Review of Mongol camel studies

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Dalanzadgad, 2009
Canberra, 2013

Content

CHAPTER 1

Bactarian camel domestication, distribution and habitat

1.1 Domestication of bactarian camels

To date no detailed studies of the origin of camels in Mongolia have been conducted. Scientists emphasize that in order to identify the time and the countries in which camels were first domesticated, it is vital to base the analysis on zoological and paleontological studies, as well as the study of ancient cultures and even findings of linguistic studies of the time (Tumurjav, 1989). Tumurjav further notes that domestication of bactarian camels is closely linked with Turkish-Mongolian culture.

The Hunnu people who lived in the territory of Mongolia are recorded as having feasts associated with camel racing (Perenlei, 1959). Historic manuscripts reveal that camel caravans traded between China and the Hunnu Empire, and that 700 carriages and 1000 camels were captured (Jamsran, Sukhbaatar, 1992).

Ancient historical findings and remains also document that as early as 1000 BC bactarian camels were reared in western China and around 840 BC bactarians were used by people in Turkmenistan (Luvsan, 1975). Ancient Romans called two humped camels as bacterian camels after Bacteri, a middle Asian country within the Macedonian Empire around the 4th century BC.

Petroglyphs of camels from 2-3 thousand years BC are found in many places in Mongolia. These include various drawings of camels grazing, people riding and leading camels in Mankhan soum, Khovd province, Ingen Tolgoi along Dund Tsenkher river; ochre cave paintings in Dund Tsenkher cave, Shar Unch in Ulgii soum, Uvs province; Ikh Inder in Bayangovi soum, and Tevsh mountain in Bogd soum, Bayankhongor province; Khuruugiin Uzuur in Battsengel soum, Arkhangai province; Yamaan Us and Khatanbaatar hill in Uench soum, Khovd province; Otson Maanit in Bayanovoo soum, Ikher Gashuun, Arvijakh, Zasvar mountain in Noyon soum, Sevrei soum area, Umnugovi province; Ikh Bulag and Durvuljin caves, Tuv province (Dorj, Novogorodova, 1975; Luvsan, 1975; Sanjmyatav, 1995; Jambaldorj, 1997).

In petroglyphs at Undur Tolgoi in Sevrei soum, in the Umnugovi province, illustrates a horse rider shooting a camel with an arrow. From this drawing it can be assumed that camels were domesticated after horses.

The majority of Mongol livestock has its origins in the Mongolian motherland. This can be seen from red ochre paintings of camels, horses and cattle in North Tsenkher cave, Khovd province, which date back to the Paleolithic era (Sanjmyatav, 1995). The age of rock paintings in Deliin Zuun Bel in Ulziit soum, Dundgovi province was studied by Dorj and Novogorodova (date) and was identified as belonging to the Neolithic era. These rock paintings illustrate a man riding a camel, which helps to document the period of time when camels were first domesticated.

Camel figures shown in Mongolian petroglyphs can be divided into three categories. In the first category camels are depicted with small heads and humps, heavy and crude bodies and short legs. Such drawings may have been done in the Neolithic era.

In the second category camels are depicted mainly with their body, back and stomach as straight, thin lines, the front legs placed in parallel and male genital organs clearly noticeable. These pictures often depict a female camel leading her calves, or camel bulls competing with each other. In the third type camels illustrated in petroglyphs have well proportioned body parts and are depicted in different positions such as standing, walking, trotting and extended trotting. Moreover, there are noticeable differences in the way in which camels are depicted in Khangai and Gobi drawings. Petroglyphs in the Gobi region show camels with big body parts, occasionally magnifying or minimizing the size of some parts whereas in the Khangai region, camels are illustrated with small humps, well proportioned body parts and the paintings are more deeply carved into the stone.

Petroglyphs are more prevalent in the Gobi region than other areas. This is consistent with the proposition that camels were domesticated in the Gobi area and that their natural habitat is the Gobi. Petroglyphs may have included wild camels but the fact that some camels were domesticated can be also ascertained from images of people leading, riding or herding camels.

Images of camels drawn earlier than the Bronze Age appear similar to wild camels (*Camelus bacterianus fetus*) and even the types of images are similar to the cave drawings from the Paleolithic era. Petroglyphs depicting separate images of people drifting camel herds, leading or riding camels, as well as camels with luggage loaded on their backs, might have been drawn during the Bronze Age or the early Iron Age. In some places, petroglyphs depict camel legs in a stylish way by adding wavy patterns to them, which are similar to the styles used in bronze items for women's headcraft exhibited in Dundgobi province central museum. In general, Bronze Age craftsmen tended to carve camel shapes on rocks and make jewelry by molding camel shapes. Moreover, the traditions of leaving bronze camel shapes or camel skull bone with dead people as part of funeral rites go back to ancient times. Evidence of such rituals can be seen from the camel skulls found in square slab tombs in the Khanui river and North Tamir river areas, in the Arkhangai province, and a bronze ornament with the shape of a camel head found from an early Iron Age tomb in Chandmani mountain. But camels were not considered as livestock as a source of grave goods in ancient Mongolia suggesting that the camel is considered to be an 'animal with a cold muzzle'.[1] However, the above-mentioned findings and documentation reveal that camels were treated with as much respect as other types of livestock, and nomads have benefited from camel products from ancient times (Sanjmyatav, 1995).

Based on the above-mentioned findings and documentation, it was concluded that bactarian camels were domesticated and reared in Mongolia from around 3000 years ago (Luvsan, 1975).

The use of camels for human and freight transportation, and military purposes as well as the use of camel milk and meat for food was documented in the 'Secret History of the Mongols', a Mongolian ancient historic literary work, which combines a sutra series by Rashid-Ad-Din and a travel diary written by Marco Polo, Plano Carpini and Gilliom de Rubric during their travels in Mongolia in the 12th and 13th century.

[1] Editors' note: Mongolian nomads divided domestic livestock into two categories; those designated as having a 'hot muzzle' (horses and sheep) and those designated as having a 'cold muzzle' (cattle, camels and goats). Hair and bone from livestock designated as having a hot muzzle were used for grave goods.

The wild camel (*Camelus bacterianus fetus*)

The wild bactarian camel is a very rare and distinct representative of fauna, and therefore, was included in the Mongolian Red Book.[2] In 1985 it was estimated that there were around 500-800 head of wild camels inhabiting an area of 5.3 million hectares located in Trans Altai Gobi Desert, Aj Bogd, Bayantooroi and along the Idren mountain range (Jarnov, Ilyinskii, 1985; Badamkhand, 1985). However, during the past few years, the number of wild camels has decreased to a maximum of 400. Internet sources report that there are currently about 350 head of wild camels living in the Bayantooroi area in Trans Altai Gobi Desert.

It has been noted that although wild camels and domesticated Mongol camels have lived together in similar ecological conditions for centuries, mainly in the Gobi desert area, and were deliberately cross bred, their body shape, skull structure and other features vary from one another (Polyakov, Prejevalskii, 1878).

Well-grounded studies have been conducted on wild camel skull bones in comparison with those of domestic camels (Andrei, Bat-Erdene, 1998). Compared to the domestic camel, the occipital bone of the wild camel is considerably bigger, the occipital crista and processus are strongly developed demonstrating that the neck muscles and function are also more developed. The temporal squama and temporal fossa are also more developed. The semi-ossified suture is located between the parietal and the temporal bones. The wild camel's skull, nasal and maxillary bones become wider to the front more than in the domestic camel, thus making the nasal cavity bigger. Wild camels have a longer muzzle than the domestic one, which can be seen by comparing the total length of the head bone. In the wild camel the length of this bone ranges from 46-52 cm, which is comprised of the facial section (60.4 per cent) and the skull section (39.6 per cent). The full length of the head bone in the domestic Mongol camel is 45.5-51 cm, comprised of the facial section (58.1 per cent) and the skull part (41.9 per cent).

The wild camel's frontal and maxillary cavities as well as the parietal and occipital bones of skull are more developed than in the domestic camel. The wild camel has an additional incisor cavity that does not occur in the domestic camel. Its head bone has many tunnels and cavities with gas, which lightens the bones and also serves as an oxygen reserve to influence gas exchange.

The wild camel's dental formula is defined as follows:

(J1/3 C1/1*Pm 3/3* M 3/3)*2=36

The above formula shows that the upper jaw has transformed premolar teeth. Therefore, wild camels have three pairs of canine teeth in the upper jaw.

The main body sizes of wild camels were studied by Andrei and Bat-Erdene (1998, Table 1).

[2] Editors'note: The Mongolian Red Book is a compilation of conservation action plans for endangered species in Mongolia, see Clark, E. L., Munkhbat, J., Dulamtseren, S., Baillie, J. E. M., Batsaikhan, N., King, S. R. B., Samiya, R. and Stubbe, M. (compilers and editors) (2006). *Summary Conservation Action Plans for Mongolian Mammals*. Regional Red List Series Vol. 2. Zoological Society of London, London. (In English and Mongolian).

Table 1: Comparative body measure indices of wild and domestic camels (by percentage)

Indices	Wild camel		Mongol camel	
	Male camel-1	Female camel-4	Male camel-15	Female camel-15
1.2 Height	55.3	56.4	52.2	51.3
1.3 Bony	12.1	9.8	13.4	11.5
1.4 Length	79.2	79.0	86.8	86.7
1.5 Pectoral	54.1	55.7	56.6	53.3
1.6 Compact	152.2	154.4	158.6	156.3
1.7 Body	120.3	122.0	137.6	135.5
1.8 Balance	95.4	97.4	93.9	-

Source: Andrei and Bat-Erdene, 1998.

The figures in the above table show that the wild camel is taller and slimmer than a domestic camel, with a shorter body, smaller costal arch, smaller abdomen and longer legs.

The origin of the Mongol camel is also validated by results of chromosome studies. Chromosome studies were done on wild camels, Mongol camels and cross breds between wild and Mongol camels (Baldan, 2000). Polymerase chain reaction results show that DNA chains of nucleotides are the same for the wild camel, Mongol camel and cross breds (1320 bp/1 bp is equal to 100 pair nucleotides). When their DNA was digested with Hae III enzyme, Mongol camel results gave 3 cuts and the wild camel and crossbreed results gave 2 cuts. For Mongol camels, DNA nucleotide was 649 bp in the first cut, 500 bp in the second and 180 bp in the third cut, while for the wild camel and crossbreed, DNA nucleotide was 1140 bp in the first cut and 180 bp in the second cut, which is the same as the third cut for the Mongol camel. This proves that the wild and the Mongol camel have the same origins from ancient times. According to John Hare (2001), chromosome DNA analysis of the bactarian camel and the wild camel show only 3 per cent difference.

The Mongol camel cell has 74 chromosomes (2n). Out of these, four pairs are metacentric chromosomes, 32 pairs are acrocentric chromosomes and the remaining one pair is the sex chromosome. The 9th, 12th and 13th chromosomes are submetacentric and the 27th is metacentric.

The Mongol camel's chromosome length gradually descends from 9.54 to 0.64 MkM. The X chromosome has a length of 7.93 MkM, which composes 5.31 per cent of the female camel's total genome length. This chromosome amount is also similar to other mammals. The Mongol camel's chromosome chariotype, as studied by Baldan (2000), can be found in Table 2.

Table 2: Absolute length of Mongol camel chromosome (MkM)

Chromosome number	Absolute length (MkM)	Chromosome number	Absolute length (MkM)
1	9.54±0.61	19	3.45±0.23
2	8.88±0.57	20	3.03±0.23
3	8.26±0.68	21	2.8±0.21
4	7.61±0.44	22	2.54±0.11
5	7.31±0.14	23	2.34±0.16
6	6.96±0.4	24	2.13±0.14
7	6.72±0.39	25	1.99±0.13
8	6.38±0.44	26	1.87±0.12
9	6.03±0.29	27	1.69±0.12
10	5.52±0.34	28	1.58±0.13
11	5.24±0.35	29	1.44±0.11
12	5.05±0.29	30	1.33±0.11
13	4.81±0.28	31	1.24±0.11
14	4.61±0.23	32	1.13±0.09
15	4.37±0.11	33	1.03±0.09
16	4.16±0.27	34	0.91±0.07
17	3.92±0.26	35	0.8±0.09
18	3.87±0.36	36	0.64±0.07
X	7.93±0.58	У	1.77±0,27

Source: Baldan, 2000.

1.9 Mongol camel distribution

According to Shuljenko (1954), Mongol camels were distributed in the following way: 10.7 per cent in the Dornod steppe, 11.7 per cent in the forest steppe zone, 62.6 per cent in the Gobi desert and steppe area, and 15 per cent in the Altai mountain range and Great Lakes Depression area. The Mongol camel distribution was later studied by Moyombuu (1969) and the results showed that 67.6 per cent of the total camel population lived in the Gobi and desert region, which comprises 41.7 per cent of Mongolian territory. At that time 19.5 per cent of the camel population were found in the Great Lakes Depression area, 7.7 per cent on the Dornod steppe and 5.2 per cent in the forest steppe zone. Within the provinces, camels tend to be located more in soums with desert or semi desert steppe. Although camel distribution has varied depending on the time of the study, the general distribution has remained similar over time. In studies conducted in the 1980s by researcher Dargia, 2.3-5.1 per cent of the total camel population in Mongolia lived in the Khangai region, 28.5 per cent in the Altai mountain range and Great Lakes Depression area, 14.8 per cent in the steppe

region and 49.8 per cent in Gobi region. Overall, the study results show that the majority of camels (49-68 per cent) live in desert or semi desert steppe regions.

1.10 Ecological conditions for camel habitat

The desert and semi desert steppe zones, where the majority of Mongol camels are found, are ecologically distinct with low precipitation, scarce vegitation, limited water resources, comparatively high average soil and air temperature during the warm seasons, and high frequency of snow and sand storms during spring time. The Gobi in Mongolia has extreme climatic conditions. Annual precipitation is relatively low, with frequent occurrence of strong winds, storms and cold weather during winter. In the Gobi and desert zones, precipitation is relatively low, ranging from 80-110mm with most of rainfall occurring during June through August. Annual average air temperature is 3.8°C, and soil temperature is 8.3°C. The number of warm days in a year is 140. The number of days with snow cover on the ground ranges from 30-60 per year. Snow and sand storms occur relatively frequently, averaging 35.2 days a year with a maximum of 55 days a year (Jambaajamts, 1986). First warm weather occurs in March, while the first frost occurs in October and during June through August the highest air temperature reaches 38°C. During January and February the lowest air temperature reaches -36° C. Air moisture in general fluctuates between 40-70 per cent, however, during spring it drops to 24 per cent. As a result, Gobi animals live in an environment with scarce water supply.

The Gobi and desert region terrain suitable for the Mongol camel consists of sandy depressions along mountains, the Gobi area with small hills, mountainside valleys, and long valleys with sandy soil. Brown desert soil is the most common type of soil in the desert and semi desert steppe region where Mongol camels are found. This kind of soil is common in areas of hills, flat steppe, terrace, large downland, narrow valleys and mountainsides. Brown soil is mainly present in areas with 800-1800 meters elevation, and supports *Stipa gobica, Allium polyrrhizum, Allium mongolicum, Kalidium, Anabasis brevifolia* and other semi desert steppe plants with 10-25 per cent vegetation cover.

Salsola passerina-Anabasis brevifolia-Stipa; Kalidium-Achnaterum splendens dominated pasture yields have been estimated. The results show that one kilogram of dry plant sample has 0.9-1.04 fodder units and 96.5-136.4 grams of digestable protein during summer; and 0.8-0.83 fodder units and 17-117 grams of digestable protein during autumn. During winter and spring, plant fodder productivity decreases dramatically (Tsetseg-Ulzii, 1980).

The *Allium polyrrhizum-Stipa-Anabasis brevifolia* type of Gobi pasture plants lack phosphorus, cobalt, copper and other macro- and, traceminerals, and during winter and spring its contains falls 2-3 times comparing with autumn. Therefore, mineral enriched supplementary fodder is essential (Namsrai, 1980) in this region.

The sodium, magnesium and boron composition in the soil, plants and water in the Dornogobi semi-desert steppe zone (the main habitat for Mongol camels) is 42.7-124.5 per cent less than in the neighboring Gobi Altai mountain zone (Erdenebileg, 1990). In a good year, Gobi regional pasture yield is 50-200 kilograms per hectare, but in drought years, it is 10-30 kilograms per hectare. In semi-desert and desert regions, 4-7 types of pastures are dominant. In semi-desert and steppe zone, the

Kalidium-Small Stipa type of pasture makes up 8-10 per cent of total area and *Stipa-Cleistogenes sguarrosa-Small Stipa* pasture composes 3-5 per cent. In the desert region *Kalidium-Anabasis brevifolia-Haloxylon ammodendron* pasture composes 3-4 per cent of the total area.

According to Grubov (1963) and Yunatov (1968), out of the 550-600 plant species used for animal fodder in Mongolia, 250-300 species of plants grow in the desert and semi desert steppe regions. Out of all species of fodder plants that grow in the Gobi region, horses consume 28.9 per cent, cattle consume 28.9 per cent, sheep and goats consume 57.3 per cent and camels consume 58.2 per cent.

Lkhagva (1985) studied the climatic impact on Mongol camel grazing behavior. The study showed that during the winter season, when air temperature falls to -29-30°C without wind, camels spend the night resting, are reluctant to go to pasture and tend to prefer sheltered areas. If the camels were forced to go to pasture they would stand and shiver and would stay on the windbreak side while the weak ones would return to their sheds. Moreover, when temperature falls to -33C-34°C, camel grazing becomes very hard, with the camels prefering to stay in warm, sheltered places. Camels that have spent the night resting will mostly stay resting for the remainder of the day.

Wind and storms increase the impact of cold weather and create conditions that are difficult for grazing. For instance, during morning and evenings when the air temperature can reach -25°C-29°C and wind speeds reach 3-5 m/s, camels, especially young, weak camels, get cold, loose their balance and have difficulty grazing. When the wind speed increases to 6-8 m/s, camel grazing becomes very difficult. In the Gobi, where the average winter temperature is -16 -17° C with 8m/sec wind, camel grazing becomes very difficult and once wind speed increases to 11 m/s grazing stops.

During summer, with 0-2m/s wind speed and air temperature of 29-30°C, camel grazing also becomes difficult and flies become a nuisance. In these conditions camels tend to lie in the pasture, female camels cry for their offspring and go back to their summer camps. When air temperature rises to 33-34°C, camel grazing tends to stop. During such times, camels cannot graze properly and will stand in one place repelling flies, sweat, go against the wind, look for water, lie in places with loose soil in groups or stay at closeby watercourses until evening. During winter increased wind speed slows down grazing, while during summer, increased wind speed increases the grazing possibilities for camels. Camel grazing decreases commencing from the second 10 days of June to the second 10 days of August. During this time, camel grazing decreases by 9-30 half days and 2-13 full days (Lkhagva, 1985).

In general, camels graze during daytime in winter, when the temperature is relatively warm and tend to stay in their shelter and warm litter during morning, evenings and nights. Camels spend an average of two minutes drinking water per day (Dargia, 1979).

Surviving winter in good shape or with minimum body mass decrease depends a lot on air and shed litter temperature during cold seasons, terrain composition, material facilities, as well human rearing techniques (Erdenebileg, 1995).

1.11 Camel productivity and labor input

Except for a few camel wool factories, the camel farming business is not well developed in Mongolia. Camel farming outputs can be identified as wool, milk, meat, household transportation and manure.

Currently, Gobi herder families have an average of 12 camels. Assuming that the average camel wool output is 4.5 kg, approximately 6,500-7,000MNT can be gained by marketing wool. It is common that domestic and foreign owned factories collect camel wool. Wool is processed by washing and carding and then exported or used for production of wool products. Camel wool products are valued because they are durable, light and warm.

In the Gobi desert area, female camels are one of the main types of milking livestock. Camel milk has a high nutrition factor and is commonly used for medical treatment purposes. Female camels give on average 80-100 litres of milk for commercial purposes annually. Camel milk is a highly sort after product and the market price for one liter varies from 800-1,500 MNT in Mongolia. Researchers note that camel milk is bacteria resistant with good keeping qualities.

During the past few years, the semi-desert and desert regions of Mongolia (the main habitat for Mongol camels) have undergone severe drought and desertification, which has decreased pasture yields, and thus negatively affected camel health.

As camels are used for meat production, the total camel population is decreasing. Currently, 36,000-42,000 camels are used for meat consumption annually. The average weight of camels in autumn is 402 kilograms, and if carcass weight is assumed to be 48-51 per cent, meat output would be 201 kilograms per camel. The price for one kilogram of camel meat is approximately 800-1,200MNT.

