. They collect all of them and hand them over to the lot-thrower. He takes the arrow-shafts or shakes the stones with raised head and fixed glance. Then he takes one of them out and says: “This is the first.” And he is recognized. Then he takes out and says: “This is the second.” And

⁶ The author uses verbs of the root s-w-y (VIII: “he sought, or desired, what was equal, equable, uniform, even” Lane 1863/93:1477f) and ‘-d-l (I: he acted equitably, justly, or rightly; or II: “he made it equal” Lane 1663/93:1972f).

⁷ The signs are shorthand for the Arabic roots concerned: “he made foremost” is q-d-m, qaddama (Lane 1863/93:2985), “to call the second” t-n-y, *tannā* (Lane 1863/93:357), to call the third t-l-t, *tallaṭa* (Lane 1863/93:347) and “to be the rearguard” s-w-q, *sāqa* (Lane 1863/93:1470f), exchangeable with “to call the fourth” r-b-‘, *rabba’a* (Lane 1863/93:1016). The author uses the first two radicals of the roots concerned, e.g. instead of q-d-m only q-d-d, and so on.

he is recognized. Then he takes out and says: “This is the third.” And he is recognized. And the fourth one becomes the rearguard. And each quarter is divided up in (further) quarters along this division.”

This is a description of the very common process of throwing the lot, as it had been known to the people from Palmyra in the north to South Arabia since pre-Islamic times. Originally, lots were thrown not only in everyday situations like the one mentioned here, but in connection with religious procedures such as divination (Hoyland 2001:155–156). This last mentioned use of the lot was and still is forbidden in Islamic times. The author tries a further explanation of how the quarters of a caravan change daily. Evidently, he was not sure if his first explanation was clear enough:

Then they cover this *marḥala* [distance of a day] according to the outcome of the lots, until they show up in the *manzil* [stopping place]. When they set out again, the rear guard has the leading part, that is, the quarter RBB, and the last quarter of this rear guard of yesterday, of the last quarter, becomes the first [quarter] of the first, of the leading one. And the quarter QDD becomes the second, and the quarter TNN the third, and the quarter TLL the fourth. Then they set out again after the second *marḥala*, and the quarter TLL leads, the quarter RBB becomes the second, the quarter QDD the third and the quarter TNN the fourth. Then they go away from the third *marḥala*, and the quarter TNN leads the way, the quarter TLL follows as second, the quarter RBB as third, and the quarter QDD becomes the rear guard. Then they go away from the fourth *marḥala* in the same pattern in which they set out from their homes, and the first is the first (again), the second the second, the third the third and the fourth the fourth. The quarters adopt this in their quarters and (further) quarters according to this division.

A further problem comes to the author’s mind now: What happens if the number of *marāḥil* was not divisible by four:

And if their *marāḥil* are four or eight or twelve or a multiple of four with any number, the quarters of it are equal to each other. But if something other is the case, then [one proceeds] with a *marḥala* called “the pay of the foot” [*ajr as-sāq*] and “the curtailed one”. But sometimes they count their *marāḥil* and decide unanimously for *manāzil* exactly in accordance with them, and when they find them, they impose as an obligation that according to . . . ⁸ there. Sometimes they favor one of them and distribute it among themselves, and in the same manner the second and the third, and there is no division between them.

If the number of *marāḥil* was not divisible by four, there were two possibilities of achieving a balance: the people introduced a shorter additional day’s distance, or they united two groups for one of the *marāḥil* on the way. A third attempt at an explanation follows, where the author uses combinations of letters from the Arabic alphabet:

As an example of this we make as a sign for the first quarter of the caravan a quadri-radical name, so that each letter of it becomes a sign for the quarter of a quarter; it is ABJD.⁹ And the sign for the second quarter of the caravan is KLMN, and the sign for the third quarter S’FŞ, and the sign for the fourth quarter QRŞT. This is a picture of that in the first day’s journey and what follows:

The author’s third effort at an explanation leads to his decision to present a table from which the change of the quarters can be read. I replaced Arabic by Latin letters (see table 9) using the sequence of the Latin alphabet.

And if each quarter of a quarter is divided by four, meaning the multiplication of four by four by four, of which the sum is 64, then the sum of this number becomes what is ABJD, KLMN, S’FŞ, and QRŞT, quarter after quarter, and the second, the third and the fourth does the same, and then the division, which made the round in the one instance in four days, makes it now in 16 days. Know it!

With this “know it!” the author ends his digression on the organization of the southern caravans.

⁸ Lacuna in the text.

⁹ al-Hamdānī has to introduce quadriradical combinations of letters to be able to denote the quarters and the quarters of the quarters of the caravan’s units. The combinations of letters give no sense.

CONCLUSIONS

Apart from water and fodder, caravans traveling through deserts had relatively minor problems compared to the caravans using a road through sometimes densely inhabited, agricultural regions alternating with mountainous, rocky, difficult terrain. These kinds of route necessitated a very deliberate organization, where risks and advantages were distributed in a balanced, equitable way among the participants of a caravan.

In my view, al-Hamdānī's "thick description"¹⁰ relates to actual practices that were widespread enough in his time to be discussed for urban readers in such a detailed manner. Yet it is remarkable that al-Hamdānī treated readers anticipating information about gold and silver with this lengthy digression on the organization of caravans.

Apart from its comparative function, the whole passage perhaps is intended to accentuate the people of South Arabia's ingenious, elaborate methods for organizing caravans. At the center of their efforts was the desire to spread the dangers and the advantages of traveling in a caravan in the mountainous regions of South Arabia as equitably as possible. These attempts at a fair treatment of all participants were apparently not dictated by a Sulṭān, Imām or another "top down" version of government, but were developed in "bottom up" ways by the people – traders, pilgrims – themselves: they can already be seen as small-scale attempts at democracy in the 10th century. The ideals of *istiswā'* (equal, equitable distribution) and of *'adl* (equity, justice, rectitude) are at the same time central values of tribal societies in South Arabia, with *'adl* especially being an indispensable quality ascribed to leading personalities in this social environment. In addition, one has the feeling that similar to other fields of activities in South Arabia, such as animal husbandry, irrigation techniques or customary law, a very long experience preceded the ingenious regulations concerning equal distribution of risks and favors (cf. Serjeant 1984:36). It is just this ever present sense of justice and equality that is one of the main bonds holding together the members of the Yemeni tribal societies.

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¹⁰ This thick description is a rather nice – and old – example for a kind of writing "in which, through a careful attention to detail and context, there is an integration of description with interpretation." (Barfield 1997:466). This use of the term was popularized by Clifford Geertz.

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ANDRE GINGRICH

Camels in Star Mythology and in Everyday Rural Life: Ethnographic Observations in South-West Arabia's Tihāma Lowlands

This short chapter discusses certain local south-west Arabian notions about the dromedary. These are connected with star lore among groups of inhabitants of the coastal plain along the eastern shores of the Red Sea, i.e. the *Tihāma*. Similar to other regions of the Middle East, local residents of rural areas in the Saudi and Yemeni *Tihāma* often tend to attribute anthropomorphic qualities to camels. They are seen as strong and enduring, but also as unpredictable and unevenly tempered. With regard to several aspects of relations to the environment, dromedaries are perceived as being much more sensitive than humans. This obviously includes their ability to notice the proximity of moisture and water.

In the winter of 1981/82, during the third phase of a joint Saudi-Austrian ethnographic field work project, several elderly gentlemen living near the villages of *Khamīs al-Qawz* and *Dawqa 'l-'Ulā* (about 200 km south of Jidda) told me independently of each other that the camel's behavior informed them each year in advance when the summer period of drought would come to a close and when the Pleiades would return.¹ The ways in which these accounts were presented featured a curious combination of pragmatic experience and mythological symbolism. In this contribution I will contextualize, examine, and unpack these folk concepts about the camel. I will begin with a section on camels' usage in their material contexts, which provides the basis for the second section and its more specialized analysis of camels' role in local star calendars. The whole chapter then concludes with a final section offering a set of interpretations.

USING CAMELS IN THEIR MATERIAL CONTEXTS

The lowlands of the Red Sea coastal plains (see graph 29) are among the world's hottest areas. Mean annual temperatures range between 29 and 30° C and thus are slightly above tropical heat. For the Yemeni *Tihāma*, and for the Saudi *Tihāma* to the south of Jidda, the figures for mean annual rainfall in the late 1970s were 50–300 mm (Abdulfattah 1981:36; Map 3, Stone 1985:9). In the *Tihāma* adjoining southern *Hijāz* and northern *ʿAsīr*, most of a year's precipitation concentrates in the two solar months of August and January. Anticipating the rainy seasons could thus be essential for the economic and, in fact, for the physical survival of local households. A wide range of star calendars, of mnemonic references and other related observations therefore represent widespread intellectual resources among local residents in this regard. This cognitive legacy also includes local folk notions about dromedaries' specific relation to the climate at the end of the summer drought season. Camels' behavior was also said to indicate the return of the Pleiades, as the main constellation in the most widespread local calendar. As one of the most conspicuous constellations in the sky, the Pleiades play an important part in many folk calendars

¹ This cooperation between King Saud University (Riyad) and the University of Vienna was funded by the Kingdom of Saudi Arabia's Ministry of Higher Education and the Austrian Science Fund (FWF). The main results were edited by Walter Dostal (1983a; 2006). I would like to thank the editors of this volume for initiating the conference and the ensuing publication, and in addition, Najwa Adra, Dan Varisco (Long Island, N.Y.) and Johann Heiss (Vienna) for their helpful comments on a first draft of this text. Host Kopp (Erlangen-Nürnberg) and his team generously contributed the accompanying map. This chapter follows Arabic transliteration rules of the International Journal of Middle Eastern Studies except for Anglicized terms (e.g., Mecca).

all around the globe. The specific ways in which regional folk calendars in south-western Arabia operate will be discussed in more detail in the second section. But in order to understand how the Pleiades are symbolically associated with conceptions of the camel, this opening section first has to provide an overview of camels' usage and significance in historical, practical and symbolic contexts of the region.



Graph 29: South Western Arabia: The coastal plain along the Red Sea coast (Tihāma) is home to various folk myths, blending knowledge and legend about the camel and its role for stellar lore and for fertility.

At first sight it may appear counter-intuitive that the camel should play such a prominent role in local symbolic conceptions with regard to rain, to annual cycles of precipitation and to local life in general within a region that has never been particularly well known for its camel-raising traditions. It is true that dromedaries from south-west Arabia's coastal lowlands hardly ever played any famous role at the peninsula's courts as racing camels, or for their meat quality in the main markets of the region. A brief outline of the historical and material contexts, however, will demonstrate that their economic role within the region has been significant and, in fact, quite indispensable.

BEYOND THE LOCAL: CAMELS AND TRADING ROUTES

For long-distance trade, the north-south routes through today's Arab Peninsula were much more important during most historical periods than those between east and west. Three such long-distance routes were used since antiquity. All of them ran roughly parallel to each other and to the eastern coastline along the Red Sea. The westernmost of these three routes in fact was by sea and followed the coastline on water. The other two were by land, the easternmost following the lower eastern slopes of south-west Arabia's fertile mountain ranges (*Sarāt*) through the transition zones towards inner Arabia. By contrast, the central route led through the *Tihāma* coastal plains.² Among these three main north-south routes, the western one by sea and the eastern one along the lower east of the *Sarāt* mountain ranges were used more frequently than the central routes through the *Tihāma*, as is already testified by documents from late antiquity for the so-called frankincense or incense routes (Müller 1978). The three north-south routes had that name in late antiquity for their relevance with regard to specific luxury goods such as incense. Yet the significance of those routes went far beyond that, for in general they connected the commerce and economies of Mediterranean antiquity with those bordering the Indian Ocean. These routes

² For a discussion of these routes up to medieval times see the article (including the map) by Johann Heiss in this volume.

were therefore not only essential for exchanging luxury goods such as incense or gems, but also some local products for everyday use such as honey or leather (Gingrich 2006a).

Commercial handbooks from late antiquity such as the *Periplus Maris Erythrei* mention many Red Sea ports. These certainly served the main commercial transactions in a north-south direction. Yet in addition they also must have served as points of departure and destination in the east-west directions, connecting the much more fertile regions of the *Sarāt* highlands with the small ports along the coast. In Islamic times, pilgrimage to Mecca had a twofold effect on the region in our present topical contexts: pilgrimage implied a rising frequency of travel, and thus increased the demand for camels for transportation, and pilgrimage also represented a growing demand for slaughter beasts,³ with unavoidable repercussions upon a region in the southern neighborhood of Mecca such as the *Tihāma*. The emergence of Islam and of Muslim pilgrimage therefore had a substantial impact on the significance of camels, through the increasing role of major regional ports and on their hinterland. This has also been demonstrated for the later Middle Ages for various smaller port towns such as *al-Qunfidha* (Gingrich 2005), *al-Mukhā* (Becker/Höfeld/Kopp 1979) and others. These developments and their impact connected the *Tihāma* between Jidda and *al-Hudayda* to regional and international trade in both directions, i.e. by providing important outlets for local products and by opening up the region to goods and ideas from outside. Together with demographic shifts from the steppe margins to the eastern slopes of the *Sarāt*, the eastern north-south route changed as well, while the *Tihāma* route maintained its significance. As the essential means of overland transportation along these routes, and as a main provider of local products such as honey, hides, or wood, the dromedary's role in the *Tihāma*'s economic history can thus hardly be overrated (see picture 40). In the Ottoman period, and particularly so after the opening of the Suez Canal in 1867, camels' significance may have reached their plateau, which continued to an extent after the 1918 collapse of Ottoman administration into the 20th century's first decades of independent Yemeni and Saudi rule in the *Tihāma* (Gingrich 2006b). Only with the introduction of modern roads and of cars since the 1950s did the dromedary's role in this region substantially decrease.

REGIONAL CONDITIONS FOR RAISING DROMEDARIES

The groups of villages where in 1981/82 I was told the local stories by the elderly men mentioned above about the camel's sensitivity to the "return of the "Pleiades" were all located at the western end of the *Tihāma* lowlands. In their eastern parts, these lowlands then rise to the so-called hilly and mountain *Tihāma* (Abdulfattah 1981). Using and raising camels is widespread in the *Tihāma* lowlands, while due to their zoological properties, in the hilly *Tihāma* the use of camels is less frequent and the raising of camels is virtually non-existent. Instead, cattle in the hilly and mountain *Tihāma* assume some of the main functions of the *Tihāma* lowland camel – i.e. as draft animals, providers of milk, dung, meat and leather, and as a means of transport over shorter distances. In a very pragmatic general sense this resulted in a widely shared local opinion that will be important for understanding the final section of this text: every rural *Tihāma* resident knew that "the bull is the camel of the mountains, and the camel is the bull of the lowlands". Cattle (or "bull") and camel therefore occupied very similar and in fact logically almost identical and interchangeable positions in the everyday experience of the residents in these two adjoining *Tihāma* regions.

The vast but arid *Tihāma* lowlands are less fertile and thinly populated. They are geographically sub-divided by the parallel courses of *wādīs*, which all roughly follow an east-west direction. Carrying occasional floods from the mountains in the east during the rainy seasons, these *wādīs* also hold more moisture during the rest of the year than the steppe zones between them.

³ If affordable, the pilgrimage to Mecca represents one of the main obligations for Muslim believers (therefore also called "pillars" of Islam), and ritual procedures of pilgrimage still require appropriate sacrificial slaughterings at the right time and site.

The *Tihāma* thus can be seen as a north-south sequence of parallel *wādīs* running through the mountain and hilly *Tihāma* in the east and leading to their mouths at the Red Sea shore in the west, where a port often has the same name as the *wādī*. From north to south, this sequence includes *Wādī al-Līth*, *‘Iyār*, *al-Dawqa*, *Aḥsiba*, *Yabā’*, *Ḥalī*, *Arīk*, *Rīm*, *‘Itwad*, *Baysh*, *Jīzān*, and many more. The course of each *wādī* also provided the preferred routes for east-west travel.

Since the areas along the banks of these *wādīs* contain more moisture and wells, they are the privileged location for permanent rural settlements, for markets and for cultivation wherever possible. In consequence, these also are the areas for milling, for caravan quarters, and for the fenced enclosures where camels are kept overnight. By contrast, the camels’ main grazing areas are off these settlement areas, i.e. either inside the *wādī* beds or in the drier steppe zones. In the 1980s, major sections of the rural Saudi *Tihāma* population lived in permanent settlements, but smaller groups were semi-nomadic or nomadic. Typically, *Tihāma* nomads and semi-nomads do not use the inner Arabian black tent, but mobile straw huts of various forms (Gingrich 2006c).

WELLS AND MILLS

This first section can be concluded by highlighting two functions of *Tihāma* lowland camel as a draft animal that was highly relevant before the introduction of other forms of energy, both remaining widespread well into the early 1980s. This concerns wells and mills. By contrast, tilling the soil required no draft animal, since the hoe and digging stick were most frequently used by hand in the Saudi lowlands. Plowing, or rather cutting the soil by use of the ard, was practiced only in the hills and mountains, where camels occasionally were used as draft animals for that purpose as well.

Well construction includes the pulley or draw wheel as the most robust and central feature, around which the well rope is used to pull up the water container by means of animal draft energy (Gingrich/Heiss 1986 for examples from Yemen’s northernmost areas). In their technical design, traditional *Tihāma* wells followed the same principle common in the highlands of Yemen and *‘Asīr*. By contrast, sesame is a crop that has been relatively specific to the *Tihāma* lowlands for many centuries (Varisco 1994:181, 195–196), but through regional trade sesame and sesame oil also play an important role in the daily lives of the highlands. The production of the oil usually takes place near the centers of sesame cultivation. The owner of a sesame mill is often a specialist serving a whole village or group of villages. In this case, the camel often wears blinkers as a protection against the circular redundancy of the operation (see picture 41–43). In short, until recently the camel was essential for *Tihāma* lowland residents not only for transportation and commerce, but also for providing access to two main ingredients of their life – to water and to oil.

For the *Tihāma* population, the camel thus provided a means of material access to water and oil, the key to commerce and wealth, and it remains a main sacrificial animal. Their far-reaching material and symbolic significance provides the basic insights to now also understand camels’ role in a much more specific dimension of regional cultural life.

CALENDAR SYMBOLISM

It should be clarified from the outset that folk calendars always combine legends and empirical observation, i.e. folk astrology and folk astronomy, in ways that are common for star lore. As already mentioned, as in many other regions of the world, the Pleiades play a central role in regional star lore and folk calendars. These regional folk calendars address a symbolic association between the Pleiades, the dromedary and the coming of the rainy season.⁴ This symbolic

⁴ Daniel Varisco (personal communication, 31 Jan., 2011) indicates that the famous South Arabian navigator Ibn Majīd refers to ways in which the Pleiades have been imagined, one being that of a she-camel (Tibbetts 1979:83).

association was repeatedly presented to me in the verbal form of a stereotypical tale, for which I shall here use the term “standardized narrative”. This is a standard form of narration which therefore includes combinations of empirical observation and legends. Scrutinizing a standardized narration in this form makes it possible to subject it to anthropology’s critical analysis of myth. In my translation this standardized narrative basically went like this:

When the Pleiades are concealed (*law istikannat al-Thurayya*) the season is very dry. During these days man and woman should not sleep together, and the soil should not be opened. When the Pleiades then slowly come back in the eastern morning, man and woman do not notice it at first, but the animals will. The first creature to notice the return of the Pleiades is the snake (*al-ḥanash*). Some days later, the goat notices and starts to tremble (*yuwaḥwaha al-tays*). Soon after that, the camel notices the return of the Pleiades too. The camel then stares all the time at the house of man and wife. Only after the camel will humans also sense that the Pleiades are returning. Then the moist season is not far away any more.

The standardized narrative is therefore built on an anthropocentric and geocentric perspective. This narrative includes three interrelated themes or main topical elements: a) stars and stellar constellations as indicators of agricultural star calendars; b) a number of related normative rules or sets of moral regulations for humans. These two elements are then combined with c) several narrative statements about animals.

These three main topical elements will now be discussed consecutively in this present section.

REFERENCE TO STELLAR CALENDARS

The main temporal reference is directly related to the setting and rising of the Pleiades. Since by their shape and location the Pleiades are a particularly conspicuous constellation, their observation is quite common in many different parts of the globe throughout various periods of history. Yet in this particular regional context, such a reference is an explicit indication of south-west Arabia’s most widespread type of agricultural folk calendar, i.e. the *anwā’ al-zirā’a* or *ma’ālim al-zirā’a* (agricultural markers).

My original question about the *anwā’* actually elicited the standardized narrative with its three elements, before my interlocutors would elaborate any details about star lore. Based on earlier publications on this topic (Gingrich 1994, 1997, 2006a) it will suffice in the present context to point out the following: according to most south-west Arabian star calendars, the Pleiades are seen as the “leader” or the “head” of a whole series of ecliptic stars and constellations that are the “followers”. The first morning rising of each of these stars or constellations introduces a period of 13–14 days and nights, the period being named after the stellar name. In the south-western parts of Saudi Arabia, no written or printed almanacs are used for these purposes as is the case in central Yemen (Varisco 1994). In most written almanacs and treatises, the *anwā’* are presented as a formalized series of 28 constellations that seems to be inspired from other literary sources (al-‘Ansī 1998, Varisco 1997). In practical life, the number of observed and known *anwā’* constellations is always less than 14 and corresponds to the main periods of agricultural activity. Often aided by rhymes and star proverbs, one would therefore associate a specific star name with a specific activity; e.g. the star group of “*al-Jabha*” would be locally known as the time of preparing the sesame fields, while a couple of weeks later, “*al-Sarfa*” is known as “sesame sowing time.” Star names in the *Tihāma* often refer to risings or settings in the morning: people would enjoy the cooler morning air while sitting either on their house roofs or in front of their straw huts, drinking coffee and commenting to each other on the current stellar rising or setting just before sunrise. This kind of local knowledge is passed on from one generation to the next among interested laypersons and experts. In some regions of the *Tihāma*, these forms of knowledge are accessible to everybody who is interested, while in others they are restricted to experts and their pupils. Restricted expert knowledge is more explicitly connected to literary sources (Gingrich 1994:205).

In some areas of the *Tihāma* of southern *Hijāz* and *ʿAsīr*, the whole chain of ecliptic stars that “follow” the Pleiades also is perceived as the “body” of the Pleiades, which are then seen as the “head” of a female figure (Gingrich 1997, see also note 4 in this text). By its visual logic and by its popularity among common rural practitioners, the *anwāʾ* system thus differs markedly from the *manāzil* or lunar mansions. Lunar mansions (i.e. specific conjunctions between the moon and certain ecliptic stars or star groups) are already mentioned in the *Qurʾān*, reference to the *anwāʾ* can be found in the *Ḥadīth*. Observation of the *anwāʾ* therefore meets no objection from Muslim scholars and theologians (Varisco 1997). It is well understood by them that in view of the Islamic lunar calendar, local residents always needed additional time referents that would orientate them through the solar year and its seasonal cycles.

MORAL RULES FOR HUMANS

For each of these main stars and constellations that are part of the agricultural and folk calendar *anwāʾ al-zirāʾa*, there is a period during the solar year when they cannot be seen from a given geographical location. At the latitudes of the *Tihāma* the period between a star group’s last evening setting (its “disappearance”) and its first morning rising (its “return”) occurs for the Pleiades in late spring/early summer. Depending on local conditions of visibility above the horizon, this period may last up to two months. The return of the Pleiades therefore occurs about one month before the summer monsoons. All climatic data for these regions indicate that winter cyclones as well as spring and summer monsoons set in with a relatively high rate of regularity and predictability. Taking the return of the Pleiades as a good and reliable indicator for the imminence of the summer monsoons is therefore the result of useful folk astronomical knowledge and experience. In this sense, the Pleiades are actually (used and interpreted as) a sign of fertility, as is commonly noted already in early *anwāʾ* texts beginning with the 9th century CE including Ibn Qutayba (al-Dīnawarī) and Qutrub (Kunitzsch 1961, Varisco 1997). Seeing the Pleiades’ absence as a period of taboos and evil spells, however, has more to do with folk astrology. Local terminology refers to this general period as *al-Kinna* (the “concealed” period of the Pleiades) or rather, in a transliteration of the region’s prevailing dialect pronunciation, “*am Āinna*.” This period is associated with a twofold set of taboos for humans: they should not cultivate their fields, and married couples also should abstain from the pleasures of sex – particularly during the first 13 days of *am Āinna*, called *ayyām al-kabāt*. The common denominator in both taboos is obviously an interdiction on any activities related to fertility; the absence of the Pleiades thus is seen as a bad time for fertility-related activities in humans and fields. Since the period of *am Āinna* certainly is the driest and hottest season of the year, the twofold taboo does not impose too serious a sacrifice upon those who observe it. Still, the implication is ominous and claims that any violation might result in disaster and bad luck.

NARRATIVE STATEMENTS: STELLAR CONSTELLATIONS AND ANIMAL BEHAVIOR

The standard narrative’s third theme, as identified earlier in this section, claims to be descriptive of animals’ behavior during the final period of *am Āinna* and the initial weeks thereafter. In a temporal sense, these claims therefore entail a prediction for a time sequence following the appropriate behavior of humans with regard to the taboos of *am Āinna*. From a logical perspective, this represents a best-case scenario that describes what allegedly may be observed if things go well. The best-case scenario thus establishes an order of creatures’ sensitivities to the return of the rain, in which humans come last and the snake comes first. The particular role of the snake in this element of the standardized narrative strongly emphasizes the non-empirical, mythological character of the overall, animal-related third element. Humans do not regularly observe snakes in this area at all, but merely talk about them quite often, perceiving them as guardians of springs and wells. This element of the standardized narrative therefore positions a non-observable phenomenon at one extreme of a scale: the snake is featured as the creature that is most sensitive to the imminence of rain, and simultaneously as the animal at the greatest dis-

tance from humans. In fact, the snake is the only wild, non-domesticated being on this scale at all.

We may thus conclude the second section of this chapter by returning to the *Tihāma* dromedary and to its role in the standardized narrative. I have pointed out that this narrative combines astronomy and astrology, pragmatic experience and legendary fiction into a mythological structure. That structure situates the camel between humans and their domesticated life at one end of the scale and the snake as an appreciated element of wild life at the other. The myth argues that if humans do not violate taboos of fertility, then the rains will come after the Pleiades return. Other creatures will be aware of this long before humans, the snake most importantly. Yet even before humans grasp that the season is actually changing towards rain, the camel will notice it and will tell them: the standard narrative says that once the camel notices the imminent return of the Pleiades it will stare at the farmer's house or hut.

CONCLUSIONS AND INTERPRETATION

The *Tihāma* stories about the camel's sensitivity to the return of the Pleiades and to the coming of the rainy season, which is demonstrated by the camel staring at the farmer's house, now allow presentist as well as historicist lines of interpretation.

In a presentist mode of reasoning, camels continued to play a relatively significant part in the local and regional economies of the *Tihāma* lowlands until the early 1980s. Camels were part of local commerce, they provided important materials for local consumption and their use as draft animals was essential in maintaining access to water and to sesame oil. In addition, they played an eminent symbolic role for local prestige and for religious rituals. The fact that they should also play a relatively significant role in association with local *anwā'* calendars was thus entirely in line with their significance in all other aspects of everyday life. Camels were important for agricultural fertility, and the Pleiades indicated a season of increased agricultural fertility.

Through the *anwā'* agricultural folk calendars, the times of *am Āinna* are established as a minor folk taboo period during the weeks when the Pleiades are invisible. Because of its lunar orientation, the Islamic calendar actually makes additional seasonal – solar and/or stellar – forms of time reckoning unavoidable and necessary. Although the Islamic calendar has its own regular periods of abstention and of fasting, Islam therefore does not oppose the observance of the *anwā'*, nor does the folk taboo period contradict Ramadan. When the Pleiades return after the driest and hottest season of the year, it is then hoped that the rains will come soon: camels are believed to display a special sensitivity in this regard.

A historicist line of wider interpretations would add the following thoughts: the camel and the bull occupy analogous positions in the rural *Tihāma* population's imaginary universe, since in many ways the camel is seen as the "bull of the *Tihāma* lowlands." In this imaginary sense, both animals are interchangeable. The standardized narrative therefore positions the camel/bull as particularly close to humans' domestic life and the snake at an extreme distance. Both are seen as imaginary animals with a specifically meaningful relationship to humans and to the return of the Pleiades as a symbol of water and life. Archeological evidence has richly demonstrated the importance of snake and bull as ritual animals and as sacred beings in the ancient south Arabian pantheon of pre-Islamic times, when they held intermediate positions between humans and the gods (Ryckmans 1987, Dostal 1983b). In the strictly monotheist frame of Islam, that previously elevated status later became subordinate to humans, as an integral part of Creation. Yet some reflection of the ancient legacy seems to persist in today's appreciation by local people for these animals' special association to fertility. In addition to its presentist relevance, the standardized narrative could therefore also include elements of ancient South Arabian mythological beliefs and legends.

And after all, one final question has to remain open: if camels are so much better than humans in anticipating water at a spatial distance, who would doubt that there might be some camels that could do the same from a temporal distance as well?

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DANIEL MARTIN VARISCO

What Camels Eat: A Study in Arabic Ethnobotany

In the name of God, Most Gracious, Most Merciful
Glorify the name of your Lord, the Most High.
He creates and shapes.
He designs and guides.
He produces the pasture.
Then turns it into light hay.
(Qur'an, 87:1–5)

What do camels eat? The simple answer is almost anything. In the extensive lore on the camel in Arabic texts, there is a wide variety of information about the kind of plants that camels eat, what are considered the best pasture, which produce the best quality milk and some that are thought to cause harm. This study focuses on the ways in which the early Arab botanical genre classified plants for camel pasturage and the experiential information available in these texts and other lexical sources in comparison to ethnographic analysis of camel nomadism on the Arabian Peninsula. Since it is not always possible to determine the contemporary scientific designation of an Arabic plant name used over twelve centuries ago, it is important to compare the historical data with modern botanical research¹. The main objective of this study is to show the potential for analysis of plants noted in the texts to be consumed or avoided by camels in Arabia. My focus is limited to *Camelus dromedarius*, the one-humped dromedary common in the Arabian Peninsula and North Africa.

Being such an important domestic animal in the Arabian Peninsula, it is not surprising that there is an extensive vocabulary for all things camel in classical Arabic.² The lexicons abound with obscure terms, some of which survive in extant dialects. Even the contemporary Arabic term for a revolution, *thawra*, also has a meaning relating to the rising up of a camel. There are a few texts devoted exclusively to the camel, including the early 9th century CE *Kitāb al-Ibl* of the pivotal linguist al-Aṣmā'ī, whose botanical text is also rich in information about camels. In general the collective term for camels is *ibl*, which can also refer to a herd of camels. The most common singular form in Arabic is *jamal*, a Semitic cognate with a long history or *ba'ir*. The female camel is generally known as *nāqa* and the male as *fahl*, although there are many other terms depending on various descriptive aspects.

The two main botanical sources consulted for this study are both from the 9th century CE. The first is by Abū Sa'īd 'Abd al-Malik al-Aṣma'ī (died 213 Hijra,3 i.e. 828 CE), whose *Kitāb al-Nabāt* and other lexical works were widely quoted in later sources. He was one of the major Basra philologists who practiced what today would be called linguistic anthropology, resorting to Bedouins for their usages. He became quite famous, eventually serving at the court of Hārūn al-Rashīd in Baghdad. Although the surviving copies of his botanical text are not complete,

¹ A table of Arabic plant names discussed in this article is available together with their contemporary scientific names at www.ahjur.org/camelplants.html.

² One of the best overall introductions to the historical context of the camel in the Arab world is by Bulliet (1975), which was updated in 1990. For a general introduction to the camel, see Gauthier-Pilters and Dagg (1981), still valuable although somewhat out of date. For discussion of Arabic proverbs on camels, see Qatāmish (1988:406–419). For contemporary scientific terminology in Arabic regarding camel care and feeding, see Murād (2005:46–48).

³ The Hijra designates the first year of the Islamic Calendar and refers to the emigration of Prophet Mohammed and his followers from Mecca to Medina (622 CE).

much more information is quoted in succeeding texts, including the much larger *Kitāb al-Nabāt* of Abū Ḥanīfa al-Dīnawarī, his contemporary. The text of al-Dīnawarī became the standard lexical text for plant names and is quoted frequently in the thesaurus of Ibn Sīda (1965) and the major lexicons, especially *Lisān al-‘Arab* of Ibn Manẓūr and *Tāj al-‘Arūs* of al-Zabīdī. Not all of his comprehensive analysis has survived, but parts have been edited by Bernhard Lewin (al-Dīnawarī 1974).

PLANT CLASSIFICATION IN ARABIA

Just as Arabic lexicons contain thousands of words related to camels, the same can be said for plants, especially those that serve as pasture. Most of the research on Arab botany has focused on medicinal plants, including the transmission of Greek commentaries such as that of the first century CE Dioscorides.⁴ The lexical sources, as well as critical early botanical texts, document the vocabulary used by Arab Bedouin and much of this is related to pasture plants. In his unmatched thesaurus of Arabic terminology, the 11th century Ibn Sīda provides an extended discussion of words related to plants and pasturage. The sections on plants follow directly on those dealing with fertility or barrenness of land. The most important term for “fertility,” which is *khiṣb* in Arabic, is defined as a combination of sufficient pasture (*kala’*) and water (*mā’*) for the Bedouin (Abū Ḥanīfa in Ibn Sīda 1965(10):170). Fresh pasture (*al-kala’ al-raṭb*) that springs up quickly in the spring season but does not last is called *‘ushb*, which can be further defined as annual herbs. Such annuals are paired against woody perennials, defined as *shajar*. The term *shajar* has no direct counterpart in English; it can refer to trees, shrubs and bushes. The key element is that *shajar* refers to plants that have a stalk or trunk (*sāq*), paired in meaning to *najm* for a plant with no stalk (Ibn Qutayba 1982:98). A further contrast can be made between fresh (*raṭb*) plants, known as *khalā*, versus *hashīsh* for dry plants (Ibn Qutayba 1982:98).