Camels are commonly used by nomad herders for transportation purposes. They are ridden, used for carrying luggage or pulling carts short distances to move to new pastures or for preparing water and timber reserves. Gobi people use camels for transportation around nine months a year, excluding summer.

Besides using camels for transportation over short distances, in recent years, it has become popular to use them for camel tours and racing. Foreign and local tourists are showing increased interest in Gobi adventure tours on camels.

On average, in a household with a camel herd, a man will spend 8.3-9.0 hours and a woman 5.9-6.0 hours a day on camel rearing and other herding duties (Dargia, 1979). According to Nansalmaa (1998), in the Gobi region, the average time spent for livestock production labor is 7 hours per day, which composes 44.6 per cent of the total 15.41 labor hours per day. For men it is 8 hours or 50.9 per cent and for women it is 6.02 hours or 38.5 per cent daily.

The optimal number and compostion of livestock per herder household in the Gobi region was identified using LINDO software. The results show that the optimal number of livestock in a Gobi herder household is at least 320 livestock, comprised of 18.1 per cent camels; 13.8 per cent cattle and horses, 34.4 per cent sheep and 33.7 per cent goats. With this size of herd, the household will break even. Currently, an

average Mongol herder family has 211 head of livestock, of which 0.9 per cent are camels. Herder families with less than 40 head of camels tend to have predominantly goats and sheep and use camels for household purposes such as transportation instead of for farming.

Herder families with 40-60 camels choose pastures suitable for camels and herd camels for household as well as farming purposes. The majority of these households tend to have 5-6 members and are middle-aged experienced herders with more than 200 head of livestock in total. Herd composition is mainly sheep and goats, with no less than 20 per cent camels. For herder families with more than 61 camels, the percentage of camels generally equals about one third of the total herd, and thus camels become the major source of income. Despite the fact that such families have more members, they have more production and sales compared to other herder households, and thus usually have better herding skills and experience. Households with over 50 head of camels, which compose more than 30 per cent of their total herd, make 50.1-69.7 per cent of their total income from livestock from camel production (Nansalmaa, 2002).

Time spent shearing wool of different age camels is 50-90 minutes and milking takes 40-112 seconds. According to Nansalmaa (1989), the average time spent shearing wool of different ages and genders is 107 minutes, which means around 20 minutes are spent shearing one kilogram of wool. Shearing fine wool requires more time than coarse wool (Nansalmaa, 1989).

1.12 Conclusion

Historical and archeological findings, petroglyphs and other resources in Mongolia reveal that Mongol camels were first domesticated around 3000 years ago. The wild predesessor of Mongol camels is the wild camel (Camelus bactrian fetus), still inhabiting Central Asia.

The origin of the Mongol camel is also validated by results of chromosome studies. Polymerase chain reaction results show that DNA chains of nucleotides are the same for the wild camel, Mongol camel and their crossbreed, and when chromosome DNA analysis of the bactarian and wild camel was conducted, the results showed only 3 per cent difference.

Between 49 and 68 per cent of bactarian camels in Mongolia live in desert and semi desert regions. The main habitat for Mongol camels has low precipitation (average 80-110 millilitres), high frequency of strong winds and storms, and relatively warm air and soil temperature. Although pasture yield in drought years varies from 10 to 30 kilograms per hectare and in a good year from 50 to 200 kilograms per hectare, bactarian camels are well adapted to such conditions. Camels can consume and digest almost all types of pasture plants. Pasture vegetation, yield, nutrition and consumption of microminerals deteriorate severely during the winter and spring resulting in considerable weight loss. Lack of protein and mineral supplements for camels leads to increased camel loss.

CHAPTER 2

Distinctions of camel anatomy

2.1 Camel anatomy

Bone structure

Researchers have conducted comprehensive studies of camel bone structure compared to other domesticated animals (Damdin 1958; Sodnomdarjaa 1963: Davaa 1967; Luvsan 1975,1986; Namshir 1982; Andrei, Sanjaatogtokh 1984; Orgil 1999, 2001; Andrei 2000; Batchuluun, Orgil 2001). Among studies on camel bone structure, the most studied part is the head bone.

Head bone

Study of the head bone is vital for describing camel growth and development processes in the peri-, and postnatal life of camels. The Mongol camel head bone size was first studied by Damdin (1958), and the results showed that the female camel head bone length is 46.3cm; zygomatic bone width is 24.4cm; upper jaw length excluding teeth is 14.1cm; occipital crista height is 4.2cm; and width is 13.9cm respectively. According to Luvsan (1975, 1986) who studied the main measurements of the head bone parts of young camels, castrated camels and female camels, the head bone of the Mongol camel grows quickly up to the age of 3, then grows slowly until the age of 7. Head bone part measurements for 3 years old camels equals 83.4-99.1 per cent of those of 5 year old camels. Measurements of 5 years old camels are 86.6-98.5 per cent of those of 7 year olds. Castrated camels' skull bone length is 50.5±0.41cm; width is 23.2±0.16cm; occipital crista height is 11.03±1.94cm; width is 9.5±1.22cm, cranial capacity is 685.0±0.36cm^3, while for female camels, the skull bone length is 48.03± 0.3 cm; width is 23.8±0.24cm; occipital crista height is 6.93±0.2cm; width 10.7±0.17cm, and cranial capacity is 613.0± 0.13 cm^3.

Dr. Davaa, 1967 studied the basic cavity atamomy of Mongol camel head bone sinus anatomy, and its morphological chanes by age. The Mongol bactarian camel has 3 major cavities such as frontal, maxillary and cuneiform bone however it does not have a palatal cavity.

The frontal cavity- is the biggest cavity located in the camel head bone. The frontal cavity is small in a camel calf, however, it gets bigger with age, and reaches buccal, nasal and lacrimal bones to be connected with nasal cavity through the ethmoid bone. In the middle part of the frontal bone, on both sides of the frontal suture there is a pair of holes, and an artery that goes through these holes makes a plexus in the frontal bone.

The maxillary cavity - is absent in a camel calf and two year old camel. It is a small cavity created from the age of two years between the maxillary first and second molars as the maxilla cancellous bones grow apart. This sinus is connected with the nasal cavity through the ethmoid bone. The naso- lacrimal duct runs over the lower concha surface of nose, which reaches 20-22 cm in adult adult camels.

The cuneiform bone cavity-is created relatively late at the age of 1.5-2 years, as a result of the spongy bones growing apart. For young camels this cavity covers half of

the front part of the crus bone, while for adult camels it covers the whole of the front part of the bone. Like others, this cavity is connected with the nasal cavity through the ethmoid bone. These cavities in the camel's head have a number of roles, such as making the head bone stronger and lighter and its connection to the nasal cavity regulates breathing air temperature and filters and humidifies the air.

Researcher Davaa (1967) first revealed that camels of all ages have a triangular shaped, not fully ossified part between the maxillary, frontal and nasal bones. This is called the membrana intercostalis nasomaxillaris. This membrane is located 3-4 cm from the frontal suture, at the front end of the orbita and it is easily seen from the outside.

Camel teeth

The change of camel teeth along with camel age was first studied by Andrei and Sanjaatogtokh (1984). The main indicator for identifying the age of a camel is by the growth of the six lower front teeth, the change of deciduous teeth to permanent teeth, as well as the wearing down process. For most Mongol camels, deciduous front teeth are replaced completely with permanent teeth at the age of eight. As the camel ages, its first teeth start to wear out first, and by the age of 16-17 years, the teeth wear out down to gum level. The Mongol camel dental formula based on deciduous and permanent teeth is as follows:

A/ dental formula for deciduous teeth J0/3*C0/0*P3/3*M0/0*2=18

B/ dental formula for permanent teeth J0/3*C1/1*P3/3*M3/3*2=34

Bones

According to Tserenpuntsag (1975), the number of camel bones is similar to other livestock, namely, they have 47-53 vertebrae including, seven cervical-; twelve thoracic-; seven lumbar-; six sacral-; 16-22 coccygeal- ; and 24 ribs ; consisting offive sternum; 31 head-bones; 42 bones in the front legs and feet; and 44 bones in the hind legs-.

Camel bones are generally large, thick, have a smooth surface, are strong and have a relatively light structure. Camel cervical bones make up one third of the total vertebrae. Neck bone elasticity is due to its distinct composition. Camel neck vertebrae are elastic because of the thick 3-4 cm cartilage between the bones, and the 4-6 cm long ligaments in the joint between the atlas and axis. Moreover, the neck bone processes are well developed and thus adapted to strong muscles (Orgil, 1999).

The front legs of the camel are thicker and longer than the back legs. The scapula has a wide base, the spine of the scapula is long and has a clear acromion. The humerus bone is divided into external, intermediate and internal parts, and is generally large and smooth. The antebrachium consist ofthe ulna and radius, they are merged and ossified to create a hole between the upper and lower bones. The olecranon or large head of the ulna is relatively short, and the carpal bone consists of two rows of seven thick bones. The camel carpal additional bone is short, flat and slightly curved downwards.

The pelvis, a girdle bone of the camel hind legs is ossified strongly on its right and left sides to create a pelvic symphysis. The pelvic cavity is narrow and has a

horizontal baggy shape. The pelvic cavity of camels, especially female camels, is large at the upper part, which is closely linked to the calving process (Batchuluun, Orgil 2001).

The camel iliac crest has a dull round shape and the external lunula of the lower shaft epiphysis is bigger than the internal lunula size. The camel patella is narrow and thick. The tibia has a triangular upper point and the fibula has not developed on its own. The hock joint bones are composed of three rows of seven bones. The hind cannon bone has a cylindrical shape, and it has direct bone separation inside. The lower epiphysis and metacarpus are divided in two parts: front and back plate; the first joint's back section has a pair of bones, which is absent in the third joint.

There are few morphometric studies of Mongol camel bone. Cannon bone measurements, that demonstrate skeleton growth of any animal, were comparatively studied on a healthy camel calf and one that died of emaciation (Erdenebileg, 1995).

Table 3: Morphometric comparative analysis on camel calf cannon bone (cm)

Indicator	Cannon bone length	Cannon bone				
		Width	Girdle	Hole diameter	Wall width	Cannon bone weight, /gram
Normal , n=2	26.55	3.45	10.2	0.37	0.7	414.5
Undersized, n=4	27.7±0.1	2.9±0.08	8.6±0.1	0.24±0.03	0.54±0.01	269.1±2.9

The camel is different from other livestock in that it has a diaphragm bone (Namshir, 1982). The diaphragm bone is located by connecting the main diaphragm muscle with the liver surface. The diaphragm bone is flat on one side and protuberant on the other, similar in shape to a sheep patella. The diaphragm bone is made of chondrocyte and is 0.6-1.4 cm thick; 1.7-2.2 cm wide and 3.3 cm long.

2.2 Distinctions in Mongol camel topographic anatomy

Some studies have been undertaken about Mongol camel regional anatomy (Namsraijav, 1979; Orgil, 1999). Topographictopographic anatomy of the following body parts were studied:

- topography of head muscles, nerves and vessels; points for inducing anesthesia;
- eye topography anatomy;
- occipat and upper part of the neck muscle, nerves and blood vessel topographic anatomy;
- front leg nerves and blood vessel topographic anatomy and their tracks;
- topographic anatomy of chest cavity organs;
- abdominal cavity, intestine topographic anatomy;

- topographic anatomy of pelvis cavity organs ; and
- hind leg muscle and bone topographic anatomy.

The camel head can be divided into facial and occipital parts. Camels do not have intracutaneous muscles in the forehead area. Other muscles are located in the same way as for other livestock.

The neck superficial fascia merges with the deep fascia in many places. The localization of facial nerves in some places, arteries and veins in the chin area as well as vessel tracking is distinct. The camel's whole lower lip, edges of the upper lip, gum, interstice in the front of the molar tooth and the mucous membrane have inborn pigments. Therefore, this should be considered when making clinical checks on camels.

A Camel has relatively thick skin with, bluish pigments. Besides the four feet pads, the camel has horny pads in seven places, including knee pads, elbow pads, stifle pads and a chest pad. This is particular to the camel.

Camels have highly developed intracutaneous fat reserves. Besides humps, camels can reserve fat in the areas from below the humps down to the white line in the abdomen, along the chest and abdominal walls and behind the diaphragm. Other livestock do not have such fat reserves.

Camel eye structure studies were conducted and publicized by Alimaa, Orgil and Bolortuya (2001). The eyeball (bulbus oculi) diameter is 40-45 mm; the height is 38-42 mm; thedepth is 38-44 mm and the total weight is 37.5-39.2 g. The eye is located in the front of the orbit; most of this part is filled with muscle, skin, nerves, blood vessels and fat. The eye lids are large, with good movement, and are extended around the inner canthus. The outer canthus narrows down towards the end and the lacrimal glands are unnoticeable. The third eyelid is located in the inner canthus, located near the edge of the black-pigmented area of the eyelids and looks like a layer of conjunctiva. Different from other livestock, this eyelid has a 1.5-2.5 cm gland at the bottom. The conjunctiva has a shape of a bag and its edges are fastened with the upper and lower eyelids. The inner canthus conjunctiva has a number of hair follicules. This hair is directed forward and outward. The camel lacrimal gland is located on the inner surface of the frontal bone temporal processus, and has a length of 3 cm and width of 1.5 cm; two lobes of the lacrimal gland (2 cm in length and 1.5 cm in width) are located covering the exterior side of the upper part of the eyeball. Tears emerge from conjunctiva, they wash the front surface of the eyeball, flow in an outside to inside direction and accumulate in the lacrimal lake.

The lacrimal lake (Lacus lacrimalis) is the pool of tears in the lower conjunctival end of the bag, which drains into the opening of the tear drainage system. The ductus naso-lacrimalis starts from the bone canal in the fossa glandulae lacrimalis in the inner canthus, slightly curving to make an 'S' shape, goes along the exterior walls of the maxillary sinuses and heads towards the front, following the side walls of the concha. The ductus naso-lacrimalis bone bag has a length of 1 cm, and reaches the inner corner of the naris with a length of 20-22 cm. This canal ends behind the naris curve, 2 cm from the skin and mucosa border.

The camel neck is relatively long and can move flexibly in different directions. This is because the neck muscle fiber is dense, the nuchal ligament, neck superficial and deep

fascia are well developed, especially the deep neck fascia, which in some parts is fastened with nuchal ligament. The neck muscles are connected to nerves through the cervical vertebra nerve canal, and fed with blood through branchs of ascending carotoid arteries and intervertebral arteries. The costal horizontal processes of the 3-6 cervical vertebre are relatively well developed. The neck sulcus, located below the cervical vertebra consumes the nerve group of esophagus, trachea and vessels.

Studies on camels' front leg vessels, nerve systems and its tracks come to the following conclusions (Namsraijav, 1979). A thick nerve-vessel's bundle composed of artery and vein as well as the arm bone nerve system is located at the shoulder joint. The axillary nerve and caudal circumflex humeral artery group goes behind the shoulder joint , and branches out to make the nerve-vessel's zone. The vessel and nerve group is located horizontally around the neck of the scapula and scapula process. A group of radial deep nerves and humeral bone veins and arteries is located in the outside part of the humeral bone lower section. A big bundle of veins, arteries and nerves is located between the radial flexor and digital flexor muscle, and under superficial fascia. The ulnar vein and nerve group is located in between the ulnar flexor and extensor muscles. A group of radial nerves and forearm intracutaneous veins are located along the inner side of the ulnar flexor muscles. In the cannon bone, two main veins are located hidden under sinew. The artery is located together with the main nerve behind sinew. The camel's 3rd and 4th fingers have nerve groups of outside, inside and side vessels; these groups are located parallel to the 2nd joint of the finger, well underneath sinew. Methods for injecting anesthetics and bloodletting were developed for vessels and nerves in the front leg area.

Camel front legs are connected with the plexus brachialis originated subscapular nerve, suprascapular nerve, axillary nerve, musculocutaneous nerve, radial nerve, ulnar nerve and thoracodorsal nerves.

The brachial plexus is composed of the lower ramus of cervical 7th and 8th and spinal 1st nerves. Cervical 7th and 8th nerves knot inside vertebral foramen exchange nerve fibers. The musculocutaneous nerve of the camel is similar to the one in cattle, however, it does not have nerve ramus leading to forearm skin. The forearm nerve surface ramus goes in parallel with intracutaneous veins of the shin until the pastern. The deep ramus of the ulna nerve connects with shin exterior nerves at the upper side of the pastern. The median nerve joins a shallow artery below the shin around the shin area to make a group of nerves, which continues with external and internal nerves to form 4 ramuses at the upper side of the pastern, that go down to the 3rd and 4th fingers.

The camel thoracic cavity has a narrow and sloping shape. The main part of camel internal ograns is located in the thoracic, abdominal and pelvic cavities, and some parts are located in the head and facial area. Lungs, heart, blood vessels, nerves, trachea, chyle vessel and lymphonodus and thymus (in camel calves) are located in the thoracic cavity.

The camel's right lung is considerably bigger than the left one; lobes are separated by notches. The left lung has 3 lobes and the right lung has 4 lobes.

The trachea continues from the larynx and forms right and left branches in the thoracic cavity parallel to the 5th rib. The camel trachea consists of 63-75

semicircular rings according to Sodnomdarjaa (1963), and 70-75 according to Orgil (1999). The edges of one trachea ring overlap with the edges of the next one.

The heart is located between the 3rd and 6th rib. Sixty per cent of the camel heart is located left of the aorta, parallel to the 3rd and 4th rib. The heart end is located at the 4th and 5th joints of the breast bone, 22 cm from the breast bone, 2-5 cm from the diaphragm; the bottom of the heart is located parallel to the thoracic spine 3rd and 4th vertebra, mid of the 1st rib. The heart end faces back towards the abdomin, its left part is located in the same line with the bottom end of the 7th and 8th ribs. Cranial and caudal vena cava join at the heart's right auricle and in the left auricle two or more pulmonary veins join. The left auricle tube is located instead of pulmonary vein fossa. There are three additional sulcus located on the front surface of the camel heart. The left ventricle wall is 2.5-3.0 cm thick and the right ventricle is 0.6-0.8 cm thick (Orgil, 1999).

The pericardium (heart sac) is a bag shaped organ composed of fibril cover from the outside and serum cover from the inside. It is linked with the breast bone and located parallel to the 5th-8th ribs. The pericardium is fed through the trachea, aorta, back and chest interior arteries. The heart and pericardium are connected to the 10th pair of nerves and sympathetic nerve ramuses.

For camels, the esophagus comes from the thoracic cavity to the abdominal cavity through the diaphragm hole parallel to the 6th rib. Inside, the esophagus has mucosa with vertical layers, which is covered by a well-developed muscle layer. It is covered by a serum cover.

The thymus in camels consists of the neck and chest part. It goes along the trachea and almost reaches the larynx. The camel parathyroid is located between the 1st pair of ribs, at the bottom part of the trachea.

An animal's abdominal cavity organs' topographic anatomy is divided into right front, left front, right back and left back.

Abdominal right front part consists of the right kidney, adrenal gland, urethra, liver, caudal vena cava, omasum, stomach, duodenum, rectum loop, the front part of the pancreas and a small part of the rumen.

The right kidney has an oval shape, and is located at the level of the first lumbar vertebrae at the front side and the 4th lumbar vertebrae at the back. One kidney weighs 800-900 g. The upper part of the kidney is located behind the quadratus lumborum muscle, at the right end of the diaphragm and liver fossa and the bottom part of the kidney borders the duodenum and cecum. The urethra relates to the urinary bladder through the right side of caudal vena cava. The kidney artery originates from the abdominal aorta and rises beneath the second lumbar vertebrae. The renal veins open directly into the caudal vena cava, 6-7 cm distance from the kidney. The right kidney adrenal gland is shaped like a kidney and is located in the inner front part. The left kidney of an adult camel is slightly smaller than the right one. Camel kidneys have a smooth, papillae surface. The ratioof the renal cortex and medulla is 1:6.

The liver (*hepar*) is located in the right front part of the abdomin, behind the diaphragm. Liver lobules are easily seen. The front surface of the liver is convex, and the back surface is hollow. The billiary drain is located between the right and middle

lobus, reaching the duodenum; the tube length is 15-20 cm. The liver has an average weight of 10 kg. Camels differ from other livestock in that a gall cyst is absent. The front surface of the liver is connected with parts of the diaphragm at the level of the 6th-7th rib. The liver's right and left corner sinew is connected to the diaphragm.

The stomach (*abomasum*) is located on the right side of the abdomin, along its inner wall. The stomach has a length of 60-70 cm; its mucosa has 13-14 spiral folds. Its shape is narrow and long, with two relatively wider parts. Its pylorus and duodenum are separated by a vertical furrow.