The most common verb for grazing on pasturage is *ra‘ā*, *ri‘ya* for the act of pasturing, *rā‘ī* for the herder of camels to pasture and with *ri‘ī* and *mar‘an* for pasture or pasturage (Ibn Manẓūr gives *r-‘y* as the Arabic root;⁵ Ibn Sīda 1965(12):11). The verb connotes caring for or protecting, as in the Arabic proverb: Do not fail to care for a young girl or pasturage, since everyone has a desire for them (*lā tada‘anna fatāt wa-lā mar‘āt fa-inn li-kull bughāt*) (al-Maydānī 1955(2):235). This term is used for domestic animals in general, i.e. *māshīya*, and not just for camels. There are several Arabic terms for pasture in general, including *ab* (Ibn Qutayba 1982:98), *sawm* (Ibn Sīda 1965(12):11), *sarḥ*, and *surūb* (Ibn Sīda 1965(12):12), as well as numerous other specific terms for the state of the pasture or how the camel grazes it. When a camel goes out at night for pasture, the term is *hayj* (Ibn Sīda 1965(12):12). As is also the case for people, feeding in the first part of the day is called *ghadā’* and at the first of the evening is *‘ashā’* (Ibn Sīda 1965(12):12). There are also terms for pasturing in certain seasons, such as *tarabbu’* for pasturing on plants in spring (*rabī’*).

Defining plants, for the Bedouin, is both a function of the availability of water and key physical characteristics of the plant itself, primarily wet or fresh vs. dry, annual vs. perennial, with a stalk or trunk or without one. Pasture can be classified according to its state, whether plentiful and thus fertile (*khiṣb*), middling (*khubba*) or dry (*jadb*) (al-Dīnawarī 1974:27). Further discrimination is directly related to plant value as pasture. This is clearly seen in the classification scheme adopted by al-Aṣma‘ī (1972:14). This model delineates several main types of plants, although disagreements have been recorded regarding which category certain plants belong to. The first is for *aḥrār* plants, which are those said to be slender and soft (al-Aṣma‘ī 1972:13). He

⁴ There are extensive resources on the botany of the Arabian Peninsula and specific countries. The basic published scientific guide is the work of Miller et al. (1996), of which six volumes are planned. See also Ghazanfar/Fisher (1998).

⁵ As a Semitic language, Arabic words are generally formed from a root of three or four consonants. Other letters are added to form different words with the same general meaning of the root.

lists 34 specific plant names, many of which are difficult to identify over a millennium later. A second distinction, *dhukhūr*, is for 35 plants deemed to be thick and tough, with a subcategory of five plants listed neither as *dhukhūr* nor recognized as *aḥrār*. The most important category of pasture, especially for camels, refers to plants known as *ḥamḍ*, of which 17 specific names are given. This is the general term for any plant with a salty (*māliḥ*) taste (al-Aṣmaʿī 1972:17, al-Dīnawarī 1974:4), thus halophytes. Ibn Manẓūr (*ḥ-m-d*) defines this as every salty (*māliḥ*) or bitter (*ḥāmiḍ*) plant, which has a stalk (*sāq*), but no bulb (*aṣl*). By contrast, *khulla* is used for plants with no salty taste (al-Aṣmaʿī 1972:17) or those considered sweet (*ḥulw*) (Ibn Manẓūr, *ḥ-m-d*).

According to al-Aṣmaʿī (1972:17), non-salty plants for the camel are like bread to a person and salty plants like meat for people, implying that both are important for a healthy diet.⁶ He is also quoted as saying that salty plants are like *udam*, which connotes seasoned food, or fruit (al-Dīnawarī 1974:27). Non-salty plants toughen the meat (*lahm*) and increase the fat (*tirq*) of a camel. These also enhance the natural color of the camel and make the hooves (*akhfāf*) firmer (al-Dīnawarī 1974:8, 11). On the other hand, salty plants cause the camel's stomach to empty out and increase its body hair (*awbār*) and lead to weight loss and lack of energy. According to al-Dīnawarī (1974:8) salty plants make the meat leaner, distend the stomach, swell the hips, lengthen the hair, make camels thinner, enable them to endure thirst, make them more vulnerable and turn heads to a whitish ash cover. Yet, as noted by al-Dīnawarī (1974:7), salty plants are useful in causing the camels to drink, which keeps them from becoming emaciated.

Al-Aṣmaʿī mentions some seventeen specific *ḥamḍ* plant names, several of which continue in use on the Arabian Peninsula through to the present, well over the span of a millennium. According to Dickson (1951:416, 632) plants classified as *ḥamḍ* in contemporary Kuwait include *rimth*, *shibrām*, *ḍamrān*, *ʿarād*, *ʿajrām* and *ghadrāf*. Also for Kuwait, al-Saʿīdān (1981(1):452) lists *irṭā*, *shibrām*, *rimth*, *ḥamaḍ*, *ashnān* and *ṭarfā*. Saudi varieties include, in order of benefit, *rawtha*, *rughl*, *ʿarād* and *sawād* (Ṣuwāyān 2000(6):207). In Saudi Arabia these plants are said to be salty and bitter but like a “fruit” for camel (al-Quwayʿī 1984:174). *Rimth* (*Haloxylon salicornicum*) is particularly important, considered by Abū Ḥanīfa al-Dīnawarī (in Ibn Sīda 1965(11):152) to be the most beneficial halophyte plant for camels and sheep. It is also said to produce, at times, a honey-like sap in the shape of pearls.

Another important type of plant, related to its seasonal appearance, is indicated by the term *janba*, used for plants that produce leaves in seasons without rain; these are said to be intermediate between *shajar* and *nabt* (al-Aṣmaʿī 1972:17) or between *shajar* and *baql* (al-Zabīdī, *j-n-b*). These are generally smaller than *shajar* (plants with a stalk or trunk) and superior to *baql* (in reference to annual plants that spring from seed). In contemporary Saudi Arabia these *janba* plants include *rimrām*, *naqd*, *raqrūq*, *shakāʿī* (Ṣuwāyān 2000(6):207). The *janba* plants that are grazed on after the sprouting of *buqūl* herbs are known as *khadir* (al-Maydānī 1955:8).

WHAT CAMELS EAT: THE DIETARY RANGE

One of the distinguishing traits of the camel is that when it is in the confines of the desert it needs no food beyond the plants which the surface of the ground offers up to it.
(Jabbur 1995:207)

Unlike most other domestic animals, the camel has long been an eco-friendly consumer. When allowed to graze on their own in an arid landscape, or even when browsing on a journey, camels tend to take only a few bites out of a particular plant before moving on. “Unlike slow-moving cattle and intensively grazing goats, which crop plants down to the roots and even climb into

⁶ This same analogy is recorded by Ibn Manẓūr (*ḥ-m-d*). It is worth noting that Gauthier-Pilters/Dagg 1981:43 conclude, “Salty plants together with dry grass, which supplies carbohydrate, form a well-balanced diet for camels.”

trees to forage,” observe Gauthier-Pilters and Dagg (1981:33), “camels are economical feeders that never overgraze the vegetation.”⁷ Thus the camel is the ultimate “eat-and-run” or at least “eat-and-walk-on” animal. Camels also tend to spread out while grazing, which further preserves vegetation from over exploitation. It has been noted, however, that camels can damage trees from repeated selection of their foliage, especially when there is overcrowding (cf. Osman 2004:127 for Dhofar, Oman). In the United Arab Emirates, for example, the camel population has doubled in the last three decades, with consequent overgrazing due to sedentarization and construction activities (Breulmann et al. 2007:10). By 1990 it was estimated that over 30% of the grazing land in Arab Gulf states had been depleted due to larger numbers of livestock, no restrictions on grazing, and destructive gathering of wood (Batanouny 1990).

Although camels are not omnivorous, they can graze on a wide variety of plants. The list of potential species grazed on or fed to camels is quite extensive. For the North African Sahara there is a list of some 150 different plant names, only some of which are identified, in the account of Daumas (1971:103–104). Gauthier-Pilters and Dagg (1981:39) confirmed 114 principal food plants for camels in the Sahara. Basically, camels can eat almost any available herbage or leaves; thus the potential diet is unlimited. The comment by Wilfred Thesiger (2007[1959]:59) is common: “Whenever we passed any bushes we let our camels dawdle to strip mouthfuls of leaves and thorns, and whenever we came to richer grazing we halted to let them graze at will.” In many cases camels are fed what is at hand. In the southern marshes of Iraq, for example, Ochsenschlager (2004:31) observes: “They are fed on dried reed stalks and any kind of green grass or sedge that can be gathered or that grows near the water where the camel can be staked.” Even in the drought of summer, notes George March (1856:83), “the twigs, seed-vessels, and withered foliage of the desert plants supply the frugal camel with the necessary nutriment.” One of the benefits of grazing camels is that they can feed on thorny plants most other domestic animals do not touch. A camel is capable of ingesting a thorn up to 1 cm in length (Mukasa-Mugerwa 1981:27). This is due, in part, to the mobile lips and tough mucosa of the camel’s mouth. Thus, except in the depths of the desert, a herder can combine camels with sheep and goats, since the camels have a wider range of dietary choice.

A single camel in Saudi Arabia is said to need 25–35 kg of plant material a day, with a minimum of 5 kg (Šuwāyān 2000(6):208), while Gauthier-Pilters and Dagg (1981:36) observed that generally non-work camels consumed only 10–12 kg per day. The weight of a single bite ranges from 1–20 grams, depending on the plant, with between 200 and 700 bites per hour (Gauthier-Pilters and Dagg 1981:35). For the Emirates, Murād (2005:54) notes that a camel may consume 30–50 kilograms per day if there is plentiful pasture after rain, but only 20–30 kilograms if it is a dry season. In a study conducted in northern Kenya in the 1970s, observation was made of 10,000 feeding minutes and the average diet of plants for camels was made up of dwarf shrubs (48%), trees (30%), grasses (11%), other herbs (10%) and vines (1%) (Mukasa-Mugerwa 1981:36). The best grazing is said to be in spring with seasonal fresh pasturage (*‘ushb*) available on the spring rains.

There is much discussion about which plants made the best pasturage. The most comprehensive contemporary analysis is for the United Arab Emirates. For this area, Murād (2005:123–144) classified natural pasturage plants according to three types: whether the benefit is excellent, good, or middle to little value. For Arabia, Dickson (1951:409) was told that *‘arfaj* (*Rhanterium epapposum*) was “one of the finest camel foods known to the Bedawin.” It was said to be one reason that the camels from the area of al-Hasa, where this plant was abundant, were so admired. It is also considered the best grazing in the mountains and hard soil of Saudi Arabia (Šuwāyān 2000(6):207). This species is well adapted to drought and valued in large part

⁷ This must be qualified. Even in classical Arabic there is a term for camels grazing in an area and not leaving any plants; the term is *jarz*. The term *mad‘ūka* refers to land overgrazed by camels and overexploited by people (Ibn Sīda 1965(12):21). The modern Arabic term for overgrazing is *al-ra‘ī al-ja‘iz* (Murād 2005:61).

because of its quick response to rain. It can also be consumed by camels whether fresh and green or dried. This is a dominant plant community in the northern Arabian plains stretching into Iraq (Ghazanfar/Fisher 1998:183). A recent study by Brown and Al-Mazrooei (2003) found that in depleted pasture *Rhanterium epapposum* regenerated from underground stumps that may have remained in the soil for decades.

Al-Zabīdī (‘-r-f-j) has a long entry devoted to this plant. It is a desert plant that appears quickly in summer, being soft or pliable and dust-covered, as well as having a coarse produce like *ḥasak* (the prickly head of a thistle). It has a pleasant aroma and yellow flower without any seed or thorns. Abū Ḥanīfa al-Dīnawarī was told by Bedouins that

its root is wide, occupying a [considerable] piece of ground; and it sends forth many shoots, proportionate to the root, without leaves [. . .] being only slender shoots, or at the extremities whereof are [buds, or the like, such as are termed] *zama*‘, at the heads of which appears a yellow substance like hair; and [. . .] it occupies a space like that of a man sitting, becomes white when it dries up, has a yellow produce, is eaten in the fresh and dry state by the camels and sheep and goats, and its flame is intensely red (translated in Lane 1984:2017).

The significance of ‘*arfaj* is indicated by a proverb: *ka-mannī al-ghayth ‘alā al-‘arfaja* (Like the benefit of plentiful rain on the ‘*arfaja*). The roots of ‘*arfaj* are called ‘*azā’ir*. The part of the plant that is no longer suitable for consumption is called *salīkh*. An area with a large amount of this plant is known as *ḥawmān*.

Camels are especially fond of ḥamḍ, the generic term for plants with a salty taste, but also used specifically for *Haloxylon articulatum* (Cav.) (Jabbur 1995:208). According to Dickson (1951:416), camels near the Euphrates, which provides a plentiful source of water, thrive on a thorny bush called camel thorn (*Alhagi maurorum*; Arabic, ‘*aqūl*), a plant that is not liked by desert camels. Near the Iraq-Saudi border, according to Dickson (1951:611), camels will only feed on *qaysūm*, which he identifies as *Artemisia herba*, when they first leave the watering holes in autumn, but never in spring. In the Eastern Desert of Egypt it is said that camels will not eat colocynth gourd because it is too bitter (Hobbes 1989:93). Other plants that are not used for pasturage of camels in Iraq include *Alyssum homalocarpum*, *Cardaria draba*, *Carex stenophylla*, *Cutandia memphitica*, *Cynodon dactylon* and *Rumex vesicarius* (Murād 2005:145).⁸

Acacia trees are important browsing for camels up to 6,000 feet on the Arabian Peninsula (Great Britain Admiralty 1946:590). Acacia leaves have a high water content, which is important for desert grazing. There are many species and several important Arabic terms, which are not often consistently applied from one area to another. For Saudi Arabia there are at least 18 recorded species, for Yemen some 11 species and for Egypt about 14 species (Dubaie and Al-Khulaidi (1990:44). These are widely distributed over a variety of ecozones and elevations and well adapted to drought conditions. Some species provide excellent foraging for camels, while others have unpleasant odors which may deter a grazing animal. The Arabic terms applied to Acacia trees are not consistent. The main terms are *umm ghaylān*, *daylam*, *salam*, *samur*, *sant*, *sayāl*, *ṭalh*, ‘*urfut*, and *qatād*. In Egypt’s Eastern Desert, *Acacia raddiana* (*sayāl*) is used for camels and other purposes when there is no pasture from rain, but only when no other fodder is available (Hobbes 1989:105, 25). Murād (2005:141) concurs that *Acacia seyal* has less value as pasturage in the United Arab Emirates.

Camels can also browse as they travel on long trips, obviating the need to carry fodder. Marsh (1856:84) made a seven-week trek during May and June in Arabia Petraea, but only one of the camels was hand fed during the journey. Marsh complains that it was hard to keep a camel on track when it was eager to snatch foliage along the way. This can, of course, slow down traveling time, as Bertram Thomas (1929:205) discovered in the Rub‘ al-Khālī: “During the latter part of this day we made little progress, the Badawi halting at every tuft of camel thorn

⁸ Murād (2005:145) notes that the source is a reference work on Iraq, but he apparently suggests that camels avoid these plants in the United Arab Emirates as well.

which the beasts snatched at and devoured hungrily.” On some journeys small balls of “*alej*”,⁹ a mixture of millet and coarse flour the size of a man’s fist, are carried as camel feed (Great Britain Admiralty 1946:510). After a long and exhausting journey a camel may need to rest for three months (Musil 1928:359).¹⁰

Although the camel is not carnivorous, it has been known to feed other animal parts to camels. Bertram Thomas (1932:89) reports that among the Mahra of South Arabia antelope stomach was fed to camels. Gauthier-Pilters (in Gauthier-Pilters and Dagg 1981:41) observed Saharan camels eating mummified young gazelles, bones and charcoal. More commonly, especially along the southern Arabian coast, dried fish is used as camel fodder. Regarding sardines near the port of Mukalla, Pike (1940:647) notes: “The fish are taken from the nets, tossed up on the beach to dry, and then packed into large bundles for transport to the interior, where they are used for camel fodder or fertilizer.” Thomas (1929:197) also includes small herrings as fish dried for camel fodder.¹¹

One of the major advantages of the camel is its tolerance of salt both in water and vegetation. This is due in part to its intestinal system; a camel may secrete urine that has a higher salt content than sea water (Mukasa-Mugerwa 1981:47). Salt intake is important for the camel as it facilitates passage of water in the urea and kidneys. The primary way of obtaining salt is through salty plants, such as *hamḍ*. If a camel does not graze on salty plants, especially during drought, for at least 15 days, it can develop bad breath, called *khulla*, like the smell of garlic (al-Ḥabartī n.d.:71).¹² A field study in northern Kenya noted that camel herders overwhelmingly preferred taking their camels to saline water sources (Kuria et al. 2004). The same study identified plant species with high salt content that were preferred for grazing, the top three being *Salvadora persica*, *Ficus species* and *Salsola dendroides*. It is reported that in Sudan salt is sometimes added to the camels’ water troughs (Parkyns 1850:258).

In addition to natural pasture, which will be described below, camels have been fed a variety of foods. For work camels, fodder in Saudi Arabia includes fodder grains, plant residue, cotton cakes, straw, dried clover, and alfalfa. In contemporary Saudi Arabia the best fodder mixture is said to be straw and chaff of wheat, barley and vetch with water at ratio of 10–15 kg straw to 2 kg grain (Ṣuwāyān 2000(6):206). Camels are especially fond of dates, including the pits, which may be given mixed with milk. “A dainty dish for a sick camel is dates and barley mixed with milk into a mush, and followed by Arab bread broken up into small pieces,” notes Dickson (1951:416). Local camels will eat the leaves of frankincense (*Boswellia sacra*) in the Rub‘ al-Khālī, while others generally do not (Thomas 1929:206). Cottonseed cake is recommended as part of a contemporary camel diet (Murād 2005:70).

What goes in must come out. The quantity and character of camel feces, as well as urine, depends on the food consumed. When the plants are tough and woody rather than soft and moist, more fecal pellets tend to be excreted (Gauthier-Pilters 1981:61). In good pastures camels may defecate twice an hour, but only once an hour when the pasturage is poor. In classical Arabic the generic term for feces is *zibl*, but one of the more common terms encountered is *ba‘r* or *ba‘ar*, which is used for the camel, sheep and goat, gazelle, wild bull and, indeed, any cloven-hoofed animal.¹³

⁹ This is *‘ilj*, which refers to thick round bread (*raghīf*), according to Ibn Manẓūr (*‘l-j*).

¹⁰ For a detailed discussion on how the feeding of a huge number of camels in a caravan is organized see the article by Johann Heiss in this volume.

¹¹ See Dostal (1967:37, note 18 for more references on the use of dried fish along the southern coast of Yemen.

¹² Dickson (1951:621) notes that a desert camel must feed on one of these plants every 15 days in order to keep fit.

¹³ For a study of the terminology of feces in Arabic and its use as fertilizer in agriculture, see Varisco 2012.

PLANTS AND MILK PRODUCTION

The best plants for producing milk in Arabia are *sa‘dān* (*Neurada procumbens*) and *hurbuth* (al-Zabīdī), although al-Dīnawarī (1974:23) quotes al-Aṣma‘ī as saying *sa‘dān* is the best for camel milk and *hurbuth* for sheep. The plant *yanama* is said to be especially beneficial for producing milk, as it fattens the mother (al-Dīnawarī 1974:24). Al-Dīnawarī (in al-Zabīdī, ‘-r-k) also notes that *arāk* (*Salvadora persica*) is the best plant for producing a pleasant aroma in camel milk. Milk production is seasonal. Milk becomes more plentiful as they start pasturing in spring; at first both their stomachs and urine are thin but become firmer as they graze, and as they eat the seeds (*hibba*) their urine thickens (al-Dīnawarī 1974:39).

A female starts producing milk at about four to five years. This has a higher nutritive value than cow’s milk, because it is low in fat and lactose and high in potassium, iron and vitamin C. Average milk yield ranges widely, from 3.5 to 35 kg per day (Khashkhali et al. 2005:164) in Pakistan. Gauthier-Pilters and Dagg (1981:99) record daily milk production in North Africa at six liters over a 918-month period. Breulmann et al. (2007:21) suggest that under controlled dairy farm conditions a camel can yield about 20 liters per day. A unique feature is that the camel is capable of lactating even when under severe stress and still provides a high water content in the milk. According to the Rawala,¹⁴ after a miscarriage a female camel can only be milked if a calf is close by (Musil 1928:333).

The taste and quality of milk is affected by the plants being foraged. In reference to Oman, Mandaville (1968) comments that camel milk often carries a trace of the local grazing plants, such as the slightly salty flavor of *rimth* (*Haloxylon salicornicum*), or the fragrance of *khuzama*. Camels that feed on mangrove (*Avicennia marina*) and *harm* (*Zygophyllaceae* sp.) produce noticeably salty milk and require water daily (Wilkinson 1977:60–61). Ibn Sīda (1965(11):153) notes that the rough plant (*dukhkūr*) called *shuqārā* or *shuqqāra* has a stench that enters the milk. In southern Algeria, flowers of the shrub *Retama raetam* give an acid taste to camel’s milk (Gauthier-Pilters 1981:45).

It is possible to subsist in the desert solely on camel milk, as has been reported about the Bedouin by several travelers (e.g. Cole 1975:42, Thomas 1931:216). The British traveler Mansfield Parkyns (1850:263) claims to have consumed only camel milk for a period of seventeen days and never felt better. Dickson (1951:416), however, warns that camel milk can be a purgative and thus “Europeans should be careful not to indulge too freely in the desert.” Milk provision is made easier by the fact that riding camels in Arabia are invariably female. Leaves of *Acacia orfota* are added to camel milk to keep it from souring (Great Britain Admiralty 1946:590).

CAMEL ILLNESS FROM PLANTS

... gushes of liquid green excrement poured constantly
down their hicks.
(Thesiger 2007[1959]:165)

Not all plants are suitable for camels. Some are toxic either by their nature or in certain seasons. Others can cause health problems given other circumstances. In general it is reported that camels avoid toxic plants in pasturage areas with which they are familiar, but less so when taken to new areas (Murād 2005:146). Since camels were such an important resource for the herdsman, it is not surprising that attention to camel health was a critical concern. One specific term for an illness that a camel or anyone catches from eating certain plants is the verb *habiṭa*, which refers to the problems from overeating, especially swelling of the stomach and inability to excrete the plant material (al-Dīnawarī 1974:18). As a result the camel can neither defecate nor urinate (al-Maydānī 1955:9). From overeating *hamḍ* the stomach is said to soften, creating a condition

¹⁴ The Rawala Bedouin clan lives mainly in Saudi Arabia.

called *harr* (al-Dīnawarī 1974:18). If a camel eats '*arfaj* and *sabaṭ*, but these do not leave the stomach, this is called *ḥabaj* and said to be similar to colic (*lawan*) in people (al-Dīnawarī 1974:18). Camels will have stomach pain from overeating '*unzuwān* (al-Jawharī in al-Zabīdī). The dangers of excessive grazing are real; a camel can get so fat that its hump may break and cause death (Great Britain Admiralty 1946:510). Simply overfeeding a camel can lead to diarrhea, indigestion and at times even death (Mukasa-Mugerwa 1981:31). Consuming too much of a plant called *islīḥ* causes diarrhea in camels (al-Zabīdī, *s-l-ḥ*).¹⁵

One of the earliest entries in the proverb compendium by al-Maydānī (1955(1):8) refers to the bloating (*ḥabaṭ*) of a camel's stomach, "Like that which sprouts up in the spring and kills, or nearly so, by bloating the stomach" (*in mimmā yunbitu al-rabī'u mā yaqtulu ḥabaṭān aw yulimmu*). The reason for this is that the first plants of spring are the thinnest and most succulent (*aḥrār al-'ushb*). This warning is said to be part of a *ḥadīth* of Muḥammad. In his commentary al-Maydānī specifically mentions the plant name *dhuraq*, which refers to a sweet smelling plant that grows in places where water collects and stagnates (al-Zabīdī, *dh-r-q*).

If a camel grazes on '*arfaj* and then drinks water, the '*arfaj* will collect in a lump in the camel's stomach and a hole needs to be cut (al-Aṣma'ī in Haffner 1905:120, 153, Abū 'Ubayd in Ibn Sīda 1965(7):172) Ibn Sikīt (in Ibn Sīda 1965(7):172) adds *ḍa'a* to this and Abū Ḥanīfa includes *sabat* and says it can kill the camel. Eating the hairlike bristles (*lubda*) of *arāk* can cause a camel's stomach to swell (Ibn Durayd in Ibn Sīda 1965(7):172). At times the important pasturage *rimth* can turn sour in the camel's stomach and then a hole must be cut in the camel's stomach and no more consumed (al-Aṣma'ī in Haffner 1905:120, 153, Abū 'Ubayd in Ibn Sīda 1965(7):172). Murād (2005:58) reports that in the dry season a camel feeding too much on *rimth* may develop foul breath like garlic. If a camel feeds on a plant called *ḥayhal*, which has salty sap, this can kill it because it cannot ruminate and the plant distends the stomach (al-Dīnawarī 1974:20). According to the Rwala Bedouins, if a pregnant camel eats too much of a plant called *kurb* she can have a miscarriage (Musil 1928:333).

As reported by Beck (1991:241–242) among the Qashqai of Iran, camels that consumed the broad-leaved wild artichoke, after being starved of adequate fodder during winter, had bloated stomachs; in extreme cases the gas could rupture their stomachs and intestines and cause their death.

All the camels were emitting bad smells, had severe diarrhea, and were moaning and trying to roll on their sides. The ones less stricken stood stiffly with their back legs stretched apart [. . .] Yadollah tried to force the camels to eat a plant with anti-gas properties, and he shoved their own dung and handfuls of loose dirt into their mouths to make them vomit. The animals did not even retch.

The treatment here was first to have the camel ingest a combination of three plants with anti-gas properties, followed by kerosene down their throats and, as a last resort, puncturing their stomachs.

The seasonal state of the plant is significant. According to the almanac of Ibn al-Ajdābī (1964:155) in April (*Nīsān*) there are times when the pasture is renewed (*nashara al-kala'*) after starting to dry up. This is harmful to camels, creating a disease known as *suhām*, which may be fatal. General Daumas (1971:103), writing about North Africa, expands on this:

Beginning on the fifteenth day of April the camels are no longer sent to pasture until after midday because it has been noted that before that hour the plants are covered with dew (*neda*) which would become a source of fatal maladies. Care is also taken not to allow the camels to eat in the *douars* the grass left over in the morning from the rations given the horses during the night. These precautions should be taken for a month and a half to two months, until there is no longer any dew.

An illness called *maghla* is caused by eating *baql* and dirt (al-Aṣma'ī in Haffner 1905:152, al-Dīnawarī 1974:18, Ibn Sīda 1965(7):173); it also called *ḥaqḥa* in reference to being a stomach

¹⁵ For Rwala names of camel diseases involving diarrhoea or constipation, see Musil (1928:368–369).

pain (al-Dīnawarī 1974:18, Ibn Sīda 1965(7):173). The term *ḥaṣal* refers to swallowing dirt or pebbles with a plant so that it collects in the stomach and does not emerge in the cud and can at times kill the camel, especially if in a fenced-in area (*jurdān*) (Ibn Sīda 1965(7):173). A camel will also have trouble passing the thick dried fibrous panicle (*labid*) of a plant (al-Dīnawarī 1974:19). In North African folklore, it is said that camels will die if they eat grass on which blood has been spilled (Daumas 1971:106).

A passage in the Qur'an (88:6) refers to *ḍarī'* as pasture that neither fattens nor satiates the animals and can be dangerous for them. This is generally identified as dry *shibriq*, a thorny plant generally identified as *Ononis antiquorum*. When it is young, the thorns do not bother the camels, but they pose a problem for swallowing when they lengthen and dry. It is reported by al-Dīnawarī (in al-Zabīdī, *ḍ-r-*) that *ḍarī'* refers to the plant in a dry state and *shibriq* in a fresh state. The people in the Hejaz called it *farā'* and claim that camels will not go near it. Others claim it is fresh '*awsaj* or even any dried up plant, especially '*arfaj*. The term *ḍarī'* is also used for a fetid plant growing in water. Ironically the same term can refer to wine or to the food of people in hell. It is said that a camel's stomach shrinks when eating coarse (*khashin*) plants, as well as during a very hot period such as *al-najr* or the intense heat of summer (*qayṣ*), but gains after the mid-summer rising of Canopus (Ibn Sīda 1965(12):18).

As noted by Dickson (1951:418) a disease of the lungs with much coughing is caused by eating too much "theleth," described as "a salty hamdh plant which grows in marshy country (e.g. Banāyat Araifjan and Taffat al Athami in Hazzaim region)." This is called *manhūs* and is said to be highly contagious. When camels eat a plant called *murāra*, it weakens their lips (Ibn Qutayba 1982:67). Omani camels eat a species of *Artemisia* called *ādhir*, which is considered poisonous to camels in northern Nejd (Great Britain Admiralty 1946:510). A source for the Great Britain Admiralty (1946:510) and Murād (2005:146) consider *ḥarmal* (*Rhazya stricta*) as toxic for camels. Al-Zabīdī claims that there is a plant called *uḥufān*, which grows in the mountains and has leaves like colocynth and pods like cowpeas (*lūbiyā'*) and a round green seed, but is not consumed by domestic animals. Similarly a thorny plant called *umm kalb* is not used as pasture (al-Zabīdī). Gauthier-Pilters and Dagg (1981:44–46) record a number of plants toxic to camels, whether year-round, only in a certain season, or only from a certain part of the plant.

One of the most common health problems affecting camels is mange (*jarab*). This is very infectious and can even be transferred to humans. A camel contracts it from the mange mite, which burrows into the skin and causes hair loss and thickening of the skin. It generally begins in the head or neck region, but can spread to the entire body in two or three weeks. Camels may also be exposed to mange through contact with other camels or by rolling in the dust where infected camels have been. If unchecked, it will cause weight loss, reduction in milk production and possibly death. It is said that camels fatten on the thorny plant *urth*, but that this can cause mange (al-Zabīdī, '*r-th*). In Kuwait both '*ajrām* (*Anabasis articulata*) and *shanān* (not identified) are applied to treat mange (al-Muṭayrī 1984:214).

CAMELS AND DRINKING WATER

A thirsty she-camel murmurs pitifully, *taḥenn*, refuses to graze, her eyes overflow with tears, *tedāma'* '*ajūnaha*, every little while she makes an attempt to urinate, and her loins sink in more and more. Musil (1928:338)

Contrary to popular belief, the camel does not store water in its body or hump. In a harsh, arid environment it can lose up to one liter of water per hour through sweating (Breulmann et al. 2007:16). The camel is well adapted to drought conditions, in part because it loses very little water through its dung and urine. It can survive without water longer than any other domestic animal. While grazing on dry fodder a camel needs 3–30 liters of water a day (Ṣuwāyān 2000(6):208). This amount can be derived simply from foraging (Mukasa-Mugerwa 1981:44). The camel has a remarkable ability to replenish its water supply. In only ten minutes it can take

in a third of its body weight in water. This can range as high as 28 gallons in a single watering (Bulliet 1975:35).

Camels are noted for preferring plants with high water content in dry areas (Murād 1995:57). For Kuwait and Saudi Arabia, according to Dickson (1951:413) there is no need to provide water to camels when they are grazing in the winter. Cole (1975:46) reports that the Āl Murrah Bedouin of the Empty Quarter do not need to take their camels to wells if the winter pasture is sufficiently lush. Somali camels are reported to abstain from drinking at water sources for a month if there is good grazing (Mukasa-Mugerwa 1981:43). For the Rub‘ al-Khālī, Thomas (1931:218) observes that camels can stay away from water sources for up to two months in winter. As the weather warms they will need water about once a week, but in the very hot period the camels will need to be watered every two days. Among the Rwala Beduins, camels need water every four or five days if feeding exclusively on salty *ḥamḍ* plants, six to fifteen days if grazing on dry plants, but up to 30 days if feeding on fresh spring grasses (Musil 1928:338). During the six or seven cool months in the Sahara, camels rarely drink water apart from that obtained by browsing plants (Gauthier-Pilters/Dagg 1981:50). Dickson (1951:415) notes that providing a camel with water lessens its homing instinct. It is considered dangerous for a camel to drink water immediately after feeding, since it might drink to excess, hence the proverb: “Take to pasture, but keep from drinking water” (*ra‘ā fa-aqṣaba*) (al-Maydānī 1955:286).

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The Economic Significance and Traditional Management of Dromedaries in Syria

The one-humped Arabian camel, or dromedary, was originally used as a food animal in Syria, and later as a beast of burden. It is a ruminating mammal which stores fat in the hump on top of its body. Its feet are broad, flat, leathery pads, with two toes on each foot, designed to prevent them from sinking in the sand. The ancestor of today's camel originated in the Syrian region but is now extinct¹. It lived around 100,000 years ago, was up to three meters tall at the shoulder and measured four meters overall (see picture 44). Fossil evidence of this was first discovered late in 2005, and more finds were made about a year later (Owen 2010).

A rare limestone tablet dating back to the second century CE was also unearthed by Syrian archeologists (see picture 45) in the centre of the ancient city of Palmyra, which is situated on one of the famous trading routes in the Middle East. The tablet depicts two young men from the city and a child, standing beside a camel which carries many items on its back including a long javelin (Baur et al. 1933, Brentjes 1960).

Arabs in the Mesopotamia and Para-Mesopotamia area, known as Greater Syria and Arabia, lived closely with their domesticated camels. In their culture, camels were treated as part of the family, all of them had names and many had special nicknames. Not only were there many songs and stories about camels in literature, but camels also were considered a flagship species in the Qur'an and Hadith (Gauthier-Pilters/Dagg 1981, Douglas 1939, Compagnoni/Tosi 1978).

CAMEL HYBRIDS

From the seventeenth century onward, a series of European travelers, anthropologists and veterinary scientists have amassed an important record of observations of the intentional cross-breeding of Bactrian and dromedary camels (Kolpakow 1935, Menges 1935, Tapper 1985). The main advantage of the hybrid over the purer species, to both nomadic and commercial users, is less its supposed versatility than its vastly greater size, strength and carrying capacity, its esthetically pleasing appearance and its correspondingly greater value, in both financial and ceremonial terms. In view of this evidence, which extends from Anatolia and Syria in the west to Afghanistan in the east, it is certain that small numbers of Bactrian camels have been kept over the past 300 to 400 years by groups of Syrians who, in the main, raised dromedaries for the purpose of producing hybrids of outstanding strength. Further, these hybrids were used specifically as caravan and draught animals. It can therefore at least be suggested that the reason why Assyrian kings seized Bactrian camels and demanded them as tribute from Iranian lands to the east of Assyria was to acquire studs and breeding females in order to practice the same sort of hybridization with a view to developing stronger pack animals for a variety of purposes (military, commercial, agricultural). While there is yet no archeological evidence of camel hybridization from the Assyrian period, there is some from later periods in the Near East, which demonstrates that hybridization was practiced in antiquity in Syria and Arabia (Potts 2004).²

¹ A more detailed discussion about the archeozoology of camels in south-eastern Arabia see the Uerpmann and Uerpmann in this volume.