The camel duodenum has a length of 29-30 cm. There are 3 layers created in the front part of the pylorus. The duodenum is 4-6 cm wide, and relates to the liver and pancreas at its upper side.

The glandular sac is located in the bottom of the rumen and consists of a number of pouch-like diverticula, which is distinct from other ruminants. Herders consider it an organ for water reservation. The shape of the Mongol camel glandular sac of the rumen was first mentioned by Luvsan (1975). The mucous membrane of glandular sacs has transverse and longitudidinal folds connected to each other to create semilunar shaped subsacs. There are 10-16 rows of glandular sacs in which one row contains 8.3 semilunar subsacs on average which are 2-4 cm in depth. The glandular sacs of rumen consist of 103.7 semilunar subsacs in total. The glandular sacs of camel rumen are long and narrow shaped, with two hollow areas with 4 rows each and 60-78 compartments on both sides of the rumen. Some compartments have dividers inside (Namshir, 1982, Orgil, 1999).

The pancreas is divided into the head, right and left lobes. For camels, this gland is located at the right of the median, with most of it lying in the right side of the abdomin. The front end of the gland is located at the level of the second lumbar vertebra, with the back end at the level of 3-4th lumbar vertebrae. This gland is connected with the duodenum below the right kidney. The pancreas has 1-2 ducts. The main duct starts from the right lobe and merges with the billiary drain. The length of the pancreas is 16-18 cm and the width is 4-5 cm.

The abdominal front left part contains the aorta, aortic plexus, lien, part of the liver, rumen, and the pancreas.

The lien is located next to the left kidney, with most of it tightly touching the kidney. The front end is connected with the rumen at the level of the 3rd lumbar vertebra, the back end is located at the front end of the ilium bone and the external end is located 2-3 cm below the lumbar bone horizontal acantha.

The abdominal back left part contains the abdominal aorta, left kidney, adrenal gland, urethra, most of the rumen, uterus, and the left oophoron.

The left kidney (ren sinistra) is fastened with a long, thin mesentery and it is movable. It is located at the level of the 4-7th lumbar vertebrae, left of the aorta. When the rumen is overly filled, it shifts to the right side. The left kidney adrenal gland has a similar shape to the kidney and is located close at its front side. The left kidney urethra leaves the kidney heading back to reach the bladder going underneath the abdominal pleura.

Most of the abdominal back left side contains the rumen. The rumen is the biggest organ in the camel's abdominal cavity. It can contain on average 100 liters of liquid, and is different from other ruminants in that its mucosa do not have villi. The left or outer surface closely touches the diaphragm and abdominal wall. Left to this surface is a lien. The camel rumen is covered with thin omentum, which has a few glands. The rumen is connected to the water pocket and psalterium. The psalterium has an approximate capacity of 3 liters. The Mongol camel does not have lobed psalterium (Sodnomdrjaa, 1963; Namshir, 1982; Orgil, 1999).

The Mongol camel's stomach is 1 m long, the duodenum is 28 cm, the ileum is 50 cm, the cecum is 35 cm, and the rectum is 1 m (Namshir, 1982).

The intestinum colon is located in the abdominal back left part, behind the rumen along the abdominal wall. This is particular to camels. The colon intestine is divided into the first curve, helix curve and the end curve.

The abdominal back right part contains the colon intestine, small intestine, ileum, cecum, uterus, horn, ovarium, first part of the rectum and some parts of the rumen.

The camel cecum is 35-40 cm long and is located in the top of the back right part of the abdomin. It starts at the level of the 4th lumbar vertebra; at this part the ileum joins its lower wall. The blind part of the cecum is slightly curved directing towards the pelvis. The cecum is located within 8-10cm of the horizontal line from the ilium head.

The jejunum is located at the level of the thoracic spine 10th vertebrae, close to the liver diaphragm, beginning from the duodenum from the front right part of the abdomin. In this part, the jejunum heads front edge of the colon intestine, and joins the mesenterium. The jejunum creates many loops on the mesenterium that touch the colon intestine's front, bottom and back parts. At the level of the ilium head, the colon intestine's last loop enters the ileum.

A study has been conducted on the lymph glands location, form and size, the results of which are helpful for clinical examination of camels (Sodnomdarjaa, 1963).

The maxillary gland is located in the inner part of the maxillary muscle. It is movable, has a light pink color, an oval shape and has many lobes. The size is similar to a chicken egg (5x3x1.5 cm).

The cervical gland is located on two sides of the episternum, at the level of the 7th lumbar vertebra, inner part of humerus head, between the humerus front muscle and trachea. It has a light color, oval shape, is movable and is 6x5x2 cm in size.

The inguinal gland has a small and a big part and is located at the front of the pelvis. The big part is 9x4x1 cm, light in color, and the small part is 4.5x3x1 cm and brown grey in color.

The thyroid gland is light yellow in color and has many lobes. In general, the camel gland is peculiar in that it consists of many lobes and knots.

Studies have been done on the structure and functions of Mongol camel reproductive organs (Luvsan, 1975, 1986; Sukhbaatar, 1979; Ganbat, 1997).

Female genital organ. For adult female camels, the vagina has a length of 22.5cm and a width of 6.6cm; the uterine cervix length is 4.7cm; the uterus main body length is 10.2cm and the oviduct length is 21.5cm.

Ovarium. In an adult female camel the right ovarium has a length of 2.88±0.2cm; width of 2.23±0.2cm; weight of 4.78±0.1gr; the left ovarium has length of 3.15±0.2cm; width of 2.05±0.2 cm; and weight of 4.41±0.4gr. The size of a female camel's reproductive organs vary depending on age. It reaches its full size at the age of 7.

Male genital organ. For adult male camels the penis' normal length is 40.2cm; extended length is 48cm. The penis has a tentacle for stimulation at the end, which is 1cm long (Sukhbaatar, 1979). The ductus deferens length is 32cm.

Testis. In adult male camels the size and shape of both testis is approximately the same, however, the right testis is generally slightly smaller than the left one. The right testis length is 8.7 cm; girdle is 12.8 cm; width is 4.8 cm; weight is 114.2 gr; the left testis length is 8.9 cm; girdle is 14 cm; width is 4.6 cm and the weight is 123 gr.

Another distinct feature of male camels is the pole glands. These grandula form first as 4 pairs of points in the male camel at 1.5 years of age. At the age of 2-3 years, these pairs of points merge with each other to form a horizontal oval shape. For adult male camels, the gland behind the nape develops into a pair of glands with left and right sections. The total length of the glandula is 15.1cm with a total width of 12.1cm.

2.3 Studies on camel microstructure

Camel body parts and system microstructure have not been extensively studied.

Luvsan (1986) and Baldan (2001) studied skin microstructure, while Ganbat (1997) studied the female camel's ovarium microstructure.

Luvsan (1986) conducted studies on camel calf hide histologic structure, as well as for camels of 3 and 5 years old and older, castrated camels of 5 years or older and female camels by analyzing samples taken from around the neck and kidney. The study results show that camel hide, depending on gender and age, has a thickness of 1367.4-5512.0μm of which occupied 2.1-8.1 per cent of epidermis, 38.3-56.3 per cent of derma and 40.9-55.3 per cent of subcutatuos cellular layers. Its secondary and primary hair follicles width ratio is 1.79-3.66. The primary hair follicle diameter is 44-77.9μm; the secondary follicle hair diameter is 19.3-37.8μm. The primary hair follicle is located 677.8-2915.0μm deep; and the secondary hair follicle is located 428.1-2071.2μm deep. For camel calves and 3 years old camels, there are 16.3-37.1 follicles per $1mm^2$, while for camels of 5 years and older the number of follicles decreases to 16.3-21.3. This leads to a conclusion that during the growth period, new hair follicle are not formed, but the total area of hide increases, and therefore, the number of follicles per unit area of hide decreases. The number of fat and sudoriferous glands per $1mm^2$ of hide for camel calves and three year old camels is 0.88-2.1 and for adult camels it is 0.68-1.48.

According to Baldan (2001) the length of camel fat glands varies widely, however, it does not affect the formation of adipocere. During their evolution camels have

adapted to warm and dry climates and are susceptible to cold and humid conditions. Camel hide sweat glands are well developed and have a long and vertical shape; at the part where hair emerges the grandgland has a funnel like shape. This also proves that camel body structure is well adapted to the environment. For castrated male camels the neck hide sudoriferous gland width is 177.8μm; for female camels it is 152.05 μm; for adult male camels it is 212.2μm. The hide hair group has 1-3 primary follicles, which are divided into lobes. One primary follicle has one sudoriferous glands and one fatgland each. The microstructure of the Mongol camel is fully developed by the age of 4 for males and 3 for females.

Ganbat (1997) conducted studies of the Mongol camel's ovarium microstructure at different ages and camels to the following conclusions. The female camel ovarium has both cortex and medulla layers. The ovarium is covered with a simple surface epithelium, which has a cylindrical shape for camels up to three years old, cubic shape for camels over six years old and a squamous shape for old female camels. Below the epithelium, a protein sheath is located and its thickness increases with age. The ovarium parenchyma is formed from the cortex and medulla layers. The cortex layer consists of spindle shaped cells and its thickness varies depending of the ovarium size. This layer contains the primary, secondary and third ovarian follicles. The primary ovarian follicle is covered with a simple epithelial layer, which has a diameter of 39-41μm from fetus to adult female camels. Eggs inside the follicle have a diameter of 26.8-28.3μm and their corpuscles have a diameter of 8.3-11.0μm. When transforming to the next development stage (secondary follicle), the primary ovarium follicle is covered with two layers of epithelium, while in the center of the follicle, a third ovarium with a diameter of 5mm is formed. The inner walls of the third follicle have eggs surrounded with cells of corona radiata of diameter is 86.0±5.46 μm on average; the corpuscle diameter is 13.8±0.25 μm and the nucleoulus diameter is 8.0±0.21 μm (Burenjargal, Magash, Ganbat, 2001).

2.4 Conclusion

The Mongol camel's head bones are fully developed by the age of five years. Mongol bactarian camels have a sinus frontalis, sinus maxillaries and sinus sphenopalatinus, which develop variously depending on age. Distinct from other livestock the Mongol camel does not have a palatile cavity.

Mongol camels of all ages have a triangular shaped not fully ossified part between the maxilla, frontal bone and the nasal bone. This is called the *membrana intercostalis nasomaxillaris*. The Mongol camel has 34 teeth, and generally at the age of eight years, deciduous teeth are completely replaced by permanent teeth.

Camel bone is large, thick, has a smooth surface, is strong and has a relatively light structure. Neck bone elasticity is due to the thick cartialage between the bones, and the copula joint between the atlas and axis. Moreover, the neck bone acantha is well developed and thus adapted to strong muscles.

Camel anatomy is peculiar due to it possessing glandular sacs of rumen, which consist of 10-16 rows ofglandular sacs, in which one row contains 8.3 semilunar subsacs on average with 2-4 cm in depth and, 103.7 semilunar subsacs on average Moreover, the camel gland is peculiar as it consists of many lobes and knots, and it does not have bile cyst or lobed omasum.

During their growth, camels do not develop new hair follicles and therefore, due to the increase in the total area of the hide as the camel grows, the number of follicles per unit area of hide decreases. The camel ovarium is covered with a simple surface epithelium, which has a cylindrical shape for camels up to three years of age, a cubic shape for camels over 6 years of age and a squamous shape for old female camels.

CHAPTER 3

Mongol camel body conformation and growth

3.1 Biological distinctions of the Mongol camel

Mongol camel color

The colour of Mongol camels has been studied by Shulijenko (1957); Luvsan (1975, 1986) and Baldan (2001).

Shulijenko (1957) classified Mongol camel color into dark (dark brown, red brown) and light yellow. Camel color was studied in seven provinces in the Gobi desert region and it was found that 41.6 per cent of the total number were red brown; 17.7 per cent were dark brown; 6.4 per cent were yellow brown; 36.4 per cent were light yellow; and 1.36 per cent were white. The study showed that dark colors dominate.

According to Luvsan (1975), dark red, brown and red is the main color of the Mongol camel. Out of the total number of camels studied, 76.6 per cent were of a dark color and the remaining camels were light in color. The researcher conducted studies in seven provinces in the Gobi desert region in 1986 and found that 23.5 per cent of the camels studied were dark red; 19.0 per cent were brown; 15.9 per cent were red; 11.4 per cent were black; 15.4 per cent were yellow; 12.4 per cent were grey blue and 4.2 per cent were white. The percentage of white color in the distribution was relatively consistent ranging from 2.6 to 5.1 per cent.

Baldan (2001) conducted studies of Mongol camel color based on the camel strain and line such as Galbyn Gobi red and Khanin Ketsiin red brown. The color of these strains is described in a separate section.

Change in camel color can occur depending on the type of breeding done. During the period 1970-1980, cross breeding was predominantly done to increase wool quality and yield, and as a result, the brown red color became dominant in Mongol camels. When such cross breeding stopped, during past few years, the brown color became more common. However, in general, the dark color is still dominant.

Mongol camel body size and shape

The shape and size of the Mongol camel (body composition) have been much studied by both Mongolian and Russian researchers.

According to Mishariev (1930), the Mongol camel body composition is suitable for transportation of loads. The camel has a light head, wide chest, good leg posture, a long main body and plenty of wool. Dolgushina (1933) studied the body size of adult camels in the western regions of Mongolia. The adult female camel has a height of 159cm between the humps; a body length of 164.7cm; chest width of 74cm; a chest girth of 216.2cm; and a croup height of 155cm. Meleshko (1937) in his camel body composition study mentioned that the Mongol camel body is peculiar in two aspects: flat and heavy. Naurzbaev studied the composition and size of the Mongol camel in two Gobi provinces, Umnugobi and Uvurkhangai resulting in the following findings: female camels have a height of 170.3cm between humps; the body length is 144.1cm; the chest girth is 196.8cm; and the circumference of cannon bone is 18.1cm, while for

adult male camels the sizes are 176,6cm; 151.0cm; 210.3cm; and 20.3cm respectively. The study showed that camels in Umnugobi province are larger in size than those in Uvurkhangai province. Shuljienko (1954) also studied the Mongol camel body composition and size in the Gobi regions. The results were: average height of 164-171cm between humps; body length 143-147cm; chest girth 201-211cm; and circumference of cannon bone 17-21cm. Dash (1958) found that the Mongol camel has a well developed bone structure and has a weight of 590kg.

A comprehensive study of Mongol camel size and body composition was conducted by Luvsan (1975, 1986). Mongol camel body size and mass were studied covering the Gobi region provinces for camel calves, young camels and adult female and male camels. No significant difference was identified in camel size or weight between provinces. However, the Galbyn Gobi red subtype camels are considerably larger in size. The following table shows Mongol camel body size and body mass on average.

Table 4: Mongol camel body average size and body mass

Description	Camel calf		Young camel		Adult female	Adult male
	Male	Female	Male	Female		
Height between humps (cm)	131.0	131.2	158.4	157.2	163.9	167.3
Body length (cm)	96.5	96.6	127.9	127.3	145.1	146.9
Chest girth (cm)	130.7	127.0	203.0	200.7	220.5	233.6
Circumference of cannon bone (cm)	13.6	13.3	17.8	17.8	19.1	22.5
Body mass (kg)	139.9	138.9	437.6	425.9	500.6	592.8

Source: Luvsan (1986).

The Mongol camel has a wide forehead, straight nose, short and light head, straight and short ears, a curvy long thick neck, wide chest, long body, long back, thick, straight and long ribs, well developed croup, developed muscles, short tail, short legs compared with the body, straight and strong legs and erect humps when healthy and fat. The distance between the humps is 20cm, and the hump height is 40-50cm (Shuljienko, 1954 and Luvsan, 1975).

Somewhere between 22.1-55.5 per cent of Mongol camels have been classified as heavy-rough and compact-heavy in build, however, there are also strains that are small, thin and fragile. The build of the camel body determines its working capacity (Luvsan, 1975). There are also camels that have a body builds in between the above-mentioned two types. Moreover, there are camels with such deficiencies as club-feet, grinding hocks, knees grinding hocks etc. The Bactrian camel's body composition is distinct as its croup is located slightly sloping down the back. This cannot be considered as a deficiency (Luvsan, 1975).

Luvsan (1975) recorded the Mongol camel female udder shape, size and lactation capacity. In general, the female camel udder is oval in shape but they may also be oval and flat. The front udder length is 3.01-3.66cm; the back udder length is 3.64-3.86cm, and the udder diameter is 5.1-6.4cm. During summer the lactating female

camel lets down its milk 47.5 seconds after the calf starts sucking. During autumn this period is 64.1 seconds and the milking duration is between 52-55 seconds. During this time, the female camel gives 662ml of milk during summer and 399ml during autumn.

Mongol camel growth and development

No comprehensive studies have been conducted on Mongol camel growth and development except for the work by Luvsan (1975). The camel body mass changes due to its age. The researcher studied camel body mass from birth up to its 7.6 years of age.

Naurzbayev (1945), Ayurzana (1947), Tserenpuntsag (1969), Tseveenjav (1971), Luvsan (1975) and Baldan (2001) suggest that the Mongol adult female camel has a body mass of 450-500kg and the male camel has a body mass of 445-603 kg.

The Mongol camel calf at birth has a body mass of 34.5-35.9kg and until they reach 36.5 months of age, the growth rate of both males and females stays approximately the same. After that age, the male camel's body mass exceeds the female camel's mass. The Mongol camel at 6.5 months of age has a body mass of 129-133.1kg; at 18 months a mass of 247-250.1kg; at 2.6 years a mass of 348.7-357.1kg; at 3.7 years a mass of 420.9-445.2kg; at 4.6 years a mass of 456-481kg; at 5.6 years a mass of 465.1-512.3kg; at 6.7 years a mass of 482.6-553.8 kg; and at 7.6 years a mass of 481.7-611.3kg. If a adult camel's body mass is considered as 100 per cent then a camel at 18.5 months reaches 44.8-48.0 per cent and at 5.6 years reaches 90 per cent of its full body mass.

Because of the harsh climatic conditions in Mongolia, daily body mass increases are greatest during summer and autumn but slow down during winter and spring. One of the distinct features of the Mongol camel is that it can compensate for the amount of body mass lost during winter and spring almost twice during summer and autumn. Based on the above study results, the researcher concluded that generally the growth and development of the Mongol camel can be considered complete within the age range of 5.6-6.7 years.

Besides body mass, Mongol camel growth and development can be defined by its body size changes. Researchers have identified that the adult female camel has a height of 160.3-175cm between the humps; a body length of 143-147cm; a chest girth of 201-220cm; and a circumference of cannon bone of 17-21 cm, while the adult male camel has a height of 174.3±0.73cm between the humps; a body length of 148.2 ±1.5cm; a chest girth of 230.5± 0.69cm; and a circumference of cannon bone of 21.2±0.3cm. Just after birth, a camel calf has a height of 101.5-108.8cm between the humps; a body length of 53.1-54.8cm; a chest girth of 73.0-76.7cm; and a circumference of cannon bone of 8.5-9.95cm. Both male and female growth rates between the ages of 1.5-3.7 years are approximately the same, however starting from the age of sexual maturity, the male growth rate noticeably exceeds that of the female as noted above. Compared to adult camels of seven or more years of age, the camel calf at birth is 58.4 per cent of the height between the humps; 36.6 per cent of the body length; has 33.1 per cent of the chest girth; and 47.1 per cent of the circumference of cannon bone. At the age of 5.5-6.7 years, the aforementioned sizes reach 90-98 per cent of the adult camel size (Luvsan, 1975).

The above mentioned study results show that Mongol camel body mass and size growth continues until the age of 5.5-6.7 years when the camel reaches maturity (Luvsan, 1975).

At birth the Mongol camel calf has long limbs, a short body and neck and a deep but not wide chest. For the new born camel calf the distance between its mouth and the ground is 11.9cm. When the camel calf reaches 40 days old the distance decreases by 5.41cm and at 2-3 months of age the camel calf can easily reach pasture grass.

Mongol camel subtypes

Researchers have identified three main subtypes of Mongol camel that are distinct from others in terms of productivity and body size (Tseveenjav 1971; Luvsan 1986, Purevragchaa 1993, 2003; Baldan 2001).

Galbyn Gobi red camel

The nuclear herd of this camel subtype is located in the Khanbogd soum, Umnugobi province. Of this subtype of camels, 27.8 per cent are red, 20.0 per cent are brown and 18.9 per cent are brown red (Baldan, 2001).

The Galbyn Gobi red female camel has a height between the humps of 167.3-171.9cm; body length of 139.8-146.6cm; chest girth of 213.03-231.2cm; circumference of cannon bone of 18.6-20.8cm and body mass of 523.1-563.0 kg. For a breeding male camel the height between the humps is 171.8-174.6cm; body length is 150.3-151.7cm; chest girth is 233.0-235.7cm; circumference of cannon bone is 21.3-23.0cm and body mass is 622.0-667.5kg.

Wool yield from the Galbyn Gobi red subtype camel, depending on age and gender, varies on average between 2.8-6.0kg (Tseveenjav, 1971); 3.2-6.4kg (Luvsan, 1989); for castrated males the wool yield is on average 5.6kg and for female camels it is 4.9kg (Baldan, 2001). An adult male camel may yield between 10.4-10.8kg. The wool hair type ratio, width, length and other indicators are the same as the Mongol camel.

The Galbyn Gobi red camel milking period lasts for 15-16 months. Camel milk has 5.45 per cent fat (Baldan, 2001) and total milk yield is 301.4-340 liters.

Before slaughter, the body mass of a castrated male camel is around 557.4-661.1kg; the carcass weight is on average 323.7-376.0kg, slaughter yield put is 63.7 per cent, in which meat is 181.9kg and fat tissue is between 55.0-61.0kg.

Compared to the Khanyn Khetsiin brown red subtype camel the Galbyn Gobi red subtype camel is 0.2-0.5cm larger in body size and 36.8-38.4kg bigger in body mass (Baldan, 2001).

Khanyn Khetsiin brown red subtype camel

The nuclear herd of this camel subtype is located in the Mandalovoo soum in Umnugobi province.

The dominant color of the Khanyn Khetsiin brown red camel was identified as brown red and red (Luvsan, 1986); 26.1 per cent brown; 19,7 per cent brown red; 17.6 per cent red and 16.3 per cent yellow (Baldan, 2001).

The Khanyn Khetsiin brown red camel has a height between humps of 150.4-156.5cm; a body length of 138.2-146.2cm; a chest girth of 208.2-224.7; circumference of cannon bone of 18.3-18.6cm and a body mass of 465.4-538.4kg (Luvsan, 1989; Baldan, 2001).

The Khanyn Khetsiin brown red subtype camel gives around 340 liters of milk during the milking period, which is 20 litres more compared to the local camels (Luvsan, 1989).

Depending on age and sex, wool output on average varies between 2.6-8.6kg (Luvsan, 1989); for male camels of 1-20 years of age wool output is 5.9kg, and for female camels 5.4kg (Baldan, 2001). Of total wool, 64.3-75.05 per cent is fine wool while 25-35.7 per cent is coarse wool.

Before slaughter body mass of castrated male camels is around 588.7kg; carcass weight is on average 292.1kg and slaughter output is 56.1 per cent (Luvsan, 1989).

Compared to the Galbyn Gobi red syptype camel, the Khanyn Khetsiin red brown camel produces 304.2-519.2gr more wool and compared to the local camel it produces 346.7-372.7gr more wool. Therefore, this subtype can be used for breeding of wool type camels.

Tukhum Tungalagyn double-mane camel

Researcher Purevragchaa (1993, 2003) studied this camel's body size and wool and milk productivity.

On average, the height of the double-mane female camel between the humps is 167.1cm; the body length is 139.5cm; the chest girth is 226.3cm; and the circumference of cannon bone is 18.9cm. At breeding age the double-mane female's height between the humps is on average 164.8±0.93cm; body length is 146.3±0.51cm; chest girth is 227.9±0.71cm; and circumference of cannon bone is 196±0.21cm; and 20 per cent of all camels have double manes. According to Luvsan (1986), depending on the age and sex of the camel, the pair of manes weight on average 475gr (0.3-1.1kg).

Depending on age and sex, this subtype of camel produces on average 2.74-7.6kg of wool. This camel produces more wool compared to other camel subtypes, except for the Khanyn Khetsiin red brown male camel, which produces 32-800gr and the female red brown camel, which produces 72-671gr more wool. Coarse and fine wool fibers are longer and thicker compared to other camels.

The double mane camel gives 301.1 litres of milk over the duration of the milking period.

3.2 Conclusion

The Mongol camel's main color is dark red, and brown and red, and the body composition is suitable for back luggage transportation. The camel has a light head, wide chest, good leg posture and a long main body.

Adult female camels from the Gobi region have an average height of 164cm between the humps; a body length of 145cm; a chest girth of 220.5cm; and a circumference of cannon bone of 19.1cm with a body mass of 500.6kg. Mongol camels tend to be heavy-rough and compact-heavy in build, however, there are also strains that are small, thin and fragile in composition. The working capacity of the camel is dependent on its body composition. Generally, camels reach their full body size and mass by the time they are 5.5 to 6.7 years old.

Among the main Mongol camel subtypes, the Galbyn Gobi red subtype is bigger in body size; the Khanyn Khetsiin red-brown subtype is known for better wool yield, and the Tukhum Tungalagyn double-mane camel subtype can be used for breeding to improve camel productivity.

CHAPTER 4

Mongol camel productivity

4.1 Wool productivity

Mongol camel wool yield was studied and estimated at 10 pounds (4kg) by Guke, Gabe (1870); 5-7kg by Dolgushina (1933); 3-4kg by Misharyev (1938); 5-7kg by Kudryashev (1945); 4-6kg by Denisov; 3-5kg by Maiskii (1959); 2.8-10.5kg by Tseveenjav (1969). According to Luvsan (1975), Mongol camel wool output on average is 2.6-5.3kg depending on age and gender and for a adult male camel it is 8.13±0.2kg. Luvsan conducted comparative studies on camel wool output in Gobi provinces and came to the conclusion that the output is similar. Luvsan's (1986) estimates of wool yield by camel age are shown in Table 5.

Table 5: Average wool yield of Mongol camel (kg)

Camel breed	Camel age						
	2 years		3 years		5 years		Male
	male	female	male	female	male	female	
Mongol camel	2.71	2.61	4.35	4.18	5.36	5.05	8.2

Source: Luvsan 1986.

One of the indicators of camel wool productivity is the percentage of fine and coarse wool. For camels between one and three years of age, 21.6-25.5 per cent of total wool is coarse. For older camels this percentage increases to 25.9-26.8 per cent.

Total camel wool yield increases with age. However, wool output per unit of body mass decreases with age. For example, a two year old camel produces 1.73-1.86kg of wool for every 50kg of body mass; for three years old camels it is 1.05-1.09kg; for a five year old and older male camel it is 0.84kg; for female camels it is 0.96kg (Luvsan, 1975).

Camels have little or no wool during June and July. For camel calves, fine wool grows on average by 2.12cm a month (during June-December) and 2.04-4.02cm for castrated males and female camels. Coarse wool grows on average by 3.52-5.29/cm per month (Luvsan, 1986). During August, camel calf fine wool grows 3.45cm while coarse wool grows 6.64cm. Female fine and coarse wool grows 4.02 - 4.54cm in August. In October, camel calf wool grows 3.14cm and adult camels grow 4cm of wool.

For castrated male camels and young camels in good condition, wool loosens during March and April and sheds completely by the end of June, and for fat camels, new wool grows underneath the previous year's wool (Luvsan, 1986, 1989). Camel wool growth intensity is generally similar for fine and coarse wool. Fine and coarse wool grows by 21.5-26.4 per cent during June-August; 70.3-77.3 per cent during September-November and 1.1-1.3 per cent in December. Camel wool grows fastest during the period fromAugust to October, and basically stops during December when pasture grass and plants lose their nutritive value.

When camel wool sheds some hair is left (Luvsan, 1989). Seventy to 81 per cent of such hair is guard hair while 18.1-30 per cent is intermediate hair. Camels have almost no cashmere after shedding.

4.2 Camel wool quality

Camel wool is considered as mixed and consists of different types of hair.

When the camel gets older, the amount of cashmere decreases and the percentage of intermediate and guard hair increases, making the total wool more coarse. The percentage of guard hair in 1-3 year old coarse camel wool is 14.6-17.88 per cent; 7.15-14.23 per cent is intermediate hair; and 69.4-75.9 per cent is cashmere. For older camels the percentage in the order aforementioned is 16.12-18.0 per cent; 12.8-14.4 per cent; and 68.5-70.3 per cent (Luvsan, 1975).

Camel coarse and fine wool contains relatively large amounts of cashmere. For instance, coarse wool contains 66.5-84.7 per cent and fine wool contains 86.0-94.4 per cent of cashmere. Adult male camel wool has more guard hair (11.89-47.5 per cent) and less cashmere (37.98-77.11 per cent).

Mongol camel coarse wool guard hair is 55.1-73.7 μm; intermediate hair is 37.95-54.42 μm; and cashmere is 15.87-23.53 μm. For fine wool, guard hairs are 59.1-68.5 μm; intermediate hair is 30.75-44.96 μm; and cashmere is14.34-20.8 μm. The thickness of hair increases with the age of the camel.

Another technical parameter of camel wool is the length of the different types of hair. The length of Mongol camel coarse wool guard hair is 190.1-348.6mm; intermediate hair is 119.7-230.7mm and cashmere is 77.4-140mm. As of fine wool, the length of guard hair is 102.2-142mm; intermediate hair is 119.7-230.7mm and cashmere is 76.4-98.4mm (Luvsan, 1975). The length of the hair in coarse camel wool tends to increase with age while for fine wool, it tends to decrease.

Mongol camel hides were studied by Luvsan (1986). Similar studies on two local subtype camels were also undertaken by Baldan (2001). The average hide thickness for a one month old camel calf around the kidney area is 1367.4-1402.2μm and around the neck area is 2438.0-2488.7μm. These measurements for 3 year old camels were 3497.1-4139.0μm and 3457.0-4250.0μm respectively. For adult castrated male camels the measueremnts are 3497.1-4139.0μm and 3457.0-4250.0μm and for female camels they are 4572.2-4622.7μm and 5003.4-5512.0μm respectively. Hide thickness is relatively similar for males and females. The surface layer percentage in hide total thickness tends to decrease with age and other layers, especially the hairy layer, tends to increase with age. For camels of 0-3 years of age, the surface layer makes up 2.1-8.14 per cent of total hide thickness, while for adult camels it is 2.6-2.8 per cent (Luvsan, 1986)

For young camels, the percentage of the hairy layer of the hide is 38.3-53.5 per cent, which increases up to 52.2-56.3 per cent when adult.

Camel hide primary and secondary bulb width increases with age. The primary hair follicle bulb is wider than the secondary one, and the neck hair bulb is wider and deeper than parts with finer wool.

Guard hair diameter in the hair follicle for camel calves is 44.0-73.9μm and for adult camels is 56.7-77.98μm. For cashmere, the diameter is 19.3-33.4μm for young camel and for adult castrated male and female camels it is 24.8-37.8μm.

The hide primary and secondary follicle diameter increases with camel age. The primary hair follicle is located at a depth of 677.8-954.0μm and the secondary hair follicle is located at a depth of 428.4-1125.7μm for camel calves. For three year old camels the primary hair follicle is located at a depth of 1420.4-2163.8μm and the secondary follicle at a depth of 462.3-1643.0μm. For adult camels the primary hair follicle is located at a depth of 2390.7-2915.0μm and the secondary follicle is located at a depth of 1772.4-2071.2μm (Luvsan, 1986). Primary hair follicle depth increases 3.6 times from birth to the adult age; secondary hair follicle depth increases 3.9 times and during this period; the real length of guard hair increases 2.33 times; and cashmere length increases by 1.83 times. This means that the depth of the hair follicle is directly linked with change in real hair length and with the age of the camel.

4.3 Milk productivity

The total lactation period for the Mongol camel was identified as 12-15 months by Dolgushina (1933); 16-18 months by Meleshko (1937); 14.5-18.5 months by Navaanchimed (1949); 16 months by Dash (1958); 17.6 months by Luvsan (1975); and 17.5 months by Tsetseg-Ulzii et al. (1989). The total milk yield per female camel throughout the lactation period was identified as 600-700 liters by Naurzbayev (1945); 265 liters by Navaanchimed (1949); 500-600 liters by Dash (1958); 150-360 liters by Shulijenko (1954); 319.8-576.3 litres by Luvsan (1975); and 353.7-365 litres by Tsetseg-Ulzii et al. (1989). Fluctuations in camel milk yield were studied by month (see Table 6).

Table 6: Female camel milk yield, by months

Calendar month	Monthly milk yield, by litres	Calendar month	Monthly milk yield, by litres
April	14.42±0.36	January	16.01±0.25
May	21.66±0.31	February	20.6±0.29
June	25.48±0.29	March	16.32±0.33
July	28.2±0.41	April	15.27±0.34
August	39.97±0.29	May	14.63±0.34
September	50.0±0.36	June	19.75±0.38
October	26.54±0.3	July	15.05±0.55
November	15.35±0.3	August	14.2±1.41
December	12.24±0.22	Average	319.8±1.04

Source: Luvsan, 1975.

Female camel milk physical and chemical factors. Composition, physical, chemical and technological factors of camel milk were studied by Dashdendev (1963); Luvsan (1975); Osorkhaan (1979); Indra (1989); Batsukh (1994) and Biichee (1995).

Camel colostrum is comprised of 18.6 per cent dry substance, 2.1 per cent fat, 3.1 per cent sugar, 10.8 per cent total protein (out of which 1.75 per cent is casein) and 1.32 per cent is ash as well as C vitamin (8.6 per cent) and calcium (0.18 per cent) (Dashdendev, 1963). Also camel colostrum contains dry substance is 25,6±0,02% , fat is 6,5±0,11%, total protein is 13,6±0,62%, casein 7,0±0,13%, sugar 4,25±0,16%, and ash 1,5±0,03% (Biichee, 1995). Composition of camel milk includes dry substance 15,5±0,07%, fat 5,65±0,09%, total protein 4,23±0,04%, lactose 4,4±0,03%, ash 0,87±0,01%, in total mineral consist of calcium 129±2,65mg, phosphorus 94±1,2mg, sodium 96±4,0mg%, magnesium 11,5±0,09mg, potassium 144±6,9mgcopper 0,09±0,01mg%, zinc 0,39±0,02mg%, iron 0,6±0,06mg respectively. One kg of camel milk can satisfy the following percentages of the human daily needs of calcium and phosphorus (100 per cent), potassium (57.6 per cent), iron, copper, zinc and magnesium (40 per cent), and sodium (24 per cent) (Batsukh, 1994).

Milk fat content is at minimum during June and July and at a maximum during late autumn and the winter months. The diameter of balls of camel milk fat is 3.7μm, melting temperature is 44.8^0 degrees C and congealing temperature is 25^0 degrees C. Saturated acids comprise about 60.9 per cent of camel milk fatty acid, including palmitic acid is 27.0 per cent; stearic acid is 14.7 per cent, myrystic acid 12.4 per cent. The amount of kapron and capric acid is minor at only 0.8 per cent (Indra, 1989). Camel milk fat is comprised of 39.1 per cent single bond unsaturated acid.

The content of protein in camel milk is highest in November and lowest in July. The main type of protein in camel milk is casein, and the amount of albumin and globulin is 1.5 times more than in cow's milk (Indra, 1989). Camel milk protein has 20-21 types of amino acids (Osorkhaan, 1979). Camel milk has 4.41-5.0 times more leusine+isoleusine, 0.53-1.59 times more aspartic acid, 1.007-2.53 times more leucine+gystidine than sheep and goat milk, thus camel milk has a perfect content of protein (Osorkhaan, 1979). Camel milk has good a bactericide quality, and therefore, it can be stored at 35-37 degrees C for 10 hours, at 18 degrees C for 18 hours and at 3-13 degrees C for 90 hours.

When the impact of camel milk on the treatment of hepatitis was studied, clinical test results showed that it decreases bilirubin amount in the blood, treats poisoning caused by changes in metabolism, lack of vitamins and malnutrition, increases body oxidation-reduction and immunity and improves digestion partially and fully in food processing systems (Jadambaa, Batsukh, Baigalmaa, 2000).

The acidity of fermented camel milk is 90-110 T^0. Fermented camel milk is comprised of spirit (0.3 per cent), dry substance (12.4 per cen)t, fat (4.8 per cent), protein (3.63 per cent), carotene (0.12mg/kg) and vitamin C (56mg/kg). One kg of fermented camel milk contains 766 calories. The boiled fermented camel milk acidity is 200 T^0 and is comprised of dry substance (21.94 per cent), fat (13.1 per cent) and protein (7.84 per cent). It calorific value is 1529.7 calories. Camel milk dried curd made with normal household or laboratory methods is comprised of dry substance (93-94 per cent) and 6-7 per cent water contents. Each kilogram of dried curd has fat

(49-50.1 per cent), ash (6.12-6.1 per cent) and has a calorific value of 6115-6659 calories (Osorkhaan, 1979).

Camel milk physical, colloid quality was first studied by Dashdendev (1963), and it was identified that milk acidity is 17.25 T^0 PH =2.58, curdle speed is 18.3min, boiling temperature is 101.4 degrees C, density is 1.030 gr/cm3, sticky quality is 2.2 cPa, according to Luvsan (1975) and Indra (1983) milk acidity is 20.5; 25.8 T^0 while Batsukh (1994) estimated that acidity is 22.5±0.25 T^0, density is 1.031±0.01 gr/cm3, PH=6.6±0.1, buffer capacity in acid is 3.8±0.11ml, alkali is 3.0±0.02ml, boiling temperature is 94.0±0.1, sticky quality is 2.7±0.3 cPa, protein sedimentation is 45.0±5.0min.

4.4 Camel milk technical quality

The technical quality of camel milk was studied by Osorkhaan (1979), Indra (1983), Tserenpuntsag (1987), and Batsukh (1994).

From three litres of fermented camel milk one kg of wet quark can be prepared, which is twice what can be prepared from sheep, cow or goat milk. Fifteen kg of dried curds with 6-7 per cent moisture, 38-50 per cent fat and 30-43 per cent protein can be prepared from 100litres of milk (Tserenpuntsag, 1987). Processing 100 liters of warmed milk at 50-55 degrees C will yield 9-10kg of cream with 66 per cent fat, and if the same amount of milk is processed using a butter machine at 45-55 degrees C then 12-14kg of cream with 35-40 per cent fat will be prepared (Indra, Osorkhaan, 1987). Ideal condition for camel milk casein sedimentation is at a temperature of 40 degrees C, a calcium ion amount of 0.45gr atom/l, and PH=6.0. The ideal condition for butter separation is at a temperature of 45-50 degrees C. Compared to cow's milk, fat loss is 1.5-2.0 times as much. Camel milk processing at a temperature of 60-63 degrees C for 30 minutes will lead to 99.9 per cent pasteurization and can extend the storage period by 1.5-2 times (Batsukh, 1994).

Six litres of camel milk is used for 1 kg of quark, 6,06 liters is used for 1 kg of dried curd, 15 liters of milk with 5.66 per cent fat is used to prepare 1 kg of whey butter with 98 per cent fat, and 13.5 liters of milk with 5.66 per cent fat is used for 1 kg of cream with 76.8 per cent fat. Fermented camel milk is prepared by using clean yeast, churning 5000-6000 times for 3 hours by electric churner, fermenting the milk at a temperature of 20-25 degrees C during first 24 hours and then decreasing the temperature to 18-20 degrees C for a further 6 more hours. Fully fermented milk can be stored in a dark glass container at the temperature of 4-5 degrees C for up to 60 days and used as a beverage, and if carbonic acid gas is used, it can be stored for 90 days. When using factory methods, quark, dried curds, butter, and cream produced with fermented camel milk, it was identified that nutritive ingredients were superior to product made using the normal household method. Ten liters of camel milk with 5.66 per cent fat will yield 1.2-1.3kg of milk powder with 28.9 per cent protein, 25.66 per cent fat and 36.34 per cent sugar. If factory methods are used for preparing milk and dairy products a camel dairy farm will generally be required (Osorkhaan, 1975).

4.5 Meat productivity

Mongol camel meat productivity, meat structure, composition and chemical factors were studied by Tserenpuntsag (1969), and Luvsan (1975, 1986). Camel fat quality was studied by Davgadorj (1970).

Camel meat slaughter output

According to Tserenpuntsag (1969), camel fatness is classified as higher than average weight, average and below average weight. Camels with higher than average weight have good meat and muscle development, and have two humps full of fat that are leaning to one side. Camels with average weight have meat and muscle development at average level, their two humps are filled with fat to the mid level and are leaning to one side. Camels with below average weight have poorly developed meat and muscles with a low amount of fat in their humps that are leaning to one side. After conditioning, body mass of camels with above average weight is 480.2kg, for camels with average weight it is 422kg and for camels with below average weight it is 445.7kg and their slaughter yield is 51.9 per cent; 49.01 per cent; 48.2 per cent, internal fat is 3.64 per cent; 3.13 per cent; 1.63 per cent, hump fat is 2.95 per cent; 2.56 per cent; 1.68 per cent and wet hide is 5.55 per cent; 5.73 per cent; and 6.49 per cent respectively.