² For a further discussion of cross-breeding between dromedaries and Bactrian camels see the article by Faye and Konuspayeva in this volume.

ADAPTION TO THE ENVIRONMENT

Today's Syrian dromedary is well adapted to the hot, arid climate and the flat terrain. Adult animals stand 215 cm to the top of their humps. Weighing 300 to 600 kg, camels can carry loads of 130 to 200 kg and can walk for extended periods. Some dromedary caravans can cover as much as 40 km a day. A riding dromedary however, which is a specialized breed, can maintain a speed of 13–16 km/h for up to 18 hours (Köhler-Rollefson 1989).

Evolved to live in desert areas, the camel has few natural enemies, and is consequently much less skittish than a horse. Though notoriously ill-tempered, it is docile enough when properly trained and handled. It has better endurance than a horse and can forage on practically any type of grass, leaf or twig. The camel's ability to go for a week without drinking is well-known. Evolved for desert conditions, camels do not prosper in wet climates, as they interfere with their procreative cycle.

RIDING CAMELS IN COMBAT

Combined with other adaptations to desert conditions, dromedaries offer their riders remarkable strategic mobility. As a combat animal, the camel has much potential. In the Middle East area they were used for battles and riding, but later on, when horses became domesticated, dependency on the camel started to decline. Their advantages were largely outweighed by disadvantages, thus limiting their range and importance as a beast of war.

Riding dromedaries effectively was difficult since the animal's hump – a store of fat – will break down and collapse under a heavy burden. One of the solutions was to put a cushioned saddle on top of the rump of the animal or to surround the hump with cushions, which were then tied at the front and back (see picture 48). The reliefs of Ashurbanipal show raiding Syrians on camels, each with two naked riders, one of whom controls the animal with a long stick while the other fires a large self-bow. Perched uneasily on cushions as they both were, it is unlikely that either man could have used any sort of melee weapon. The well-armed Assyrians probably had no problems defeating them.

Sometime after 500 BCE, however, the North Arabian saddle was invented. This consisted of two large arches or saddle bows shaped like inverted Vs, which were connected by sticks resting on pads set in front of and behind the hump. A rider could sit firmly on cushions placed on the saddle and hang equipment and supplies on it (see an example from Al Badia Festival in Hama – Ibn Wardan Palace in picture 46).³ Later, better equipped dromedary riders had greater military impact, playing an important role in allowing first the Nabataean Arabs and then the city dwellers of Palmyra to dominate desert trade routes.

THE US ARMY PINS ITS HOPES ON SYRIAN CAMELS

Syrian camels played a role in US history too. After acquiring huge new territories, including California and Arizona, as a result of the 1846 to 48 Mexican-American War, the US government was confronted with the task of finding a reliable way of supplying its garrisons in the new lands.

The US Navy, represented by Major Henry Wayne, who was sent to the Middle East to find camels, brought them from Syria in 1856 with the idea of supplying US garrisons across the Sonoran and Mojave deserts. Many questioned whether horses and mules would make the journey across these scorching deserts with loads of guns and ammunition, so the military decided to try camels. War secretary Jefferson Davis, the future Confederate President, personally ap-

³ The article by Walter Dostal in this volume gives additional insights on camel-riding techniques and saddle variation in the Arabian Peninsula.

proved the plan and in 1856 the US Navy supply ship was dispatched to Syria to purchase the animals (see picture 47). Sailing back with the first herd of three-dozen dromedaries was their Syrian driver, Hadji Ali, the US Army's newest recruit. A second trip to Syria brought the size of the herd to 100, and in 1857 Ali, by then nicknamed Hi Jolly, set out with his first caravan from Fort Defiance, Texas, to southern California. That trek and many others were successfully completed. The camels were auctioned off with the first shots of the Civil War, but many eventually found themselves abandoned in the desert, which they roamed for many years afterwards. A heartbroken Ali survived by working as a scout and prospector until he died outside the town of Quartzsite, Arizona, in 1902. A pyramid-shaped monument topped with a copper silhouette of a camel marks the gravesite of the Syrian, who is recognized for over 30 years of "faithful service to the US government" (Woodburg 2008, Kniazkov 2004).

PASTORALISTS' STRUGGLE FOR SURVIVAL

In Syria, as in many other extremely dry zones, camels are the preferred livestock species, enabling people to live in otherwise uninhabitable areas. Camels' attributes include the ability to go without water for days without decreasing their feed intake and milk yield, utilizing feed that is unpalatable to other species, the ability to carry heavy loads over long distances, and a low susceptibility to disease. They also ensure a sustainable livelihood for their owners by generating milk for subsistence and providing income from the sale of excess animals, while constituting a source of capital accumulation.

Syrian pastoralists are now being forced into more marginal areas owing to population pressures and restrictions on their grazing rights. Here, there are greater risks of disease to camels and a lack of access to basic human amenities, including water and health facilities. Such areas are typically far from markets, leading to the waste of excess milk (beyond that needed by offspring and herders' families), camel hair and hides, which could each be a source of additional income. As pastoralists' need for cash increases, they tend to keep a higher proportion of small ruminants and cattle, because these command higher market prices than camels, as camel products are not very commonly consumed by Syrians. This reduces the stability of the ecosystem and results in a vicious circle of environmental degradation, through the increased number of small ruminants overgrazing the steppe, causing desertification. As poor pastoralists become poorer, they are often forced to sell their few remaining animals to large herders. To break this syndrome and to avoid working as hired laborers or migrating to urban unemployment, herder pastoralists are looking for new ways to utilize their animals. Building networks can be an effective strategy for pastoralists to secure their income.

The Camel Applied Research and Development Network (CARDN) was founded in Syria in 1991, but operations only began after the signing of a contract with the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) as the executing agency in 1996. The network operates through national coordinators in ten member countries. The general objective is to ensure continuing and sustainable use of dry-land range by camel keeping by mainly non-sedentary pastoralists, avoiding further degradation of land and vegetation, thereby assuring continuation of the pastoralist production system, reducing its risks, improving living conditions and alleviating poverty. A general assembly and an executive committee with country representatives – mainly at ministerial level – provide recommendations for the network's operations. The coordinator of the network operates from ACSAD headquarters in Damascus.

According to the challenging situation for pastoralists, the number of camels in Syria has fluctuated over the last 100 years. Especially over the last 30 years their numbers have decreased dramatically. As the number of cars increased and a network of asphalt roads was constructed across the rural areas linking the major cities, the camel owners dispensed with camels for riding and as a means of transport. In 1922 there were about 250,000 Camels in Syria. This increased to 772,000 in 1938 and then declined again, so that by 1954 there were only 106,000 animals left. Again, numbers picked up to 629,000 in 1958. Today, numbers are at their lowest

level ever, with only 22,000 camels in the whole country. This wide variation in numbers was related to the use of camels in the different periods as a draught animal, then falling out of use as transport in the Syrian steppe was taken over by motor vehicles.

THE SPECTRUM OF SYRIAN CAMELS

There are several different varieties of dromedary in Syria (see picture 49) but the predominant variety in the steppe region is the *Shamyeh* breed. These are characterized by a small head, long neck and a thick upper lip, which they use to touch food before eating. It is also characterized by the convex forehead, small erect ears and its average size. Other features include a thick-set body, abundant hair on the hump and limbs, a thin, medium-length tail, light eye color and long eyelashes. It also has long legs, in males up to about 92 cm; the height of the withers, i.e. the ridge between the shoulder blades, is 195 cm in males and 182 cm in females; the chest circumference is about 226 cm in males and 220 cm in females. The body circumference around the hump is 264 cm; the length of the body with the neck is up to 3 m. The weight ranges between 650 and 783 kg in males and between 574 and 680 kg in females .

Another variety, the *Al Khowar* dromedary, spread from Iraq to the border region of the Deir Azzor steppe and Al Jazeera in Syria. This is characterized by its medium-sized head, its long, thin limbs and thin tail, which are light colored. It is known for its high milk yield

The *Al Jodiyeh* dromedary existed in the Palmyra steppe and the Syrian *Al Hamad* dromedary, which is characterized by its big bones and large body, is used for carrying and transport. This variety spread into Syria with the *Al Najdi* dromedary, also distinguished by its large size. Sudanese *Al Tyhyeh* dromedaries and a few from Egypt have also found their way into the country .

Dromedaries are called by different names among the people of the Syrian steppe according to the location. For example, *Al Eas*, *Fater*, *Thalool*, *Mateyeh*, *Baeer*, and the significance of each name is linked to the animal's color (Asaad 1990). See table 10 for some examples.

<i>Al Maghateer</i>	light-coloured (white)
<i>Abdan</i>	black-coloured
<i>Al Majaheem</i>	dark colours
<i>Al Wadha</i>	white colours
<i>Al Malha</i>	black colours
<i>Al Hamleh</i>	red colours
<i>Al Shealeh</i>	white & black hair
<i>Etrah</i>	dark cream colour
<i>Al Zarqaa</i>	grey colour
<i>Al Shaqha</i>	black eyes, beige yellowish colour, white front legs, (colour is like a gazelle)
<i>Al Hamraa</i>	light red colour
<i>Al Sahmeh</i>	dark red colour, black nose, black hump tip, black shoulder tip, white legs and their sides tend to be pale white

Table 10: Names of camels in Syria according to their colors.

Dromedaries are also given special names by their breeders according to their use, as table 11 shows:

<i>Al Thalool</i>	used for riding and racing
<i>Al Zamel</i>	used for carrying
<i>Fater</i>	To be slaughtered
<i>Qaedeh</i>	used as guide for other dromedaries and ridden by 'a dromedary man' referred to as <i>Rahool</i>

Table 11: Names of camels in Syria according to their use.

<i>Hewar</i>	from birth until the age of 6–7 months
<i>Makhlool</i>	from 8 months to a year
<i>Ben Labon</i>	of two years of age (called <i>Lajy</i>)
<i>Haq</i>	3 years and into the fourth
<i>Jethea</i>	4 years and into the fifth
<i>Thani</i>	5 years and into the sixth
<i>Rabbaa</i>	6 years and as it enters the seventh
<i>Khamasi</i>	7 years and as it enters the eighth
<i>Muneib</i>	canine development is completed
<i>Malol</i>	8 years
<i>BoThani</i>	9 years (2nd year after canine complete)
<i>BoThaleth</i>	10 years (3rd year after canine complete)
<i>BoRabea</i>	11 years (4th year after canine complete)
<i>BoKhames</i>	12 years (5th years after canine complete)

Table 12: References to dromedaries in Syria according to their growing stages.

Dromedary breeders in Syria have been organized in three groups according to their situation and distribution. Most of them are from specific clans.⁴

CONCLUSIONS

Camels played important historic socio-economic roles within the pastoral systems in the dry areas of ancient Syria. Their role in Syria as a domestic animal is now undergoing fundamental change as subsistence nomadism shifts towards semi-sedentary, cash-based systems. The existing camels of the poor families in arid areas of east Syria must become more productive and competitive if the communities concerned are to survive. As Greater Syria and Arabia were divided into smaller countries with political borders (that is, today's countries of Lebanon, Jor-

⁴ The Association of Breeding Dromedaries in Palmyra, for example, is located in Al Talilah Natural Reserve 30 km east of Palmyra, and the steppe of Palmyra in the middle of Syria. Most of its members are from Al Sabaa clan and a few from Al Roleh and Bani Khaled. They use the grazing in the steppe of Palmyra, and now reach Al Beghali, Al Kom and the West Hir Palace north of Palmyra. It has 53 members who between them own 3850 dromedaries. Another association, the Association of Breeding Dromedaries in DerAzzor, operates in the Euphrates valley. The majority of its members are from Al Fadaan clan and a small group from Al Sabaa and Al Roleh. They use the grazing in the Der Azzor Steppe from Der Azzor to the Iraqi border. It has 35 members who between them own 2700 dromedaries (Asaad 1990).

dan, and Palestine, and Gulf states, emirates and kingdoms), citizens limited their travels and tended to stay within their own political divide. Camels, however, are oblivious to such things and even today continue to cross the imaginary lines, acting as symbols of a free world.

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MOHAMMED SHUNNAQ, SUSANNE RAMADAN SHUNNAQ

Camel Trekking in Jordan: Between Oriental Perception and Authentic Tourist Expectation

The colour of the Orient, the smell of the Orient, its remoteness, its mystery, its glory. Another life, another dream of a life.

(Georges Clairin cited in Lemaire 2005)

The Prince invited me to keep him company on the journey. He led me to a small fire some distance from his tent, where his slave was preparing sweet black coffee in my pot. His riding camel was kneeling beyond the fire, and he forced my camel to kneel there too. Beside the fire a wooden stand about twelve inches high was driven into the sand and upon it sat a falcon with a red cap on its head. When the slaves had finished loading all the stores and the Prince's tent, the scribe brought forward a war mare and tied it by the rein to the camel's saddle girth, while Nuri took the stand with the falcon, put the bird on the back of the camel's saddle, and thrust the stand into the saddle bag.

(Alois Musil: *In the Arabian Desert*, 1930)

Tourism to the Arabian region has long been encouraged by the visitor's desire to experience adventure, unveil the mysterious, seek escape, or live the western fantasy about the East. Images of camels in the tourism industry have played a significant role in propagating the traditional perceptions of the Arabic region in the mind of the western tourist. Camels, the ancient ships of the desert, play a vital role in keeping such traditional visions alive. This article will discuss camel trekking in Jordan's desert areas as a unique tourism experience for those who are attracted by the oriental flair of the desert. This exploration is qualitative and based on the observation of participants and conversations with numerous tourists in recent years. This study will also explore the possibility of marketing Jordan's most attractive tourist destinations successfully by addressing the tourists' oriental fancies about the region in general and the desert in particular.

INTRODUCTION: THE TOURIST SHIP OF THE DESERT

The role that preconceived notions, fantasies and unlive dreams play in the tourism industry has been explored in several studies with an eye to the extraordinary travel experiences tourists seek in their holidays (Macbeth 2000, Laing/Crouch 2005, 2009, Prideaux et al. 2004, Correia et al. 2007). Exotic adventures are a soothing balm for emotional deprivation or dissatisfaction by means of realizing the three Fs of the tourism industry: fantasies, feelings and fun (Holbrook 2000, Sheridan/Teal 2006). Adventure tourists want to be thrilled, but not necessarily endangered (Cater 2006), whereby "the reward for those who seek adventure lies in the discovery and unveiling of the hidden and unknown" (Weber 2001:59). The mysterious and unknown do not necessarily produce a sense of danger, but do carry an embedded sense of risk. Since risk has to be present for an adventure to take place, tour operators sometimes inject it by offering exciting activities to fulfill the tourists' desires and subconscious expectations. Camel trekking in isolated desert areas is commonly perceived as an exciting way to explore the dangers of the desert and the unknown regions of Arabia. Since tourists usually experience destinations subjectively, it is interesting to take a closer look at the role camels play in the tourist's mental images about the East. few studies explicitly address how tourists impose their preconceived notions about a geographical location onto their tourist destination and how their fantasy aids in constructing a

successful tourism experience (Hirschman/Holbrook 1982, Light 2010). The body of criticism generally lacks studies that link the tourists' mental images about the East to tourism business in the Middle East. This study will explore the significance of the camel not so much as a tourist attraction in itself, but as the epitome long stored images in the western collective unconscious about the East.

Camels have long been connected to Arab life and Arab poets have often sung the qualities of the "ship of the desert".¹ They are considered an important cultural icon and source of pride for Arabs. Camels appear in stories, tales and legends of the East and have become an indispensable image when describing the desert regions of Arabia. They have long played a significant role in Arabic culture (Ripinsky 1975) signifying patience, endurance, wealth, the beauty of women riding on top of camels and the pangs of loss when the caravans carry away the poet's beloved. Explorers of the region have long recorded the presence of this desert animal in Arabia and have described its habitat, qualities and responsibilities (Wright 1927, Musil 1927, 1928, Doughty 1936). Arabs have used camels for transportation and trading and, more recently, for the tourism industry and creation of niche markets. Several studies testify to the importance of camels as tourist attractions (Chatelard 2005, Çalışkan 2009, 2010). Camel trekking and camel safaris in remote semi-arid regions of the Middle East or the deserts of Arabia have become a basic part of tourism packages. With the more recent surge of tourists to Jordan especially after Petra was declared one of the seven modern wonders of the world in 2007, camels have been brought to the attention of tourists in the Badia, the Jordanian desert. Camel trekking adventures have become a means fulfilling tourist expectations by creating adventure tours with an oriental flair.

JORDAN: LOCATION AND CLIMATE FOR CAMEL-CENTERED TOURISM

Jordan is a relatively small country in the Middle East with a diversity in terrain and climates that make it attractive for tourists all year round. Western Jordan enjoys a Mediterranean climate and much fertile land especially in the Jordan valley, which is warm in winter. The south and east of the country is mainly Badia or semi-arid areas.

Despite the harsh climactic conditions with a scarcity of water and extreme temperature differences, large parts of the Jordanian Badia are inhabited by Bedouin and their variety of livestock.² These Bedouin belong to a variety of tribes which have been roaming the Jordanian desert for centuries. Many have turned away from a nomadic life-style, encouraged by the Jordanian government to settle down in villages. Even though many have done so, they still keep goats and sheep for their dairy products and meat and camels for tourism services. The traditional Bedouin lifestyle is disappearing rather quickly, so traditional pastoral nomadism has become increasingly rare, not only because of the closed borders with neighboring countries but also because of rapid urbanization. Many of these Bedouin have come to welcome tourism as a substitute or additional source of income.

During the past decade, the local government has paid great attention to developing tourism strategies in selected areas. It plays an important role in Jordan's economic sector and has developed into one of the largest productive sectors even though it can offer less infrastructure and resources than other competitors in the region. The strategy outlined by the Jordanian Ministry

¹ Since pre-Islamic times, camel convoys have traveled from southern Arabia to Mecca and from there to the Levant in summer and winter trips carrying pilgrims and goods. They were called "ships of the desert" by locals since they were the only means of transportation for people and goods across the Arabian Peninsula. Early Arabic poetry is rich in references to camels, describing their nature, life, shape, stages of growth, and habits. Du Al-Rummah (696–735 CE), one of the Umayyad poets describes the camel as "the ship of the land" in his poem *When we once passed Myyah's house*.

² The term Bedouin scientifically means a camel-herding tribal member, but it has more commonly been used to designate nomadic Arabs (Kay 1978).

of Tourism and Antiquities (MoTA) targets developing niche markets such as eco-tourism and adventure tourism in areas such as Wadi Rum³ and Petra. According to the MoTA statistical department, eco-tourism and adventure tourism receive the highest rating among tourists (MoTA 2010). In response, Jordanian tourism operators offer adventure tours and serve tourists by promoting romantic perceptions of life in the East and adventures in the desert. Many operators offer Bedouin treks in Wadi Rum and Petra for groups of five then visitors. The desert adventures offered usually range between three to eight days of desert experience including trekking and camping.

ORIENTAL PERCEPTIONS OF THE ARABIAN DESERT

For centuries the Orient has exercised an irresistible fascination over the European mind. Stories of distant lands, mesmerizing desert scenes and romantic eastern cities have captured the imagination of many Europeans ever since contact with the Orient has been established even though contact was kept to the minimal through trade and military campaigns.

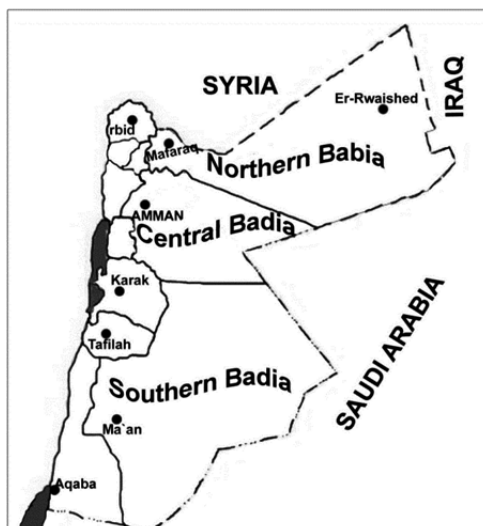
For decades, Edward Said explored the projection of the East by the West as its 'Other.' In *Orientalism* (1978), Said explains that the West has created an image (and thus a stereotype) of the Orient not from facts and reality, but from preconceived notions which were antithetical to the West. Raymond Schwab (1984), in line with Said, argues that the Western imagination depicts the East as a land of fantasy and self-rediscovery – an “Oriental renaissance”, in which the European mind finds its rebirth in an idealized East. The Occident, which created the notion of the Orient as the strange “Other” with the intention of asserting European power and superiority, “orientalized” the Orient, resulting in “one-sidedness, or even untruthfulness” (Liu 2009). These biased notions of the Middle East in particular and the Orient in general are still very much alive.

The Orient has long been a place of fascination and fear, attraction and rejection. Such notions still linger in the subconscious of the European travelers seeking novelty and adventure by traveling east. Stripped of the tiring shells of civilization and the burdensome routine, the visitor to the Arabian Desert yearns to enjoy the pleasures of the slumbering Orient, as opposed to the fast and stressful life in western cities: Arabian scents, exotic food, and hot desert sands. A *Time* advertisement from 25 April, 2011, invokes the Eastern images constructed by operators for consumption by tourists. A henna-painted female hand points out of an airplane window at six camels walking the lonely desert dunes. The caption reads: “Here silence is serenity. The quest for stillness is found amidst tranquility. And the vastness fills you with unforgettable peace.” These images address the tourist’s desire to escape to the far regions of the East, to “unchartered worlds . . . where every day dawns with the promise of a new beginning.” The camels in the advertisement play a vital role in stimulating the Oriental perceptions of the East in the Western mind.

TOURISM DEVELOPMENT IN THE JORDANIAN DESERT

Since 80 percent of Jordan has a desert climate, we find nomads with their camels in the northern, middle, and southern Badia, the Jordanian desert. It is largely underdeveloped land with an annual rainfall of less than 200 mm (Allison et al. 1998). Bedouin in the area mainly live from breeding livestock and from tourism. Since Petra and Wadi Rum have been designated as tourist attractions on the world tourist map, the local government and international agencies have shown interest in developing these areas of the southern Badia.

³ Wadi Rum is a valley cut into the sandstone and granite rock in the south of Jordan. It lies 60 km to the east of Aqaba and is the largest Wadi in Jordan. On June 25, 2011, the Wadi Rum was registered as a new Unesco World Heritage site, making it Jordan’s fourth World Heritage site after Petra, Qusair Amra, and Um Ar-Rassas (<http://whc.unesco.org>).



Graph 30: The Badias of Jordan's desert (map courtesy of Mr. Muwaffaq Bataineh, cartographer of the Faculty of Archeology and Anthropology, Yarmouk University).

ESTABLISHED CAMEL TOURS IN THE SOUTHERN BADIA

At 36,750 sq. km the southern Badia forms the largest part of the Jordanian desert (50%). It is characterized by its mountainous landscape and arid climate with an annual precipitation rate of ca. 50 mm. Wadi Rum is the favorite and most targeted tourist attraction in the region, having been inhabited by many civilizations since prehistoric times. Evidence of human population in this part of the Jordanian Badia can be found in the form of rock paintings – some showing camels, the preferred means of transportation in the area. Rock inscriptions mark the site as one of the caravan stations. However, currently, Western tourists may know Wadi Rum best for its connection with the British officer T.E. Lawrence, who was stationed in the desert during the 1917–1918 Arab Revolt. The 1962 epic movie of Lawrence's heroism in the Arab desert, encourages many tourists to follow the footsteps of this remarkable figure in the still and silent desert of Arabia (Caton 1999). It is interesting to note that most local Badia dwellers are not familiar with the movie, though some have heard of its hero and know him as "the friend of Arabs."

Wadi Rum, also known as Moon Valley⁴ (see picture 52), is home to a number of tribes. The most well-known is the Zalabia Bedouin tribe, which has made tourism its main source of income. Tourism operators who draw on the historical and natural significance of this tourist destination consider Wadi Rum the perfect place for foreign visitors. Popular activities in the Rum area include camel trekking, mountain climbing on the fascinating rock formations, camping and hiking. Bedouin desert dwellers have come to realize that their established presence is of interest and attraction to the Western world. They have learned to read the demands of the recent tourism market and, despite their limited resources, have geared these towards pleasing tourists. Despite the fact that most Bedouin in the area have already settled down in villages and have houses and cars, in response to the demands of the tourism market they stay all year round in tents and follow their traditional lifestyle. In addition to being a source of social prestige and a symbol of wealth, camels have become a second source of income. In the southern Badia they have been institutionalized as commodities through the establishment of NGOs geared toward the selling of the camel image for tourism. However, the commodification of cultural emblems like the camel may lead to a merging of tourist images and self-images and the identity concepts of the toured (Comaroff/Comaroff 2009:26). The desire to return to a semi-nomadic life-style or the wish to use camels for transporting tourists indicates the desire to revive or preserve the

⁴ James Irwin, one of the Apollo 15 astronauts of the fourth American lunar landing 1971 was quoted as having told HM the late King Hussein during a trip to Wadi Rum that this is the closest to what he saw on the moon. According to Senator Biltaji, this was the origin of the name.

cultural heritage for the sake of pleasing tourists. In Petra, the Bdoul Bedouin who use camels to transport tourists emphasize that anyone who not have a camel or an entry permit for one⁵ has a souvenir shop.

Recently, due to the rapid pace of tourism development, the number of visitors to the Wadi Rum area increased enormously. In the 1980s there were no more than a few dozen a year (Chatelard 2005:197) while in 2010 there were over 285,000 (MoTA 2010). In these three decades the private and governmental sectors of the tourism industry have adjusted the marketing image of the Wadi Rum area from one suitable for adventure tourism, to a heritage site, then to a nature preserve, and more recently to a site where the Western tourist will be able to live his suppressed fantasies of the Orient or create new ones performed by the theming of the tourist industry. The image of the Bedouin changed from the savage to the noble savage civilized by colonial powers to a more romantic representation by amalgamating the Oriental images of Eastern men and the masculinity seen in Arab desert dwellers.

Tourists have pre-tour understandings of their destination, partially the inherited stereotypes about the Orient and the Middle Eastern desert life with princes and Sheiks and imagined scenes of distant romantic lands far away from the stress of civilized life. Tourists also acquire information from tour brochures and other sources which target at times the existing expectations and dreams of tourists and at others produce them (Bruner 2004). Tourism materials such as guidebooks, advertisements, TV commercials, and tourism magazines market Wadi Rum as a place where the tranquility of the boundless empty spaces with its timelessness and unspoiled nature brings visitors into contact with the remote areas of their inner selves, relieving them of the discontents and comforts of civilization. Such marketing strategies tickle the Westerner's suppressed yearnings of self-indulgence in the distant lands of the East. To ensure success, tour operators make sure that their clients experience what they expect. They are aware that for many travelers, holidays are "experiences in fancy" (Dann 1976:19); a way of de-stressing after months of demanding work and hectic routines. In such cases "a certain picture is built up of a world that makes up an escape from present reality" (ibid.:22). Since tourist perceptions are known to be closely related to fantasy and the world of dreams (Dann 2002:173) tourists tend not to see the countries they visit objectively, but project their wishes, illusions, and fantasies. Thus the tourism industry allow pictures and images to speak and reinforce the tourists' fancies.

Most pictures marketing Wadi Rum show the vast, empty areas of the untouched semi-arid desert of the area, Bedouin tents, Bedouin camel riders or desert guards in their traditional clothes (see picture 53), or mesmerizing sunsets experienced after long rides on camels and a quiet meal with peppermint tea in a Bedouin tent. The camels are always an indispensable element in the marketing strategies of Western tourist operators while objects of modern civilization such as cars and recent technology are avoided. The images promote the idea of a modern Western tourist traveling into the past and leaving behind hi-tech civilization so as not to disturb the long preserved images of the Oriental life-style of Bedouin Arabs in the tourist's mind (see picture 54).

CAMEL TRACKING IN THE NORTHERN BADIA?

In contrast to the southern Badia, where tourism is well developed by theming and marketing Wadi Rum as a kind of authentic Arab desert experience explored by camel, the northern Badia still has potential in this regard. With a total area of 26,000 sq. km, the northern Badia constitutes 36 percent of Jordan's desert. Rainfall is minimal throughout the year, averaging less than 50mm annually. A number of archeological sites, historical cities and desert palaces, constitute important tourist attractions, but they are still under-advertised and under-explored. Yet a cam-

⁵ The Ministry for Tourism allows permits for 30 camels to enter Petra. All are owned by the Bdoul Bedouins.

el-based tourist experience can easily be linked to the rich history of camel caravans in this particular part of the Badia.

Ancient caravan routes connected three important cities in the Arabian Peninsula from the second century BCE until the 17th century: the two Nabatean cities Petra (the rose-red city) and Busra al-Sham or Nova Trajana Bostra (declared the capital of the Province of Arabia in 106 BCE and still an important halt for pilgrims going to Mecca until the 17th century CE) and a third city, Tadmur or Palmyra (described as the bride of the desert and famous for its heroic history under the rule of queen Zenobia). There were a number of villages on these caravan routes, such as Khirbet As-Samra, Umm al-Jimal, Umm Quttein, Jawa, Deir al-Kahf, Deir al-Kinn. Khirbet As-Samra, midway between Amman and Bostra, made it a suitable caravan stop. Umm al-Jimal, the best preserved of the ancient Houran towns,⁶ was linked to the Grand Imperial Highway (*Via Nova Triana*) during the reign of the Roman emperor Trajan in 106 CE. Due to the Roman military presence the city flourished. Between the 5th and 8th centuries CE, it was a prosperous trading center and agricultural settlement. As for Umm Quttein, Jawa, Deir al-Kahf, Deir al-Kinn, their strategic presence between the imperial highway and another road known as the Strata Diocletiana, which ran from the city Sura in Babylonia to Palmyra and between Bostra and Azraq, made them important resting places for desert travelers on the ancient trade routes (Rollin/Streetly 1998:114, 120).

Since northern Badia has been part of a long and exciting history of cross-cultural interaction since Greco-Roman times, it can be marketed successfully by exposing its importance in the study of the Silk Road. In ancient times, caravans traveling from Iraq to Jordan to Syria and Saudi Arabia played an important role in transferring culture and transporting goods. The impressive remains brought to light by 18th and 19th century travelers to the area and by archeologists in more recent times of archeological sites such as Umm al-Jimal's monuments makes the area even more attractive for tourists. Such rich history and vital presence on ancient trade routes, well known to historians, orientalist and explorers, make the northern Badia an interesting place for those who like to explore the past. If promoted successfully as a tourist attraction for people interested in desert adventures, tourists may experience a climatically more moderate desert adventure than in Wadi Rum. The northern Jordanian desert is an extension of the Syrian plateau (or Badiat el-Sham in Arabic) with an annual precipitation of 135 mm, in contrast to the southern Badia, which is part of the Arabian subcontinent with minimal precipitation. Camel trekking would not only be an exciting means of discovering the desert wonders and ancient cities in the arid lands of north-east Jordan, but would also encourage sustainable management of Badia resources through eco-tourism and nature preservation (Dutton et al. 1998).

Developing a sustainable tourism strategy through camel trekking as niche tourism could promote the rich archeological and historical assets in the northern Badia (see Shunnaq et al. 2008) and could market a variety of camel products such as milk, meat, and products made from camel hair. This approach would not only help in developing local communities and provide an additional source of income (as is the case with the Bedouin in Wadi Rum), but would also attract tourists who desire to spend a few days exploring the natural beauties and remnants of ancient civilizations on camelback. A sustainable tourism strategy would also encourage migration to the Badia and establish self-supporting communities (Al-Homoud et al. 1995).

DESERT CASTLES IN THE MIDDLE BADIA

With 10,400 sq. km, the middle Badia is the smallest but central part of the Jordanian desert (14 percent). It has one aquatic natural reserve (Al-Azraq meaning "blue"), a wildlife reserve (Al-Shomari), and is rich in archeological sites with characteristic desert castles (for an example see

⁶ Houran is a geographic area extending from southwestern Syria to northwestern Jordan. Its boundaries extend from near Damascus in the north to the Ajloun mountains of Jordan in the south.

Amrah in picture 55).⁷ These can only be reached by private car, since no camel tours or another kind of transportation is available. For centuries the Al-Azraq wetland was a point of attraction for camel caravans carrying spices and other goods from Arabia, Mesopotamia and Syria. Additionally, for thousands of years, migrating birds have stopped here on their journey between Africa and Europe. National efforts have been focusing on rehabilitating these wetlands after the over-pumping of the groundwater led to the drying up of numerous natural springs which were essential to the biodiversity of the area. Al-Azraq's water is still being pumped to Amman to provide drinking water for the capital's increasing population. Developing a sustainable and nature-friendly tourism strategy in the area may allow some community involvement and may further development in the middle Badia region. For nature lovers, the wetland area, the wildlife reserve and the desert are attractions worthy of exploring. Camel trekking would here also be a unique way for tourists to enjoy the beauty of the desert castles, following the ancient routes of past inhabitants and travelers. Tourists could learn about the remnants of ancient and Islamic civilizations and the vitality of this area centuries ago while enjoying the beautiful scenery from the backs of camels.

CONCLUSIONS: THE LURE OF THE JORDANIAN DESERT

The majority of Western visitors to the Middle East are in search of the exotic: the strange and unique Other in its various forms. Tourism operators therefore, promote cultural differences as "fascinating, but not disorienting; strange and unique, but not too unfamiliar" (Salazar 2010:84). The tourism market is largely aware of the tourists' demands and fancies, so tourist operators and tourist guides are trained to fulfill – and thereby further promote – what the advertisements promise. Surfing through dozens of websites Wadi Rum is repeatedly promoted as a Jordanian Badia tourist attraction with the image that a journey to this area is a journey to another world where silence dominates its infinite tranquility; Bedouin with their camels can be enjoyed alongside wonders of the Arabian desert; camel trekking is offered to explore ancient routes of Arabian caravans and to enjoy the mystery and remoteness of the Arabian desert. At night, after watching a unique sunset, the tourist can enjoy the hospitality of the Arabian Bedouin in a traditional tent with the Eastern scents and spices. Camels are always nearby, never absent from the Eastern scenes. Tourists will be offered an enjoyable Oriental buffet with peppermint tea, nargile (schischa), belly dancers,⁸ henna painting, carpets and cushions and then, if they wish, they can sleep outside under the dark velvet sky with thousands of stars.