Slaughter yield of castrated camels is 61.9-64.1 per cent depending on live weight, out of which carcass weight is 57.6-65.5 per cent, internal and hump fat is 5.1-6.4 per cent, wet hide weight is 5.7-6.37 per cent and hide size is 4.86-5.13m^2 (Luvsan, 1975).

Mongol camel carcass meat structure

Mongol camel carcass meat deboning is important for identifying the correct ratio between meat, fat, bone, tendon and sinew, as well as assessing meat quality.

Regarding Mongol camel meat composition, if carcass meat total weight is considered as 100 per cent, meat output is 54-56 per cent; fat is 17-19.8 per cent; bone is 19.8-24.07 per cent; sinew, skin and tendon are 3.2-4.9 per cent; and waste during deboning is 1.3-1.45 per cent (Tserenpuntsag, 1969; Luvsan, 1975, 1986).

Table 7: Mongol camel carcass meat structure

Age (years)	Carcass weight, kg	Including (in kg)					Muscle unit area mm^2	Meat ratio
		Meat	Fat	Bone	Skin, sinew	Waste during deboning		
2-3	175.7	110.0	13.5	7.9	6.1	1.55	57.1	3.32
4 and older	197.7	169.9	26.9	10.1	8.7	1.0	77.05	4.06

Source: Luvsan, 1986.

Table 7 indicates that for a young camel carcass, meat content is on average 62.6 per cent, and for a adult camel carcass, meat content is on average 64.7 per cent. A young camel carcass has relatively less meat, fat and bones, while for camels that are 4 years

and older, both muscle unit area and the meat ratio is considerably larger. Slaughter by-products are grouped into first class, including the liver, kidneys and heart; second class, including planta, head, rumen, stomach and blood; and third class, including lungs, trachea, lien, penis, and bladder. First class by-products are mainly used for food.

Camel meat chemical composition and caloricity

Mongol camel meat contains on average 66.1-74.3 per cent water, 25.7-33.9 per cent dry substance, in which 5.34-13.9 per cent fat, 18.95-19.95 per cent protein, and 0.91-0.96 per cent minerals. One kg of meat contains 1622.4-2071.3 calories (Tserenpuntsag, 1969, Luvsan, 1975, 1986). According to Tserenpuntsag (1971), camel meat contains 15 types of amino acids, including cysteine, leucine+histidine, arginine, asparagines, serine+glycine, glutamic acid, threonine, alanine, proline, valine, phenylalanine, and leucine+isoleucine. When camel meat ages, most amino acids increase, forming tryptophan and methionine. It has been concluded that camel meat quality can be assessed with changes in amino acids. Mongol camel meat is also dried, especially during winter and spring.

During winter, if humidity is around 39-76 per cent, with plenty of air and wind, meat gradually loses its water and moisture and retains its nitrogen content. Meat dried in such a way turns brown yellow and has a good flavor.

Meat dried during spring becomes stiff, with a dark black color and becomes bitter because it loses it moisture rapidly. Dried camel meat has 7.07 per cent moisture; 20.04 per cent fat; 69.2 per cent protein; 3.75 per cent ash; and contains 2753 calories. Spring dried meat protein contains 18.1 per cent myoalbumine, 68.1 per cent globuline and 13.6 per cent myogen. Dried camel meat has 13 types of amino acids.

4.6 Mongol camel working capacity

According to Guke, Gabe (1870), Prejevalskii (1875), Kudryashev (1945), Dash (1952), Shulichenko (1954) and Maiskii (1959), the Mongol camel has a capacity to lift 160-240kg on its back, to carry 300-400kg and can walk 4-5km per hour with a load and travel 30-35km per day. According to Ayurzana (1947), 40 camels each with a load of 226-238kg spent 24 days to travel 740km from Umnugobi Bayanovoo to Ulaanbaatar, and on the way back each camel carrying 237.7kg traveled 14 days over the same distance. On the route Umnugobi Bayanovoo-Ulaanbaatar, when load weight was equal to 38 per cent of camel body mass, camels traveled on average 30.8km a day and on the way back, when the load was 41.5 per cent of body mass, the camels traveled 53km a day. At the beginning of the trip, camel body mass was on average 603kg, while at the end of travel it fell to 565kg, meaning that each camel lost 38kg on average average or 0.78kg per day. Despite this weight loss, the camels' working capacity was maintained.

From early times, the Mongol people have raced camels and selected the fastest ones. Mainly castrated adult camels are used for racing, however, during the past few years, two year old camels have also been used for racing. This is useful in terms of preparing camels for racing, riding and transportation from an early age. When two year old camels raced a distance of 8km the winner took 15 minutes and 15 seconds, for an average speed of 31.5km/hr. When castrated adult camels were raced over

distances of 9-18km, their average speed was 31.5km/hr. Camels with short bodies, long legs and light bones tend to be faster (Biichee, 1998).

Using Mongol camels for camel polo in Mongolia was initiated by Parliament member Ts.Oyunbaatar, who developed the rules and techniques and had them approved as intellectual property. The initiator of camel polo named this sport camelball. A camel polo team has five members, including 2 attackers, 2 defenders and 1 goal keeper. The polo field is 300m in length and 120m in width, marked with a white line around the field, and the size of gates should be no more than the length of 8 camels standing in a row or not more than 2.5m with special markings and flags. Two referees stand next to the gates on either side and when a goal is scored, let the public know by waving a flag. A polo game has two rounds with a duration of 15 minutes each. If scores are equal, then the game extends for a third round of a further 10 minutes. If no goals are scored by either team, the five members of each team will hit the ball from a distance of 10m from the gates in order to determine an outcome. The polo stick has a diameter of 2-3cm, a 30cm long hook and a total length of 135cm. The ball has a diameter of 10-12cm and is made from rubber.

Recently, it has become popular to participate in camel treks in beautiful landscapes of the Gobi. For instance, camel treks are organized to Umnugovi province Khongor river sands every year.

4.7 Conclusion

Mongol camel wool output, depending on age and gender, varies between 2.8 and10.5kg on average. Between 21.6 and 35.5 per cent of total amount of wool is coarse. Camel wool grows from July to December and when camel wool sheds away, some guard hair remains. Between 68.5 and 75.9 per cent of camel wool is relatively long cashmere between 23.2 and 29.6μm in diameter.

The Mongol camel lactation period is 17.5 months on average and milk output is 319.8 liters. One kg of camel milk can satisfy 100 per cent of daily needs of calcium and phosphorus, 57.6 per cent of calium, 40 per cent of iron, copper, zinc and magnesium, and 24 per cent of daily sodium needs. Camel milk fat consists of 69.1 per cent single bond unsaturated acid.

The slaughter output from an adult castrated male camel, depending on camel fatness, varies between 61.9 and 64.1 per cent, while one kg of meat contains between 1622.4 and 2071.3 calories and 15 types of amino acids.

A Mongol camel has the capacity to lift between 160 and 240kg on its back and to carry between 300- and 400kg, can walk 4-5km per hour with a load and 30-35km per day. Moreover, camels can be used for camel polo games, camel racing and eco-tourism.

CHAPTER 5

Some ethological studies of camels

5.1 Grazing behavior

The Mongol camel behavioral characteristics are an overall quiet manner, they spread out during grazing, likes to lie and turn over in ash or marshy soils, is easy to handle and is hard working for riding and carrying loads (Gurjav, Choijiljav; 1982)

Grazing camels prefer to spread out across the rangelands and not graze in subgroups. A camel picks up the upper parts of pastural plants during walking. In summer camels go out with the wind direction and use upper ground water in small streams and backwaters in the Gobi region.

Dr. Biichee (1984, 1995) reported that young camels cannot survive on pasture usage entirely and that they walk faster than adults. In the cold winter-time the young camels cannot use pasture because their mouths become chilled.

Table 8 shows data collected by Biichee (1995) and illustrates that the calf camel walks 929 times per hour and during this time picks up plants 771 times. This investigation verified that young camels do not have pasture use experience, are fast walking and pick up plants during walking in grazing time.

Table 8: Grazing time for a she-camel and calf camels

Activity	Class of animals	Occurences of activity per hour	Occurences of activity per minute	Average time of this action in seconds
Walking	Calf camel	929	15.5	3.87
	She-camel	597	9.95	6.03
Take plants	Calf camel	771	12.8	4.66
	She-camel	759	12.6	4.73
Chewing the food	Calf camel	2036	33.9	1.75
	She-camel	532	8.7	6.88

Source: Biichee (1995)

A camel has some special anatomical structures for grazing such as a long neck with free movement which facilitates picking up plants during walking, good eyesight, forked lips with movement muscles for each part, a long muzzle and a mucous membrane of the mouth that is adapted to hard, thorn and bushy plants.

Grazing camels often move and pick up plants 2.5±0.23 cm above ground and graze across a width of 64.0±4.1-99.7±4.8 cm of pasture as they walk depending on their age (Luvsan, 1989).

5.2 Behavioral features of parturition for she camels

Orgil (1987), Biichee (1989) and Erdenebileg (1995) have conducted studies on calving behavior of Mongol she-camels. A she-camel's udders will fill with milk 15-20 days before calving. During this period the length of udder increased from 25.57±1.13cm to 28.0±1.52cm in first calving she-camels; and from 23.18±2.31 to 34.44±1.78cm in adult camels. The width of the udder increases from 22.37±1.07 to 30.27±1.17 cm in first calving camels; and from 34.0±1.54 to 38.77±1.11 cm in adult she-camels. (Orgil, 1987). Hair falls from around the udder and nipples elongate 1-2 weeks before calving.

Precursor signs of parturition in she-camels are increased size of the udder 23-27 days; the udder filling with colostrum 1-3 days; swelling of the vulva 4-10 days; erythema of vaginal mucous membrane 3-5 days; opening of the cervix 20.5-34.6 hours and relaxation of pelvic ligaments 4-5 days before calving (Orgil, 1987). Some physiological, hematological and blood biochemical indicators of pregnancy are: increases in body temperature by 0.6 degrees C; an increase in breathing by 2.6 times; and an increase in pulse rate. Also, pregnant have increased number of red and white blood cell (Biichee, 1989).

One special precursor sign of labour in she-camels is ‘go out’ from their herds, which is called ‘shilreh’ by herders. This instinct happens 17.1 ±1.57 hours before calving in adult she-camels but 5.5±2.38 hours before calving in first calving she-camels. The ‘shilreh’ may be related to behaviors to select a suitable place for calving and to protect their new offspring. Shilreh’ first involves a fast walk for 1.5-2.5 kilometers from their herds with no grazing followed by trotting up to 0.5-1 kilometers followed by urination. These actions may be repeated until the she camel is 2-10 kilometers from her herd.

Parturition in camels has three stages: opening the cervix; removal of the fetus; and separation of the afterbirth. The first stage may take up to 10 hours after the she camel leaves her herd but the final two stages are relatively quick (Orgil, 1987).

Orgil (1987) reported that the time it takes for the removal of the fetus in adult camels is 27.2±1.06 minutes and for first calving camels it takes 41.2±1.5 minutes. The afterbirth separation in adult camels takes 30.3±3.1 minutes and in first calving camels it takes 43.1±3.83 minutes. Erdenebileg (1995) estimated that camel calving averages 35.0±2.75 minutes and their placenta separation occurs 62.8±3.97 minutes after birth.

When dogs, wild predators and people approach the new born calves, the mothers are very sensitative and attempt to protect their calf from these threats. Female camels’ instincts for offspring protection are well developed. Sometimes, adult she camels can protect their calves from cold freeze. The protective instincts of adult camels with good body condition are better developed than in first calving camels and she camels with poor body conditions. She-camels do not lick their offspring after birth but they can smell them.

5.3 Behavior of calf camels

A newborn camel calf is covered by a thin white film that may be the fourth fetus layer (Orgil 1987). Most mammals have three fetus layers but a camel has four layers. This fourth fetus layer grows from the skin epidermis of the dorsal part of the head and neck and covers the fetus, except for the pads of the feet, umbilical canal, mouth, nose and anus.

On average, in March a new born calf camel will change from a recumbent position to sitting up in 6.06 ±1.0 minutes after birth. The calf will then stand on its own within 3.5 hours and will suckle for the first time 5 hours after birth in the Gobi region. The time it takes for the calf to stand on their own, as well as the calf to suckle for the first time depends on environmental temperatures, the body condition and age of the mother. (Erdenebileg, 1995). In April a camel calf stands on its own 2 hours after being born and will suckle for the first time 2.5 hours after birth in the steppe region of Mongolia (Erdenetsogt, Seterkhaan, 1982).

The body temperature of the newborn camel calf is 37.6±0.09 degrees C but the body temperature decreases by 3 degrees C 40 minutes after birth which arises because the she camel does not lick her calf after birth and the calf's body heat must be used to dry their hair (Erdenebileg, 1995).

The standing, playing, sleeping, and suckling behaviors of calf camels vary depending on the manner in which they were raised. These behaviors develop when the mothers come back from pasture and the calves imitate them. A camel calf spends its day in the following way; 16.6-45.8 per cent is spent grazing, 29.1-45.8 per cent is spent suckling, and 75-87.5 per cent is spent sleeping and playing. Again, these periods depend on raising methods (Biichee, 1989).

Calves try to eat pasture plants from 17.5±0.42 days, and their first chewing of the cud appears 39.3±0.77 days after birth. Normal chewing and normal rumination occurs in calf camels 3 months after birth (Erdenebileg, 2002).

5.4 Camel behavioral features of breeding

The rutting of male camels is divided three periods: pre-rutting; rutting; and the end of rutting. During the rutting period the bull camel's behavior changes tremendously. During the advancement of the rutting period, the camel exhibits the following symptoms: goes off feed, the abdomen is significantly tucked up, its body condition deteroiorates, there is frequent urination, production of gurgling sounds and grinding of teeth in excitment, wind sucking, bleating, escapes confinement in search of females and butts wethers with his head. The bull's rutting behavior is exhibited more frequently in cold winter conditions compared with warmer winters (Tserenpuntsag, 1972). Old and cowardly bull camels have some bad behavior traits when separated from female herds. These bull camels tend to drive their herds long distances, not manage their females and also abandon them for others. Most of bulls do not want to mate with exhausted female camels because they become barren (Choijiljav, 1976).

The indicators of estrus in she camels are as follows: decrease in appetite; sitting down; excitement; bleating; swollen vulva with slimy discharge; attempting to smell

urine and external genitalia of the male; raises the tail; shows some homosexual tendencies; and also approaches the male.

Some of the indicators that a she camel has conceived include cocking of its tail 3-7 days after mating, frequent urination and wide legged stance when approached by male camels or handled by herders. If the she camel has an abortion or has not conceived the tail is not cocked, lochia is excreted from external genital organs, milk production decreases and the she camel will go on heat again (Ganbat, 1997).

5.5 Conclusion

The Mongol Bactrian camel has the following behavioral characteristics: generally quiet in manner, grazes over large areas, enjoys lying and rolling in ashy or marshy soil, is easily handled and is hard working when riden and used for transport.

Young camels do not have the capability to utilize pasture effectively and walk as fast as adults. In the cold of winter young camels cannot use pasture because their mouths are chilled. Camels pick up the parts of pasture plants that are 2.5 cm from the ground during walking and the camel. Bactrian camel puts pressure on each square meter of pastoral field during the grazing. When first born camel calves are slow moving. The time it takes for the calf to stand on its own and the time it takes for the calf to suckle for the first time (normally 2-5 hours) depends on environmental temperatures.

A camel calf spends its day in the following way; 16.6-45.8 per cent is spent grazing, 29.1-45.8 per cent is spent suckling and 75-87.5 per cent is spent sleeping and playing depending on raising methods.

The male camel exhibits the following behaviour during the ruting period: goes off feed, the abdomen is significantly tucked up, its body condition deteroiorates, frequent urination, production of gurgling sounds and grinding of teeth in excitment, wind sucking, bleating, escapes confinement in search of females and butts wethers with his head. The indicators of estrus in she camels are as follows: decrease in appetite, sitting down, excitement, bleating, swollen vulva with slimy discharge, attempts to smell urine and external genitalia of males, raises the tail, shows some homosexual tendencies and also approaches the male. Some of the indicators that the she camel has conceived include cocking its tail 3-7 days after mating, frequent urination and wide legged stance when approached by male camels or handled by herders.

CHAPTER 6

Some physiological and blood biochemical values for camels

6.1 Some physiological values of Mongol camels

Dorjpurev (1989); Luvsan (1975); Erdenebileg (1995) have described some physiological values for Mongol Bactrian camels related to their age, sex and physiological conditions.

Camel calves between 6-7 months of age have body temperatures of 37,4-38.4 degrees C; heart rates of 50.3-64.8 (beats/minute); and resting respiratory rates of 10.5-18.1(breaths/minute). After 30.5-90.8 months, or 2.5-7.6 years, the camel's heart rate reached 38.0-49.1; respiratory rates reached 8.3-14.5; and body temperature reached 36.2-37.7 degrees C (Dorjpurev 1969, Luvsan, 1975).

A newborn camel calf, that has not yet suckled has a respiratory rate of 22.0±0.77 (breaths/minute); heart rate of 102.5±2.5 (beats/minute) and a body temperature of 37, 5±0.09 degrees C. These physiological indictors for calf camels decreased from 82 to 29.3 per cent after 15-30 days. The physiological parameters in newborn calf camels are unstable and higher compared with a one month old camel calf (Erdenebileg, 1995)

Erdenebileg (1995), studied the monthly dynamics of physiological values in calf camels from 4 months to 1.5 years of age, in other words during the transition from calf camels to yearlings. Average month's physiological values of a calf camel and yearling camel are respiratory rates 11.4±0.43 (breaths/minute); heart rates 51.9±2.7 (beats/min); and body temperature 37.3±0.19 degrees C. The average physiological values of calf camels increased in summer but decreased in winter months. In the calf camels the maximum respiratory rate was 13.8±0.6 (breaths/minute) occurring in May and the minimum was 8.1±0.3 (breaths/minute) occurring in February. The maximum heart rate was 68.0±1.68 (beats/minute) occuring in June and the minimum rate was 35.2±0.06 (beats/minute) occuring in March. The maximum body temperature was 38.6±0.07 degrees C occuring in June and minimum was 37.5±0.06 degrees C occuring in November (Erdenebileg, 1995).

Daily biorhythm of physiological values for a calf camel at 6am shows as respiratory rate of 10.4-10.9 (breath/minute); heart rate of 41.5-53.8 (beats/minute); and body temperature 36.7-37.5 degrees C. At 6pm these values were: 13.6-18.7; 41.2-53.8; and 37.4-38.5 respectively. Average differences of the physiological values were in respiratory rates by 0.8-8.3 heart beats per minute by 3.4-25.6; and body temperatures by 0.7-1 degrees C between morning and evening period which was related to both environmental temperature and metabolic processes.

6.2 Hematological values of camels

Calf camels from 1-2 months old have a red blood cell (RBC) count of 11.8±0.14 mln/mm^3, a white blood cell (WBC) count 13.25±0.17 thous./mm^3, hemoglobin (Hgb) 13.5±0.12 gr./%. Adult camels have 12.3±0.12 mln./mm^3; 13.3±0.21 thous./mm^3; 14.25 gr./% respectively. Camel calf have more number of the basophil, eosinophil

cells than adult camels. But the adults have more numbers of segmented neutrophil in their blood than young camels. (Dorjpurev, 1969).

A calf camel that is up to 7 days old has a RBC count of 11.5±0.26*10^{12} /L, a WBC count of 10.9±0.38*10^{9}/L, and a Hgb count of 14.4±0.32 gr./% Calf camels from 4 months to 1.5 years of age have an average RBC count of 10.7±0.44*10^{12}/L; a Hgb count of 11.7±0.31 gr./%, and a WBC count of 9.7±0.93*10^{9}/L. The WBC contains basophil 1.18±0.37; eosinophill 1.0±0.37; neutrophil 34.0±0.12; lymphocyte 61.7±3.07; and monocyte 1,34±0,21%. The number of camel calf blood cells does not change across months or seasons; however, the volume of hemoglobin in the blood decreases in winter and spring time. The WBC of the calf camel sharply increases in January and then decreases in May. These changes are related to environmental stress factors such as severe cold weather and food supply shortages (Erdenebileg, 1995).