Jordan's Badias are isolated places from the world and tourism operators have more freedom to create unique experiences for tourists in such areas. The camel is thereby an essential element for projections of fantasies and stereotypes about the Arab East and for creating authenticity in the tourist experience. Thus, tourism in the Jordanian Badia is mainly-adventure based or fantasy driven. Camels, sheiks, dunes, hot desert sand and Bedouin are very prominent elements in tourists' visualization of the Middle East. These perceptions are woven together by tourists and tour operators alike from ideas presented in the media, in legends, and in literature. The majority of travel agents advertise the Arabian Peninsula and the Fertile Crescent as locations with beautiful desert dunes and archeological or historical sites, where camels are either a backdrop or a

⁷ Jordanian desert castles such as Safawi, Al-Hallabat, Ein Elseel, Asikhm, Mshash, Al-Azraq, Amrah, Owaineed, Kharraneh, Al-Hammam, and Tuba were originally Roman fortresses. The Ghassanids, tribes of Arab origin, converted the fortresses into palaces (Luck 2011). During the 6th century CE, an earthquake destroyed most of them. During the Umayyad period (661–750 CE), the castles were rebuilt and used as caravan stations for travelers to Al-Hijaz, baths, hunting lodges, fortresses, meeting places, or as retreats for nobles when Muslim Arabs had succeeded in irrigating large areas of the desert. With elaborate mosaics, frescoes and stucco, the desert castles are also rich examples of early Islamic art.

⁸ Belly dancers were introduced by the tourism industry in Jordan in the 1990s and have never been from the local population. Most are Syrian, Lebanese, Algerian or Moroccan dancers who are hired by tourism operators to create images about "typical Arabia."

focal point. Images of camels have become a vital element in the tourism business advertising Arabia and are used as interest catchers and fantasy triggers.

A number of Arabian countries such as the UAE and Saudi Arabia have had many years of experience in camel trekking adventures, camel festivals, camel-milking contests, auctions and beauty pageants. Studying these possibilities, the Jordanian Badia could be an ideal place to promote the presence of camels by introducing camel trekking in the northern and middle Badia and promoting camel contests and auctions as part of tourist attractions and desert adventure tours. Camel trekking in Jordan is not only a regular part of tourism packages sold to Westerners, but has much deeper implications in the Western mind. Camels have become a dominant motivational factor for the Western tourist to visit the land where Laurence of Arabia roamed the desert, Harrison Ford starred in *Indiana Jones* and Agatha Christie chose her setting in her famous novel *Appointment with Death*. Tourists expect to be thrilled and transported by living their mental images about the East. They also expect that their tour operators fulfill their promises by addressing their desires and fantasies. The tourists' oriental perception of Jordan therefore plays a vital role in their experience of the Jordanian desert as they await the fulfillment of their expectations while experiencing the Badia in a very subjective pre-fabricated way on camel back.

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Camel Urine and Milk in the Arab Heritage (Folk Medicine): A Review

The strong mutually beneficial relations between the Arabian or one-humped camel (*Camelus dromedarius*) and its Arab owners have been documented since ancient times. The dromedary is valued as a source of power, fortune and delight, reported the Arabic historian Al-Jāhiz, who described it as a “complete animal” for human beings (Baesmel 2004, Al-Ani 2004). It is exceptionally well-adapted to long periods of drought and heat and can survive and reproduce in conditions intolerable to other domestic animals (Abdalla et al. 1988). The camel as the king of the desert has thus played a crucial role in the life of desert dwellers, not only for transportation, meat and wool, but also as a source of milk and urine. These fluids were of special significance in the folk medicine of people living in the deserts, since they were traditionally used to maintain good health and to treat diverse diseases (Redwan/Tabll 2007, Conesa et al. 2008, Agrawal et al. 2009). This review aims to discuss the most important aspects of camel urine and camel milk as medical remedies past and present.

THE HISTORICAL USE OF CAMEL URINE AND CAMEL MILK

In the Holy Qur'an (How the camels are created, Q 88, 17) the camel is mentioned as particularly important animal of the Arabian Peninsula under various terms: *al-ibil* is the plural, *al-nāqah* refers to a she-camel, *al-jamal* is the male camel, and *al-ba'ir* indicates a camel regardless of its sex. A further name, *al-'ishār*, occurs in Q 81, 4, meaning a she-camel that is ten months pregnant, and *al-hīm* (Q 56, 55) are camels that have been affected by disease.

The folk-medicine use of camel milk and urine is reported in the pre-Islamic era and it appears in various written Islamic sources. The curative effects of camel milk and urine were already mentioned by the Islamic scholar Al-Bukhārī. In his *hadīth*-collection¹ called *as-Sahīh*, it stated that some people arrived in the Madinah area and fell sick because of the climate. The Prophet (peace and blessings of Allah be upon him) told them to drink the milk and urine of camels, after which they recovered and were as healthy as before (Al-Bukhārī, no. 2855², Al-Abdalall 2010).

Another source for the medicinal use of camel urine dates back to the time of the famous Persian scholar Avicenna (980–1037), author of the book *Al-Qānūn*, where he reports “for the Bedouin people, camel urine remains an important natural remedy for different health problems” (Al-Abdalall 2010).

The old name of urine in Arab history is *wazr*, and in pure Arabic is *bawl*. It was used as a treatment for women's hair, for stomach pain (mixed with milk), for gums and toothache, eye infections, skin injuries and infections, snake bites, camel mange, for pregnant women, liver tumour, to assuage thirst and hunger and to wake up a drunk man (Baesmel 2004). The camel owners in the desert gave patients suffering from internal ailments a mixture of camel urine and

¹ The Hadiths are collections of sayings and acts of the Prophet Muhammad gathered and written down during the 8th and 9th centuries.

² Cf. <http://hadith.al-islam.com>.

milk as a morning drink. For all these uses the urine had to be fresh from a young she-camel. Milk was added to overcome its strong odor. The duration of this kind of folk medical treatment lasted a few weeks, after which the patients were declared as healthy again.

A current *in-vivo* series of experiments in which a mixture of camel urine and milk was given to albino mice showed no effects on the normal liver (Khalifa 1999), kidney (El-Elyani 1999) or stomach (El-Elyani/Khalifa 2006), indicating its biological safety.

THE IMPORTANCE OF CAMEL MILK AND URINE

Many components of the camel milk can also be found in the milk of other animals, but the she-camel produces the highest percentage of vitamin C (Mehaia 1994), ranging from 23 to 100 mg/kg. The concentration of vitamin C in urine was found more in female camels than in male. Early tests on camel milk, known in Arabic as *khalafāt*, showed that the whey lysozyme in it inhibited pathogenic bacteria such as *Clostridium perfringens*, *Staphylococcus aureus*, *Shigella dysenteriae* and *Salmonella typhimurium*, but not *Bacillus cereus* or *Eschericia coli* (Barbour et al. 1984). Another advantage of camel milk is its insulin characteristics (Zagorski et al. 1998). Recent experimental studies have also shown clear antigenotoxic and anticytotoxic effects of camel milk in mice treated with the drug cisplatin (Quita/Kurdi 2010), due to its generally high level of immunoglobulins. The camel's immune system also has special features, camel antibodies being mainly composed of heavy chains, which is an important feature in the development of diagnostic and therapeutic features (Hamers-Casterman et al. 1993) as an indication of the role of blood in various vital secretions.

FACTORS SUPPORTING THE POSITIVE CHARACTERISTICS OF CAMEL MILK AND URINE

The morphometric speciality of camel kidneys is considered to be the first natural factor in its positive characteristics (Abdalla/Abdalla 1979) as an anatomical requisite for the production of hypertonic urine. The second factor is the high salinity of urine due to various biochemical contents, with plants being the most effective factor responsible for its therapeutic action. It has been found that these desert plants as well as those growing naturally in different areas have antimicrobial characteristics (Kaul/Nigam/Dhar 1976, McCallion et al. 1982, Zaki et al. 1984). Analysis of various types of desert plant has found a strong effect against bacteria, yeast and fungi, and Zaki et al. (1984) have proved a similar effect in wormwood.

The camel's selective grazing habits probably play a direct role in searching for such plants during its long journeys in the desert (Wilson 1984). Laboratory analysis of these plants found active ingredients which are reflected in the urine used for therapeutic purposes, including *Suaeda monoica* and *Schrad citrullus colocynhis*. Thirdly, a pure bacterial isolate from camel urine, patent registered by (Al-Awadi 1998), was found to have potent antipathogenic characteristics and survived in the high alkalinity of urine. The fourth factor attributed to the miracle action is the urea present in camel urine; this was described by Read (1925) and may play a role as invasive action on the keratin layer.

Camel kidneys are physiologically adaptive organs that can regulate their excretion of urine (1–7 L per day) depending on the environmental conditions such as temperature and water availability. It has also been found that unusual member-bond bodies in the basal lamina of the uriniferous tubules of the kidneys are directly related to its adaptive function (Safer/Katchburian 1991). The glomerular filtration rate and urine concentration also has a direct relation to the high salinity of camel urine (Yagil/Berlyne 1978). The concentration of urine and its chemical components vary in accordance with the challenges camels face in their varied habitat. The renal functions can also withstand severe dehydration, with changes in the urea metabolism (Etzion/Yagil 1986). During dehydration potassium is excreted while sodium tends to be retained in the extra fluid and is used later to restore the camel's fluid volume (Siebert/Macfarlane 1971).

The first analysis of camel urine was carried out simultaneously by two different researchers (Read 1925, Smith/Silvette 1928) in dromedaries for not more than 10 substances, which included total nitrogen, ammonia, total creatinine, creatine, hippuric acid, purine bases and chlorides. Although it was initially found that the composition of camel urine was little different to that of other herbivorous animals (Kalra/Arya 1959), more detailed work determined additional compounds (Amer/Al-Hendi 1996, Faye et al. 1999, Salwa et al. 2004). In more detailed analysis of pregnant camel urine, more than 30 components were identified with molecular weights ranging between 220 and 490. These included sulphur, oxygen, nitrogen, heterocyclic aromatic compounds belonging to thiophen, furan, pyridine and quinolone (El-Nadi/Al-Torki 2007).

In analysing the effects of age and sex on the pH of racing camels' urine, no significant effect was found in the same age groups of the same sex, whereas different age groups of the same sex showed a significant difference (Wasfi/Boni/Hadi 1998), showing that the urine pH increases with age.

The trace-element excretion pattern seems to differ partly between camel and cow urine in cases of mineral supplementation. The retention ability of these elements is either clearly better in the camel (i.e. manganese) or slightly less than in the cow (i.e. copper, zinc, iron). These findings suggest that the camel anticipates the transitory mineral under-nutrition period (Faye et al. 1999). Etzion/Yagil (1986) showed that desert animals are characterized by their physiologically thrifty characteristics.

Amer/Al-Hendi (1996) described microscopic features and showed the presence of phosphorus, calcium oxalate, ammonium urate and epithelial and granular cells. Using neutron activation analysis, Al-Attas (2008) tested some essential elements in milk and urine of camels, and discovered that it contained large amounts of sodium and potassium, substituting the loss of such elements in the case of diarrhea. It also contained high levels of zinc, which assists in the cure of the infection due to diarrhea. Mycotoxins are a diverse range of molecules that are harmful to animals and humans. They are secondary metabolites secreted by molds, mostly *Penicillium* and *Fusarium*, and they are produced in cereal grains as well as in forage before, during and after harvest in various environmental conditions. Due to the diversity of their toxic effects and their synergetic properties, mycotoxins are a danger to consumers of contaminated foods and feeds (Yiannikouris/Jonany 2002). Al-Awadi and Al-Jedabi (2000) proved an inhibitory and antibiotic activity of camel urine against the growth of *Candida albicans* (yeast), *Aspergillus niger*, *Fusarium oxysporum* even after boiling at 100°C. The effect of urine and milk on efficiency of aflatoxins as inhibitors to *Bacillus subtilis* growth is seen as a primary step to find a way to destroy fungal toxins.

Recently, Al-Abdalall (2010) found that camel urine and milk have successfully inhibited aflatoxins and mycelium growth. The author added that camel urine at low concentrations has no significant inhibitory effect on fungal growth, while inhibition can be clearly recorded at high concentrations. Studies of the chemical composition and nutritional quality of camel milk show 11.7% total solids, 3.0% protein, 3.6% fat, 0.8% ash, 4.4% lactose, 0.13% acidity and a pH of 6.5. It is low in cholesterol and sugar and rich in sodium, potassium, zinc, iron, copper, manganese, niacin and vitamin C (Knoess 1979). In addition, camel milk has a low level of protein and high concentration of insulin, which means it can safely be taken by people with a high sensitivity to lactose and immune deficiency (Gast 1969).

Camel milk is pure white and slightly sweet. Yet camels who feed on certain diets, such as some wild desert plants, may produce salty milk. Physiological and genetic factors also affect milk production. The percentage of water in camel milk varies according to the amount of water the camel drinks; it may reach 89% in the milk if it drinks water every day, or 91% if it drinks for one hour a week. It seems that camels can not only endure harsh conditions – they even release more water into their milk during in these conditions; an effect that can be to the benefit of babies or human beings in general (Farah 1993, Abu-Lehia 1989).

In Kazakhstan camel milk is also used as an adjunct to chemotherapy for some cancer treatments, especially those of the digestive tract. Good results were reported in autoimmune diseases such as Crohn's disease and multiple sclerosis (Yagil/Van Creveld 2000). The positive effect of camel milk on diabetic patients has been studied in India (Agrawal et al. 2003), where the consumption of 0.5 L of camel milk per day decreased the insulin demand in diabetic patients and glycaemia was better balanced. Consumers appreciate camel milk for its medicinal properties; it is reputed to be anti-infectious, anti-carcinogenic and anti-diabetic. More generally, it is regarded as an energy-giving product for convalescents.

Camel milk is commonly used to help treat infectious diseases such as tuberculosis in humans. Shubat, a sparkling beverage of fermented camel milk with a sour flavor is commonly used as a cure in sanatoriums (Urazakov/Bainazarov 1974) and works as a laxative on people unaccustomed to drinking it (Rao 1970). A series of metabolic and autoimmune diseases are successfully treated with camel milk. In India, it is used therapeutically against oedema, jaundice, problems of the spleen, tuberculosis, asthma, anemia, piles and diabetes (Rao 1970).

The early effect as a possible anti-carcinogenic agent was described experimentally by Kabarity et al, 1988, who showed that treatment by colchicines inhibited formation of c-tumour in *Allium cepa* root tips. The anti-oxidant and anti-mutagenic activity of camel urine was also demonstrated after bone-marrow cells in mice showed toxicity induced by the drug cyclophosphamide (Al-Harbi et al. 1996). These studies hint at a definite effect of camel urine in the pathophysiology of various cells. In other experiments, the fungi *Aspergillus niger*, *Fusarium oxysporum* and *Rhizoctonia solani* and the yeast *Candida albicans* were exposed to camel urine and were inhibited at different concentrations (Al-Awadi/Al-Gudaibi 1999). The growth of various pathogenic bacteria, *Acinetobacter* sp 1&2, *Ent. Faecalis*, *P. aeruginosa*, *H. influenzae*, *Klebsiella* sp., *E. coli*, *M. morganii*, *Providencia* sp., *Strep. pneumoniae*, *Citrobacter* sp., *Enterocloacae*, *S. aureus* (MSSA) and *S. aureus* (MRSA) was inhibited when exposed to fresh camel urine (Shoeib/Ba-Hatheq 2009).

It was reported that camel urine produced a significant improvement in the histochemical content of infected liver tissue with *Escherichia coli* in rabbits (Khalifa et al. 2005). Furthermore, it has been proved in *in-vivo* and *in-vitro* experiments that early pregnancy camel urine has hepatoprotective and anti-parasitic (*Fasciola gigantica*) effects (Khogali 2005).

INDUSTRIAL PROCESSING OF CAMEL URINE

Experiments on the value of camel urine as a therapeutic agent in a series of *in-vitro* and *in-vivo* laboratory experiments were mostly conducted in Saudi Arabia. They resulted in the discovery registered by Faten Khorshid (US Patent Application 20090297622 2008) under the title "Separation and formulation of bioactive fraction and subfraction from camel urine work as anti-cancer agent" and designated as PM701 and PMFK.³ The urine's physical characteristics described in this patent was: a yellowish color, a solid crystalline form, a sharp (offensive) odor, a pH of 8.03, water insoluble and a specific gravity of 1.045.

In the studies published in the literature regarding the medicinal properties of camel urine, it has been found to have anti-oxidant and anti-mutagenic compounds following the treatment mice with toxicity induced cyclophosphamide (Al-Harbi et al. 1996). Khorshid and Moshref (2006) have also reported the anti-carcinogenic effect of camel urine in different cancer types in rats. However, these studies did not investigate the mechanisms by which camel urine exhibits such anti-carcinogenic effects. Noor (2008) showed that it had inhibited mild steel corrosion, and suggested chemisorptions of organic matter in the urine (i.e. urea, uric acid and/or creatinine).

³ <http://www.patentstorm.us/applications/20090297622.html> (accessed 29 Sept. 2011).

Abdulqader et al. (2011) provided the first evidence that camel urine has the potential to block dioxin-like compounds. It inhibits the TCDD-mediated effect, at least in part by inhibiting the expression of Cyp1a, a cancer-activating gene, at both the transcriptional and the post-transcriptional levels through an AhR-dependent mechanism. These results are of potential clinical significance to humans in that they reveal the molecular mechanism involved and could explain the anecdotal evidence for the successful use of camel urine in the treatment of various medical conditions.

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ANJA FISCHER

The Saharan Dromedary as a Sign: The Prominence of Dromedaries among the Nomadic Imuhar Society in the Algerian Desert

Ahaggar yessuf amis wa baydadjen.¹

In the Ahaggar the white dromedary is preferred.

The Imuhar nomads, known under the foreign designation of Tuareg, live in one of the most extreme environments in the world in Libya, Algeria, Niger, Mali and Burkina Faso. The Imuhar I discuss in this article live in the Algerian part of the Central Sahara and they are highly specialized dromedary and goat breeders. The “red Ferrari” of these nomads is the white, long-legged he-dromedary called the *ebaydag*, which is ridden both by women and men among the Imuhar. With gender-specific accessories, the *ebaydag* becomes a sign of masculinity and femininity. The dromedaries’ speed and strength are not their most treasured attributes, but their elegance and sublimity are signs of prestige to be coveted. Dromedaries, in contrast to most other domestic animals, are signs of social prestige and they fulfill important social functions among the Imuhar society in the Sahara. This article illustrates their significance as creatures of affection among nomads.

The research for this article is based on about twenty months of fieldwork between 2002 and 2011 among the Kel Ahaggar (people of the Ahaggar) nomads in the south of Algeria, especially among the subgroup of the Kel Ahnet (people of the Ahnet) nomads. This group of about 180 Imuhar live to the northwest of the village of Tamanrasset in the Ahnet area. Parents and their children live as nuclear-family units in tents, and they travel with their herds and other tent units in irregular patterns through the extreme environment of the Central Sahara. Wide fluctuations in temperature shape the arid climate here. During winter nights it can drop to below zero, while during winter days it can climb to as high as 30 °C. On summer days the temperature can reach over 50 °C. The amount of precipitation averages no more than 100 mm per year. The Kel Ahnet nomads have been able to adapt their economic activities to these challenging climatic conditions and thus they remain a very vital group of nomads (Fischer 2010).

THE ECONOMIC SIGNIFICANCE OF SAHARAN DROMEDARIES

The work of the Imuhar nomads is organized by a gender-specific division of labor. Imuhar women manage the herds of goats, while men take care of the herds of dromedaries. But compared to the goat, the dromedary is not a major resource for subsistence, especially in the south of Algeria, which is not ecologically well-suited to the maintenance of large dromedary herds (Keenan 1977:120). Imuhar nomads mainly sell goats to the sedentary Algerian population in the surrounding villages. They sell dromedaries only sporadically and they represent a kind of savings account for them (Fischer 2008:81). According to the labor division among dromedaries the Kel Ahnet nomads have three categories of dromedary – for breeding, transport and riding.

¹ (Foucauld/Calassanti-Motyliniski 1984:130). The transcription of Tamahaq, the language of the Imuhar is transformed in this article to a more readable version without special characters. The translation is from the author.

MILK AND BREEDING DROMEDARIES

The Kel Ahnet nomads of the Sahara own herds of female dromedaries, their calves and one bull-dromedary. Dromedary breeding is a slow process, since the she-dromedary gives birth to only one calf every two years. They normally mate during the cold season, and the she-dromedary has to lie down for copulation, so the act of mating may pose some difficulties for the bull. At night the herds of breeding dromedaries stay close to the tents of the nomads, who bind up the right forelegs of the in-heat she-dromedaries during the night. This brings the she-dromedary to lie down and facilitates the act of mating for the bulls, which is normally seen and heard by the whole group of nomads in the camp. Imuhar generally prefer white dromedaries for breeding.

Mother dromedaries are milked twice a day. The milk is drunk and not used for making butter or cheese as in the case of goat milk. Kel Ahnet nomads tie a cord around the forelegs of the calves, which is then fixed in the soil near the tents while the mother dromedaries roam freely in search of pasture. In this way, unlike the pack dromedaries, the mothers are also bound to the camp.

PACK DROMEDARIES

Imuhar use castrated dromedaries for transport, while female dromedaries are generally not used for this purpose. If nomads do not need their pack dromedaries, they are hobbled with a short rope between their forelegs, freely grazing in the surrounding area. But even with a hobble-rope the pack dromedaries can roam far in good grazing conditions, and one of the nomads' greatest chores is recapturing the runaway pack and riding dromedaries. Although the nomads use male dromedaries of any color and size, they prefer strong, heavy animals with especially large feet.

DROMEDARIES FOR RIDING

These are almost always castrated male dromedaries, because they are calmer than uncastrated ones, which are said to be very fierce and dangerous. Ideally dromedaries that are ridden should have a relatively short body and be deep-chested and tall with small feet and slender limbs (Nicolaisen/Nicolaisen 1997:119). The most popular animal is a white, long-legged dromedary for riding, called the *ebaydag*. Like men, women also prefer to ride an *ebaydag*. Animals that are really suitable for riding are occasionally sold for five to six times the price of a normal dromedary. In the past, dromedaries that were ridden were important in conducting raids. White animals were presumed to be the dromedaries for raiding troops par excellence, so an *ebaydag* can also be associated with a thief or raider (Ritter 2009:399).

Kel Ahnet nomads do not have pure mast-dromedaries for meat production, and they rarely kill their own dromedaries to eat them. Even very old dromedaries fetch high prices in the marketplace and nomads prefer the money to eating their old dromedaries. Only at weddings is it common to eat dromedary meat, which is rather tough and must be boiled for several hours to be eatable. Nomads slaughter dromedaries that have had an accident, and then it is common to share the meat with neighbors. Not only the meat is of use, they even work the skin of the animal to make straps, whips etc.

THE SIGNIFICANCE OF DROMEDARIES IN SPEECH

The importance of the dromedary in the Imuhar society can be understood from the extensive and detailed the vocabulary used to describe the animal. This enables the nomads to speak about their dromedaries precisely and the terms for dromedary can be classified in categories such as sex, age, color, special qualities, training and use, specific situations, number of dromedaries in a herd (Nicolaisen/Nicolaisen 1997:150).

Imuhar nomads have specific notions with regard to speech. Direct speech can be particularly dangerous because it can expose others to misfortune (Casajus 1987a:107, Fischer 2012). Thus they do not like to talk about their property and they also do not like to talk about their dromedaries for fear of the “evil eye” (Keenan 1977:121). If nomads are asked how many dromedaries they have, it is possible that they will not tell the truth, because they are anxious about misfortune happening to their animals.

Furthermore, nomads often use dromedary terms as synonyms. In various folk songs Imuhar men and women sing about the beauty of the dromedaries they ride (Casajus 1987b:98–100). Often the dromedary is a synonym for a person. If someone compliments a dromedary, they are actually complimenting its rider. This extensive vocabulary and the presence of so many synonyms indicate that the interest in dromedaries is not solely confined to their practical uses (Nicolaisen/Nicolaisen 1997:155).

THE AESTHETIC REQUIREMENTS OF DROMEDARIES

The most popular dromedary for riding is the *ebaydag*. This white, long-legged dromedary is what I would call the “red Ferrari” of the nomads. The red Ferrari, like every expensive car, has an almost universal image of exclusiveness, class, prestige, and elegance. In Europe, in addition, it has the image of speed, vitality, potency and power, emphasized by the color. In Europe, they are owned by mostly men, and the car is often used to draw attention to the masculinity of the driver.

The *ebaydag* is the Imuhar’s most expensive dromedary, which both men and women prefer to ride and even to own. Primarily, an *ebaydag* has to be long-legged, male and white. Generally, Imuhar prefer white to black, the reasons for which are complex. Basically, their perception of white and black can symbolize the juxtaposition between good and evil. White often has a positive while black is often has a negative connotation (Drouin 1987:84, Fischer 2012).

The Imuhar mark and improve their white dromedaries; branding them with various signs. These signs or brands are sometimes found on the flank, the neck or on the heads of the animals. Two parallel lines, for example, stand for the group of the Kel Ahnet nomads, and added lines or points identifying the family it belongs to. Another artificial sign for a dromedary that can be ridden is a copper ring fixed to the right nostril to fasten the reins. Moreover, the nomads boost their dromedaries by modifying their bodies. Mainly for aesthetic reasons, they make cuts on the bridge of its nose and the resulting scars appear as small bumps. There may be just one bump, but mostly a line of three. A hanging fold of skin under the chin also augments its beauty (see picture 56). These body decorations raise the value of the animal and make it much easier to recognize. They represent the engagement between individual owners and their means of transport. Women, similar to men, will own an *ebaydag* if they can afford one. But both sexes like to have these body forms depicted on their *ebaydag*, so one cannot see if the owner is a man or a woman simply by looking at its body. For this information one has to scrutinize the dromedary’s tackle.

THE CAMEL TACKLE AS A GENDER-SPECIFIC SIGN

Gender-specific marking is done by adding extra tackle to a riding dromedary. A typical male accessory is the drinking bowl, called a *tamennast*, which is made from tinned brass. Hung from the saddle by a long cord (see picture 57), the *tamennast* is a useful tool during travel, used not only for drinking but also for kneading dough or as an eating bowl. Other helpful tools are carried in a small bag which also hangs from the saddle.

Apart from the male accessory, one can recognize a male rider especially by the saddle, which for men is placed in front of the dromedary’s hump so that the rider can sit cross-legged with his feet resting upon the lower part of the animal’s neck. The saddle, made by blacksmiths,

is made of wood covered with leather and metal fittings and is secured by long cords tied around the belly and the hind part of the animal. A cruciform pommel and a large backrest are particular features (see picture 57). The saddlecloth for men is traditionally made of cotton and embroidered with colored thread. Especially on festive days they like to add long, black fringes made of goat hair.

Women, in contrast, ride on a palanquin called a *tachawit*, placed like a throne on the hump of the dromedary (see picture 58). The *tachawit* is a very large saddle decorated with a wooden arch on either side. It rests on staves fixed with straps made out of dromedary skin. Women make these saddles in teams, so they do not need to go to the villages where only men go to buy their saddles.² The women add appliqué of special long black fringes with red bands at the ends. They also have a very large, colored, gender-specific saddlecloth, which is also used as a blanket to keep warm. Two large, richly adorned leather bags on the right and left of the saddle are a typical sign of a wife. Only married women own these, in which they keep all their family belongings such as clothing, money, medicine and jewelry. Unmarried young women do not have such bags and keep their belongings in their mothers'. Another piece of tackle that can be sometimes found on both women's and men's dromedaries is an amulet case fixed to the dromedaries' neck, intended to ward off evil spirits from the animal.

THE EBAYDAG AS A SIGN OF SOCIAL PRESTIGE

The Imuhar have feelings for dromedaries and there are strong emotional bonds between *ebaydag* and their owners. Unlike other domestic animals, dromedaries have a high social and emotional worth and they are creatures which display affection and are regarded as good-natured by Imuhar nomads. Interest in dromedaries and the notional value of the *ebaydag* is much higher than its actual intrinsic worth. Boys especially grow up with an intimate knowledge of dromedaries and with very little interest in anything else. The games played by boys centre around dromedaries. For example, a goat's jawbone with a saddle and rider is a toy made of blades of grass and remnants of old clothes. A roughly cut stone is also used as a toy she-dromedary and a smaller version is used as her calf (see picture 59). In the same way as boys, girls build a kind of garden where they let their toy dromedaries graze. Building figures such as toy dromedaries from dry dromedary droppings and acacia thorns is a game for children of both sexes. They even know the name of the most famous *ebaydag* in the nomad camp.

It is possible to recognize the social status of a person in Imuhar society by the animal they ride. This is evident from the following three cases.

Tellit is the mother of three children. Not long ago, she and her husband came from a small village to live in the desert with the nomads and to work as breeders. The family was very poor and belonged to the sedentary group of the Kel Ahnet before they arrived in the Ahnet region. In the first two years in the desert Tellit had only a donkey to ride and felt a little ashamed. After two years she got an *ebaydag* and the other women made her a *tachawit*, the above-mentioned saddle for women.

Suda, a widow, has a white dromedary for riding, which is not so long-legged. Also, she does not have a *tachawit*, only a pack saddle.

Halla, a wife with five children, is very proud of riding an *ebaydag* saddled with a *tachawit*.

The ultimate dream of both women and men is to ride an *ebaydag* through the desert, since this animal with its gendered attributes is considered the most exclusive means of travel among Imuhar nomads. Accordingly, it is one of the most valuable possessions an Imuhar can have.

² For a further discussion of dromedary saddles and riding techniques see the article by Walter Dostal in this volume.

The image of the *ebaydag* with specific accessories is comparable with the image of the red Ferrari in Europe. The red Ferrari does not interest nomads, but rather the *ebaydag* is the approved status symbol. It is the husband's duty to make sure that his wife has a good dromedary to ride. Dromedaries even fulfill social functions among nomads, for example a dowry for a bride. They use them for these kinds of social payment and for paying many indemnities. In Ahaggar the indemnity for adultery is fixed at three dromedaries paid by the seducer, while one dromedary is given by an unfaithful wife (Nicolaisen/Nicolaisen 1997:156).

Staying with the metaphor, an Imuhar wedding is like a Ferrari motor show. Everybody shows up with their best dromedaries. Women and men ride their most beautiful *ebaydag* with their exclusive accessories. At a wedding, women ride their *ebaydag* on a *tachawit* in a long parade and try to impress with charm and grace. Every woman tries to outdo the others by showing off their best accessories. Sitting on the hump, a high point of a dromedary, riding on a throne-like saddle, leading the dromedary and lowering her head at the same time, the woman seems to gleam in an aura of gracefulness in the eyes of Imuhar.

At the *ilugan*, a ceremonial ride by men at weddings or on other festive days, women sit close together on the ground, singing and playing drums while the riders pass by. The dromedaries are ridden at a gentle trot with their heads drawn back (see picture 60) and the riders sit straight in their saddles without looking at the crowd of women. Strength does not count at the *ilugan*, but rather elegance and sublimity, and the dromedaries are trained by men and become extensions of their trainers' or riders' personalities (Youssouf/Grimshaw/Bird 1976:802).

Festive events give men and women riders the opportunity to display the beauty of their dromedaries and their own abilities as riders. Even from a great distance a nomad can tell something about the kind of person approaching – the age, and the person's attitude towards the world – from the way she or he sits on the dromedary (ibid.). The beauty of a dromedary, its saddlery and the way it is ridden are all to some extent considered to be the qualities of its rider. At these events men and women try to impress with their white, long-legged dromedaries and compete for prestige. Women and men enhance themselves with an *ebaydag*, one of the famous prestige "objects" among Imuhar nomads. Generally, the nomad's wealth is the dromedary, as an economic expression of his social prestige (Dostal 1989:39).

Prestige is equated with approval, recognition, esteem, defense, acclaim, attention, admiration and respect (Goode 1978). Social prestige is generally connected with occupation (Goldthorpe/Hope 1972), but in a society of only stock breeders such as the Imuhar nomads, the domestic animals become a source of prestige. The conception that prestige is based on the evaluation and recognition by the audience of the bearer's claims (Goode 1978, Simmel 1950) is also to be seen among Imuhar. Kel Ahnet nomads evaluate whether or not prestige is deserved. The idealization of the *ebaydag* means that it is worshipped among the nomads both by women and men, sometimes in poems and songs endowing it with a quasi-mystical status. Prestige is usually demonstrated by material or symbolic rewards which the bearer wears or manipulates (Wolf 1996:665). In the case of the *ebaydag*, the Imuhar boost the dromedaries by shaping their bodies and adding extra gender-underlining accessories. Prestige is usually demonstrated by desired objects. "But we call those objects valuable that resist our desire to possess them" (Simmel 1978:67). Rareness and exclusiveness are the main criteria. Social prestige or esteem center upon the notion of utility. Overall the usefulness of an *ebaydag* is measured in the admiration created.

Apart from the actual economic value, the *ebaydag* constitutes a symbolic capital (Bourdieu 1977), which adds prestige and esteem. Symbolic capital is ultimately a "disguised form of physical, 'economic' capital" (Bourdieu 1977:183). More precisely, capital exists and acts as symbolic capital "in its relationship with a habitus predisposed to perceive it as a sign" (Bourdieu 2000:242). In this sense an *ebaydag*, like a goat, is economic capital, but above all other domestic animals for Imuhar nomads it is also symbolic capital.

CONCLUSIONS

The prominence of white dromedaries among the nomadic Imuhar society in the Algerian desert is highly visible on festive days. Dromedaries give nomads prestige (Bernus 1990:166). Social prestige is linked with the social status of a person in a society. In particular, the white, long-legged dromedary is a treasured prestige “object”. Both men and women enhance themselves with an *ebaydag*. Riding an *ebaydag* with gender-specific accessories emphasizes the femininity of a female rider as well as the masculinity of a male rider. Thus, the value of *ebaydag* as symbolic capital is much higher than their value as actual economic capital. While black dromedaries are marginalized, the white, long-legged dromedaries are idealized. The image and the beauty of something or somebody are in the eye of the beholder. Even prestige is a cultural resource. The preference for a specific color or stature of an animal is culturally constructed and hence in a constant state of flux.