At 6.00am the average RBC count in a calf camel is 9.84-10.1*10^{12}/L and at 12pm, 6pm and 12am the RBC count increased slowly. The Hemoglobin count in camels is 96.0-110 g/L at 6.00am and this increased to 109-114 g/L by 12.00am.

6.3 Blood chemical values of Mongol camels

A calf camel from 6-7 months old has a higher volume of total serum calcium and crude protein but this slowly decreases to a long term level as the camel ages from 1-4 years old. Calf camels from 1-7 months old have a serum crude protein level of 6.08-6.75 gr./%; a calcium level 12.05-13.6 mg/%; an inorganic phosphorus level of 6.71-6.74 mg/% and the acid capacity of blood is 750-768 mg/%. An adult female camel has the following values: 6.5±0.12; 13.0±0.2; 6.45±0.19; 747.0±8.5 respectively. Some blood hematological and biochemical values of camels change across the seasons. For example, in summer and autumn adult camels have a RBC count of 12.71±0.11 mln./mm^3, a Hgb count of 15.82±0.22 gr./%, a WBC count of 13.37±0.2 thous./mm^3, a total serum calcium level of 14.37±0.13 mg./%, an inorganic phosphorus level of 7.17± 0.1 mg/%, and a crude protein level of 7.1±0.13 gr./% but in winter and spring the RBC count is 11.85±0.24 mln./mm^3 , the Hgb count is 13.37±0.12 gr./%, the WBC count is 12.9±0.17 thous./mm^3, serum total calcium level is 11.38±0.24 mg/%, the inorganic phosphorus level is 6.66±0.11 mg/%, and the crude protein level 5.94±0.11 gr./% (Dorjpurev,1969).

Dr. Dorjpurev described some blood serum biochemical values of camels compared by age and the year's seasons. He demonstrated that some serum biochemical values for camels, such as calcium and crude protein, slowly increased up to 6-7 months old. Calf camels between 1-7 months old have average serum protein of 6.08-6.75 gr./%, calcium of 12.05-13.6 mg/%, inorganic phosphorus of 6.71-6.74 mg/%, and acid capacity of blood of 750-768 mg/%. Adult camels have average serum total protein of 6.5±0.12 gr./%, calcium of 13.0±0.2 mg/%, inorganic phosphorus of 6.45±0.18 mg/%, and acid capacity of blood of 747±8.5 mg/%.

A camel's physiological conditions can influence their physiological and hematological values. In particular, during the second half of pregnancy, a camel can experience higher heart rates, respiratory rates and body temperature than a castrated male camel (Dorjpurev, 1969).

The study of dynamics of blood biochemical values for young camels has shown that in young Bactrian camels a critical period for their metabolism occurs from January to the end of April in the Gobi region of Mongolia. In this period some biochemical values such as blood glucose, serum total cholesterol, calcium, phosphorus and blood urea decreased but blood ketone bodies and the activity of alkaline phosphates increased. Young camels (between 4-16 months old) have the following average biochemical values: total protein 52.7 g/L, which consists of 61.0±2.56 per cent of albumin, 39.0±1.43 per cent of globulins (the albumin-globulin ratio is 1.72±0.2), serum urea 6.85±0.63 mmol/L, blood glucose 2.3±0.2 mmol/L, ketone bodies 2.46±0.18 mg/%, total cholesterol 3.02±0.81 mmol/L, serum inorganic phosphorus 1.81±0.08 mmol/L, serum crude calcium 2.67±0.06 mmol/L, activity of blood alkaline phosphates 5.5±0.64 biochemical oxygen demand units and blood acid capacity 456.2±13.0 mg/% (Erdenebileg,1995).

An adult camel's blood crude protein is made up of 44.2-48.5 per cent albumin, 9.31-19.6 per cent alpha globulin, 15.7-17.8 per cent beta-globulin and 21.6-24.0 per cent gamma-globulin. The serum total lipid of camels was 3.45 g/L in winter, 3.75 g/L in spring, 4.9 g/L in summer and the blood glucose was 3.9 mmol/L in winter, 4.98 mmol/L in spring and 4.5 mmol/L in summer. The volatile fatty acids of serum count was 1.36-1.72 mmol/L and the ketone body count was 0,037-0,042 g/L (Buyankhishig,1992).

The daily biorhythm of some biochemical values for calf camels was closely related to the seasons, habitats of pasture use and digestive metabolism. For example, serum total calcium was at a minimum volume at 6.00am and this slowly increased from 12pm, reaching a maximum volume at 12am , after which it slowly decreased. Some blood biochemical values do not change hourly. The blood glucose of calf camels was 2.29±0.1 mmol/L at 6.00pm (which is the minimum volume for the day); this was followed by significant increase from 12am and by 6.00am the blood glucose volume reached 3.92±0.11mmol/L. Glucose concentration in the blood was related to the camel protein-carbon metabolism. Furthermore, the amount of serum crude protein and urea for calf camels increased from 6.00pm to 12.00am, which related to their rumination period. A serum total protein of the camel reached a minimum volume of 41.0-61.9 g/L at 6.00am but the amounts of urea in the blood of calf camels did not change hourly (Erdenebileg, 1996).

6.4 Reproductive physiology of she camels

Tsevegmed (1969); Ganbat (1997); Badamdorj, Erdenebaatar and Batsuuri (1999) have conducted a wide range studies on the reproductive physiology of Mongol Bactrian female camels.

She camel can go on heat between January and the beginning of April. The estrus of most she camels (75 per cent) happens in the last 10 days of January and during February. Calving occurs between March and May depending on estrus date but calving commonly occurs in March (Tsevegmed 1969).

The gestation period of the Mongol Bactrian camel is between 390-405 days (Dashdondog, 1958), 408 days (Tsevegmed, 1969), 399.2±1.68 days (Luvsan) and

according to Ganbat (1997) 401 days for first calving camels, 385±1.73 days for adult she camels.

74.3 per cent of all female camels become pregnant in February and 82.5 per cent of them deliver a calf camel in March of the following year (Luvsan, 1975)

Tsevegmed (1969) found that if the female camel does not mate with a bull camel, the estrus cycle continues for 45 days with a range of 17-60 days. During this period the weight of the camel's ovary and size of its follicles increase. A she camel has one heat period, which takes 3-16 days. Ovulation occurs after mating with bull camels. The ovulation is completed within 72 hours after mating.

Badamdorj, Erdenebaatar and Batsuuri (2001) investigated the progesterone concentration in the blood and milk of camels. If the she camel has estrus but not mated, the progesterone concentration in her blood serum and milk was 0.27±0.05 ηmol/L for 28 days with no yellow body formation. Six days after mating with a bull camel, the concentration of hormones in the blood and milk of the she camel increased to14.83 ηmol/L, which demonstrates that ovulation and yellow body development is normal.

The rectal investigation method for fetus age determination is unsuitable for she camels as thick fatty tissues cover the rectal area. In pregnancy the female camel has 5.5±1.39 ηmol/L bloodprogesterone concentration before 14 days of calving and rapidly decrease up to 2.81±0.4 ηmol/L before 5 days of calving. During 14 days after calving the concentration of progesterone in blood of she camel was0.21±0.06 ηmol/L. These camel blood progesterone parameters can be used for she camel pregnancy diagnosis.

At present the dominant hypothesis is that camel ovulation occurs due to external induced and gonadotrophin-releasing hormone-like elements in the semen of bull camels.

Follicle-stimulation hormones injected in she camels before mating can influence follicle growth but do not encourage ovulation. The female camel can be injected with some of the follicle stimulation group hormones after calving. But she camels did not show positive results due to pastural and harsh environmental factors.

6.5 Reproductive physiology of bull camels

Eighty-three per cent of synchronization for heat in the she camel occurs through the injection of progesterone, gonadotropine and prostaglandin during the mating session. One female camel can take at least 7 oocytes when mating with bull camels (Badamdorj, Batsuuri et.al 2001).

The rutting period of male camels is divided three stages: pre-rutting; rutting; and finish of rutting. The pre-rutting period for male camels lasts 30-45 days or from mid November to mid February every year. In this period the bull camel shows the following behaviour: goes off feed; seldom butts wethers with his head; and produces a weak gurgling sound with grinding of teeth. In this period the bull camel does not want to couple with female camels.

During rutting the bull camel collects their own she camels, loses condition and begins copulating with she camels. This period starts in January and ends in April each year. Heat in adult bull camels occurs 30-40 days earlier than in young bull camels. During the advancement of the rutting the camel shows the following symptoms: goes off feed; tucked to a great extent in the abdomen; falling off in body condition; frequent urination; excitement during which time the bull produces a gurgling sound with grinding of the teeth; wind sucking; bleating; escapes confinement in search of females and butts wethers with his head (Tsevegmed, 1971; Badamdorj, Batsuuri, 2002).

The majority of bull camels (that is, 91.1 per cent) can copulate with she camels 1-2 times per day, up to a maximum of 5 times per day, depending on their body conditions, age and the estrus of the she camels. The bull camel can be used for breeding purpose from 5 to 14 years of age. The bull camel can mate up to 18 years of age (Tsevegmed, 1971 and Bolikhorloo, 1975). During the mating period the bull camel loses about 10 per cent of his body weight. The penis of the bull camel is slender and has a rotary movement. Animal scientist Mr.Sukhbaatar created an artificial vagina for bull camels in order to collect their semen for artificial insemination.

The average duration time of Mongol bull camel mating was 4 minutes 31 seconds, whereas dromedary camel mating takes 5 minute 24 seconds. The volume of semen in the Mongol bull camel was 5.83±0.53 ml; 5.34±0.75 ml in a dromedary bull; and 7.17±1.29 ml in a wild bull camel. The semen of the bull camel requires an alkaline medium and it is possible to store in thinner with sucrose, yolk of eggs and glycerin. (Badamdorj and Batsuuri, 2002).

6.6 Conclusion

Some physiological, hematological and blood biochemical values of the Mongol Bactrian camel do not change according to their age but the above values increased in summer and autumn, and decreased in winter and spring closely related to their metabolism and gas exchanges. In the Gobi desert region the critical period of metabolism for young camels occurs from January to the end of April. During this period some biochemical values of the camels, such as their blood glucose, serum total cholesterol, calcium, and phosphorus and blood urea decreased but the blood ketone bodies and the activity of alkaline phosphatase increased.

The estrus of most (75 per cent) of she camels occurs during the last 10 days in January and during February. Calving occurs between March and May depending on their heat period but usually in March each year. If there is no mating the estrus cycle continues up to 45 days (with a range of 17-60 days). In this period the weight of ovary and size of its follicles increase in the she camel. She camels have one heat period lasting 3-16 days. Ovulation occurs after mating with bull camels. The ovulation is completed within 72 hours of mating. A bull camel can copulate with she camels 1-2 times per day. The duration time of the act of mating in Mongol bull camel is on average 4 minutes 31 seconds. The bull camel can be used 11 years for breeding purposes.

CHAPTER 7

Camel rearing, pasture and fodder

7.1 Camel fodder digestibility and nutrition

The flora dominating the semi-desert pastures where 60 per cent of camels live (salsola passerina-anabasis, brevifolia-stipa, kalidium-achnaterum and splendens-stipa), have a maximum pasture yield of 2.84-7.62 hec/hr in August and a minimum yield of 0.67-1.5*100kg/hectare in April. In terms of dry matter, 1kg is equivalent to 0.90-1.04 fodder units and 96.5-136.4g digestable protein during autumn, it is equivalent to 0.80-0.83 fodder units and 47-117.0g digestable protein during winter and spring it is equivalent to 0.76-0.84 fodder units, and 72.0-107.0g solvable protein respectively. This shows that winter and spring pasture plants have 1.25-1.31 times less fodder nutrition and 1.3-2.1 times less digestable protein content.

Table 9: Mongol camel consumption of grass and fodder from grazing/absolute dry weight, in kilograms

Season	Absolute dry weight, kg							
	1 year old		2 year old		3 year old		Castrated grown	
	Weight	Fodder unit	Weight	Fodder unit	Weight	Fodder unit	Weight	Fodder unit
Winter	5.6	3.4	8.3	5.2	10.0	6.1	16.0	9.7
Spring	4.1	3.2	6.0	4.7	7.8	5.0	15.7	12.5
Summer	4.1	4.1	5.0	5.4	9.8	9.6	17.9	17.5
Autumn	4.1	3.6	6.5	5.3	10.5	8.6	17.3	14.2

Source: Testseg-Ulzii, 1986.

A milking camel consumes 10.2-17.5kg of dry fodder by grazing 8 hours in summer, 11.2-12.9kg by grazing 7.5 hours during autumn, 10.8-12.1kg by grazing 6 hours during winter and 8.3-16.7kg by grazing 8 hours during spring (Tsetseg-Ulzii, 1980). A milking camel's consumption of drinking water equals 39.8 liters in summer, 29.0 liters in autumn, 24.0 liters in winter, and 30.0 liters in spring. This means that to digest one kilogram of dry fodder, a camel uses 2.88 liters of water in summer, 2.41 liters in autumn, 2.1 liters in winter, and 2.39 liters in spring.

In the Gobi region, camel grazing time decreases by 2-4 hours during winter and spring, thus the fodder consumed from pasture during this time is 35.4-43.7 per cent less than during summer and autumn and fodder nutrition decreases by 28.6-44.6 per cent. Therefore, it is necessary to provide supplementary fodder during this time of year.

A Mongol camel reared on pasture grazes for 11.5 hours in autumn, 9.8 hours in winter, 13.1 hours in spring and 16.5 hours in summer, which corresponds to 40.8-68.7 per cent of their day. The rest of their time is spent in camp. The Mongol camel travels a daily distance of 15.0km in autumn, 7.8km in winter, 24.7km in spring and 16.5km in summer. The average grazing radius is 1.7-2.5km in autumn, 2.3-4.0km in

winter, 3.8-6.2km in spring and 4.5-6.0km in summer. The Mongol camel consumes a maximum of 22 varieties of pasture plants during summer, and 6 varieties in winter, 17.7 per cent of which is sedgy grass. A castrated mature male camel loses 100kg or 17 per cent of its total weight during the cold season, 88 per cent of which is lost during November-February. While grazing, a camel picks grass and plants 9-13 times and chews 7-11 times and then swallows.

With increased pasture yields, time spent chewing and swallowing decreases. Fodder appetite increases during spring and summer and the frequency of picking and chewing per unit of time increases by 1.5-1.7 times compared to autumn and winter. The camel picks pasture grass 8.06-18.2 thousand times, chews it 6.2-14.3 thousand times and swallows 815-1738 times daily. A grown castrated male camel consumes 11.5kg of pasture grass daily during autumn, 7.2kg during winter, 14.2kg during spring and 39.9kg during summer. A camel digests 51-70 per cent of consumed dry fodder, which fluctuates from season to season. Digestion of total nutritive substances, including protein, cellulose, and anazotic substances is the highest during summer (73 per cent), which gradually decreases to its minimum level (53.7 per cent) during winter. Starting in spring, the digestion level is restored, which is directly related to nutritive level and content of the fodder. Digestion of fat and cellulose is relatively low compared to other types of nutritive fodder substances. The rumination period of the adult castrated male camel is equal to 22.2-26.9 per cent of a day, which consists of 5-8 rumination phases, with a duration of 46-59 minutes each. For the total duration of rumination, there are 437-526 parts. Each part includes 26-59 chewing movements for the duration of 28.5-36.6sec and for the total duration of rumination, the chewing movement occurs 11.8-15.2 thousand times (Buyankhishig, 1999).

The duration of one rumination period for a camel calf is 40.4±1.59 seconds; the duration between two ruminations is 6.63±0,18 seconds with 50.6±0.9 spent on chewing; for a female camel these durations are 32.0±1,31; 8.63±0.37; and 36.0±0.37 and for a castrated grown up male camel they are 29.45±0,75; 9.27±0.28; and 26.6±0.56 respectively (Erdenebileg, 2002). An infertile male camel grazes 10-20km during winter, 20-30km during summer and autumn and 5-10km during wool shearing in the spring (Nansalmaa, 1997).

Compared to a normal rearing system, if a camel is provided with 3.3 fodder units daily for 120 days from 1 January, its live weight will increase by 9.8 per cent, its wool output wil increase by 0.7 per cent and its milk output will increase by 61.9 per cent. Furthermore, if the camel is fed for 90 days starting at 1 January with 2.3 fodder units, its body mass will increase by 2.7 per cent, its wool output by 0.1 per cent and its milk output by 45.3 per cent. If a two year old camel is fed for 120 days with 2.3 fodder units daily, its live weight will increase by 20.6 per cent; if fed for 90 days with 1.3 fodder units its live weight will increase by 11.1 per cent (Tsetseg-Ulzii, 1986).

Mongol camel drinking water consumption was studied by Luvsan (1975) and the results showed that if water is provided every other day, a two year old camel consumes 24-25.1 liters; a young camel consumes 45.5-48.8 liters; and a grown female camel and castrated male camel consume 56.8 liters of water. Castrated male camels should be provided with drinking water at least once every three days during spring time, and every other day during summer and should be grazed within 8kms

from a water point. Female camels and two year old camels should be provided with water every day, and grazed within 4kms of a water point.

During spring, castrated grown male camels consume 44 liters; female camels comsume 36.5 liters; and two year old camels consume 17 liters. During autumn, castrated grown male camels consume 55 liters; female camels consume 47 liters; and two year old camels consume 25 liters (Oyunsuren et al., 2002).

The Mongol camel comsumes 176.3 grams of protein from one kilogram of dry fodder and 240.7 grams of minerals from 27.6 kilograms of grass while grazing *Stipa-Allium pollyrrhizum turcz-Anabasis brevifolia-Salsola passerina* type of pasture, which dominates in semi-desert region in summer and autumn. During winter and spring, camels consume 13.8 kilgrams of sedgy grass, which contains 127.5 grams of protein and 135.8 grams of minerals daily. Moreover, camels drink 34.3-42.3 liters of water with 0.7-2.3 per cent of mineral content during warm seasons and 22.3-28.4 liters of water during cold seasons (Namsrai, 1980).

Camels receive 1.87-6.76 kg of minerals through fodder, of which, 32.3-58.3 per cent is absorbed into their bodies. Camels get 82.6 per cent of their daily requirement of minerals from pasture grass and plants, 3.6-7.0 per cent from water and the remaining amount from salt, mineral enriched fodder and salt peter. For camel body mass maintenace, 3.14 grams of minerals are required daily. During spring, the composition of macro and microelements such as phosphorus, cobalt and copper decreases 2-3 times, therefore, when fed with supplementary fodder containing the above mentioned elements, a camel calf's weight increases by 142-147 grams or 21.0-29.0 per cent daily, a female camel's weight increases by 80-90 grams or 6.2 per cent, the daily milk output increases by 111.0-129.0 mililitres and wool output increases by 43.0 grams (Namsrai, 1980).

7.2 Camel calf rearing method

Camel calf growth and development is divided into colostrum, lactation and grass fodder phases (Biichee, 1995).

The colostrum phase relates to the first 7 days, when the camel calf consumes its mother's first milk. This is considered the calf nursing period.

The lactation phase lasts for 30 days, until the camel calf's middle front tooth emerges, and the calf starts to eat some grass. During this phase, the camel calf is raised mainly on the mother's milk, the mother always stays in nearby pastures and comes back to camp regularly for lactation. In this phase, the camel calf's body mass increases by 16.2 kilograms on average, which corresponds to a daily weight increase of 540 grams and relative growth of 148 per cent.

The grass fodder phase lasts basically until the camel reaches 1.5 years of age. During this phase, grass becomes the main fodder instead of its mother's milk. This phase is peculiar, as the camel calf and two year old camels faces their first harsh winter on their own. In Mongolia, there are three main methods for livestock raising, of which the partial suckling method is the most prominent (Biichee, 1995). The following section contains a brief description of the camel calf raising methods.

Tying method

This is a traditional method, where the camel calf is raised from birth until it is ready to eat pasture full time by being tied to its mother. The advantage of this method is that neither camel calf nor mother get tired from travel during the hot season and both become tamed. The disadvantage of this method is that the camel calf sucks the mother's milk constantly, has limited movement and a reduced possibility to learn to graze, and has a late shift to the grass fodder phase.

Suckling method

This is when the camel calf is raised from birth by following its mother. The advantage of this method is that the camel calf grows well, however the disadvantage is that it becomes untamed, and the milking potential of the camel is reduced.

Partial suckling method

This method was used for the first time by D.Jidee, herder and merited labor hero from Umnugovi province, Mandal Ovoo soum. This is when the camel calf is raised by partial suckling method starting at the time of camel calf's shift to grass fodder until June, when pasture vegetation is in full growth. The camel calf is fed when tethered 1 or 2 times a day, or tethered during the morning and then the suckling method is used in the afternoon. The advantages and disadvantages of the above mentioned methods are indicated in Biichee (1991, 1995), Luvsan (1989) and Tseveenjav (1990).

7.3 Preventing the loss of camel calves and two year old camels

According to Bandi and Khuleg (1987), two year old camels are susceptible to disease and are at risk of death especially during winter and spring due to the fact that they will face their first harsh winter, with snow and storms, and their body is not yet adapted to such climatic conditions. Therefore, their metabolism undergoes severe changes. Moreover, according to experienced camel herders, the hair and wool of camel calves and two year old camels easily breaks and thus they frequently get cold.

According to Biichee (1984, 1995), young camels move quickly, and therefore, do not have experience in grazing. Due to the cold weather, they tend to stay in their warm litter instead of grazing and as their mouth gets chilled easily, their ability to pick grass decreases. It has been identified that a camel calf walks 924 steps (597 steps for a female camel), and picks grass 771 times per hour (759 times for a female camel).

According to Luvsan (1968), during winter, a camel calf looses 12.6 per cent of its body mass, a two year old camel looses 8.9 per cent and a three year old camel looses 14.9 per cent. Biichee (1981) identified that a camel calf's body mass decreases by 150-200 grams daily and Tsetseg-Ulzii (1989) and Erdenebileg (1995) indicated that a young camel looses 7.26-16.0 per cent of its body mass by the end of year. During the first 15 days, a camel calf's daily increased body mass is 274-292 grams, which is relatively little. However, it increases intensively over the proceeding months (Luvsan, 1975).

In Gobi conditions, a camel calf grazes on average for 7.5 hours during May-September and during winter and spring seasons, on average for 8 hours daily (Luvsan, 1975).

Researchers noted that in order to prevent the loss of camel calves, it is necessary to provide them with warm sheds. According to Ivanov (1932), in pastoral livestock production, coverlets (blankets or rugs) serve the function of a mobile shed. Using coverlets for livestock not only protects from cold weather but also protects against strong wind and precipitation. As a result, body heat loss is limited and fodder is effectively used. Therefore, it is better to use coverlets for camel calves with poor hair and wool growth in spring, as well as camels used for transportation, skinny camels or sick camels during winter.

Researchers like Shulijenko (1957), Luvsan (1968), Bandi and Khuleg (1987) and Bataa (1989) noted that it is essential to check all two year old camels annually at the end of October, and release the weak, underdeveloped camel calf's mother from milking and provide daily supplementary fodder of 0.1-0.2 fodder units equivalent and start using coverlets no later than November 15.

When a female camel is used for milking and its calf is raised in normal conditions without coverlets, and if climatic conditions are favorable with good pasture yields, then the calf would loose 7.67 per cent of its body mass by spring. If, under the same conditions, coverlets were used, then the calf would only loose 2.17 per cent of its body mass. Moreover, if coverlets were used over winter, with 0.5 kilograms of hay and 0.2 kilograms of combined feed daily, starting January 10 through end of March, then the calf would gain an additional 10.26 per cent of its body mass by spring. Based on the above experimental results, mothers of late born, and small calves should be released from milking starting in November, coverlets should be used and the camels should be provided with 0.1-0.2 fodder unit equivalent feed from January through to the end of March (Erdenebileg, 1995).

According to Biichee (1981), coverlets should be made of affordable, wind proof material and should fully cover the calf's abdominal section. Calf coverlets can be 110cm in length, and 30cm wide. For a two year old camel, they should be 110cm along the back side, 125cm along the abdominal section, 65cm wide, 22cm between the humps, 18cm for the front hump hole, and 20cm for the back hump hole.

Luvsan (1986) noted that camel calves, two year olds and young camels occupy 0.22-1.67 m^2 when lying and 0.21-1.4 m^2 when standing, and therefore, sheds should be built considering these dimensions.

Dash (1966) indicated that camel calves and two year old camels should have dry litter and windbreak sheds, and during the coldest parts of winter, calves should be tied lying at the end of the warm litter.

Biichee (1989) also points out the necessity of winter sheds for calves, two year olds and calving female camels. Experienced herders build one meter high, half circular and circular sheds in different spots of their winter camp. It has been mentioned that a project was developed for the construction of roofed sheds for camels.

Based on the aforementioned foreign and local sources, it can be concluded that loss of young camels mainly occurs during a calf's first harsh winter and spring. The review and summary of research work conducted on calf underdevelopment, clinical symptoms, diagnostic methods, and mitigating measures are included in the section on camel non-infectious diseases in this research material.

7.4 Conclusion

The Mongol camel, depending on its age, consumes 3.2-17.5 fodder units which is equivalent to 4.1-17.9kg of dry fodder and hay from pastures daily and digests 51-73 per cent of its nutritive substances. The rumination period of the camel consists of 5-8 rumination phases, with a duration of 46-59 minutes each. The number of chewing movements per rumination period is greater for young camels compared to grown up camels.

Under Gobi desert conditions, depending on the season, the Mongol camel consumes 24-56.8 liters of drinking water when watered every other day, and uses 2.1-2.88 liters of water to digest one kilogram of dry fodder. A camel receives 1.87-6.76 kilograms of minerals through fodder, of which, 32.3-58.3 per cent is absorbed into its body. For one kilogram of camel body mass, 3.14 grams of minerals are required daily.

In Mongolia, there are three main methods for camel calf raising, including suckling, partial suckling and tying methods. For young camels, due to their poor experience in the use of pasture and fodder during their first harsh winter, as well as the lack of herders' experience in rearing calves, camels loose weight easily and thus calf loss is common. It is possible to fully prevent such loss by providing coverlets, supplementary fodder and warm sheds during winter.

CHAPTER 8

Selected diseases of Mongol Bactrian camels

8.1 Some infectious diseases of Mongol Bactrian camels

Between 1947 and 1966 one of the biggest camel disease outbreaks, with clinical findings such as ataxia and intractable diarrhea, occurred in the Gobi-steppe regions of Mongolia. Thousands of camels were affected in this outbreak of disease and more than 90,000 camels died.

Infectious enterotoxaemia

This disease of the Bactrian camel is caused by the bacteria Clostridium perfringens type C. All classes of camels can suffer from enterotoxaemia although young camels and females are more susceptible (Moebuu et al., 1966; Ipatenko, 1974).

Baatar (1970) reported that one of the major reasons for camel deaths from enterotoxaemia is an activation of bacteria such as Clostridium perfringens and Escherchia coli when the camels have poor immune-competence and disorders of the gastro-intestinal track due to a lack of rangeland nutrients and harsh environmental factors.

Enterotoxaemia in camels can occur as acute, per-acute and chronic cases. According to Moebuu et al. (1966) the most common clinical findings of the disease in camels are a soft limping during the first few days of disease followed by acute diarrhea. The diarrhea and limping features tend to continue for a long time. The fecal consistency can range from soft to watery with grey-green colors. Sometimes affected camels show additional clinical signs such as wandering away from the herd, ataxia, abnormal walking, standing dropped down onto their knee joints and hematuria. Severely affected camels develop a high fever, recumbence, convulsions and death after a few days.

Typical pathological lesions of camel enterotoxaemia are hemorrhagic and mucous enteritis, and petechial hemorrhage in the intestines, rumen and omasum. The gastrointestinal tract of the camel is crowded by undigested feed mass, catarrhal gastritis and associated with hypertrophy of the mesenteric lymph nodes (Moebuu, Davaa and Toivgoo, 1966, 1968).

The above authors reported that immune-serum and vaccines of C.perfringens type C for sheep have been used in an attempt to control and prevent enterotoxaemia in camels. These preparations have not shown good results. As a result, they tried to isolate C.perfringens type C from affected camels and created a trial vaccine.

Infectious pneumonia

Dr. Sakhai O. (1965) investigated this bacterial disease for his dissertation and included an intensive study of the available literature. He has isolated the diplococci named Pneumococcus cameli from an affected camel. The capsular diplococci give formed small-crystals dew growths in meat-and-peptone agar medium with 1 per cent glucose within 24-48 hours. The bacterium can create haemolysis in the blood agar

medium. Animals used for the experiments, such as white mice and guinea pigs, are more susceptible to this type of bacterium.

Various stress factors such as transportation, long treks, starvation and shearing are considered predisposing factors for this infection that causes death in Bactrian camels. The disease usually lasts about a month, the main symptoms being a chronic cough, fever, nasal discharge, purulent lacrimation, hypertrophy of the shoulder and inguinal lymph nodes and limping due to rheumatism in the joints. A severe cough occurs in the affected camels in the morning and after active and forced movement of the animals (Sakhai O., 1965).

The most pronounced pathological lessions of the disease are seen in the lungs. The organs have dark-brown colored areas and a combination of bronchopneumonia and pleurisy. Mongolian nomads called the camel disease that related to the above pathological lesions, the 'black lung'. Thoracic and abdominal cavities contain huge amounts of catarrhal and mucosal fluids via inflammatory processes within these cavities. Treatments of infectious pneumonia use some antibiotics including tetracycline, 'biomycin', penicillin and 'micerin'. Sakhai O. (1965) mentioned that the most effective results were found using a combination of one of the above antibiotics with sulfanilamide preparations.

Treatment of camel pneumonia used 40 ml solutions of 10 per cent calcium chloride administered intravenously, combined with 10 ml per day of Chanacycline La through intramuscular applications in total three times. The treatments for the disease have shown good results (Erdenebileg U., 2001)

Salmonellosis in camels

Dr. Yondondorj (1987) has isolated and identified *Salmonella dublin, S. Typhimurium* from the pathological intestinal materials of young camels that suffered from diarrhea and death. These camel salmonellae are very similar to small ruminants' serotypes in terms of their morphology, cultivation character, biochemical activation, and virulence and immune-competence characteristics. He indicated that some camel herds contained salmonella carriers. The microbe carrier camels can spread the disease to other non-infected camel herds, which will then develop diarrhea.

21-28 days old camel calves usually suffered from diarrhea, the disease named by nomad herders 'Chatsarailah'. In order to treat this disease, calf camels were injected under the skin with 10-15 ml of an antiserum for lamb colibacillosis. It was very effective and the camels soon recovered (Erdenebileg, 2001).

Camel Brucellosis

Camel Brucellosis is a chronic infectious disease with clinical signs of abortion and periodic limping. Dr. Namshir (1987) has indicated that Mongol camels suffered from Brucella abortus and Brucella melitensis infections. Special clinical findings of camel brucellosis are abortion and periodic limping. He reported that camel limping, especially shifting from one leg to the other is closely related with brucellosis infection. Brucellosis affected the camels' limping on the hip, knee and hock joints for a few days to a month, after which the clinical symptoms disappear due to the intensity of Brucella infection and camel immune-tolerance. The limping is a consequence of arthritis, synovitis and bursitis caused by Brucella.

For the diagnosis of camel brucellosis serological tests are used. Many authors regard the complement fixation test as being the most sensitive and specific test for camel brucellosis (for example Tserendash and Shumilov, 1970). In order to prevent brucellosis in camels, the REV-1 vaccine has been used to generate active immunity. In immunized camels at least 5 years immunity has been observed. The optimal dosage for immunization of a camel is 4 billion microbes per head (Namshir, 1990). After vaccination of camels not secret the Brucella by milk during one month Because can use camel milk after vaccination without withdrawal time. The dynamics of the immune-reaction for the brucellosis vaccination for a camel is very similar to other livestock species but the neutralization of the immune-reaction is not proportionate with other animals.

Camel Paratuberculosis

Camel Paratuberculosis is a chronic disease typically causing severe enteritis and emaciation. This disease has been diagnosed in camels suffering from severe diarrhea (Guake et al. 1964). Guake reported that the main clinical findings of camel paratuberculosis are cachexia, continuous diarrhea and ataxia or poorly coordinated movement during walking. He recorded some biological values of affected camels including: body temperature of 35.5-38.5 degrees C, pulse rate of 50-60 (beat/minute), red blood cell count of 4.1 - $4.8*10^{12}$ and white cell count of 7.8-$14*10^{9}$ per liter of blood.

Guake et al., (1964) and Toivgoo and Davaa (1968) have described the pathological lesions of camel paratuberculosis, which occurs in the duodenum, small intestine, ileum and colon. In the internal wall of camels' intestines mucosal inflammation develops with deep transverse folds, covered by grey scurf, as well as hypertrophy of the mesenteric lymph nodes.

Davaa (1966) implemented a trial experiment using pure culture of *Mycobacterium paratuberculosis* from the pathological organs of affected camels. 8 milligrams of the pure culture were injected intravenously into goats and 72 hours afterwards he conducted an allergic test by avian and bovine tuberculin. The results of these trials indicated that a positive reaction against avian develops, but a negative reaction to bovine tuberculin develops.

The authors suggested the use anti-parasitic ('naganin', 'phenotiazin') and antibiotics (penicillin, streptomycin and chloramiphenicol) as a treatment for sick camels.

Camel Necrobacillosis

Necrobacillosis is a disease that the nomads call 'the black legs of camels'. Dr. Davaa (1987) and Dashnyam (1998) reported that the Mongolian Bactrian camel suffers from necrobacillosis in the steppe region of Mongolia. The source of infection is illness and camels recovering from the disease. Another important source is the natural source of B.necrophorum in soil. Any form of abrasion of the camel's feet are main sources of infection.

When camels stay for long time in water and damp environments such as lakes, bogs and slush, the skin of the camel's feet becomes soft enough that during the grazing period, the camel's leg skin is damaged by hard, thorn bushes. The bacteria of *Necrobacillus necrophorum* enters through the wound and the disease develops (Davaa, 1987). Davaa suggested the following treatment method: at the early stage of

the disease wash the damaged part of the camel's feet in warm water with soap. After washing, the lesions on the feet should be powdered with manganese and boric powders.

Abscess

On camels abscesses tend to be localized on the head, neck and croup, and found in the subcutaneous layer, hair follicles, sebaceous follicles, lymph nodes, muscles and some internal organs. Forms of abscess include folliculitis, furunculosis, and groups of abscesses, pyodermatitis and pyogenic septicemia.

Since 1985 many researchers such as Yondondorj et al. (1986) and Luvsannyam et al. (1990) have studied the causes of camel abscesses. They mentioned that the disease is caused by pathogenic staphylococcus bacteria such as *Staphylococcus aureus*.

The abscess usually occurs in young and female Bactrian camels. Outbreaks of the disease start from early spring and continue to late autumn in Mongolia. Sources of infection are sick animals, draining abscesses, purulent discharges from wounds, infected water points and animal handling equipment such as halters, ropes and fences. The incubation period of abscesses in camels is from 2-3 days to 1-2 weeks depending on the virulence of the causative agents and the resistance of the camels to the pathogenic organism.

The clinical course of camel's abscess can be acute and chronic. Acute cases are characterized by abrupt fever, rapidly increased pulse and respiration rate, foaming from the mouth and bighting mucosa due to blood sepsis and generalized intoxication. This acute form usually occurs in spring (Luvsannaym et al.1990).

When the abscesses grow in deep muscles of camels' legs the following can occur: continuous fever with no clinical findings, unexplained limping, emaciation, recumbence and death due to blood sepsis. In the chronic form of the disease many small infected follicles develop in the subcutaneous tissue of the superficial muscles. This process can continue for one or more months.

In order to treat camels' abscesses antibiotics such as neomycin, monomycin and polymycin at 20,000-25,000 IU/kg should be injected intramuscularly 3-4 times a day until clinical signs are resolved. Adding sulfanilamide preparations to the antibiotic regime will increase the effectiveness of the therapy. Furthermore, the treatment of affected camels should deal with the consequences of the bacterial toxins by including 10 per cent of calcium chloride and 40 per cent of glucose by intravenous injection. Deep abscesses should be surgical drained and wounds washed with 1:500-1000 solutions of potassium permanganate and furozolidone. 'Hemotherapy' is also recommended for abscesses of camels (Yondondorj et al., 1986; Luvsannaym et al., 1990).

Foot and mouth disease of camels

Dashnaym (1998) reported that mortality caused by foot and mouth disease in camels reached 1.2 - 2.5 per cent of affected animals during the outbreak of the disease between 1963 and 1966 in Mongolia. Khukhuu at al. (2000) have described the clinical findings of foot and mouth disease of camels during the outbreak in 2000 in the Western Gobi region. In camels signs very similar to infected cattle appear, such as vesicles forming on the tongue, followed by soft ulcers forming on the mucous

membrane of the mouth and lips after the breaking of these vesicles. However the plantar areas of the legs are affected more gravely with the vesicles converted to ulceration. The following can occur in the camel: loss of nails from digits, peeling of skin at the junction with the pad, peeling of sterna skin and severe limping. The affected camels have hyper salivation with foamy and clammy saliva and an unfavorable odor can be smelled from the mouth of the camels. It took the lesions on the camels' feet up to 10-14 days to proliferate.

Camel pox

Dashtseren (1987) estimates economic losses from camel pox. Estimations are based on a mortality rate of affected calf camels of 90 per cent, a 26 per cent rate of abortion of affected pregnant female camels and expenses for disinfection of camel originated products and handling of equipment equates to 10 – 20 per cent of animal losses.

Contagious ecthyma of young camels

The disease is caused by *Para poxvirus cameli* (Khukhuu, 1982). Khukhuu, (1982) and Dastseren et al., (1984) reported on outbreaks of contagious ecthyma in Mongol Bactrian Camels, especially in young camels. Khukhuu (1982) studied the biological characteristics of parapoxvirus, the causative agent of this disease.

A 10 per cent suspension of scurf from affected camels was cultured in the chorio-allantois fluid of chicken eggs with embryo in order to diagnose the disease. After 72 hours, some samples from the infected eggs were taken and specimens prepared with stained by Paschen-Morozova method. The specimens were checked by microscopy to show special Paschen's corpuscles. The virus of contagious ecthyma of camels contains 12-15 capsids of nucleoproteins. Only camels are susceptible to this type (Para poxvirus cameli) of virus. The virus can live at -20 degrees C in environmental conditions and in an egg culture from 4 to 6 months.

Contagious ecthyma in camels is usually characterized by local pox-like lesions on the face. Outbreaks of the disease occur from March to mid July and sometimes from mid September to November. The virus is resistant to cold weather conditions.

The virus gains entry through injured mouth mucosa of calf camels due to their inexperience in eating bushy pasture. Other sources of infection are diseased calf camels and handling equipment. Studies by Dashtseren et al. (1984) have shown that neither immune serum nor the Parapoxvirus ovis vaccines protect against parapox disease in camels. However, the authors have achieved protection against this disease using camel parapoxvirus strains cultivated in eggs. Vaccinated camels were protected from the diseases for at least six months.

Influenza of camels

Although ruminants and camelids in general are not considered susceptible to infection of the influenza virus, a severe outbreak was reported among Bactrian camels in Mongolia. The outbreak started in 1979 and was caused by H1N1 influenza, a virus of the family Orthomyxoviridae (Lvov et al. 1982). Thirteen virus isolates were obtained from a total of 92 nasopharyngeal swabs cultured in the allantoises fluid of infected chicken eggs with embroys. The isolates were identified by the hemagglutination test as H1N1 influenza A viruses. The origin of camel influenza viruses is still unknown, but it has been suggested that these isolates may be resorting

viruses formed from two well characterized human influenza A strains (Dashtseren, Bekh-Ochir, 1980; Lvov et al., 1982).

By microscopy the samples that were prepared from lung, liver, spleen and trachea of camels suffering from influenza showed mono-; dipole-; pseudo; strepto-., staphylococci (Bekh-Ochir et al., 1987).

Electron microscopy of the camel H1N1 influenza A virus displayed the following characteristics of the virus; the length of the virus was127±3.5 нμ; the virus had 12 нμ thigh capsules; the ribonucleoproteid (RNP) of the virus was 60 нμ; and the diameter of fibers for RNP was 12 нμ (Bekh-Ochir, 1987). After several passages of the virus through the eggs the hemagglutination activity of the virus rapidly increased.

Camel H1N1 influenza A virus lost 50 per cent of its activity of infection at room temperature after 6 hours and after 24 hours activity of infection had ceased in all viruses. At 40 degrees C, 75-80 per cent of the activity of infection in the virus remained for 24 hours and 100 per cent of the virus lost active infection after 7 days. However, at minus 100 degrees C the virus lost activity after 7-14 days.