Nowadays, the hegemony of dromedaries as auxiliaries in the Algerian desert is coming under attack from cars. At a wedding the relatives of the nomads from the villages arrive with the newest sign of social prestige, the Toyota Land Cruiser (see picture 61). It is the new and most popular means of transport and, of course, it has to be white. Again, men drape the colored saddlecloth on the car seat, and they hang the traditional leather water bags on the four-wheel-drive vehicle. So far, only men drive Toyotas in Imuhar society and therefore it is still only a sign of masculinity. In contrast, the *ebaydag* can also be a sign of femininity. But this is only the current situation and it remains to be seen what the future will bring for the highly specialized dromedary breeders who can live and work in the desert independent of any fossil energy source.

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The Traditional Management of the One-Humped Camel in the Horn of Africa: Milking, Fostering and Weaning Techniques

The domestication of the one-humped camel or dromedary (*Camelus dromedarius*) took place a few thousand years ago, probably in the Arabian Peninsula (Uerpmann/Uerpmann 2002) and from there it expanded to its modern-day range: Africa north of the Sahara, and other Middle Eastern and Asian countries.

All modern-day people who own camels, with the exception of the Turkana of north-west Kenya, use them as pack animals and riding animals. However, the most important use of dromedaries is for milk. As humans have to compete with camel calves for the valued milk and to fully utilize the milk production capabilities of the camel, various ethnic groups of the Horn of Africa and Middle East have developed a series of complex husbandry practices to maximize milk yield and to encourage calf weaning.

The traditional knowledge of camel milking and husbandry is vital to the success of food-security strategies of pastoral cultures in arid areas. This will be even more so in the near future, if the latest climate predictions (Thorton et al 2011) foreseeing a much drier world with a large decrease in the length of the growing season and pasture yields and an increase of rain-fed crop failures in many sub-Saharan areas are correct.

This article will discuss pastoralists' techniques and devices regarding milking, fostering and weaning camels. The insights presented here are based on direct observations obtained while carrying out the duties of Divisional Veterinary Officer for the government of Kenya in the northern part of the country between 1981 and 1989 and from then up to the present as an independent veterinarian working in development projects among camel pastoralists in Kenya (Turkana, Somali, Rendille, Borana, Gabbra, Arier, Samburu), Ethiopia (Borana, Ogaden Somali, Afar), Eritrea (Tigre, Tigray-tigrinya, Rashaida), Sudan (Darfur camel livestock owners: Arabs, Zaghawa, Rizeiqat, Omdurmann camel traders), Somalia (major camel-owner clans: Hawiya, Darod, Isaaq, Issa), Western Sahara (Saharawi), Yemen and the UAE (Arabs) (Dioli 2007, Schwartz/Dioli 1992).¹ Countless hours have been spent among camel pastoralists of these countries in discussions or just as an observer trying to understand and record their knowledge of camel husbandry.

MILKING TECHNIQUES

After the female camel has delivered, a complex husbandry is implemented by the owner to manage her lactation and the well-being of her calf. There is a wide difference among pastoral ethnic groups and sometimes even among individuals on the approach used regarding the intake of the "first milk", the colostrums, by the calf. The colostrum milk is produced by all mammals in the late phase of the pregnancy. Colostrum has a particularly high amount of protein and a lower fat level than regular milk and it contains antibodies that help to protect the newborn against disease (Elagamy 1998). Colostrum is thus milk of a special value for newborns. However, in some pastoral societies the colostrums is milked off owing to the fear of causing diarrhea, or it is used for human consumption (e.g. among the Turkana), while in some others (e.g. Somalis) the newborn calf is allowed to suckle all or part of the colostrums at will.

¹ The author is grateful to the many camel nomads in the Horn of Africa and the Arabian Peninsula who shared their wisdom and experience.

Delivery almost always occurs at the herdsman's camp. Since the newborn calf is weak and unable to walk long distances the mother and calf will not join the herd after delivery. Usually the calf is just placed under the protective shade of a shrub near the herdsman's camp and the mother left free to graze in the surroundings. New mothers are very protective towards their newborn and will never go far from it. After two to three weeks the calf is usually sufficiently developed to be able to follow its mother for considerable distances and mother and calf rejoin the main herd. At this time, to maximize milk offtake for human consumption two different management strategies are adopted, which will be discussed in the following: a separation of mother and calf, or the use of suckling-control devices, which limits the calf's drinking and guarantees milk for human consumption.

MOTHER AND CALF SEPARATION

This management strategy simply consists in separating the calf from the mother to prevent the calf suckling at will. Two milking sessions are most commonly adopted. At the beginning of the grazing day, in the morning, the mother is forced to join the main herd while the calf, together with all other calves in the herd, is kept in the night enclosure. Once the herd is far enough away, all the calves are let out and allowed to wander freely in the nearby areas. Sometimes calves are kept in their enclosure all day or tied to a nearby tree. The herd will be back at the main camp in the evening and then, after a pause to allow the herd to settle down, a milking session is implemented.

Each calf, one by one, is allowed to join its mother to suckle, then, as soon as the milk release reflex is established, the calf is again separated and the mother is rapidly milked. Unlike in cows, the milk release reflex in camels is very short, so the milk flow is available only for one to two minutes, and in the case of camels with a abundant milk production milking is often done by two people simultaneously (see picture 62). When the milking is completed the calf is allowed free access to the mother for the next few hours, only to be separated again in the middle of the night or very early morning. The next milking session is in the morning, using the same methodology, just before the herd is going to graze. The amount of milk that the calf is actually allowed to suckle when joining its mother varies greatly. It is individually controlled by the herdsman on the basis of many factors, such as the calf's age, sex and vigor, the lactation stage and the amount of milk produced by the mother, as well as by the respective season, the number of lactating camels in the herd and the household's needs. The two milking sessions within a 24-hour period can be increased to three or four, especially in the rainy season when favourable pasture conditions support more abundant milk production and allow the herd to stay longer at the main camp or to graze not far away. The camels can then be brought back to the main camp for an additional milking session at midday.

SUCKLING CONTROL DEVICES

Under this management strategy mother and calf are together all the time. To prevent the calf suckling its mother dry and to ensure a milk supply for the household, devices are applied to the teats of the udder or to the udder itself. The devices applied to the teats consist simply of a string of cloth or of tree bark (*Acacia* spp.) tied firmly around the teat so that the teat canal is occluded and milk cannot be sucked (see picture 63). Sometimes a thin, slightly curved stick is tied on the side of the teats to prevent the calf grasping the teat and exerting suction. Even sand may also be added, by wetting the teat with the last milk of the milking sessions (or even breaking up and smearing the teat with the camel's own stool) and then throwing some sand on it to make the teat even more unpalatable to the calf. The number of teats "off limit" to the calf vary from one to all, depending on the calf's age and sex (males often are penalized), strength, lactation stage and the amount of milk produced. Obviously, the season, the number of lactating camels in the herd and the household food requirement also influence the amount of milk the calf is allowed to suckle. For each camel the number of teats tied varies during the course of the

lactation. Generally, at the beginning of lactation, to strengthen the calf and support a rapid growth, only one teat is tied and the rest are left free for the calf to suckle (Schwartz/Dioli 1992, Dioli 2007) .

Devices applied to the udder consist of an “udder net”: a piece of cloth or a woven net entirely covering the udder (see picture 64) and obviously preventing the calf’s access to the udder. When the camel needs to be milked, both of these devices, udder net and teat bindings, can be easily removed and the calf is allowed to suckle until the milk release reflex is established. Then the calf is removed and the camel is rapidly milked. After the camel has been milked for human needs, the calf is allowed to suckle for a variable amount of time and then the devices are applied again. In addition to the suckling control devices attached to the mother camel, occasionally a “net” is also put over the calf’s mouth to prevent it suckling.

FOSTERING TECHNIQUES

Camels are very protective mothers and as a rule a lactating camel will refuse to feed any calf other than her own. Full-term vital twins have extremely rarely been recorded (Tinson et al 2001), so when a camel is seen suckling two calves the most obvious explanation is that she is suckling her own calf and an adopted one (see picture 65). Calf rejection is a serious issue as a lactating camel almost always needs the presence of her calf to have a long and abundant lactation period. If the calf dies or is rejected and the herdsman fails to persuade the mother to adopt a foster calf, the lactation period is usually very short, only three to five months instead of the average lactation period of fourteen to sixteen months. In addition to a reduction to less than a third of the milking period, the daily milk production is also reduced when the camel has no calf. It is therefore essential that the lactating camel readily adopts another calf if her own dies, and/or to avoid a newly lactating camel rejecting her own calf. To this end, a series of techniques and devices have been developed by the different camel breeders’ ethnic groups of the Horn of Africa and the Middle East. These techniques can be categorized in immobilizing, stimulating, tricking (olfactory deception) and distracting mother camels, and will be discussed in more detail.

PHYSICAL RESTRAINTS ON THE MOTHER CAMEL

A variety of methods is used aiming at restraining the movements of the rear legs of the mother in such a way that the foster calf or the rejected calf is able to access the udder and to suckle. It can consist of simply of a rope tying the rear legs close together or of a short hobble applied to the rear fetlocks or of a front leg, bent up and tied there or to the other front leg (see picture 66).

STIMULATION OF THE MOTHERHOOD INSTINCT

The objective of this technique is the stimulation and strengthening of the motherhood instinct so that the she-camel finally accepts the calf. This is achieved by placing the lactating camel and the calf in a small, loosely built enclosure isolated from the main herd enclosure. At sunset or early night, a human disguised by a blanket or an animal skin begins to mimic the behaviour and sounds of a predator, creeping close to the enclosure and emitting high-pitched sounds. The impersonator regulates his acting carefully so that as soon the camel reacts positively, namely allowing the calf close to her side, the “predator” retreats rapidly. This technique is used among Somali and neighbouring ethnic groups for very young rejected calves and is based on the fact that camels are naturally gregarious animals that huddle together when threatened. Generally a few nights with this deceit are sufficient to establish a strong natural bond between the young calf and the lactating camel.

OLFACTORY DECEPTION

Camels recognise their calves through smell. This olfactory bond between mother and calf is so powerful that in the a calf's death the milk release reflex can be stimulated simply by presenting the skin of the dead calf to the mother. The common strategy of using the skin of a dead calf to cover a different calf so that the mother is convinced to adopt this calf, as it is often practiced with cattle (see picture 67) and other livestock species, is rarely used by camel pastoralists.

In case of a stillbirth, i.e. the delivery of a dead calf, a different technique with a similar outcome is usually used. This can only be implemented successfully *before* the dead calf is actually delivered. On verifying that the unborn calf is dead, the delivering camel is restrained with both front forelegs tied and with her head completely and securely covered with a large cloth, e.g. a blanket. The dead calf is then delivered and while the carcass is removed from the area a young camel calf selected to be fostered is brought closer to the rear of the restrained and blindfolded mother camel (see picture 68). The foster calf is immobilized by tying the front and rear legs of one side together, then fetal membranes of the dead calf are vigorously smeared all over the calf's coat. Once this is done the foster calf is placed in front of the tight she-camel and her blindfold is removed. The camel, who has just gone through the delivery process, will naturally proceed to smell the foster camel calf in front of her and, detecting the unique smell of her own afterbirth and amniotic fluids, she will think it is the one she has just delivered. The two animals will go through the biological steps of post-partum mother-calf bonding ensuring a normal lactation. For the complete success of this method it is crucial to ensure a perfectly smooth and rapid coordination between blindfolding the mother removing her still-born calf and smearing the foster calf with the afterbirth fluid. This method was described to the author by Somali herdsman but it has also been seen directly thousands of kilometers away in Western Sahara.

PHYSICAL DISCOMFORT

Another method of convincing a mother camel to accept a (foster) calf is based on a series of devices that are applied to the camel to cause physical discomfort. The aim is to distract the mother camel from rejecting the calf by creating an increasing "discomfort" until a level is reached where the camel's attention shifts from rejecting the calf's suckling attempts to how to escape the uncomfortable situation. As soon as the camel allows the rejected calf or the foster calf to suckle normally, the devices are removed. The objective is normally achieved within a few hours and the result is permanent. It has to be mentioned that some of these "techniques" can be easily identified as cruelty to animals, and as such they are ethically to be condemned. However, animal welfare comes second in harsh desert environments where the availability of camel milk can be crucial to the survival of children. These techniques can be broadly classified according to the level of discomfort caused:

DEVICE CAUSING MILD DISCOMFORT

This is a simple device that impedes walking and a normal weight bearing: one front leg is tied to the other or the fetlock of one front leg is flexed and kept in that position by a tight hobble.

DEVICE CAUSING MEDIUM DISCOMFORT

This device consists of a rope passing through the perforated nasal septum and firmly tying the other end to a very high tree branch in such a way that the head and neck of the camel are kept in an unnaturally higher and extended position (see picture 69).

DEVICE CAUSING SEVERE DISCOMFORT

This is a set of practices aimed at causing increasingly severe discomfort to the she-camel by the mechanical closure of the anus and of the nostrils. They are used widely all over the Horn of Africa and the Middle East. The *qalla'h* technique used among ethnic Somali pastoralists consists of two flat pieces of wood that are applied to the loose skin folds of the anus and then tied together trapping the folds between them and impeding defecation (see picture 70) and of flat stripes of bark that are applied around the animal's nostrils to impede breathing through the nose (see picture 71). In the Arabian Peninsula a comparable system is used, called *diar*. The anus is closed by the insertion of a large cloth "cork" into the rectum and kept in place by stitching the device to the perianal skin, tying the loose strands to a transverse piece of wood and then tying all together (see pictures 72 and 73). The nostrils are blocked by inserting cloth deep into the nasal sinus and wrapping of several "sock like" cloths over the area (see pictures 74 and 75).

In both these methods the feeling of suffocation caused by the closed nostrils (since air intake is reduced to mouth-breathing) and the abdominal pain caused by the progressive accumulation of feces in the intestine cause profound distress to the animal to such an extent that the rejection behaviour toward her own calf or toward the foster calf is completely inhibited. Furthermore, the device causes pressure on the vaginal walls causing the production of oxytocin and triggering a milk release reflex, the Ferguson reflex (Balasse 2003). The efficacy of this technique in stimulating milk release may explain why "anus closure" is also routinely used to stimulate the milk reflex in lactating camels which have lost their calf (and which are without a foster calf; see picture 76).

The devices are left in place until the camel allows the calf to suckle. The devices may be applied from early morning, left on through out the day and removed in the early evening for a maximum of two to three days. During this period the she-camel was not allowed to graze with the main herd but kept in proximity of the camp together with the foster calf and constantly supervised by the herdsman. The herdsman often physically encourages the foster calf to suckle and in each of these occasions the behaviour of the she-camel is closely monitored to assess the degree of rejection and the strength of her milk release reflex. As soon as the camels allow the calf to suckle and the milk release is sufficient, the devices are removed.

WEANING TECHNIQUES

A camel calf is usually weaned at around 12 months of age and subsequently used only to stimulate milk release at milking time, since under natural circumstances the length of lactation is around 14 to 16 months. However, it is not unusual for a calf to try to suckle well after it has been weaned. This behavior is harmful in the view of the pastoralists because it will reduce the amount of milk available to the household and, by causing the lactation to continue, it will not allow the lactating camel to have the necessary resting period between two lactation periods. The vice of prolonged suckling periods is actively discouraged by the herdsman with a series of devices:

PREVENTING THE SUCKLING OF THE TEATS

All teats of the udder have a long stick tied to their sides. Once the calf attempts to suckle the stick will irritate its palate and prevent it from continuing.

CAUSING REJECTION BY THE MOTHER CAMEL

This is done simply by placing one or more sharp wooden sticks over the muzzle of the calf. When it tries to suckle, the device will sting its mother's udder, forcing her to react and to actively reject any suckling attempts by her calf (see pictures 77 and 78).

PREVENTING THE CALF'S TONGUE FROM MAKING SUCTION CONTRACTIONS

One method involves tying a piece of wood across the mouth over the tongue. The wood is kept in place by tying the protruding sides to each other with a rope passing under the mandible (see pictures 79). Another method consists in making a cut several cm long across the tongue just a few mm under the upper surface (see picture 80). Both these techniques work by making the tongue of the calf unable to contract and consequently to create the suction needed for suckling. It is important to note that grazing will not be affected.

PREVENTING THE CALF FROM GRASPING THE TEATS

Another method is tightly fixing of both upper lips of the calf with a thin rope. The compression and lack of circulation will make the lips insensitive and unable to move in a coordinated way, so the calf cannot grasp the teat to suckle (see picture 81). Another method consists in limiting the movements of the lips by stitching them together with a single thick thread (see picture 82).

DISCOURAGING THE CALF FROM NUZZLING THE UDDER TO STIMULATE MILK RELEASE

A painful wound is created on the calf's muzzle. Whenever it tries to nuzzle its mother's udder there will be contact with this wound, and the pain will cause it to stop. A simple method is to burn the lips of the calf. However, the most common method is to cut a thin strip of skin on the calf's muzzle. To make the system more effective, sometimes the skin fold is wrapped with bark to keep it erect and more sensitive to contact (see pictures 83). An alternative system consists in cutting two thin strips of skin from the upper side of the nostrils and leaving them hanging (see the healed wound of this technique in picture 84).

These practices may without doubt be classified as outright animal cruelty. As such they are ethically to be condemned. However animal welfare takes second place in the harsh desert environment where a milking camel may represent the difference between a live human child and a dead one.

CONCLUSIONS

Some of the husbandry practices shown here may be questionable or open to criticism, however they represent the distillates of hundreds of years of camel husbandry that has successfully allowed people to survive and to flourish among one of the most hostile and harsh environments in the earth. In an environment where camel milk is an essential food such practices are meaningful. As such, this traditional knowledge should be respected and not simply dismissed as backward. However, many of these practices and methods obviously cannot be adopted in a modern set up where human survival priorities are less extreme. Further studies should therefore be warranted to identify and develop more humane milking, fostering and weaning methods that can be adopted in a modern camel husbandry industry.

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The Informal Camel Milk Marketing Sector in Kenya and Somalia

The importance of camel¹ milk as a source of nutrients for pastoralist communities in arid regions of Kenya and Somalia is well documented. Compared to cow's milk, camel milk keeps better. This allows transport and trade of non-chilled raw camel milk over long distances. The rise in numbers of urbanized and sedentary (ex-)pastoralists is creating an ever growing market demand for camel milk, a regular commodity in informal Kenyan and Somali markets. Income generated by pastoralist households from sales of camel milk is on the same scale as income from sales of livestock. The informal camel-milk value chain, described in this article, is dominated by milk women, who stem from pastoralist communities but who have lost their traditional, livestock-based livelihoods. Camel milk sales represent the main if not the only source of income for these often female-led households. Improving milk handling and hygiene at production, transport and retail level can potentially increase the incomes of camel milk value-chain actors.

Several aspects of camel milk production and marketing in Somalia and Kenya are discussed in this paper, which also looks at intervention strategies aimed at strengthening the camel-milk chain.

THE SIGNIFICANCE OF CAMELS IN KENYA AND SOMALIA

Two thirds of the world camel population is found in the Greater Horn of Africa. Somalis were the first people to keep camels in Africa (Bulliet 1990). They occupy a vast arid region, the "Somali ecosystem", shared by Somalia, Djibouti, Kenya and Ethiopia. With an estimated camel population of 6.3 million (GFA 2005) Somalia alone accounts for one third of the global dromedary camel population or about half of the African camel population (FAO 2004 FAO-STAT data, FAO/WB/EU 2004) and is the largest producer of camel milk in the world (FAO 2010). The human population in Somalia is estimated between 6.4 (GFA 2005) and 7.4 million (UNDP Somalia 2005). In north Somalia (discussed in this paper) 82% of the human population depends entirely on mobile livestock keeping (GFA 2005). For Kenya the camel population is estimated at a million animals with three million Kenyans depending on mobile livestock production for their livelihoods (Republic of Kenya 2005). Since the 1960s, camel keeping has gradually gained in importance in East Africa, in parallel to the decline of cattle-rearing pastoralist economies (Sperling 1987). Between the 1970s and the 1990s the arid parts of Kenya experienced a 12% reduction in cattle, sheep and goats versus an 18% increase in camels (FAO 2002).

Under arid conditions in Kenya and Somalia, camels have lactation periods between nine and 18 months (Simpkin 1996, FAO/WB/EU 2004, Farah/Fischer 2004, Farah et al. 2007) and produce four to five times more milk per annum than cattle (Dahl/Hjort 1976, Pratt/Gwynn 1977, Stiles 1983). In such environments goats lactate only three to four months per year (Baumann et al. 1993) while cows play a very limited role as dairy animals (FSAU 1990). Camel milk represents an important staple food and is a major source of animal protein and vitamins for more than 6.2 million pastoralists in Kenya and in Somalia (Farah et al. 2007, Field 2005;

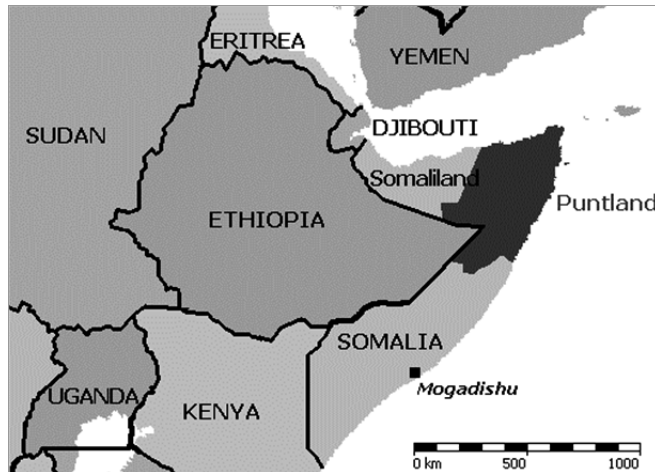
¹ In this paper the term camel always refers to the dromedary (*Camelus dromedarius*).

see picture 85). The importance of camel milk is further highlighted by the fact that 12.5% of the total milk available for human consumption in Kenya is produced by camels (Hesse/MacGregor 2006).

CAMEL MILK PRODUCTION AND MARKETING IN KENYA AND SOMALIA

In north Kenya the total value of milk (predominantly camel milk) is more than double that of meat in the pastoral economy (ICTSD 2007). Driven by the ongoing sedentarization and urbanization of pastoralists and the enormous influx of Somali refugees into Kenya, informal marketing systems that commercialize camel milk evolved almost simultaneously in Somalia and in Kenya (Herren 1990, FAO/WB/EU 2004, Farah et al. 2007) and have many similarities in both countries. Low average milk yields of only 2.5 to 4 liters per day and the high mobility of milk-producing herds result in often erratic camel milk supplies unable to meet the market demand for camel milk on a regular basis (SNV 2008). The absence of infrastructure in camel milk producing regions and the volatility of camel milk supplies have so far prevented the emergence of significant formal camel milk marketing and processing in Kenya² and Somalia. Camel milk production for commercialization to distant markets is mostly concentrated in the more accessible fringes of the camel-keeping regions with easier access to tarmac roads (e.g. Isiolo and Bangali in Kenya). While the camel milk production potential of herds on remote pastures may be underexploited locations favorable to milk marketing are frequently over-stocked (SNV 2008) resulting in degradation of woody and herbaceous vegetation. Camel milk supply peaks towards the end of the two rainy seasons (May/June and November/December) and for a short time markets may experience a glut, with camel milk prices dropping too low to justify transport costs. During these short periods of surplus, camel milk is not sent to markets but is consumed in large quantities by pastoralist families, to some extent offsetting prolonged periods of malnutrition. Some milk producers also resort to opportunistic sales, directly targeting travelers along roads in the production regions. There is anecdotal evidence that surplus camel milk is occasionally used to fatten lambs, but in 15 years of extensive travel in north Kenya and in Somalia the authors have never witnessed this practice. Under traditional camel milking management, the morning milk yield is higher, due to separation of the suckling calf from the dam overnight (Simpkin 1996). For Puntland (north Somalia, see graph 31) it was estimated that as much as two thirds of the camel milk produced can be marketed, with 30% of the marketed camel milk sold directly from producer to consumer; 68% sold to collectors and traders and 2% sold to restaurants and teashops (Farah et al. 2007). Transport distances between milk-producing regions and final markets can vary from 40 km to more than 400 km, while bulking points are often located between 10 km and 80 km from production sites. Distances up to 10 km to primary milk-collection sites (see picture 86) are normally covered on foot or by donkey (Adongo et al. 2009). Transport to secondary collection points and to bulking sites uses public transport vehicles, operating along dirt roads and onward long distance transport to urban centers is mostly by bus on tarmac roads. Due to very high temperatures and considerable distances large milk traders in Puntland hire or own special milk-collection vehicles that travel at night to take advantage of cooler temperatures. In response to this, camel-milk producers in Puntland milk long before sunrise to fit the transport schedule. This phenomenon is also starting to be observed in Kenya. Faster and more efficient milk transport reduces spoilage rates and increases profit.

² Despite a relatively well developed infrastructure, more or less stable cow milk production volumes and a modern milk-processing industry over 80% of cow's milk produced in the Kenyan highlands is marketed informally. The underlying economic reasons (Leksmono et al. 2006) apply even more to camel milk marketing and will be discussed in the conclusion.



Graph 31: Map of Somalia showing the two semi-autonomous regions of Puntland and Somaliland where the Somali Pastoralist Dairy Development project is located.

During the dry season milk collection and transport have to be extremely flexible to keep up with the high mobility of milk-producing herds in constant search of pasture, an absolute necessity to maintain lactation in the absence of feed supplementation. The camel-milk value chain is mostly organized along kinship lines and is based on a certain level of mutual trust. Groups of women from the same community collaborate in the collection, transport and distribution of milk and often supply to permanent urban camel-milk buyers. In terms of managing her financial assets each milk-woman represents an independent microenterprise. Milk collectors and traders are mostly female while milk transport is an almost entirely male monopoly (drivers, vehicle owners). The informal camel-milk value chain comprises:

- Mobile pastoralist producers
- Highly mobile primary collectors operating at pasture level
- Partly mobile secondary collectors operating at permanent or semi-permanent settlements
- Brokers and stationary milk bulkers operating in rural towns on or very near to tarmac roads
- Transporters operating public transport vehicles and busses
- Urban wholesalers, distributors and retailers
- Urban milk consumers

All actors involved in camel-milk production and marketing reap a certain profit and the camel-milk chain provides considerable income opportunities, especially to women. The social network allows for payments (in cash, occasionally in kind) and empty milk containers to be sent back from urban markets to producers and collectors in distant locations via public transport and intermediaries. Nonetheless, milk containers can be damaged or lost and milk payments to producers and primary collectors in the production region are often delayed for long periods (Abdillahi 2009). Defaulting on milk payment appears to be influenced by the degree of urbanization and the social environments. Abdillahi (2009) mentions 15% defaulting on milk payments in the rural Isiolo town versus a 30% likelihood of defaulting in the metropolitan Nairobi-Eastleigh camel-milk market.

Milk prices fluctuate seasonally according to milk supply, which is dictated by rainfall and calving cycles. Prices can also vary on a short-term basis as a result of impassable roads (heavy rain, insecurity). In urban milk markets camel milk fetches higher prices than cow's milk. The preference for camel milk is partly based on medicinal properties traditionally ascribed to it (SNV 2008). Camel milk is sold either fresh or sour, with fresh milk higher priced than sour milk (KARI/KASAL/MDG 2009). Fresh camel milk is consumed raw, but a considerable amount is used in tea (SNV 2008). Spontaneously fermented camel milk (Somali *Sussa*) of very variable quality and acidity is also sold in urban markets. Camel milk markets are mostly located in the open along dusty and dirty roads. Due to high environmental temperatures and high

levels of bacterial contamination, camel milk has to be distributed and retailed as quickly as possible. Most camel-milk markets operate for only a short time. Immediately after milk has arrived by public transport some of it is delivered directly to large restaurants, hotels and to customers with standing orders. Larger towns have several informal camel-milk markets serving a particular quarter (see picture 87). Consumers attempt to buy the freshest milk available but expect it to go sour quickly. Sour camel milk is typically consumed after sweetening with sugar. Due to the buyers' preference for fresh milk, prices immediately after arrival of the milk are higher than those one or two hours later. The duration of transport between production sites and terminal markets is perhaps the single most important factor affecting profits from camel-milk sales.

Volatile milk prices are a constant source of disagreement between producers, collectors and traders about the actual prices achieved on a daily basis and the daily milk money payments due (Abdillahi 2009). In some cases sour and/or highly contaminated milk of very low market value may be returned to producers (Adongo et al. 2009). Contrary to some claims (SNV 2008), camel milk that is too sour for consumption does not go to waste, but is used in cooking.

In 2008 prices for informally traded raw camel milk in Nairobi-Eastleigh reached 80 Kenya shilling per liter (€ 0.80, SNV 2008), while one liter of packed, pasteurized cow's milk in Nairobi's supermarkets sold at 55 Kenya shilling. The most dynamic urban camel-milk market in Kenya is Garissa town, the administrative headquarters of Kenya's Northeast Province, inhabited by ethnic Somalis. In 2008 Garissa received camel milk from three districts transported daily by 15 trucks, 20 pick-ups/Land-Rovers and five minibuses. An estimated 1200 women were involved in the distribution and retail of between 40,000 kg (dry season) to 70,000 kg (rainy season) camel milk daily (Shalle 2009, A. Bruntse ALLPRO project direct communication).

CAMEL MILK HYGIENE AND QUALITY

The quality of camel milk depends on the hygienic conditions during milking, transport and retail. Potential consumer health hazards originate not only from infected camels (zoonotic diseases, mastitis pathogens)³ but to a considerable extent from post-milking contamination related directly to the type of container used for transport (Younan et al. 2003). Basic awareness of milk hygiene is mostly lacking among camel-milk traders, but also among most camel-milk consumers. Boiling of camel milk before consumption is unacceptable to traditional consumers, who regard it as a degradation (Kagunyu 2009). The widely practiced consumption of raw and of spontaneously fermented camel milk represents a major health hazard, in particular to children (Schelling et al. 2003, Weller 2007, Abdelgadir et al. 2008, Kaindi 2008).

To delay the onset of souring and to safeguard market value, traders attempt to compensate camel-milk hygiene deficits by briefly heating the milk to boiling point (Mohammed 1993) or by intermediate chilling of raw milk at bulking sites before long distance transport (Isiolo town cooling hubs offer milk chilling for a fee). Urban hotels and restaurants that procure larger volumes of raw camel milk also boil it immediately to ensure that it can be used in tea for a certain period. There is evidence that antibiotics (Tetracycline powder) and alkaline salts (Magadi salt) are added to raw camel milk to suppress fermentation and delay souring during transport (Younan, personal observation in north Somalia).

Three types of container are used for storing and transporting camel milk:

- Plastic jerrycans
- Metal cans, often poor quality steel with seams and without tightly fitting lids
- Traditional containers made from woven fibers, wood or gourds (see picture 88).

³ One milk-borne disease is brucellosis, which leads to chronic infections that are fatal unless treated. Mastitis pathogens (streptococci, staphylococci) are potentially dangerous, especially for small children.

Traditional milking buckets and milk storage containers used at milking sites are sanitized by heat. Picture 89 shows this systematic treatment of the inner surface with a glowing wooden stick followed by “smoking” over the embers in inverted position. Total bacterial counts (TBCs) in correctly heat-treated traditional milking buckets and storage containers can be within EU raw-milk quality requirements (Younan et al. 2003). Camel milk from heat-treated traditional containers acquires a distinct smoky flavor, regarded by most camel-milk consumers as an indicator of good quality. Traditional containers are unsuitable for vehicle transport, comparatively expensive (labor-intensive) and limited in supply. Plastic transport containers are typically recycled 3 ltr and 5 ltr cooking-oil jerrycans, often leftovers from food-aid distributions. Such cheap, single-use items are not intended for repeated use by the manufacturer. These plastic containers cannot be cleaned effectively, because the opening is too narrow for a hand or brush to pass through and the handle is hollow. Due to water scarcity and very poor water quality in the production regions and at urban markets, “washing” of plastic milk containers is at best symbolic (see picture 90). In exceptional cases milk-women use hot water to flush the containers. The transfer of clean camel milk into plastic transport containers leads to a rapid surge in contaminating bacteria (Younan et al. 2003).

At a recent pastoralist forum in Garissa/Kenya (2010) female participants expressed concern about rising rates of throat cancer in children, which they attributed to the common use of such recycled plastic containers for transporting milk and water. The recycled plastic containers owe their popularity to two simple advantages:

First, they are light and occupy little space (plastic jerrycans with milk are commonly transported hanging on the outside of public transport vehicles), which reduces the transport fee. Secondly, they are low value – the loss of milk containers is only a minor economic risk, and sometimes the plastic container and milk are sold together as one product.

Type of container from which milk was dispensed by retailers in the urban market*			
Plastic jerry can	Open metal pot ‘Sufria’	Metal can with lid	Traditional container
449 (75%)	119 (20%)	32 (5%)	0

Table 14: Container types used at Burao milk markets, Somaliland (SPDDP 2007). * n = 600 milk-women

Camel milk for marketing is produced and collected mostly in the very early morning, while evening milk is normally kept for home consumption. Morning milk transported immediately after milking reaches markets faster, is less likely to go sour and fetches higher prices. Sometimes milk from the previous evening may be pooled with fresh morning milk, which accelerates spoilage of the whole milk batch. Traders are well aware of this problem and sometimes offer price incentives to producers to ensure that morning milk is kept and transported separately from evening milk. Willingness of camel-milk consumers to pay for better quality has been documented and is related directly to the freshness of the milk, the absence of milk adulteration (no added water!) and freedom from visible contamination (Wayua et al. 2009). Improved raw milk hygiene also results in better quality of spontaneously fermented camel milk, and good quality sour milk can fetch prices close to those for fresh milk.

The common poor hygiene, especially during milk transport but also when dispensing milk from transport containers, is the most significant factor negatively affecting potential incomes from camel-milk sales. In Puntland only 20% of the marketed milk is sold as fresh milk while 80% is sold in fermented form (Farah et al. 2007). The largest camel-milk market in Puntland, Bosaso, situated far from the producing region, receives mostly sour camel milk, which cannot be used in tea. As a consequence camel milk loses significant market shares to imported milk powder and to imported ultra-heat-treated (UHT) cow’s milk, which can be kept for long periods without cooling. This competition between fresh camel milk and imported milk powder and/or UHT milk is found in all milk markets in the region.

CONCEPTS TO STRENGTHEN THE CAMEL-MILK CHAIN

A large number of poor pastoralists and especially women are economically dependent on the camel-milk chain. Development projects, mostly implemented by NGOs, are aimed at strengthening the camel-milk chain in order to improve incomes of the poor. Past and current development interventions operate under three basic paradigms:

- A considerable surplus of unmarketed milk exists in the production regions;
- Value addition (processing, pasteurization, packaging) leads to increased incomes;
- Improving milk quality and milk hygiene improves market value and incomes.

SURPLUS UNMARKETED CAMEL MILK IN THE PRODUCTION REGIONS

The perception of huge untapped camel-milk production volumes, shared by some development planners, is based on unsubstantiated claims that “50% of the milk is not extracted from the udder” (SNV 2008). Obviously, camels nearer to markets tend to be more intensively milked than animals kept in more remote locations, indicating that a certain unexploited milk production reserve may in fact exist (Farah et al. 2007). But in the absence of adequate supplementation, negative effects of more intensive milking on health and fertility of milking camels quickly become obvious to camel owners (Herren 1990). In the overstocked Isiolo milk catchment in Kenya this has led to the emergence of a “division of labor” between commercial “intensive” milking camel herds (the focus is on producing as much milk for the market as possible) and traditional “extensive” camel breeding herds, which supply lactating camels or pregnant heifers to the commercial herds (Shibia 2010). Exchange of female camels between the two systems in accordance with their lactation status is also practiced (dry animals sent to remote pastures, only lactating animals kept near the market).⁴

A seasonal camel-milk glut may occur after rains have ceased and last for less than four weeks. In extensive milk-production systems only about 40% of a lactation is available for human consumption if consumption by the suckling calf is included (FAO/WB/EU 2004). More than half of the milk produced is consumed in the production region, by pastoralist families and by local customers, and hence is not available for urban markets (Farah et al. 2007).

There is no doubt that improved road infrastructure in the production regions and locally available cooling of raw milk (evaporative cooling, cooling powered by solar electricity or by the national electric grid) will improve market access for camel-milk producers in more distant regions, expand camel-milk catchments and result in overall increase of marketed camel-milk volumes and total income generated by camel-milk value-chain actors in the future.

INCREASING INCOMES BY ADDING VALUE TO CAMEL MILK

Current camel-milk retail in informal markets operates on roadsides or from simple stalls without a cold chain. Camel-milk shops are still very uncommon and even those that exist are often not equipped with appropriate dispensing utensils and refrigeration. At home the vast majority of camel-milk consumers do not practice any milk refrigeration but use fresh milk immediately after purchase (e.g. in tea) and consume leftovers later as (sweetened) sour milk. If kept under high ambient temperatures, pasteurized and packed milk does not ferment spontaneously but undergoes very rapid spoilage with proteolysis, production of gas and ballooning of the milk package, which makes the milk unfit for human consumption. Traditional camel-milk consumers used to the spontaneous souring of purchased raw milk are not familiar with packed milk that requires continuous cooling. This basically rules out the marketing of packed pasteurized

⁴ A more extreme version of such a division of labour is found around Nouakchott, Mauretania, where stationary commercial camel-milk producers buy lactating female camels from mobile pastoralists and sell them for slaughter at the end of lactation.

milk or yoghurt⁵ via existing retail channels, even more so in a hot tropical climate. Yoghurt sold fresh without packaging and sour camel milk produced through controlled fermentation are two simple processing options with the potential to increase profits for urban camel-milk bars. Thermo-tolerant starter cultures should be developed that do not require freezing for storage and are available in small packages; this would significantly lower the necessary investment for small-scale processors interested in producing and selling camel-milk yoghurts and sour milk (David Stroo, Marketing Director, Christian Hansen A/S, Hørsholm, Denmark, direct communication).

One traditional value-adding method practiced in Kenya and Somalia is the extraction of butter fat (ghee), using seasonal surplus cow's and goat's milk. Camel milk is not commonly processed into ghee for marketing (Farah et al. 2007, SPDDP report 2007). Compared to goat's and cow's milk, ghee production from camel milk is rather inefficient and poses certain technical difficulties related to the melting point of camel-milk fat (Farah/Fischer 2004). Technical difficulties can be overcome by using a (manual) centrifuge and warming up the milk. But consumers rank goat's milk ghee highest in value, followed by cow's milk ghee, with camel-milk ghee being ranked lowest. Processing the most expensive raw milk, camel milk, into a product of low market value does not make economic sense.

Production of cheese was traditionally absent from Kenya and Somalia and cheese is still a niche market in the region. Camel-milk casein forms a comparatively soft and unstable curd, which poses problems to efficient cheese production. Validated protocols for camel-milk cheese making are available but require a specific rennet that requires cold storage (ibid.). The resulting camel-milk cheeses are at best similar to cheeses made from cow's or other milk. Again, processing the most expensive raw milk into an at best average product, which has to compete with cheaper cow's milk cheeses for a limited market in the region does not make much economic sense.

Kenya's only camel-milk processing plant (Vital Camel Milk) in operation since 2005 (New Agriculturalist 2006) handles only insignificant volumes and supplies a small niche market in Nairobi supermarkets. Pasteurized, packed camel milk is sold at 120 Kenya shilling per 500 ml (€ 2.40/liter, current prices). The plant does not collect milk from pastoralist producers but relies on deliveries to the factory gates from ranch-based camel herds. The economic difficulty of running a profitable camel-milk processing plant in competition with a well-established, large informal camel-milk market is illustrated by the fact that Vital Camel Milk, with donor support, is currently venturing into camel-milk-based cosmetic products.⁶

Unlike in Kenya, where milk processing was established by a private investor, the first camel-milk processing plant in Somalia (Maandeq Milk Plant) was the result of a donor-funded project "Sustainable Improvement of Camel Milk Production and Trade" implemented by an NGO (UNA) in Gardo, Puntland, north Somalia, between 2001 and 2004. From the start the Maandeq Milk Plant lacked a clear economic concept and ownership structure (cooperative versus private business). Also the problem of how to secure cost-efficient regular supplies of raw camel milk from pastoralist producers in direct competition with the informal "street" market was never solved. While it was still operating, the Maandeq Milk Plant in Gardo was in constant competition with informal milk traders for raw milk supplies. The plant was leased to a private business (Karkaar Food Industries) in 2004, which uses the infrastructure for production of non-milk commodities. On two visits by one of the authors, in October 2006 and in January 2007, part of the cold-store capacity was leased to a camel-milk bulker for intermediate storage and cooling of raw camel milk destined for the Bosaso market. Though unsuccessful in terms of

⁵ In the absence of a cold chain, packed yoghurts behave essentially like pasteurized milk.

⁶ See for example <http://www.facebook.com/pages/Malaika-Beauty-and-Skin-Healing-Cr%C3%A8me/165448466851099> and www.malaikacosmetics.com.

improving the camel-milk chain in Puntland, the UNA project generated very valuable information.

The informal camel-milk chain can tolerate wide day-to-day variations in raw camel-milk quality, which affect profit margins but do not block the retailing. But for profitable milk-processing operations, widely fluctuating raw milk quality and quantity represent insurmountable obstacles. For efficient heat treatment and processing, a milk plant needs raw camel milk of constant good hygienic quality, which can only be obtained if the milk is chilled soon after milking. Without premium price payment systems and substantial investment in milk collection technology the raw milk quality required for processing cannot be supplied by camel pastoralists.

The risks and transaction costs of ensuring a regular raw milk supply from distant mobile camel-milk producers to fixed milk-processing units are considerable; even more so in an environment with hot ambient temperatures and a poor road infrastructure. For the very same reason the few operating commercial camel-milk processing plants are supplied either by semi-stationary pastoralist milk producers who keep camel herds within a 90 km radius around the processing plant and heavily supplement their animals (Tiviski/Mauretania), by lactating camels kept on commercial ranches (Vital Camel Milk/Kenya) or by camels kept inside permanent dairy farms that rely on bought in feed (Emirates Industry for Camel Milk and Products and Al Ain Dairy, both in the UAE).⁷

IMPROVED MILK QUALITY AND MILK HYGIENE INCREASES INCOMES

Improving hygienic conditions effectively contributes towards increasing incomes generated by all actors in the camel-milk chain from milk production and sales. Numerous NGOs are currently involved in development projects aimed at strengthening camel-milk chains in north Kenya (KARI/KASAL and MDG 2009) and in Somalia. *Vétérinaires sans Frontières Suisse* (VSF-Suisse) has been and still is working with camel-milk traders in north Kenya under successive projects. The latest VSF-Suisse camel-milk project reached 1590 beneficiaries and consisted of milk hygiene training, the provision of 3 ltr aluminum milk cans, of canvas transport bags (soaked in water to provide evaporative cooling during milk transport) and of appropriate dispensing utensils for retailing milk.

The camel-milk project of the Netherlands Development Organization, SNV, in Kenya supports the establishment of urban camel-milk bars with improved retail practices and increased profit margins through business training and access to micro-credit.

Since 2006 the Somali Pastoralist Dairy Development Project (SPDDP), implemented by *Vétérinaires sans Frontières Germany* (VSF Germany) in Puntland and in Somaliland, has focused on strengthening the camel-milk chain by preserving raw milk quality and market value through improved milk hygiene and transport conditions. It provided hygiene training, metal milk containers (3 ltrs, 5 ltrs, 10 ltrs sold at wholesale prices to milk traders) and established a network of milk collection centers with washing and cleaning facilities in important milk production areas. These milk collection centers are managed by local, predominantly female groups of milk traders and financed through a small levy charged per milk container (milk volume) passing through the center. (Equipping vehicles with affordable evaporative cooling technology is currently under discussion.) In addition, retail facilities at urban markets were improved through the construction of shaded milk halls with market stalls and washing facilities in major towns (Burao, Galkaayo). SPDDP also engaged local authorities to enforce minimum regulations for milk safety and quality.

⁷ See the homepages Vital Camel Milk <http://www.vitalcamel milk.com>, Tiviski <http://www.tiviski.com>, Emirates Industry for Camel Milk and Products (EICMP) <http://www.camelicious.ae> and Al Ain Dairy <http://www.alaindairyuae.com>.

A very relevant feedback from various development project experiences is that improved hygienic quality of raw camel milk does not necessarily increase retail prices. It rather attracts more regular customers to buy from a particular milk-woman, thus increasing her daily turnover and income (Biovision/VSF Suisse 2010). Another significantly positive effect on income observed by both VSF Suisse in Kenya and VSF Germany in Somalia is the higher percentage of milk sold daily as fresh milk at “premium” prices, rather than being sold sour. In Puntland the amount of fresh milk sold increased from an average of 20% before the introduction of improved milk hygiene to between 50% and 80% after hygienic handling and transport had come into use. One remaining problem is to ensure that camel-milk producers routinely receive their share of the improved profits and that they also invest into improved milking hygiene. The existing premium payment system for morning milk could potentially be expanded to provide incentives to milk producers for hygienically improved camel milk.

CONCLUSIONS

One cautious conclusion shared with others (SPDDP, Herren 1990) is that the duration and volume of the unmarketed camel milk surplus tend to be overestimated by development policy-makers, who often do not fully take milk consumption by the suckling camel calf and by pastoralists and their families into account. In the absence of supplementary feeding it is difficult to see how the currently low milk volumes available for human consumption can be substantially increased. Irrigation farming, traditionally absent in the East African region, is gaining ground in arid parts of Kenya and Somalia and is very likely to offer new opportunities for cost-efficient semi-intensive camel-milk production in the future.

Modern camel-milk processing operations disconnected from pastoralist producers and from the informal camel-milk chain, whether financed by development projects or by private business, are very limited in scope and currently do not improve incomes of camel-milk producers and other actors in the informal camel-milk value chain in East Africa. The most efficient value addition for camel milk in Kenya and Somalia at present is the safeguarding of raw milk quality and its market value during collection, transport and retail. Donor investments aimed at strengthening the camel-milk chain should support improvements in the infrastructure for milk collection and retail, coupled with enforcement of minimum milk-quality regulations by local authorities. If well targeted, such interventions have been shown to improve incomes of micro-enterprises involved in camel-milk marketing. Long-term investments in improved road infrastructure in arid regions, as is currently happening in north Kenya, will lower transaction costs and allow larger numbers of pastoralists to participate in the camel-milk trade. It will also result in camel milk being supplied from larger catchment areas, thus reducing if not eliminating the currently negative environmental impacts of “intensified” commercial camel-milk production.

Donor and policy support to camel-milk marketing in East Africa must avoid repeating misguided dairy policies of the past, which initially overlooked the importance of informal cow’s milk chains and focused predominantly on modern milk processing. Many of these past efforts failed to strengthen the milk value chain and did not benefit poor producers and traders (Leksmono et al. 2006). The information provided in this paper on the camel-milk marketing sector in Kenya and in Somalia is by no means comprehensive. Initiatives to develop the camel-milk value chain are implemented by very different actors (NGOs, governmental institutions, private investors, researchers). As a result the information generated during such interventions is fragmented, not widely published and scattered among a multiplicity of project reports and other documents. This involves the risk of different actors repeating the same mistakes, unaware of previous experience. Hopefully this paper will provide a basis for ex-ante assessments, decision-making and planning for future projects.

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Extending the Shelf Life of Camel Milk

This article is based on a study carried out to increase the efficiency of the keeping quality of raw milk by the activation of the lactoperoxidase enzymes system (LPS), which was recommended by FAO. Fresh raw milk samples from both bovine and dromedary milk were obtained from the University of Khartoum farm during May 2010. The activation was done two hours later after the morning milking and the milk samples were divided into LPS-activated and control samples. The preservation of the samples was then carried out at room temperature (37° C) and refrigeration conditions (8° C). All samples were subjected to some quality tests (standard plate count, acidity and clot-on-boiling test) during the storage period.

The LPS-treated milk samples from camels showed better keeping quality and longer shelf life than cow's milk both at room temperature (10 vs. 3 days) and refrigerator temperature (14 vs. 9 days), compared to non-treated milk samples stored at room temperature (3 days and 6 hours) and refrigerator temperature (10 and 3 days), respectively.

The data obtained are compare favorably with the control samples stored in refrigeration conditions. This supported the previous recommendation that LPS is an efficient method for preservation and prolonging the shelf life of raw milk in tropical environments that lack refrigeration facilities. Because camel milk showed superior quality compared to cow's milk, camel communities' herders in arid and semi zones should be involved in the field application of LPS in order to encourage them to collect and utilize their valuable camel milk. It is also recommended that the governmental and private institutes should establish the collection centers equipped with technical facilities to enhance the processing and trading of the non-utilized milk from camels and other species in Sudan.

INTRODUCTION: THE VALUE AND SUPREMACY OF CAMEL MILK

More than 60% of the dromedary population is concentrated in the four northeast African countries of Somalia, Sudan, Kenya and Ethiopia. Somalia with over six million head has the largest herd in the world, followed by Sudan with more than four million (Farah et al. 2007). Dromedaries are natural browsers and thrive and produce milk on rough, sparse pasture, where other domesticated animals would virtually starve (Elamin 1984). This makes the lactating she-camel a very valuable animal for the nutrition of the camel herder's family in this harsh environment. Camels, besides many other functions in nomadic life, are reliable milk producers with a long lactation period, and they maintain milk production throughout the long dry spell when milk from other livestock is scarce (Bekele et al. 2002).

Farah (1996) reported that camel milk is a very important human nutrient in several zones of tropical and subtropical regions, where it represents the only protein source. Camel's milk is used in some parts of the world as a cure for certain diseases and is a rich source of proteins with potential antimicrobial and protective activities; these proteins are not found in cow's milk or only in minor quantities (Wernery 2003). Proteins and peptides such as lactoperoxidase, lactoferrin, bacteriocins, lysosome and xanthine oxidase occur naturally in milk and have antimicrobial properties (Yuan 2001).

Hussain/Islam (1990) stated that the majority of the dairy farmers in many countries cannot install cold rooms or buy refrigerators. Similarly, heated milk is not generally accepted by the public. An alternative method is to preserve milk with chemical preservatives. However, the FAO/WHO strongly discourage this except by the use of hydrogen peroxide (H₂O₂) at native

LPS (Ozer et al. 2003). If H_2O_2 is added to the milk samples, heat treatment should be applied before use in order to ensure the complete destruction of the residual H_2O_2 (to water and oxygen) before consumption. On the other hand, Hannuksela et al. (1994) mentioned that the lactoperoxidase is a natural bacterial defense system through the oxidation of thiocyanate ions (SCN^-) by hydrogen peroxide. These are both present in biological fluids and together with lactoperoxidase are termed the lactoperoxidase enzyme system (LPS). This is based on the activation of the lactoperoxidase, thiocyanate and hydrogen peroxide system (naturally present in milk in varying concentrations) to inactivate several vital metabolic bacterial enzymes, consequently blocking their metabolism and ability to multiply (Gaya et al. 1991).

Compared to cooling in small-scale dairy enterprises, coupled with good hygiene and sanitation the lactoperoxidase system is a reliable and economical method of preserving raw milk (FAO/WHO, 2005). This natural antimicrobial system present in milk has been used to preserve raw milk quality in areas where for technical and/or economic reasons it is not possible to use mechanical refrigeration (Seifu et al. 2005). Its application at collection centers is aimed at raising regional awareness of a safe, cheap and effective alternative milk-preservation method (Codex Alimentarius Commission 2004).

The raw milk sold to consumers in Sudan is never subject to the real quality-control measures needed for good quality food (Mohamed/El Zubeir 2007). The country's dairy industry is weak and at an early stage of development, since the marketing of raw milk and dairy products made from raw milk are common features of dairy marketing in Sudan (Elmagli/El Zubeir 2006b). However, currently some new private dairy factories have begun processing dairy products, but they have faced many problems, of which the quality control measures constitute an important concern (Abd Elrahman et al. 2009). Moreover, the lack of a stable electricity supply is one of the main constraints facing dairy-product marketing. Most use raw milk supplied without cooling, as the milk-marketing system is weak and at a transitional stage (Elmagli/El Zubeir 2006a). These situations necessitate the introduction of safe methods of preservation suited to local conditions. The recent awareness of the medicinal value of camel milk is leading to more commercially oriented attitudes by the *abbala* (camel herders) in Sudan, towards selling camel milk, which was previously given free of charge or as a gift (Sheiup/El Zubeir 2008). Camels represent the backbone in the economic life of the *abbala*, either by selling male camels in local markets or for export (Musa et al. 2006). Some camel herders have started to sell their raw milk in urban and suburban areas (Sheiup/El Zubeir 2008). The introduction of LPS makes it possible to preserve camel milk for commercialization, as camels are always far from the consumers, in search of water and pasture. This study was thus carried out as a trial to evaluate the preservation of milk using lactoperoxidase enzyme system, new enzyme kits that have been recently approved and introduced to the developing countries by the FAO for further demonstration after the successful large-scale field trials in Pakistan, the Philippines and Cuba, which have shown promising results (Lambert 1993). Currently the kits are distributed free by FAO for field trials involving 80 developing countries, one of which is Sudan.

MATERIALS AND METHODS: CAMEL MILK IN COMPARISON WITH COW'S MILK

The lactoperoxidase enzymes system for the preservation of camel's and cow's milk in this study was obtained from Ministry of Animal Resources. The kits were offered by the FAO for field trials of the LPS in Sudan. The study was carried out in May 2010. Camel's milk and cow's milk samples were obtained from the University of Khartoum farm and were examined after two hours of milking.

The samples were divided into two equal portions; treated (by the addition of LPS) and control. Both treated and control samples were put into 20 ml sterile bottles and kept both at room temperature ($37^\circ C$) and refrigerator temperature ($8^\circ C$). The samples of the two types of milk were divided into eight groups: control camel-milk samples kept at room temperature (CR), control milk samples kept at refrigerator temperature (CC), treated milk samples kept at room temperature (TR) and treated milk samples kept at refrigerator temperature (TC).

ANALYSIS OF MILK SAMPLES

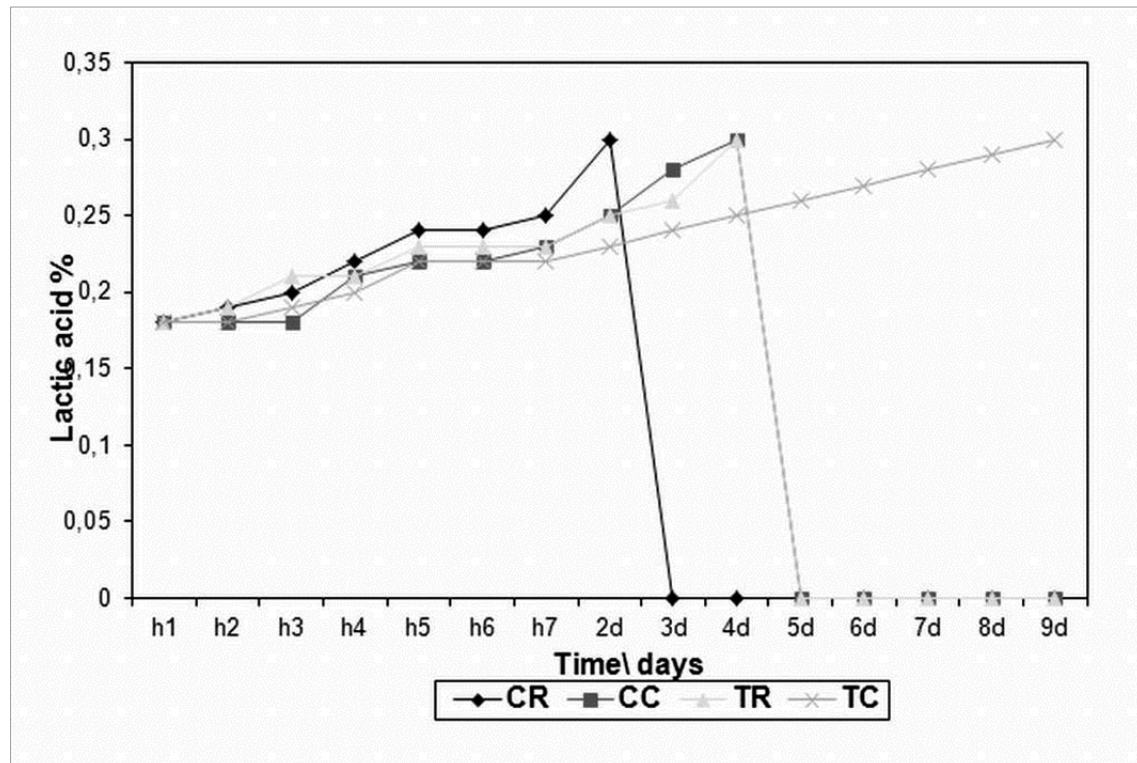
The acidity of the milk samples and the clot-on-boiling test were carried out according to Foley et al. (1974). Both acidity and the clot-on-boiling test were determined daily to assess the shelf life. Plate-count agar was used to determine the total viable bacterial counts. Preparation of the samples, serial dilutions of milk samples, the incubation (32° C for 24–48 hours) and counting were done according to Houghtby et al. (1992).

Measurements		Camel's milk	Cow's milk
Treated by LPS	Refrigeration	14 days	9 days
	Room	10 days	3 days
Control	Refrigeration	10 days	3 days
	Room	2 days	6 hours

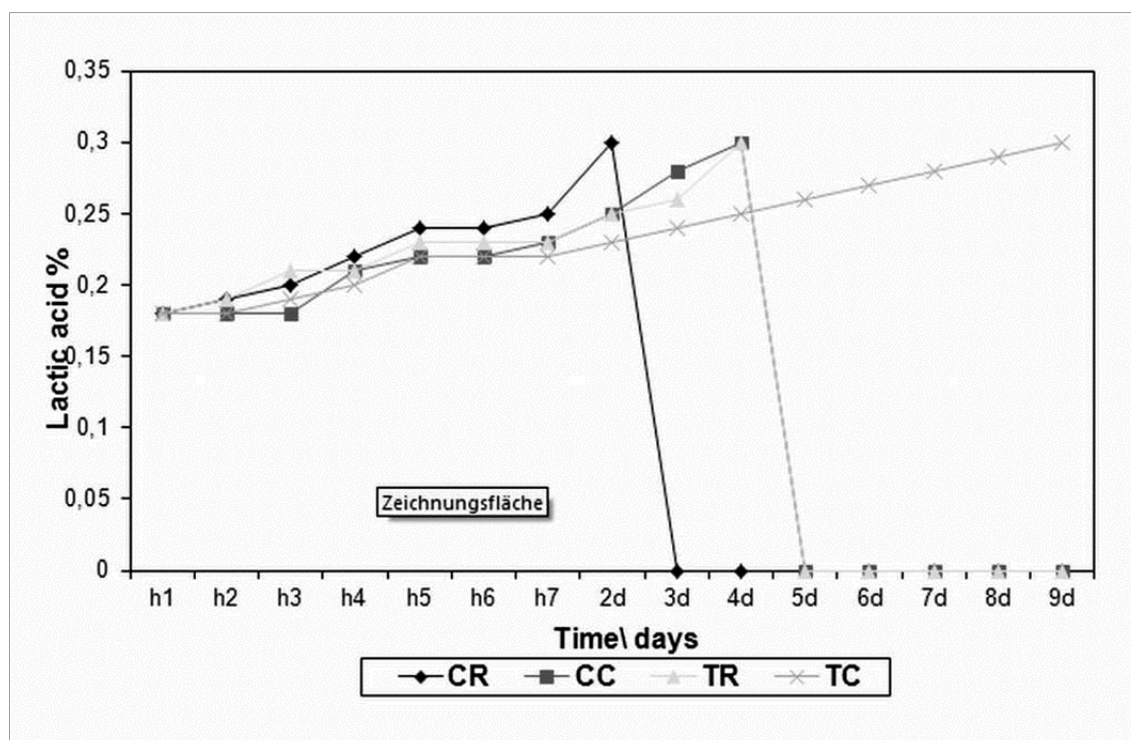
Table 15: The effect of lactoperoxidase enzyme system on the keeping quality (shelf life/day) of the camel's and cow's milk.

RESULTS AND DISCUSSION

The study showed that the addition of lactoperoxidase enzymes system resulted in improved keeping quality and shelf life of both camel's and cow's milk whether at room or refrigerator temperature (see table 15). The treated milk samples kept at room temperature had a longer shelf life than the control samples. Moreover, and as detected by the acidity, the addition of lactoperoxidase enzymes system to camel's milk (see graph 32) was more efficient compared to cow's milk (see graph 33).



Graph 32: Variation in the development of acidity in camel's milk treated by lactoperoxidase enzymes system. In this and the following figure: CR= control milk kept at room temperature; CC= control milk kept at refrigerator temperature; TR= treated milk kept at room temperature; TC= treated milk kept at refrigerator temperature.



Graph 33: Variation in the development of acidity in cow's milk treated by lactoperoxidase enzymes system.

This suggested that the lactoperoxidase enzymes system can be used as an efficient procedure for keeping the milk in farms and areas where there are no cooling facilities (Lambert 1993). This was in accord with El Zubeir et al. (2006). Hence it might help in marketing camel milk in towns where it can have commercial values especially because of its health and nutritional benefits (Wernery 2003).

The results show that the LPS-treated milk samples kept at room temperature did not show any significant difference in total viable bacterial counts when compared to the samples kept in the refrigerator. This might be because two hours' exposure of combined LPS resulted in a decrease in numbers of viable bacterial attached to the stainless steel (Dufour et al. 2004). It might also indicate that LPS could be a method of milk preservation when cooling facilities are not available (Lambert 1993, Seifu et al. 2005, El Zubeir/Hassan 2006). The suppression of bacteria by LPS indicated the antimicrobial effect of LPS (McLay et al. 2002, Dufour et al. 2004).

CONCLUSIONS AND RECOMMENDATIONS

The study recommended the uses of LPS in Sudan after establishment and development of milk collection centers, especially in the rural areas in order to utilize the large quantities of milk that has been unavailable to the consumers. Further research on the antimicrobial effect on the different milk-borne diseases and spoilage organisms is needed to examine the LPS under the different conditions of Sudan.

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SHEHU AHMAD MAIGANDI

Bringing Camels into Focus: A Photo-Essay on Dromedaries in the Nigeria-Niger Corridor

The one-humped camel (*Camelus dromedarius*) is a multipurpose domestic animal. It is well adapted to the harsh conditions of the arid and semi-arid zones and therefore thrives where other livestock species do not. The dromedary is versatile and its ability to survive and perform in the harsh, arid and semi-arid areas of the world has earned it a good reputation amongst pastoralists of tropical Africa and Asia (Waziri/Shehu/Kwari 1999). Camel keeping is a common activity in the Nigeria-Niger border areas. The dromedaries are found in the northern parts of Nigeria on latitudes 8°N and 14°N. According to Bourn et al. (1994), the camel population estimate in Nigeria stood at 90,000. Niger Republic, which is one of Nigeria's neighbors to the north, has a camel population of 420,000 (FAO 1990; as cited in Breulmann et al. 2007). Pastoral groups of Nigerien origin own most of the camels in Nigeria.

This border region is characterized by extensive, flat dry lands, in which transhumant livestock herders move several kilometers north and then south again each year, following the rains and the grazing. Sedentary farmers grow crops along a south-north gradient of diminishing rainfall and increasingly erratic distribution, and population density is increasing as a result of both natural increase and immigration from more densely settled areas in the south (Mortimore et al. 2008). The region has a uniting effect on both countries in terms of a common cultural heritage, seasonal livestock movements and commerce. Camels are commonly thought of as being confined to the northern borders of Nigeria, and this is still largely true of breeding herds (Blench 1999). Although individual farmers may breed camels on a small scale, relatively few breeding herds spend the entire year in Nigeria; most cross into the Niger Republic for three to four months at the height of the wet season (Blench 1999) between July and September in company of their traditional nomadic herders (Mohammed/Hoffmann 2006), so there is a tendency for Nigeria's camel population to fluctuate as a result of this transhumant activity.

The dromedary can provide a wide array of functions and products. It is probably best described by Bulliet (1975) who wrote that, "the camel can be milked, ridden, loaded with baggage, eaten, harnessed to a plough or wagon, traded for goods or wives, exhibited in a zoo or turned into sandals and camel hair coats" (as cited in Waziri et al. 1999:135). The camel feeds on plants or parts of plants not eaten by more conventional livestock. In addition to being complementary to other livestock in the use of feed resources, camels complement them in production. Milk is among the most important products of the camel, with long lactation periods and the ability to maintain milk production through long dry spells. The vitamin C content of camel milk is superior to that of cow's milk, which is very important from the nutritional viewpoint, especially in arid regions where fruit and vegetables are scarce. Moreover, the fat content is lower than cow's milk, making it easily digestible, and as it does not sour as quickly as cow's milk it is ideal in hot areas (Teka 1991). Meat is largely a by-product of a camel-rearing system, as males are used to advanced ages for transport, power and often for recreation in the form of racing. Other economic products include wool and hair, and investment and capital accumulation are aspects of camel productivity.

During a field survey carried out in Nigeria and Niger Republic between July and September 2010, different aspects of camel production were photographed.¹ This article highlights the significance of these pictures for camel research and development in Nigeria. Photographs can serve as a tool to draw the attention of scientists and researchers to issues relevant to camel research and development in developing countries. They are useful because they convey complex information, and in the case of a photo-essay the photographs are not separate from the research context (McClatchey/Gollin/Rakotonandrasana 2005). Today, photos are a necessary tool that can be used by everyone in most areas of science research (Mokkamul 2006). They can continue to produce better information long after the field-data collection process is over.

METHODOLOGY

Informed consent was obtained from the camel owners who participated in the field survey. Photographs were taken from Kano in northwestern Nigeria, Garin Alkali in northeastern Nigeria and Kursilla in the Maine Soroa Department (Diffa Region, southeastern Niger) and Gujjo in Goure Department (Zinder Region, Southeastern Niger). All photographs were taken using a Nikon Coolpix L18 digital camera with a 5.7–17.1 mm lens. Other than image resizing, the photographs have not been substantially modified. The photographs were broadly classified based on the following criteria for ease of discussion: camel phenotypes, camel reproduction and fetal wastage, and camel health. These are prioritized because, in addition to camel nutrition, they form the cornerstone of any camel-rearing system. Prioritizing these aspects in our research agenda will aid the development of a viable camel industry that could improve the livelihood of the pastoralists who rear dromedaries in the Nigeria-Niger corridor.

PICTORIAL REVIEW 1: CAMEL PHENOTYPES

According to Mukasa-Mugerwa (1981), the name of the dromedary breeds and types in Africa is often a reflection of their locality or country, the people who breed them or simply the animal's color, rather than any division into work, riding or milking breeds. He further opined that it is possible for the same camel types, with a common ancestry but occupying different geographical areas, to be labeled as two separate types or breeds. There is an absence of a well-defined breed classification for dromedaries in northern Nigeria. Identification is mainly by body color. Mohammed (2000) reported four major phenotypes in livestock markets of northwestern Nigeria based on body color. These comprise the sand-brown (see picture 91), gray-white (see picture 92), dark-brown (see picture 93), and pied phenotypes (see picture 94). In addition to these phenotypes, we also observed the white (see picture 95), brown-black (see picture 96) and black phenotypes (see picture 97). According to Mohammed (2000), the pied phenotype has been described by respondent Tuareg pastoralists as a beast with good mothering ability and highly palatable milk, although difficult to control when grazing because it is deaf. Epstein/Mason (1971) also reported that the pied dromedary was of great value to dromedary pastoralists in the Sahel (as cited in Mohammed 2000). A gap in knowledge exists as far as the identification, documentation, characterization, preservation and economic evaluation of these phenotypes is concerned. The bottom line is that we do not know whether these phenotypes are individual breeds or several types of the same breed. To answer this, a genetic characterization of these phenotypes is needed and should be a priority in future research.

PICTORIAL REVIEW 2: CAMEL REPRODUCTION AND FETAL WASTAGE

Breeding behavior of camels differs from sheep and cattle in two primary ways: males show strong seasonal activity (rut), while females are induced ovulators; that is, the act of mating stimulates ovulation (Lapidge/Eason/Humphrys 2008). Mature dromedary bulls during rut or

¹ The authors are grateful for the cooperation given to them by the key informants and the camel owners whose animals were used in this study. We are also grateful to Nura Ibrahim Mukhtar and Muhammad Baba Bello for the help with the field work.

musth are characterized by a dramatic increase in androgen levels in the blood with intense sexual desire and extremely aggressive behavior (El-Wishy 1988). They become unmanageable, blow out a palatal flap from the mouth, vocalize, and spread urine over their backs with the aid of their tails (Yagil/Etzion 1980). The *dulaa* is a palatal flap (see picture 98) that is extruded on the side of the mouth of the male camel during the mating season, and sometimes incorrectly assumed to be the tongue (Yagil 2006). The flap is formed under the influence of testosterone, so the more virile the male, the longer is its *dulaa*, which protrudes further in a ball-like structure. According to Kuhad et al. (1998), potential airway obstruction could be caused by the *dulaa* in male racing camels and this reduces maximum oxygen uptake and therefore lowers performance. Attempts have been made to alleviate the problem by surgical resection of the *dulaa* to provide better air-flow in the upper respiratory tract during strenuous exercise (Kuhad et al. 1998).

According to Agarwal/Khanna (1990), higher testosterone and active poll glands have been reported during the rut season (as cited in Al Eknah 2000). The poll glands (see picture 99) are situated on the back of the neck between the ears (Yagil 2006) and secrete a coffee-colored acrid fluid, which flows down the back of the neck, marking the skin with a dark color. The males rub their necks on any solid object, thus marking their territory (Yagil 2006). It was earlier assumed that the poll glands secreted substances of a male character (Purohit/Singh 1958; cited in Tingari et al. 1984), which was substantiated by evidence that the secretions have similar concentrations of androgens as in the blood (Yagil/Etzion 1980). Tingari et al. (1984) suggested that the poll glands could be a source of pheromones, and histological examination confirms that the glands are of endocrinological origin (Tibary et al. 2005; as cited in Yagil 2006).

Picture 100 shows a pregnant camel, diagnosed by traditional method in which when pushed slightly on the flank, she urinates and curves her tail upwards toward the hump (tail “cocking”). According to Yagil (2006), a pregnant camel will show it by lifting and curving her tail when a male advances. The male then moves off looking for another receptive female. This is the method used by nomads to determine pregnancy. Other methods of pregnancy diagnosis include ultrasound (Schels/Mostafawi 1978, Skidmore 2000, Vyas et al. 2002, Vyas et al. 2004), chemical tests such as Cuboni and barium sulfate tests (Khanvilkar/Samant/Ambore 2009), vaginal cytology (Khanvilkar/Samant/Ambore 2009), and the detection of gonadotrophins (Khanvilkar/Samant/Ambore 2009) or immunoassays for progesterone (Agarwal et al. 1987, Homeida 1990).

Fetal wastage as a result of the slaughter of a pregnant camel is shown in picture 101. Ataja/Uko (1994) reported that 24.06% of female camels slaughtered for meat at Sokoto abattoir in 1992 were pregnant (as cited in Muhammad/Ashiru/Abdullahi 2007). Reproduction is the basis of any livestock economy. It is an important factor in determining the production efficiency of individual animals as well as the entire herd and livestock industry of a nation. The percentage of young animals is crucial for herd replacement while milk off-take for the neonate and human consumer is dependent on reproduction. If the menace of fetal wastage through slaughter of gravid animals is not checked, the rate of decline in the numerical strength of replacement stock will worsen and translate into a deficit in access to adequate animal products, especially with the impending increase in human population growth.

Slaughtering of pregnant animals for meat is contrary to the rules of slaughter, under which only unproductive, infertile, sterile, old or accidentally injured animals are allowed to be slaughtered (Khan/Khan 1989; cited in Ademola 2010). This practice ultimately reduces the quantity and quality of animal protein available for human consumption, which worsens an already bad situation in most developing countries (Ademola 2010).

PICTORIAL REVIEW 3: CAMEL HEALTH

The diseases of the African camel have not been extensively studied in the Nigeria-Niger corridor. In a study of ectoparasites of *Camelus dromedarius* in Sokoto, Nigeria, Lawal/Ameh/Ahmed (2007) reported that ticks were the most abundant parasites infesting camels. They observed that these ticks occurred in clusters mostly at the base of the tail. Other body sites where they were commonly seen include the interdigital spaces, perineal region, axilla (see picture 102) and abdomen. In addition to these, we were able to find ticks in the eye region and the nostrils (see picture 103) and on the udder and inguinal region (see pictures 104 and 105). Ticks on the udder can be regarded as risk factor for mastitis and udder lesion (Megersa 2010). We could not classify these ticks into genus and species but they seem to belong to the hard ticks group in different stages of development. The effect of tick infestation on camels has been highlighted by Moallin (2009), who mentioned that, “ticks on camels are found in inguinal, perineal and axillary regions. They are also found in the ears, nose and eyes. Ticks cause irritations and anemia. Heavy infestation with ticks can lead to injuries on bite sites and wounds. Pyoderma may occur as a consequence”.

Lymphadenitis, an inflammation of the lymph nodes, was also observed during the survey (see pictures 106 and 107). According to Moallin (2009), the cervical lymph node is the most involved in camel lymphadenitis. He further mentioned that in this disease skin abscesses are observed on the head, shoulder, abdomen and legs and several bacterial species were isolated from these abscesses. Didier (1975) considered different corynebacteria as the main cause of lymphadenitis in camels (cited in McGrane/Higgins 1985).

During the survey, camel owners reported that the plants “Kalumbo” (*Leptadenia pyrotechnica*; see picture 108) and “Yadiya” (*Leptadenia lancifolia*; see picture 109) lead to abortion when consumed by pregnant camels and the latter also acts as an aphrodisiac in the male camel. These claims are anecdotal and their veracity needs to be established.² However, it is possible that these plants contain some phyto-oestrogens, which could interfere with the normal physiology of pregnancy in the camel leading to its termination. The phytoestrogens are associated with a number of problems, including development, infertility, reproductive disorders, abortion, premature maturity and even death caused by immune-system failure (Allawati/Kumar/Musa n.d.). These authors reported the possible role of fresh Alfalfa (*Medicago sativum*) in an outbreak of abortion in camels. They further stated that Alfalfa is widely used for feeding camels in the Gulf region and contains an oestradiol concentration of 37.76 pg/ml. Alfalfa also contains flavones, isoflavones, sterols and coumarin derivatives, and the isoflavones genistein and dadzein, appear to be responsible for oestrogen-like effects in animals and are collectively referred to as phytoestrogens (Allawati/Kumar/Musa n.d.). There is a need to document indigenous knowledge in the Nigeria-Niger corridor with respect to plants known to cause abortion in camels and to determine their oestrogen level.

Camel owners also mentioned some ethnoveterinary remedies for treating infertility in their herds. They described the scarification of the frenulum of the tongue, a fold of mucous membrane extending from the floor of the mouth to the midline of the underside of the tongue (see picture 110) and the excision or cutting off a protrusion from the vagina (see picture 111) as ways in which they address the problems of infertility in their herd. In both cases they allow the bull to mount after the surgical intervention. Camel owners in Sheikh District of Somaliland have reported protrusion in the vaginal area as one of the signs of brucellosis in female camels (Barre 2009). Camels with this disorder were also reported as being excited, exhibiting behavior similar to camel bulls and a tendency to mount other females in the presence of male camels. If Somaliland camel keepers have treated the vaginal protrusion in their female camels with some kind of traditional method, it was not mentioned in Barre’s study (2009). There is therefore a

² For a further discussion of camel fodder in a historical Arabian context see the article by Daniel Varisco in this volume.

need to investigate the scientific basis behind the practice of surgical removal of the vaginal protrusion as a remedy for female camel infertility in the Nigeria-Niger corridor.

CONCLUSIONS

Camel keeping in the Nigeria-Niger corridor is an important activity that calls for urgent attention from researchers and policy-makers. Aspects such as camel phenotype characterization, camel reproduction and camel health should be given priority because, in addition to camel nutrition, they form the cornerstone of any camel-rearing system. Prioritizing these aspects in our research agenda will give rise to a viable camel industry that could improve the livelihood of the pastoralists who happen to be the traditional herders of the dromedary in the Nigeria-Niger corridor. Boosting camel-rearing in this context could provide the much needed animal protein to the inhabitants of this area, who are constantly threatened by the menace of desertification, and the camel, known for its resilience with regard to desert ecosystems, is probably the best candidate for this.

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RICHARD W. BULLIET

Afterword: Camels and Deserts

In the summer of 1967 the thought struck me that in my many years of studying classical Arabic I had never encountered any reference to a wheeled vehicle. This thought prompted me to wonder whether the long history of Middle Eastern chariots and ox-carts so vividly portrayed in the Bible and uncovered by Egyptian and Mesopotamian archeology had come to an end before the Arab conquests of the seventh century. Pursuing this further, I concluded that wheels did, indeed, disappear from the region in late antiquity and that the reason for their disappearance was the cost advantage that the pack camel enjoyed vis-à-vis the ox-cart, which was explicitly attested by documents of the Roman era. I published this thesis in *Annales: économies, sociétés, civilisations* in an article titled “Le chameau et la roue au Moyen-Orient” (Bulliet 1969). This left me, however, with a chronological problem. Since there was no reason to suspect that the economic efficiency of camel transport improved dramatically during the Roman period, why did the competition between the camel-driver and the carter play out at that particular time instead of a thousand years earlier or later? To answer this question I began to investigate the history of camel use and domestication.

Given the geographical diversity, topical variety and scientific detail of the excellent articles contained in this collection, and in particular its contributions to the understudied history and status of wild and domestic Bactrian camels in Parts I-III, it may not be obvious that the literature available for studying camels 45 years ago was very sparse and often quite non-scientific. Aside from Joseph Freiherr von Hammer-Purgstall's monumental 1854 collection of Arabic camel-related vocabulary mentioned in the introduction – a work that unfortunately lacks source references and examples of usage – the outstanding research of Knut Schmidt-Nielsen on the physiological characteristics of North African camels stood out both for the rigor of his scientific method and the importance of his findings (Schmidt-Nielsen 1997). However, I could find no parallel research on two-humped camels, which lived in a strikingly different climatic zone. The best of what was available about either species dealt primarily with veterinary matters: A. S. Leese (1927) and H. E. Cross (1917) in English, Ivo Droandi (1936) in Italian, G. G. Curasson (1947) in French and Victor N. Kolpakow (1935) in German, though originally probably in Russian. These works reflected the veterinary problems that Europeans faced in dealing with military and transport matters in their colonial possessions. Other authors wrote more directly about these matters: A. G. Leonard (1894) in English, C. Cauvet (1925, 1926) in French and M. A. Vitale (1928) in Italian. Historical questions, from the origins of domestic camel populations down to 19th century experiments with acclimatizing camels to various habitats around the world, were touched on by a much larger number of authors, but seldom in a fashion that highlighted the importance of camel history *per se*.

My own book on camels, *The Camel and the Wheel* (1975), and my two subsequent publications dealing with camel harnessing, “Botr et Baranès: hypothèses sur l’histoire des Berbères” (1981), and the hybridization of one- and two-humped camels, *Cotton, Climate, and Camels in Early Islamic Iran: A Moment in World History* (2009) were similarly devoted to somewhat narrow topics – no camel folklore, no camel religious rituals, no camel gods or demons, no camel food taboos, no camel stew recipes, no camel symbolism, no camel art motifs, no camels as embodiments of moral virtues, no famous war camels. If I had delved into these more expansive topics, however, I would have been hard pressed to muster the substance of a book. Compared with any other large domestic animal, the affective associations of the camel are remark-

ably few, except among actual camel breeding populations such as those discussed in this book in articles devoted to Mongolia (Lang, Chuluunbaatar), Arabia (Bakhsh et al., Gingrich), and Algeria (Fischer).

Moreover, unlike cattle, horses, donkeys, sheep, goats and pigs, which have spread throughout the globe, camels continue to be bred and utilized only in their native habitats or, in the case of Somalia, the Sahara and the Canary Islands, in habitats that share the climatic extremes of Arabia and Inner Asia. (The camels of Australia are feral descendants of imported working animals that were set free early in the 20th century. They are neither bred nor used, except in tourist situations.) Thus, despite the fact that camels are remarkably strong, easy to feed, and gifted with incredible endurance, they have not enjoyed a worldwide spread. Though many efforts were made to introduce camels to other lands, including Italy, Spain, Poland, Texas, British Columbia, South Africa, German Southwest Africa, Nyassa province in Portuguese Mozambique, Céara state in northeast Brazil, Java, Jamaica, Peru, Venezuela and Cuba, all such experiments eventually failed. The camel might conceivably be compared with the yak or the reindeer in its enduring association with particular environments, but unlike yaks, which are high-altitude, low-temperature substitutes for cattle, or reindeer, which are similarly adapted to life in frigid climates, camels are the world's strongest pack animals and thus had an economic utility that was universally recognized in the era before mechanized transport. Hence the innumerable experiments with importing them to exotic locations.

The question therefore arises: Why has such a useful animal remained so limited in its cultural manifestations and so restricted in its geographical range? Though I cannot propose a definitive answer to this question, I will suggest two lines of inquiry. First, the camel's limited cultural impact relates to its comparatively late period of domestication. And second, the economic utility of the camel derives from its ability to sustain itself in extremely barren environments but is undermined under other circumstances by its long maturation period.

As the origins of domestication are currently understood – and this is a highly fluid field of study – domestic ungulates, that is, hoofed animals, divide into two chronological groups: early domesticates and late domesticates. Domestic forms of cattle, pigs, sheep and goats seem to have come into being some ten to eleven thousand years ago. Horses, donkeys, water buffalo and camels, both one-humped and two-humped, seem to have undergone domestication four to five thousand years later. Given the substantial time gap between these incidents of domestication, it is not surprising to find major differences between the uses to which the early domesticates and the late domesticates were put. These uses can be broadly divided into two categories: affective and economic. Economic uses include exploiting animals for meat, milk, fiber and labor. Affective uses are less obvious, but they include considering animals as symbols, as objects of veneration or divine representation, as sources of aesthetic pleasure and as pets.

The early group of ungulates, at the outset of their domestic exploitation, had comparatively high levels of affective utility and low levels of economic utility. Though their meat was consumed, milking, wool shearing, plowing and vehicle pulling, referred to by scholar Andrew Sherratt in his much cited article (Sherratt 1981) as secondary products, emerged only slowly, with several millennia elapsing between first domestication and evidence of these uses. And even meat consumption had a strong affective basis insofar as most slaughtering was highly ritualized through the institution of blood sacrifice. These early domesticates also appear with great frequency in artistic representations, myths (e.g., the primal cow of Norse cosmogony), religious symbolism (e.g., “behold the lamb of God”), manifestations of divinity (e.g., most Egyptian deities, Zeus as a bull, Verethragna as a boar) and human-animal hybrids, (e.g., minotaurs, fauns, satyrs, etc.).

The later domesticates are far less likely to be represented as gods, though they may be used by gods (e.g., horses pull the chariots of the gods, donkeys bear prophets on their backs). The consumption of their meat and milk is less likely to be ritualized, their use as sacrificial animals is minimal and they seldom serve as exemplars of moral virtues or failings. The tropes of the

noble horse, stubborn mule, and stupid donkey are not as deeply embedded in cultural imagery as the raging bull, the nurturing cow, the lecherous and satanic goat, the greedy and unclean pig and the docile and pathetic sheep that must be cared for.

What the later domesticates do primarily is provide labor for plowing, carrying riders and burdens, pulling wheeled vehicles and operating mechanical devices such as wells, mills and irrigation wheels. The appearance of the late domesticates also coincides roughly with the origins of the Old World urban civilizations in Egypt, Mesopotamia, the Indus Valley and the North China plain, all of which utilized animal labor for plowing, transport and other purposes. The early domesticates, by contrast, appear at roughly the same time as domestic wheat and barley in the Fertile Crescent. Some scholars look upon these as linked developments, but the relationship of animal domestication to grain growing is far from proved. Some regions with great herds of domestic cattle, notably the Sahara prior to its desertification after 5000 BCE, seem not to have practiced agriculture; and New World civilizations that did depend on grain crops such as maize and quinoa had no domestic animals other than the dog.

On the basis of these differences between early domesticates and late domesticates it can be argued that a major threshold in the history of animal domestication was crossed sometime around 4000 BCE, when economic utilities associated with animal labor surpassed affective utilities as the principal benefit of animal husbandry. Though pigs were always kept for food and acquired no secondary uses, changes in herd configuration among other early domesticates, for example increases in the proportions of females and gelded oxen, point to strategies designed to maximize milk, wool and labor. Among the later domesticates, leaving aside water buffalo, meat and milk consumption are traditionally pretty much limited to the peoples who do the herding, though articles in this volume by Iqbal, El Zubeir and Younan and Mwangi indicate contemporary changes in these consumption patterns. With respect to camels, despite the long-standing debate over when and where they were first domesticated, a debate that is advanced by the contributions to this volume by Burger, Trinks et al., Dostal and Uerpmann and Uerpmann, most theories place camels on the later, economic utility side of the 4000-BCE threshold. Hence it is not surprising that camels, like water buffalos, play comparatively diminished roles in the ritual and imaginative lives of the peoples who mainly use their labor, particularly when those peoples are not themselves breeders but rather purchasers of draught and pack animals.

However, even given this understandably lower affective profile for camels, the extraordinary strength and carrying ability of camels would seem to have destined them to widespread use over a much broader geographical expanse. At least this seems to have been the motivation behind the many efforts to export them to other lands. In all likelihood, the failure of these transplantation efforts was rooted in the economics of maintaining a sufficient camel herd to ensure a regular supply of work animals. Unlike cattle, which mature in one year, or horses, which mature in three years, camels mature in six years. Though camels may be put to work when they are three to five years old,¹ age at sexual maturity governs the rate of reproduction of the herd. This suggests that the investment in the production of a useful camel may not compare favorably with that for a more rapidly maturing species.

By investment I do not mean the cost of fodder and stabling. In many environments, camels graze in desert or semi-desert landscapes and consume no purpose-grown fodder. Nor in those landscapes do they compete with some other productive exploitation, such as farming or more intensive pasturing. Moreover, they do not require stabling. Investment instead takes the form of human dedication to herd growth and maintenance, in most cases with an associated need to migrate with the herds across barren lands. It is possible, of course, to raise camels on a farm and feed them like other farm animals. But then they would often be competing with other farm

¹ Practice likely varied from one region of camel use to another and may have been comparatively early in Australia, where, contrary to the practice in most nomadic camel-breeding societies, the male animals were usually gelded (McNight 1969).

animals for grazing and fodder while taking years longer to reach the age of reproduction and useful labor.

If herding conditions do not take advantage of wasteland and instead put camels in competition with other domestic animals in farm or ranch settings, why would a stockbreeder producing animals for the labor market prefer camels to, say, mules, oxen or donkeys? Given the time and expense required to bring one camel to maturity, he could produce two mules, three oxen or three donkeys. This might conceivably make sense if the immediate labor market specifically required camels, for example if there were a demand from caravan organizers for animals that could withstand climatic extremes too stringent for a mule or a donkey, whether Saharan and Arabian heat and aridity or Central Asian snow and cold. But under these circumstances, it would seem unlikely that camels would be bred in farm or ranch settings. A more sensible system would be to raise the camels in a desert, even a very distant desert, and then walk them to market, as is still done with Sudanese camels sold in Cairo and was historically done by brokers who ranged the Arabian Peninsula buying animals from the tribes and walking them to Basra or Damascus for sale.

An economic comparison between camels and elephants is suggestive. Zoo and menagerie practice gives ample proof that Indian elephants reproduce successfully in captivity, and elephants have been used historically throughout India and mainland Southeast Asia as sources of labor and for military purposes. Yet they always seem to have been bred in the wild and then tamed after capture. The reason for this is that they eat enormous amounts of vegetation and take ten years to mature. It would therefore be foolish to spend ten years feeding one in anticipation of using its labor when that same labor could be procured by an elephant hunt followed by a period of training. In the case of wild one-humped camels, which once lived in desert wastes where, like elephants in a forest, they had no natural predators, training an animal captured in the wild to carry a load should not have been terribly difficult. The difficulty would have lain in finding the animals in the desert wastes, a problem that does not arise with elephants. Hence the greater rationality of herding over wild capture, despite the camel's long maturation period.

The absolute economic superiority of desert-bred, and hence nomad-herded, camels is confirmed by an article published in 1985 by scholars from the University of Pennsylvania and the Pakistan Agricultural Research Council (Heston et al. 1985). It provides a rare example of the monetary costs involved in using camel labor. The following chart lists the typical expenses and income in rupees of a person renting a pack camel:

Feeding costs:	
200 working days	0
165 non-working days	0
Medicines	200
Cost of harness	50
Amortization of camel cost	1350
<u>Revenues</u>	<u>12,000</u>
Return to labor/owner	10,400

Source: Heston et al. 1985:132

These findings, combined with the observation that Pakistan's camel population rose from 719,000 in 1955 to a million by 2006, and quintupled in the desert province of Baluchistan, led the authors to the following:

One conclusion is that the camel can compete successfully against other work animals and/or machinery in several ecological situations. Wherever there are no direct feeding costs for camels, their num-

ber is likely to dominate that of all other work animals, except perhaps that of donkeys. . . . It is our conjecture that if it is necessary to incur feed costs for camels, they cannot compete in traditional tasks like sugarcane crushing and drawing a Persian wheel for irrigation. In these areas the machine is likely to be more cost effective in view of the pricing of machinery and fuels (Heston et al. 1985:130–131).

The camel will continue to find several ecological niches for itself in Pakistan, including head-to-bumper confrontations with the Suzuki in the crowded streets of cities like Karachi (ibid.:123).

Extrapolating from a single case is always hazardous, but the economic logic seems irrefutable. The outstanding strength, tractability and stamina of the camel understandably recommended it to experiments in relocation. But the costs of raising such slow-maturing animals in non-desert habitats would inevitably be greater than the costs of breeding horses, mules, oxen or donkeys. And raising camels in desert environments without having pastoral nomads to keep track of them and channel them to camel markets was always difficult.

Australia, which today has zero nomads but tens of thousands of camels, might seem to provide an exception to this. But most of their ancestral stock was imported to Australia from India, an estimated ten to twenty thousand animals between the 1880s and 1907 (McNight 1969:56–61). A few local experiments with selective breeding did take place, largely employing the know-how of immigrant camel men called “Afghans.” But given that the somewhat sketchy Australian livestock censuses rarely counted more than 10,000 camels, it seems apparent that most of the animals used by explorers, surveyors, gold prospectors, railroad builders, haulers and farmers came from imported stock (ibid.:72–76). Thus the feral camels that now roam the Australian outback are mostly the descendants of imported animals that were freed into the wild after mechanization made their labor obsolete. In other words, a Baluchistan-bred camel might still compete with a Suzuki mini truck in Karachi, but not in Perth, where the cost of importation would have to be added.

In sum, it makes economic sense that camels have continued to be associated with deserts and nomads even though their natural capabilities as laboring animals exceed those of any other domesticates. Given its slow rate of maturation, the camel is competitive as a source of labor only if it can be raised in the zero-cost environment of desert grazing or if it is put to work under climatic conditions that other domestic animals cannot endure. Despite innumerable experiments in transplantation, this limitation has prevented it from following in the hoof-prints of cattle, horses and donkeys and becoming a ubiquitous element in the world’s pre-industrial energy picture. The result, for better or worse, has been an irreducible association with deserts, nomads and exotic locations.

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PART V

PICTURES



Picture 1 (Eva-Maria Knoll): Camel-riding supporter of the embattled Egyptian president Hosni Mubarak in the midst of Arab Spring turmoil during a clash between pro-Mubarak and anti-government protesters in February 2011 on Cairo's Tahrir Square (picture by Chris Hondros, Getty Images).



Picture 2 (Pamela Burger): Wild camels are easily differentiated from domestic camels by their smaller and pointed humps, flatter skull and the development of fewer callosities. Mongolian herdsman have continuously utilized the domestic Bactrian camel as a source of nourishment and transportation (picture by P. Burger, 2006).



Picture 3 (Bernard Faye, Gaukhar Konuspayeva): The Oralbokeilik type of Kazakh Bactrian is mainly concentrated in the steppe zone in western Kazakhstan and in sandy regions in Atyrau oblys (administrative region). This type is the tallest of the Kazakh breeds (200 cm height, up to 900 kg) with a yellow-brown, long-haired coat and a characteristic mane, beard and a “hairy short trousers” (picture by G. Konuspayeva).



Picture 4 (Bernard Faye, Gaukhar Konuspayeva): The Kyzylorda type of Kazakh Bactrian camel occurs in Kyzylorda oblys and around Aqtobé city. They are compact animals (190 cm height, 750 kg) with darker hair and are mainly selected for meat production (picture by G. Konuspayeva).



Picture 5 (Bernard Faye, Gaukhar Konuspayeva): The Ongtüstik-Kazakhstan type of Bactrian camel type is well-distributed in Almaty, Jambyl and southern Kazakhstan. The main purpose of these more stocky animals (170–184 cm, up to 700 kg) with a yellowish/ light brown coat is wool and milk production (picture by G. Konuspayeva).



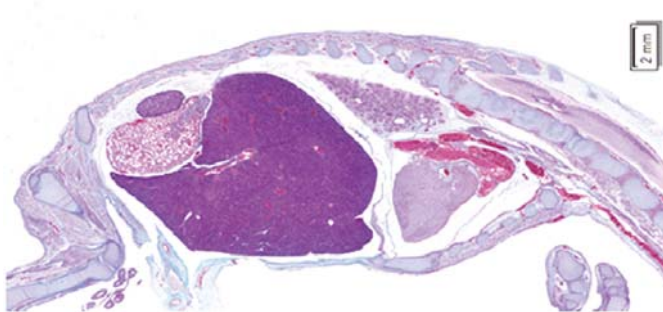
Picture 6 (Bernard Faye, Gaukhar Konuspayeva): The Arvana type of dromedary camel is the only dromedary breed in Kazakhstan and originates from Turkmenistan. They have high milk productivity and are used for hybridizing in order to improve milk production of Bactrian breed (picture by B. Faye).



Picture 7 (Bernard Faye, Gaukhar Konuspayeva): Arvana dromedary and Oralbokeilik Bactrian camel on a farm in the Oral region (picture by G. Konuspayeva).



Picture 8 (Bernard Faye, Gaukhar Konuspayeva): Hybrid F1 between Bactrian and dromedary camel. These hybridizations allow a high heterosis effect for milk, meat and wool production (picture by G. Konuspayeva).



Picture 9 and 10 (Knospe et al.): Despite previous assumptions that dromedary fetuses undergo a two-humped embryonic stage, no hump-like structure was detected in any of the dromedary fetuses with a crown-rump length below 22 cm (pictures by Knospe et al.)



Picture 10 (Knospe et al.)



Picture 11 (Knospe et al.): In older fetuses the hump extends at its base from the 10th thoracic to the 5th lumbar vertebra, approximating the position of its homologue in the adult dromedary (picture by Knospe et al.).



Picture 12 (Knospe et al.): The hump in the embryonic development of dromedaries consists of white fatty tissue, directly connected to the subcutaneous adipose tissue, but clearly separated from the trunk muscles (picture by Knospe et al.).



Picture 13 (Knospe et al.): Bactrian camel fetus showing a cranial and a caudal hump (picture by Knospe et al.).



Picture 14 (Knospe et al.): Tulu (hybrid) fetus showing an elongated hump with a slight indentation in the frontal part (picture by Knospe et al.).



Picture 15 (Walzer et al.): A wild Bactrian camel (*Camelus ferus*) near a water point in the Great Gobi Strictly Protected Area “A” (GGSPAA). This wildlife refuge, located in the south-western part of Mongolia, is one of the last four locations of this critically endangered animal. The animal is unaware of the scientists and was feeding on the tamarisks (picture by P. Kaczensky).



Picture16 (Walzer et al.): Wild Bactrian camels are not fast runners, reaching only a maximum speed of 35 to 40 km per hour (picture by P. Kaczensky).



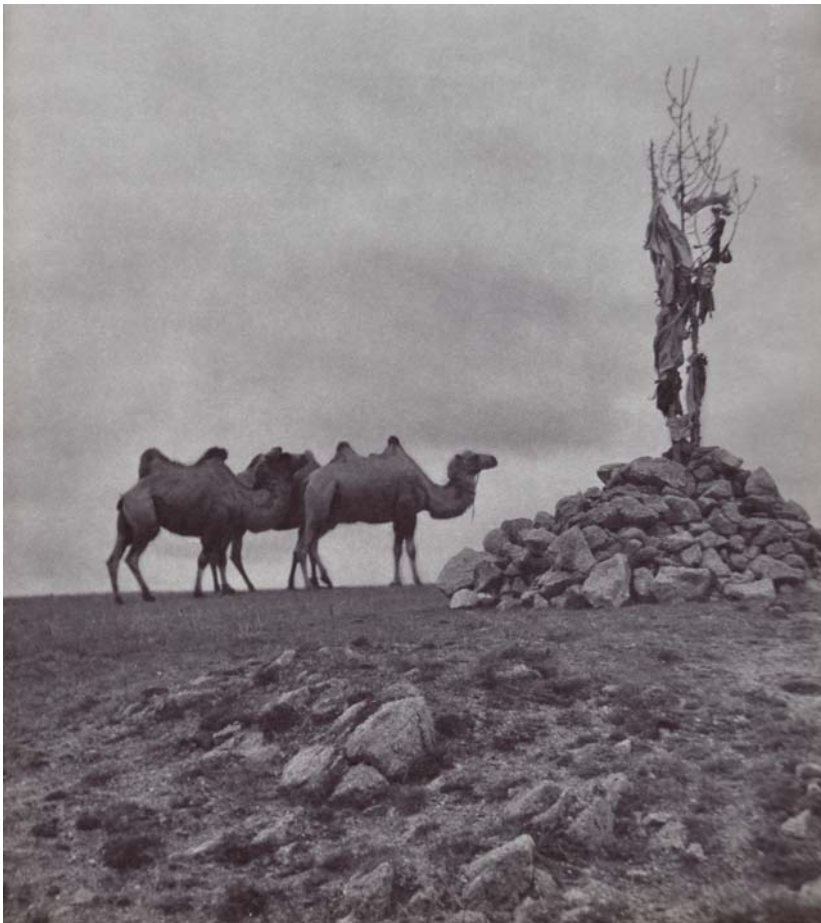
Picture 17 (Walzer et al.): Approaching a wild camel. We try to drive in a jeep on a parallel track at some 10 to 15 meters distance to place an injection dart from a CO₂-powered rifle (picture by P. Kaczensky).



Picture 18 (Walzer et al.): A wild camel fitted with a GPS Argos satellite collar after reversal of the anesthesia components. The camel was recumbent for about 30 minutes in order to fit the collar, which will transmit locational data six times every 24 hours for an 18-month period. After the functional lifespan the collar will be released from the animal by the use of a drop-off device containing a small pre-timed black-powder charge, which unlocks the collar on detonation (picture by P. Kaczensky).



Picture 19 (Walzer et al.): The extreme working conditions for a veterinarian in the Gobi are, in fact, the conditions of a freezer: taking a blood sample is challenging at close to minus 40o C since the blood instantly freezes in the needle and the risk of hypothermia in the camel has to be considered (picture by P. Kaczensky).



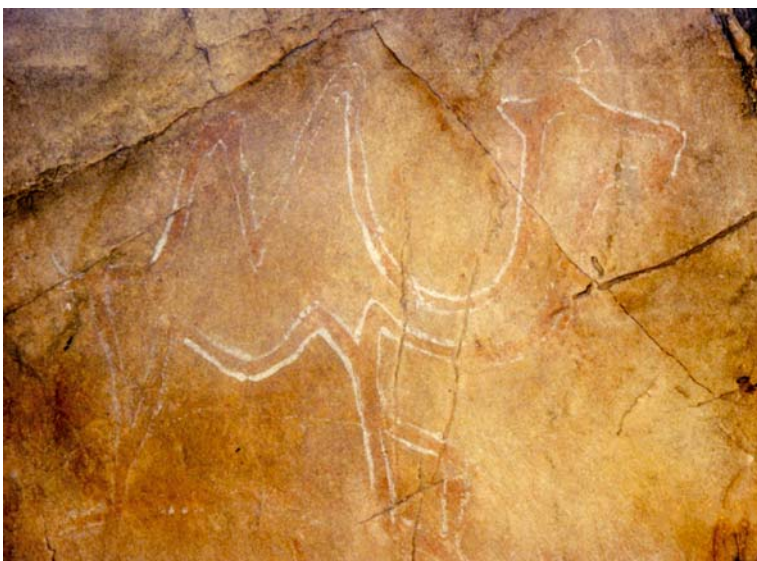
Picture 20 (Maria-Katharina Lang): Camels at an *owoo*, a sacred stone cairn (picture by Jisl, Lumir 1960).



Picture 21 (Maria-Katharina Lang): White camel in Bulgan Aimag, a province in northern Mongolia (picture by M.-K. Lang 2011).



Picture 22 (Maria-Katharina Lang): Thangka depicting the Winter Goddess riding on a camel. Mongolia, 19th century (Museum of Ethnology Vienna, Collection Hans Leder, inventory number 74.984, picture by M.-K. Lang).



Picture 23
(Otgonbayar Chuluunbaatar): Cave paintings, *Xoit cenxeriin agui*, *Manxan* district, western Mongolia, 1999 (picture by O. Chuluunbaatar).



Picture 24 (Otgonbayar Chuluunbaatar): Camel with a *tamga* (brand) of the Oirat-Mongolian *Zaxč'in* tribe (picture by O. Chuluunbaatar).



Picture 25 (Otgonbayar Chuluunbaatar): Camel with nose-peg (*buil*) and its shape as *buil tamga* (picture by O. Chuluunbaatar).



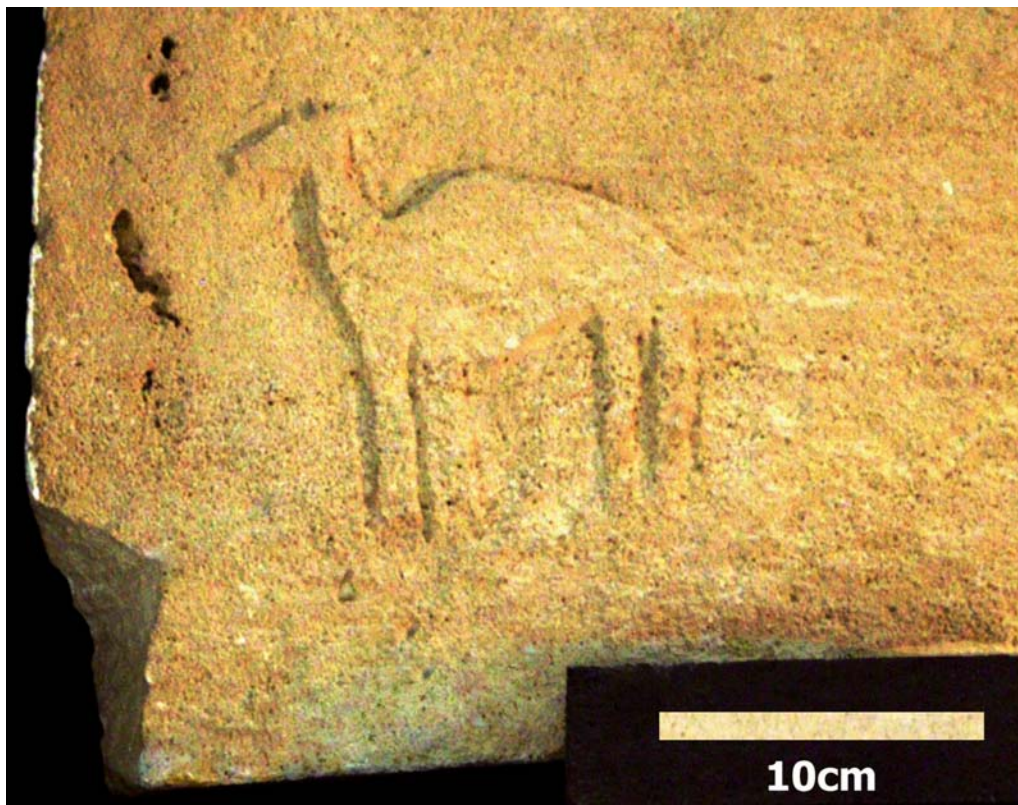
Picture 26 (Otgonbayar Chuluunbaatar): The camel is also used to transport a satellite dish in the high Altai Mountains (western Mongolia), 2005 (picture by O. Chuluunbaatar).



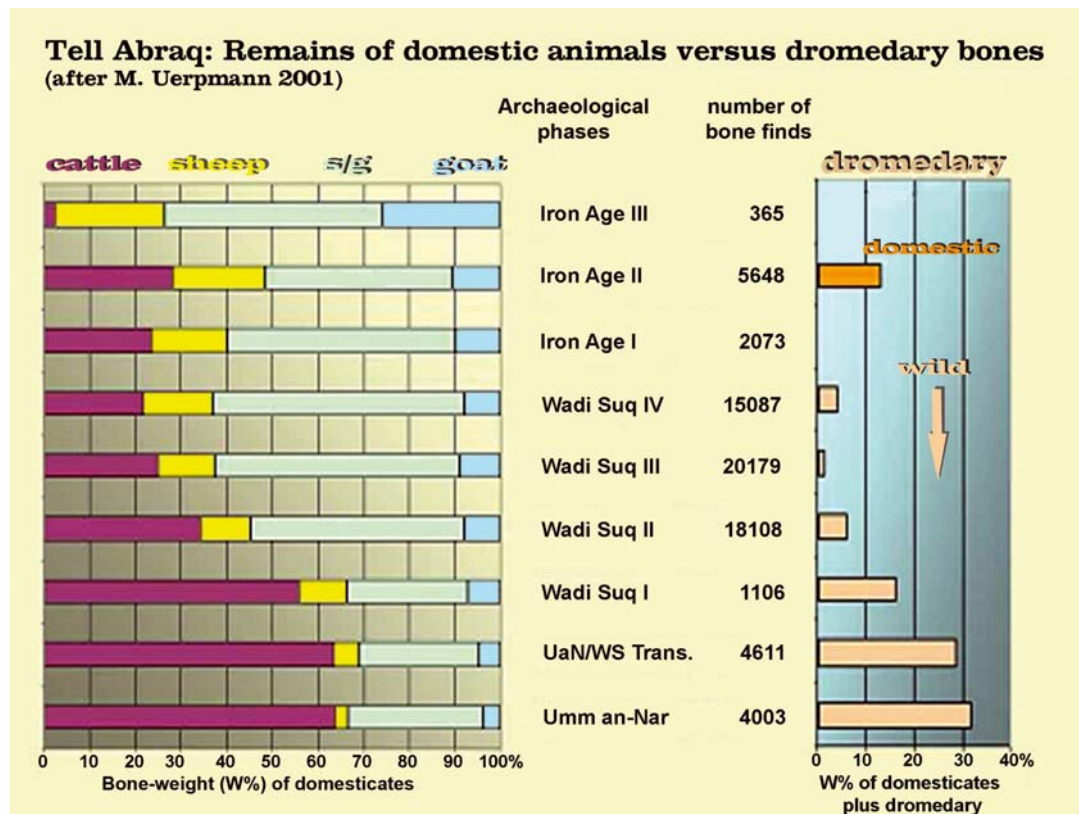
Picture 27 (Otgonbayar Chuluunbaatar): An orphan baby camel that later died lies next to a yurt (*ger*), the traditional dwelling of Mongolian herders: bottle-feeding cannot replace the mother's care. Non-breastfed babies are also vulnerable to disease and death (picture by O. Chuluunbaatar).



Picture 28 (Otgonbayar Chuluunbaatar): The fiddler Colmon of the Oirat-Mongolian Xoton tribe plays the *morin xūr*, the horsehead fiddle (picture by O. Chuluunbaatar).



Picture 29 (Uerpmann, Uerpmann): Facing stone with dromedary relief from one the tombs on Umm an-Nar Island (picture by Aissa Abbas).



Picture 30 (Uerpmann, Uerpmann): Percentages of bone weights of domestic ruminants versus dromedary bone weight throughout the stratigraphic sequence of Tell Abraq (excavator D. Potts).



Picture 31 (Walter Dostal): The *shadād* saddle for riding the dromedary's hump is constructed by the principle of the saddle bow. This is one of the two different saddle constructions used for riding dromedaries in the Arab Peninsula. The space for the rider between this male saddle's two knobs amounts to 48 to 50 cm; the whole saddle is about 60 cm high and 52 cm wide (Museum of Ethnology, Vienna, collection W. Dostal, inventory number 135.918, picture by Museum for Art History Vienna).



Pictures 32 and 33 (Walter Dostal): Details of the *shadād* saddle. (Museum of Ethnology, Vienna, collection W. Dostal, inventory number 135.918, picture by Museum for Art History Vienna).



Picture 34 (Walter Dostal): Female saddle (*ghabiye*) of the *shadād* construction principle. Awazim Bedouins of northern Arabia: Arches are connected by leather straps on the saddle's quadrangular base; there are balancing bars on both sides (Museum of Ethnology, Vienna, collection W. Dostal, inventory number 135.919, pictures by Museum for Art History Vienna).



Picture 35 (Walter Dostal): A particularly impressive example of a female saddle (*ghabiye*) of the *shadād* construction principle. The wing-shaped balancing bars of such a women's saddle – here covered with gazelle leather – can span up to 3.8 meters. The balancing bars at the rear are decorated with turned knobs. Rashidi Bedouins northeastern Arabia. (Museum of Ethnology, Vienna, collection W. Dostal, inventory number 135.920, pictures by Museum for Art History Vienna).



Picture 36 (Walter Dostal): Detail of the female saddle (*ghabiye*) of the *shadād* construction principle. Rashidi Bedouins northeastern Arabia. (Museum of Ethnology, Vienna, collection W. Dostal, inventory number 135.920, pictures by Museum for Art History Vienna).



Picture 37 (Walter Dostal): The second saddle construction of the Arab Peninsula, the *hawlāni* type, was used for riding on the rearmost of the three possible riding positions, on the crupper behind the dromedary's hump. A cushion or pad (*hawiya*) is put behind the hump and the saddle is fastened by a rope to two saddle arches, which are kept in place by a girth around the dromedary's withers. The picture shows a *tōma*, a woman's saddle from the al-Say'ar region (a border area between southern Saudi Arabia and southern Yemen). It is an adaption to the *hawlāni* principle, the *tōma* is simply put on the cushion on the camel's crupper without any fixing device and fixed to the belly with girths (picture by W. Dostal, 1960; image editing by M. Knoll).



Picture 38 (Walter Dostal): Women's saddle among the Karab, a Bedouin group herding their camels west of the valley entrance to the Wadi Hadramawt. The saddle construction is based on a cross of bars fixed with leather straps (Museum of Ethnology, Vienna, collection W. Dostal, inventory number 140.679, picture by Museum for Art History Vienna).



Picture 39 (Walter Dostal): Karab woman spinning wool. Camel wool is highly valued and often the woman's private property among the Bedouin of the Arabian peninsula (picture by W. Dostal, 1960).



Picture 40 (Andre Gingrich): A caravan of young camels being led to the main weekly market town al-Bahr in the northern *'Asir Tihāma* (winter 1981/82). The tribal families selling these camels will thereby achieve their main cash income during the season. Most of these animals will be traded northward to serve as beasts for slaughter in Mecca, but a few will remain in the region to be trained as draught animals (picture by A. Gingrich).



Picture 41, 42 and 43 (Andre Gingrich): Sesame Mill: A camel working a sesame mill in Al-Grahi-Hodeidah, Yemen. The camel is wearing blinkers over its eyes as protection against the circular redundancy of the operation. Until recently the camel was essential to Yemen's *Tihāma* lowland residents, not only for transportation and commerce but also for providing access to two main ingredients of their life – water and oil. Sesame is a crop specific to the *Tihāma* lowlands, but through regional trade sesame and sesame oil also play an important role in the daily lives of the highlands (pictures by Mohammed Al-Athori, 2009).



Picture 42 (Andre Gingrich)



Picture 43 (Andre Gingrich)



Picture 44 (Darem Tabbaa):
Artist's impression of the Giant
Camel found in Syria.
www.nowpublic.com/Syria_giant_camel_update_scientists_find_more_100_000_year_old_bones.



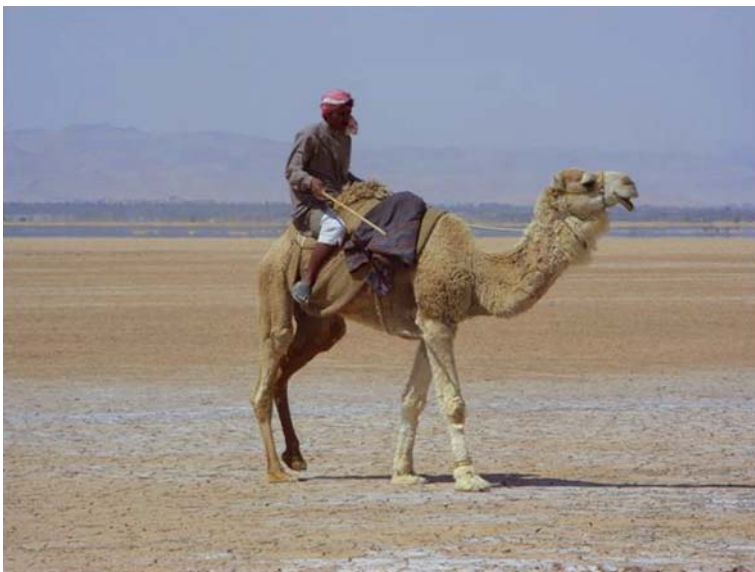
Picture 45 (Darem Tabbaa):
Limestone tablet with a camel
carrying many items on its back,
dating back to the second century
CE. Discovered in the center of
the ancient city of Palmyra, on
one of the famous trading routes
in the Middle East, it can now be
seen in Palmyra Museum (picture
by D. Tabbaa).



Picture 46 (Darem Tabbaa): The north Arabian saddle consists of two large arches or saddle bows shaped like inverted Vs, which are connected by sticks that rest on pads set in front of and behind the hump (Al Badia Festival in Hama – Ibn Wardan Palace; picture by D. Tabbaa).



Picture 47 (Darem Tabbaa): Loading of Syrian Camels for the US Navy in 1856. The Army camel herd in the United States comprised about 100 animals and was imported to supply new US garrisons (picture provided by D. Tabbaa).



Picture 48 (Darem Tabbaa): Camel rider near Palmyra, Syria (picture by D. Tabbaa).



Picture 49 (Darem Tabbaa): In Syria dromedaries are given special names by their breeders according to their use, color and growing stage. This camel herd near Palmyra comprises individuals of different colors and ages (picture by D. Tabbaa).



Picture 50 (Arshad Iqbal): *Marecha/Mehra* and *Barella* are the two main camel breeds kept for milk and as work animals in various provinces of Pakistan. The *Marecha* breed is light brown with a small pointed muzzle, a long neck, small head, tight lips, alert pointed ears, a slim body and long legs. This breed is mainly found in central and southern parts of the country (picture by A. Iqbal).



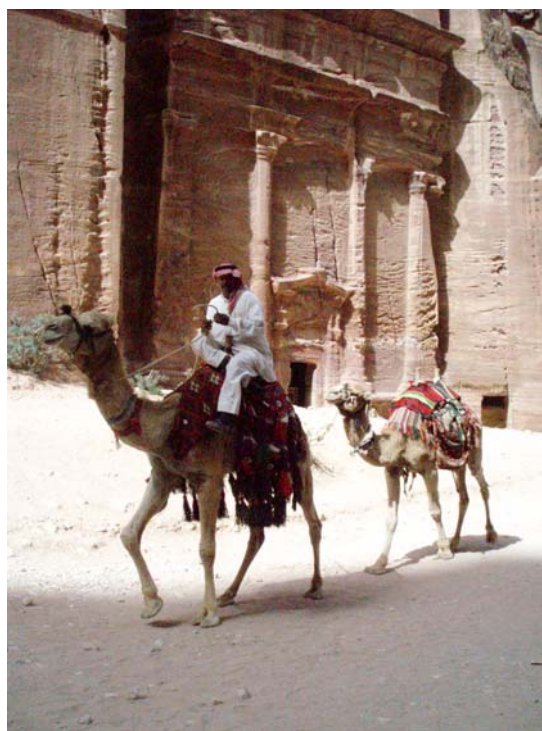
Picture 51 (Arshad Iqbal): The *Brella* is dark brown to light black with thick pendulous lips, a Roman nose, round ears, a long slim neck and a muscular body with stout legs. They are very much liked for milking and as beasts of burden and can be found in all irrigated areas of the Punjab (picture by A. Iqbal).



Picture 52 (Mohammed Shunnaq, Susanne Ramadan Shunnaq): Wadi Rum in Jordan, also known as Moon Valley. James Irwin, one of the Apollo 15 astronauts of the fourth American lunar landing 1971 was quoted as having told the late King Hussein during a trip to Wadi Rum that this is the closest to what he saw on the moon. The vast emptiness of Wadi Rum provides a perfect scenery for camel tours and tourist images about authentic desert life (picture by M. Shunnaq and S. Shunnaq).



Picture 53 (Mohammed Shunnaq, Ssanne Ramadan Shunnaq): Tourists usually encounter the desert guards in their attractive, colorful uniform, which consists of a long khaki dress held by a red bandolier with a holster for a dagger and a pistol. On their heads they wear the traditional red and white kouffieh, held in place with the black 'igaaal (picture by M. Shunnaq and S. Shunnaq).



Picture 54 (Mohammed Shunnaq, Susanne Ramadan Shunnaq): Apart from jeeps, a more luxurious form of vehicle used by some to explore the Badia, camels are preferred by those who would like to spend more time exploring the desert. Locals humorously call this means of transportation "desert limousines." Here two camels with the traditional gear woven by Bedouin women (picture by M. Shunnaq and S. Shunnaq).



Picture 55 (Mohammed Shunnaq, Susanne Ramadan Shunnaq): Qusair (“small palace” in Arabic) Amrah lies 50 km east of Amman on an ancient route between Damascus and Mecca. It has a hammam (bath) and is known for its beautiful frescoes and elaborate mosaics. Even though it is not the best-known of the desert castles, it is on Unesco’s list of World Heritage sites (picture courtesy of Yousuf Al-Zoubi, Faculty of Archaeology and Anthropology, Yarmouk University, Jordan).



Picture 56 (Anja Fischer): Imuhar nomad sitting on a dromedary with three bumps and a hanging fold of skin on its head / Algerian desert (picture by A. Fischer).



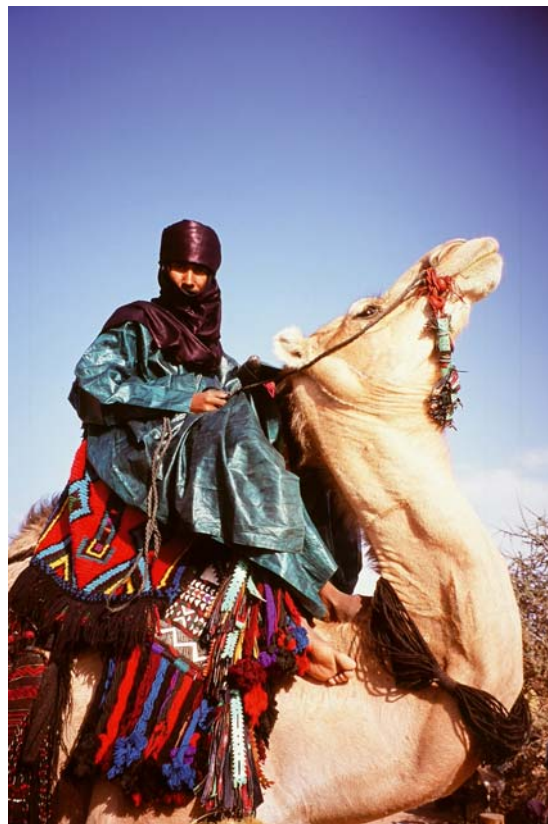
Picture 57 (Anja Fischer): Imuhar nomad and his dromedary with male-specific tackle / Algerian desert (picture by A. Fischer).



Picture 58 (Anja Fischer): Imuhar women and their dromedaries / Algerian desert (picture by A. Fischer).



Picture 59 (Anja Fischer): Imuhar boy with his toy dromedaries / Algerian desert (picture by A. Fischer).



Picture 60 (Anja Fischer): Imuhar nomad riding a dromedary, head drawn back / Algerian desert (picture by A. Fischer).



Picture 61 (Anja Fischer):
Imuhar men with dromedaries
and a four-wheel-drive vehicle
/ Algerian desert (picture by
A. Fischer).



Picture 62 (Maurizio Dioli):
Two people milking a camel
in Kenya: unlike the cow, the
milk release reflex in camels
is very short, so milk flow is
available only for one to two
minutes and milking is thus
often done by two people
simultaneously (picture by
M. Dioli).



Picture 63 (Maurizio Dioli):
Somalia: The udder of a lac-
tating camel with all teats tied
with acacia bark to prevent
her calf suckling. All the milk
produced by the camel is for
human consumption and the
calf will be allowed only a
little milk at the beginning
and end of the milking session
(picture by Schwartz and Dioli,
1992).



Picture 64 (Maurizio Dioli): United Arab Emirates: A lactating camel with an “udder net” to prevent her calf suckling. This is a common device used to prevent the calf from suckling its mother at will (picture by M. Dioli).



Picture 65 (Maurizio Dioli): United Arab Emirates: A camel feeding her twins? No, a camel feeding her own calf and an orphan (picture by M. Dioli).



Picture 66 (Maurizio Dioli): Kingdom of Saudi Arabia: A lactating camel with a fostered calf. Note that while the foster calf is free, the range of movements of the foster mother is restricted: the rear legs are closely hobbled together and tethered to a fence post and a rope halter is tied to her front leg. This is done to restrain or minimize aggressive rejection movements of the lactating camel towards the calf when it tries to suckle (picture by M. Dioli, 2007).



Picture 67 (Maurizio Dioli): Kenya: An orphan calf (red coat) with the skin of a dead calf (white coat) draped over it to fool the mother of the dead calf to accept it. This technique is seldom used in camels (picture by M. Dioli, 2007).



Picture 68 (Maurizio Dioli): Algeria (Western Sahara): A technique used to force a delivering camel, whose unborn calf is known to be dead, to foster another calf. The mother of the dead calf is kept blindfolded with a blanket while the herdsman brings another calf. Note the carcass of the dead calf being carried away on the extreme right (picture by M. Dioli, 2007).



Picture 69 (Maurizio Dioli): Kenya: A technique used to force a mother camel to accept her rejected calf. The technique is used in extreme cases when the mother rejects her calf in a determined and vicious manner. The nasal septum is perforated to allow the passage of a rope, the septum will be tied with the rope the other end of which is tied to a tall branch of a tree to keep the head of camel in an unnaturally high position. This is done to cause severe and increasing discomfort to weaken the will of the lactating camel on the issue of rejecting the calf. The camel will be left in this uncomfortable position for several hours until it allows her calf to suckle without rejection attempts (picture by Schwartz and Dioli, 1992).



Picture 70 (Maurizio Dioli):
Kenya: The first step of *qalla'h*, a technique used to force a mother camel to accept her rejected/foster calf. The skin of the anus is stretched to allow the placing of two flat pieces of wood that are then tied together, trapping the skin between them, closing the anus and stopping defecation. The device will cause increasing discomfort and trigger the Ferguson Reflex; milk release reflex (picture by M. Dioli).



Picture 71 (Maurizio Dioli):
Kenya: The second step of *qalla'h*: the nostrils are wrapped with a wide strip of bark. Camels are preferred nose breathers and the device causes severe discomfort and weakens the will of the lactating camel to reject the calf (picture by M. Dioli).



Picture 72 (Maurizio Dioli):
United Arab Emirates: The first step of *diar*, a technique used to force a mother camel to accept her rejected/foster calf: a cloth "cork" is inserted into the rectum to stop defecation (picture by M. Dioli).



Picture 73 (Maurizio Dioli): United Arab Emirates: The *diar* procedure: to prevent the cloth “cork” being expelled, the skin surrounding the anus is stretched and tied tightly with a rope attached fixed to a transverse wooden stick (picture by M. Dioli).



Picture 74 (Maurizio Dioli): United Arab Emirates: The second step of the *diar* procedure: cloths are inserted in the nasal passages to prevent nasal breathing (picture by M. Dioli).



Picture 75 (Maurizio Dioli): United Arab Emirates: The second step of the *diar* procedure: to completely prevent breathing through the nose, several sock-like cloths are tied around the nostrils (picture by M. Dioli).



Picture 76 (Maurizio Dioli): Ethiopia: A technique (*qalla'h*) used to stimulate the milk release reflex of a lactating camel that has lost her calf. The device stimulates the Ferguson Reflex: milk release. The device is applied just before milking and is removed a few minutes after the camel has been milked (picture by M. Dioli).



Picture 77 (Maurizio Dioli): Somalia: Weaning calf with a device that will cause pain to its mother when the calf tries to suckle. The sharp points of the wood sting the udder of the calf mother every time the calf tries to suckle, forcing her to move or/and to chase her calf away without allowing it to suckle (picture by M. Dioli, 2007).



Picture 78 (Maurizio Dioli): Sudan: Weaning calf with two sharpened pieces of wood inserted through its upper lips. The sharp points of the wood sting the udder of the mother whenever the calf tries to suckle, forcing her to move or/and to chase her calf away without allowing it to suckle (picture by M. Dioli).



Picture 79 (Maurizio Dioli): Sudan: Weaning calf with a piece of wood across the mouth over its tongue. The wood is fixed in place by tying his sides with a rope passing under the lower jaw. The device interferes with the suction movements of the tongue, making the calf unable to suckle. Note the multiple crusted lesions on the lips and labial commissure and the enlarged mandibular lymph node indicating that the animal is affected by contagious ecthyma (picture by M. Dioli).



Picture 80 (Maurizio Dioli): Somalia: The traditional method of weaning a calf: a longitudinal cut is made on the upper middle part of the tongue, just a few mm under the tongue mucosa, to create a wound that will cause pain when the tongue is contracted to produce suction for suckling. The calf will stop suckling immediately because of the pain, however, since its tongue is not much involved in grasping fodder, it will still be able to graze normally (picture by M. Dioli, 2007).



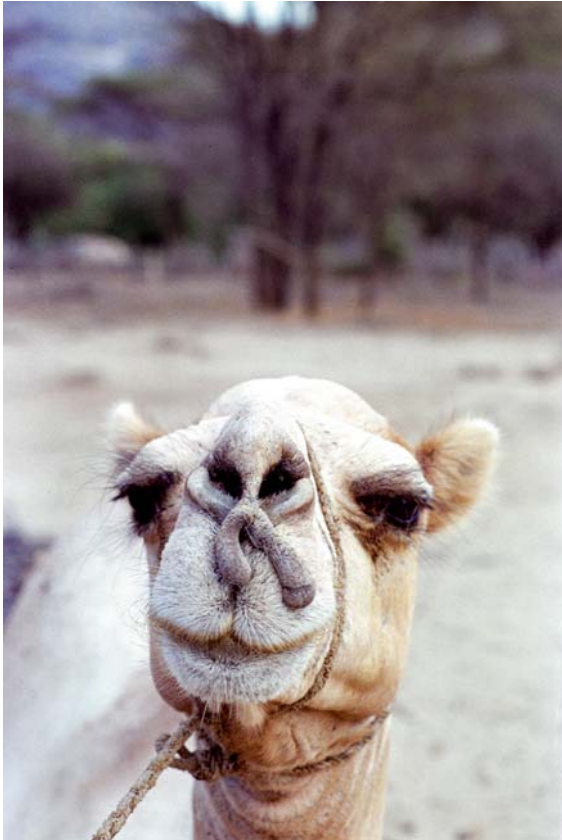
Picture 81 (Maurizio Dioli): Kenya: Weaning calf with two thin ropes tied very tightly to the right and left upper lips. The compression and lack of blood supply make the lips insensitive and unable to move in a coordinated way, making it impossible for the calf to grasp the teat to suckle (picture by Schwartz and Dioli, 1992).



Picture 82 (Maurizio Dioli): Sudan: Weaning calf with a rope tying the right and left upper lips. This obviously limits the mobility of the lips, making it impossible for the calf to grasp the teat to suckle (picture by M. Dioli).



Picture 83 (Maurizio Dioli): Kenya: The traditional method of weaning a calf: a thin strip of skin is cut from an area close behind the nostrils. The raw wound will be painful to the touch, forcing the calf to avoid any form of physical contact or action with the wound area such as nuzzling its mother's udder to stimulate milk release. Note the bark tied around the skin flap to make the wound extremely sensitive to touch (picture by Schwartz and Dioli, 1992).



Picture 84 (Maurizio Dioli): Kenya: An adult camel showing a healed wound from a traditional weaning method: two thin strips of skin on both the upper sides of the nostrils have been cut out and left hanging. The raw wound that resulted is obviously painful to the touch, forcing the calf to avoid any form of physical contact or action with the wound area such as nuzzling the udder of its mother to stimulate milk release (picture by Schwartz and Dioli, 1992).



Picture 85 (Mario Younan, David M. Mwangi): Camel milk represents an important staple food and is a major source of animal protein and vitamins for more than 6.2 million pastoralists in Kenya and in Somalia (picture by M. Younan).



Picture 86 (Mario Younan, David M. Mwangi): Primary milk-collection site typical of Kenya and Somalia. Milk is transferred from a traditional milking bucket into a metal can. The hygienically contentious plastic containers are in the foreground (picture by M. Younan).



Picture 87 (Mario Younan, David M. Mwangi): Women selling camel milk in informal camel-milk markets of larger towns (picture by M. Younan).



Picture 88 (Mario Younan, David M. Mwangi): Variants of traditional milk containers as used in Kenya and Somalia (picture by M. Younan).



Picture 89 (Mario Younan, David M. Mwangi): Traditional milking buckets and milk storage containers are sanitized by heat. This picture shows this systematic treatment of the inner surface with a glowing wooden stick followed by “smoking” over the embers in inverted position (picture by M. Younan).



Picture 90 (Mario Younan, David M. Mwangi): The inside of a plastic jerrycan used for camel-milk transport. These plastic containers are hygienically problematic since they cannot be cleaned effectively, because the opening is too narrow for a hand or brush and the handle is hollow (picture by M. Younan).



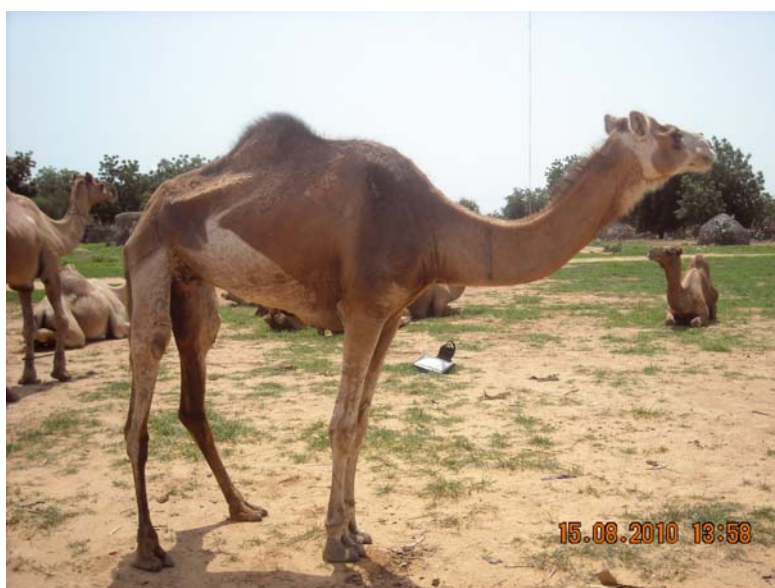
Picture 91 (Abdussamad M. Abdussamad et al.): Sand-brown phenotype (southeastern Niger; picture by A.M. Abdussamad).



Picture 92 (Abdussamad M. Abdussamad et al.): Grey-white phenotype (northeastern Nigeria; picture by A.M. Abdussamad).



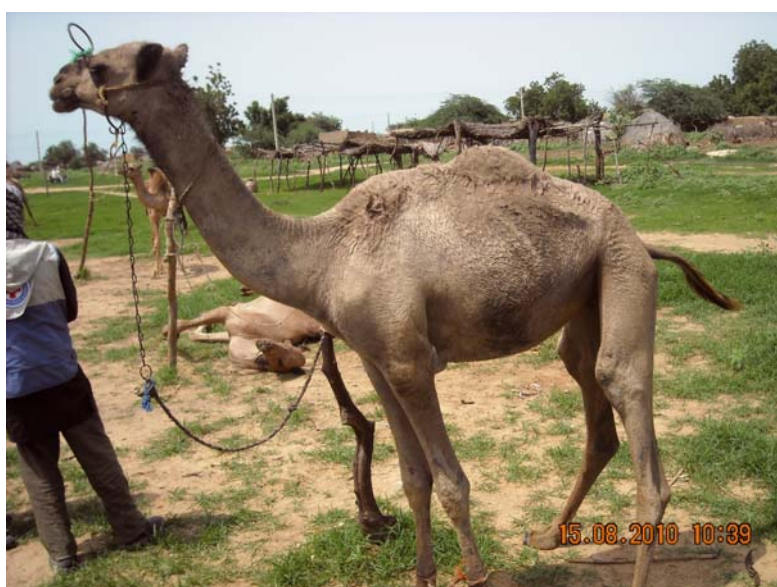
Picture 93 (Abdussamad M. Abdussamad et al.): Dark-brown phenotype (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 94 (Abdussamad M. Abdussamad et al.): Pied phenotype (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 95 (Abdussamad M. Abdussamad et al.): White phenotype (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 96 (Abdussamad M. Abdussamad et al.): Brown-black phenotype (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 97 (Abdussamad M. Abdussamad et al.): Black phenotype (southeastern Niger; see pointer; picture by A.M. Abdussamad).



Picture 98 (Abdussamad M. Abdussamad et al.): Extrusion of soft palate and frothing of the mouth in dromedary bulls during rut (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 99 (Abdussamad M. Abdussamad et al.): Location of the poll gland (see pointer) in the camel bull (northwestern Nigeria; picture by A.M. Abdussamad).



Picture 100 (Abdussamad M. Abdussamad et al.): A pregnant dromedary camel showing the characteristic tail "cocking" (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 101 (Abdussamad M. Abdussamad et al.): Wasted fetus from slaughtered pregnant camel (Kano, northwestern Nigeria; picture by A.M. Abdussamad).



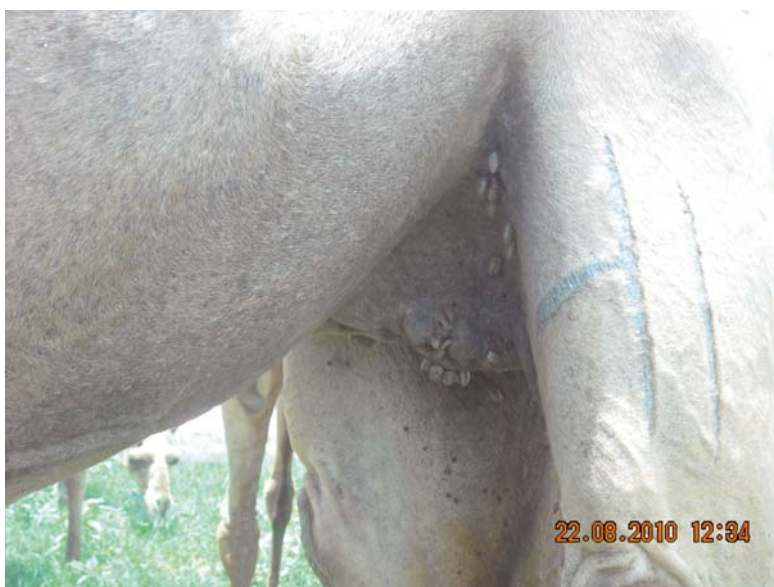
Picture 102 (Abdussamad M. Abdussamad et al.): Hard tick infestation on the axillary region (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 103 (Abdussamad M. Abdussamad et al.): Hard ticks on the eye region and nostrils (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 104 (Abdussamad M. Abdussamad et al.): Hard ticks on the udder and inguinal region (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 105 (Abdussamad M. Abdussamad et al.): Hard ticks on the udder and inguinal region in a close-up view (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 106 (Abdussamad M. Abdussamad et al.): Camel lymphadenitis of the cervical region (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 107 (Abdussamad M. Abdussamad et al.): Camel lymphadenitis of the cervical region in a close-up view (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 108 (Abdussamad M. Abdussamad et al.): *Leptadenia pyrotechnica* (southeastern Niger; picture by A.M. Abdussamad).



Picture 109 (Abdussamad M. Abdussamad et al.): *Leptadenia lancifolia* (northeastern Nigeria; picture by A.M. Abdussamad).



Picture 110 (Abdussamad M. Abdussamad et al.): The frenulum of the camel's tongue (southeastern Niger; picture by A.M. Abdussamad).



Picture 111 (Abdussamad M. Abdussamad et al.): Opening the vulval lips to get access to the vagina of the camel (southeastern Niger; picture by A.M. Abdussamad).