The history of influenza epizootics and the clinical course of the disease are poorly documented. Outbreaks affecting 61 camel herders occurred between 1978 and 1988 in different parts of Mongolia. One of the outbreaks involved about 4,000 camels affected with severe respiratory symptoms and with occasional fatality. The clinical symptoms observed were as follows: death 9.1 per cent, abortion 2.6 per cent, and cachexia 6.7 per cent. Further symptoms during the acute form involved a dry cough, bronchitis, pneumonia and fever. There was a mucous ocular and nasal discharge. The clinical course lasted about one week.

A total of 34 healthy three and four year old Bactrian camels were infected experimentally with the H1N1 influenza isolates from affected animals. These test camels were first confirmed to be free of pre-existing specific influenza antibodies. Groups of three camels were each infected by either the intranasal, intratracheal or intramuscular route. In three independent experiments performed between 1985 and 1986 no severe clinical symptoms were observed after the experimental infections, although the challenge virus strain was re-isolated and the experimental animals seroconverted, exhibiting hemagglutination inhibition titers between 1:16 and 1:128. Only mild clinical symptoms, such as fever up to 39 degrees C and mucous nasal discharge were observed. All animals recovered.

Camels affected by influenza developed short-term immunity (from one to six months). Bekh-Ochir (1988) created a new vaccine against camel influenza that can protect from H1N1 A infection for six months. The designers of this camel vaccine won the Mongolian state prize in 1990.

Rabies

A natural source of rabies infection is the dog, especially stray dogs. Rabies in camels is usually transmitted from infected wildlife species such as prairie foxes and wolves. An epidemiological survey of rabies has shown that of the total number of animal deaths from rabies during the past decade in the Umnugobi province of Mongolia, 79 per cent of them were camels. The Mongol Bactrian Camel has a high susceptibility to rabies related to the following factors: (i) wildlife infected with rabies often attack

bushy plants that are the main sources of camel food; and (ii) camels come into direct contact with the natural transmitters of the disease due to poor control of their movements (Erdenebileg, 2000).

8.2 Parasitic diseases of camels

Reviews of parasitic helminthes in Mongol Bactrian camels

Russian scientist Ivashkina (1953) identified parasitic helminthes of the Mongol Bactrian Camel involving the following species: two species of tapeworm and 19 species of nematodes or roundworms. After these studies Mongolian researchers conducted a wide range of studies on the helminthology of Mongolian camels. They have described one species of flatworm, four species of tapeworm and 23 species of nematodes. In wild camels (Camels fetus) only two species of nematodes were identified (Sharkhuu, 1982). Many authors have studied parasitic helminthes and their infestations of the Mongol Bactrian Camel (Shumakovich, 1937; Ivashkina, 1953; Ivashkin, 1955, 1957; Baatar, 1971; Sharkhuu, 1975, 1982, 1986; Tsedevsuren, 1980). General signs of helminthosis of camels are diarrhea, cachexia and periodic limping.

Echinococcosis of camels

Shumekovich (1937) reported on the diagnosis of echinococcosis in the Mongol Bactrian Camel. Ivashkina (1953) wrote that of 23 camel carcasses autopsied two of them were affected by hydatidosis. Mongolian veterinarian Udev (1953) examined the internal organs such as the liver, lungs and spleen of 105 slaughtered Mongol Bactrian Camels and found 48.5 per cent were infested by hydatidosis. The lesions of hydatidosis were located in the liver (76.1 per cent), lungs (70.4 per cent), and spleen (8.5 per cent). Camels are more susceptible to echinococosis due to the behavior of definitive hosts (such as foxes, dogs and prairie wolves) that tend to defecate on bushy plants that are the main sources of food for camels (Sharkhuu, 1982).

Roundworm infestations of camels

Diseases in Bactrian camels that cause diarrhea, cachexia, edema on the lower jaws, foamy salivation, and periodic limping are closely related to roundworm infestations.

The eggs and larvae of the roundworms *Trichostrongylus, Nematodirella and Nematodirus* are highly resistant to harsh Gobi desert environmental conditions and can remain alive for long periods of time. Young camels are infested from contaminated rangelands from May and June each year. Young camels with infestations have shown progressive anemia, hypotrophy of body growth, periodic diarrhea and death from heavy infestations (Sharkhuu, 1982, 1986).

Mongol Bactrian Camels infested with Trichostrongylus have an average of 32,970 ± 646 worms per animal (maximum 87,450 ± 1718, minimum 2,780 ± 52) (Tsedevsuren, 1980). In the Gobi region, 60.2 per cent of total camel herds infested by roundworms have an average intensity of infestation of 1044 worms per head. Calf camels and yearling were affected by the Nematodirella infestation (Sharkhuu, 1975, 1982, 1986).

In the Gobi region 15.6 per cent of camels are infested by similar species of roundworms to those found in wild antelope or gazelle, suggesting that these wild

species are possibily transmitters of the roundworm infestations (Sharkhuu 1986, 1988).

The roundworm infestations do not have any special clinical signs and usually occur as mixed helminthes infestations in the camels. In the affected camel anorexia and diarrhea can occur due to migration of the helminth larvae to the host's intestinal mucous membrane. Due to the helminthes infestations the following general clinical findings were displayed such as a decrease in milk and wool productiveness, conjunctivas, sclera, mucous membranes becoming white, periodic diarrhea, edema under lower jaws and abdomen. Sometimes, a sudden high fever can occur, as well as profuse diarrhea and death within 2-3 days. Dorjpurev (1968, 1969) investigated the blood of sick camels with diarrhea and found decreased numbers of red blood cells (RBC), concentration of hemoglobin in RBC and some forms of white blood cells as lymphocyte, but an increase in neutrophill forms of white blood cells (WBC).

More than 70 per cent of young camels in the Gobi region infected by the disease named ‘Juguntukh’ were infested by Nematodirella roundworms. The blood of the affected young camels contained decreased numbers of RBC and their hemoglobin contained increased neutrophill forms of WBC. Furthermore, total protein, volume of calcium and inorganic phosphorous of the blood serum were reduced in sick camels. All these metabolic disorders result in autotoxemia and progressive anemia (Erdenebileg, 1995). Many authors such as Gauke et al. (1964); Moebuu et al. (1966); Toivgoo et al. (1968); Dorjpurev (1968); Zanaa (1968); Baatar (1970) mentioned that some photogenic microbes in the camel's alimentary tracts were activated because of weakening of immune-tolerance and helminthes infestation.

A 1.25 per cent solution of copper sulfate, ‘phenotiazina’ and ‘tetramezol’ are effective against helminthes of camels (Tsedevsuren, 1980, 1981; Sarkhuu 1982, 1989).

Parabronema infestation of camels

In the western and southern region of Mongolia, 97-100 per cent of camels are infected by Parabronema and have an average of 450-770 helminthes per animal (with a maximum of 2830) (Choijoo, 1960; Tsedev, 1967; Tsedevsuren, 980, Sharkhuu, 1982; Ivashkin 1955, 1957; Baymbaa et al., 1997). Parabronema infestation is a common disease in Mongol Bactrian Camels.

Ivashkin (1957) suggested that ‘phenotiazina’ is more effective against these types of parasitic infestation. The treatment dosage of ‘phenotiazina’ is 300-500 grams per head and the optimal time for treatment is during May. Also ‘tetramezol’, ‘vermatan’, 10 per cent of solution organophosphates and ivermectin are 86-100 per cent effective agents against adult *Parabronema*.

Lungworm infestation

Lungworm infestations of camels are caused by *Dictyocaulus cameli nematodes* in Mongolia. Sharkhuu (1982) reported that lungworm infestation of camels was found only in wetlands such as the lowlands of the Great lakes in Khovd and Uvs aimags. 36.4 per cent of these camel herds were affected by this type of lungworm and an average of 115 worms per animals were found.

To treat lungworm infestations in camels use intratracheal injections of potassium-iodine solution (pure iodine 1 gram plus potassium iodine 1.5 gram, in 1500 ml of water) (Maygmar, 1974). 'Loxeran' and ivermectin are also effective against lungworms in camels.

Mange

Camel mange is caused by Sarcoptes cameli mites. The infested camels suffer alopecia with intense irritation. The eggs of the mites have an average length of 152μm and a width of 87μm with an oval shape and are covered by a rough coat. The length of adult mange mites is 373-512μm and the width is 283-354μm. The mites of camel mange can live from one week to 10 days in conditions of 68-75 per cent humidity and temperatures at zero degrees C. The mites cannot infect other species such as rabbit, sheep and goat (Tsedev, 1972).

Dr. Tsedev also reported that camel mange intensity increases from September to January and it is inactive from February to the following September due to the cold weather conditions in Mongolia at this time. Usually young camels (41.2 per cent of total affected camels) suffer from sarcoptic mange because these camels have not developed immunity against the mange mite. The main sources of the infection are diseased animal, handling equipment and camel fences.

Mange has acute, sub-acute and chronic clinical courses.

Acute course of camel mange

An acute course of mange develops from September to December. During this course, the nidus of the disease spreads to all parts of the camel's body and a rapidly increase in itching occurs. As a result the camel brushes against fences, trees, stones and other animals for longer periods especially, during the night.

Sub-acute course camel mange

This course occurs from March to May. The nidus of mange slowly spreads to new healthy body parts, and the chronic form of mange is converted in to the sub-acute form. During this course the camels develop itching in their skin folds, and they shed wool on the affected parts of their bodies.

Chronic course of camel mange

This course of mange appears in January and February and from June to August. During this course the nidus of the disease is not spread due to influence on mite development of harsh environmental conditions such as severe cold, hot and extreme dry weather conditions (Tsedev, 1972).

Sarcoptic mange (*Sarcoptes cameli*) of the Mongol Bactrian camels usually infests the neck (46 per cent) but sometimes spreads to the fore flank, the middle part of abdomen, rear flank, flank, thigh and fore and hind legs. In young camels the mite usually infests the head and neck. The main clinical signs of mange are that the camels brush against hard objects such as trees, fences, stones and shelters, they bite their own body parts and are increasingly excited. In the nidus of sarcoptic mange twin papules grow and the skin in this area becomes hard and wool is shed. After 14 days the papules combine to create a huge nidus with mild inflammation occuring in the surrounding skin.

Skin scrapings of several sites may be required to find mites and confirm the diagnosis of sarcoptic mange. The sample of scrapings can be examined by clearing the sample with 10 per cent NaOH, then using 'Dobichin and Shic' methods followed by microscopy studies.

During the 1960s treatments for camel mange involved the use of a chamber with exposure to fumes of pure sulfurs. Second generation treatments of sarcoptic mange included solutions of 'hexachorin' and 'lendan' for spraying. Nowadays, ivermectin is given subcutaneously at one milligram per 50 kilogram of body weight and is effective if used twice 14 days apart.

Ticks

Mongol Bactrian camels can be infested by Hyalomma asiaticum ticks in the axillary and inguinal regions. This species represents only 4 per cent of total camel ticks. Dermacenter nutalli and D. degastanicus are located mainly in the neck of a camel. These ixodic ticks are the most introduced tick species to the camel, and represent 96 per cent of the total camel ticks species. The Rhiphacephalus pumillo species seldom infects camels in Zuungar Gobi and Bor tsonj Gobi (Dash, 1965). Camels are infested with tick species from March to August each year.

Nasal bots

Nasal bots in camels are caused by the larvae of Cephalopina titillator insects. Most of the larvae (67 per cent) are located in the nasal cavities and the rest (33 per cent) are located in the labyrinth of ethmoid and frontal cavities (Tainert, 1989). The larvae of Cephalopina titillator take 21.0+0.5 hours to hatch from larvae to pupae after falling from the nose of camels, and take 33.8+0.74 days from pupae to develop into adult bot flies (Erdenebileg, Odbayar, 2003).

The intercostal cartilage on the head bone of the camel is the most suitable point for treatment of camel nasal bots (Davaa, 1968). Using Ivermectin, 6 and 50 per cent of 'bublin' and 'three-chlorophone' are 96 per cent effective for treatment of camel nasal bots (Tainert, 1989).

Myiasis (fly-strike)

All classes of camel can become infected by myiasis but mainly female camels are infected. Females are more commonly infected due to the 2-3 day estrous bleeding from the vagina during July and August each year. Myiasis occurs in approximately 10 per cent of female camels (Khadjiiskii, 1969). Erdenebileg (2001) observed that of the herds infested by myiasis, 73 per cent of the camels were female and 16 per cent were young camels. The myiasis affected the vagina, and abscesses and wounds in the head, neck and other body parts.

Fleas

The Mongol Bactrian Camels can become infested by flea species such as *Bermipsilla alacurt, Dorcadia ioffi,* and *Dorcada dorcadi* (Tsedev B., 1975).

8.3 Non-infectious diseases of camels.

Chronic rhinitis

Chronic rhinitis is named ‘guvruu’ by nomadic herders. Erdenebileg et. al. (2003) indicated that the disease originated from accumulated serous and purulent exudates in the nasal cavities. The special inflammation develops due to the enlargement of these cavities and causes breathing difficulty. Erdenebileg (2003) also examined 140 slaughtered camel skulls and found that more than 10 per cent of them had chronic rhinitis.

One of special signs of rhinitis in camels is a cold feeling in the nasal cavities observed by vets checking the cavity with their fingers. At autoscopy of the nasal cavities displays the following changes: most of the cavities have red-brown and blue-brown coloring, the cavities are filled by mucous and purulent exudates and the wall of the nasal cavities become thicker. One of causative factors of rhinitis in camels is the larvae of camel nasal bots.

Alimentary dystrophy

The reason for camel calf alimentary dystrophy is that the *Salsola passerina* type pasture yield decreased by 37.7-57.7% as well as its nutritional value declining by 18.6-23.7%, digestive proteins by 22.3-46.4% and its water contents by 19.1-55.8%, making the pasture less digestablity for animals during the winter and spring season in the Gobi region. Moreover, camel grazing time is reduced by 2-4 hours in these seasons (Tsetseg-Ulzii, 1985; Erdenebileg, 1995).

The body weight and some blood biochemical parameters of the Mongol Bactrian camel tend to decrease from December to April of the following year (Erdenebileg, 1985). In one study camel body weight losses were found to be 4.5-16.2 per cent of the autumn body mass of young camels, 6.6-23.5 per cent in adult she-camels, and 7.0-9.4 per cent in adult males through the winter and spring seasons (Luvsan, 1975; Tsetseg-Ulzii, 1980).

There was one occurence of yearling and she-camels affected by alimentary dystrophy during this period. Clinical signs include collapsed fat humps, extreme exhaustion, protruding hipbones, shoulder joints and backbones. The skin of a camel becomes bluish and thinned. Erdenebileg (2001) reported that the total protein (especially albumin), inorganic phosphorus and calcium of the blood serum of affected young camels have been shown to decline considerably compared with healthy camels ($P < 0.01$-0.001).

Prevention of alimentary dystrophy in camels involves using supplementary feeding and blanketing them during winter and spring.

Alimentary ostoedystrophy

Oyuntsetseg (1991) and Erdenebileg (1995) conducted studies on alimentary osteodystrophy in young camels related to protein and minerals deficiency from grazing pasture plants in the Gobi and semi-desert regions of Mongolia. The morphology of dead young camels affected by alimentary dystrophy was compared with normal young camels (for example those eaten by wolves). Morphometry of the

metacarpus for affected young camels demonstrated the following: length of the bone was 2 cm greater, the width of the bone 0.5 cm; girdle of the bone 1.55 cm; bone medulla diameter 0.13 cm; wall thickness of the bone 0.16 cm lower than normal one. the weight of affected camel whole bone was 36 per cent lower than normal young camels (Erdenebileg, 1995) showed that in the bone of affected animals had morphological changes. Furthermore, the bone of diseased young camels contained reduced levels of fat (35.6-56.2 per cent), ash (2.54-2.05 per cent), calcium (4.6-27.1 per cent), phosphorous (0.77-21.2 per cent), and magnesium (15.0-26.5 per cent) relative to the bone contents of normal young camels.

'Juguntukh' - young camel disease

Erdenebileg (1995) conducted a study on a disease affecting yearling camels called 'Juguntukh' by the nomads. The disease of young camels is a general metabolic disorder closely related to protein-mineral exchanges especially calcium and magnesium deficiency due to unfavorable environmental conditions, harsh winter and spring conditions, shortage of feed resources, some parasitic infestations and young animals with weak adaptation to the environment.

The results of the Erdenebileg (1995) study showed that common camel infectious diseases caused by photogenic aerobes and anaerobes, camel brucellosis and common viral diseases including camel influenza were not related to this disease. But the eggs of helminthes examined in the sick camels showed that 70 per cent of affected young camels are high affected by helminthes infestations. It has been demonstrated that helminth infestation in young camels can influence the emergence of this disease in the Gobi region.

'Juguntukh' usually affected 2 years old camels and sometimes 3 years olds. The main clinical findings of the disease are ataxia, uncoordinated movements like a camel with fetters, lying for a longer time than normal, sometimes hematuria and a reduction in body temperature. The blood of the sick camels have a RBC count of $10.2+0.65*10^{12}$/L, and a hemoglobin count of 117.7+4.16 g/L less than normal camels in the same regions. Also when camels are infected with the disease there is a decrease in the crude protein in the blood, and their albumin fraction and albumin/globulin rate becomes a disorder of protein exchange in affected camels. Furthermore, the volume of calcium, potassium and magnesium in sick camels is considerably decreased when compared with normal camels ($P<0.001$).

Mongolian nomadic herders claim that to treat sick camels the use of many new growing root chives (*Allium polyrrhizum*) is effective. Erdenebileg (1995) conducted an analysis on the plant. In the growing season many root chives (Allium polyrrhizum) contain up to 25-43 per cent crude protein, calcium and magnesium in total dry matter. For treatment of the 'Juguntukh' Erdenebileg uses a 'Paravert' solution which contains calcium and magnesium and combines A, D, E vitamins intravenously and does de-worming using 'tetramezol' preparation. This kind of therapy is very effective for this camel disease (Erdenebileg, 1995).

Fluorosis of camel teeth

Mongolian nomads call this disease 'black teeth' and it causes abnormal mixed levels of erosion and black coating on some of the camels' teeth. The examination of 685 skulls of camels, slaughtered for the purpose of identifying teeth lesions, showed that

143 (20.8 per cent) had some form of teeth lesions. As a result of abnormal erosion, teeth become gingival and buccal membranes become severe traumatized by unprocessed feed in mouth cavities. Sometimes feed matter is driven through holes formed from eroded teeth and can develop into big pouchs, that nomads called 'khumuj', between the teeth and cheeks (Erdenebileg, 2001).

'Green diarrhea' or boric enteritis

This is a chronic diarrhea in camels seen in spring and autumn in the Gobi and desert regions of Mongolia. The camel diarrhea appears in areas where the following plant types dominate rangelands: saxaul (*Haloxylon ammodendron*), saltworts, reaumuria (*Kalibium foliatam, Salsola passerina, Reaumuria soongorica*) and short leaved anabasis (*Anabasis brevifolia*). In the Dornogobi semi-desert region, samples of soil and plants contain higher levels of boric than other Gobi regions. The soil samples contained free boron at levels of 2.3 ± 0.37 mg/kg; in dry grass 23.8 ± 2.6 mg/kg (in spring) and in green grass 40.0 ± 5.71 mg/kg (in summer). Green grass has especially high volumes of boric that can lead to a hyper boric state in camels, causing boric enteritis (Erdenebileg, 1992).

Hypothermia of calf camels

One of the main reason for losses of new born calf camels is death by frost. Female camels give birth from mid March each year. March is warmer than winter in the Gobi with average daily temperatures of 1.3 - 13.2 degrees C, but minimum temperatures can drop to -7.80 to -15.9 degrees C. Together with heavy snow and dust storms, the conditions can become too extreme for survival of new-born calf camels (Erdenebileg, 1995).

Retention of a meconium

Tsedevsuren (1989) reported that new-born camels died from a retention of a meconium in their intestines. Usually, new-born calf camels are affected by meconium retention due to exposure to cold in the first few days of their life. The clinical findings of the disease are anerexia (poor suckling), ocular discharge, recumbence and pain in the abdominal wall. The main pathological changes of dead animals are bloodletting in the small and large intestines and mesenteries, bloating and dried meconium in the small intestines.

Diarrhea of the new-born calf camel

Tsogttyua (1979) studied the causes and clinical findings of digestive disorders in new-born calf camels. 45 per cent of annual loses of new-born calf camels were found to be caused by some form of digestive disorder. The cause of diarrhea is still unclear but various predisposing factors are known such as cachexia of mothers, low hygiene conditions of calving houses and delayed colostrums intake. The diarrhea is typically milky white or grey in the first stage of the disease. The fecal consistency can range from soft to watery and sometimes hemorrhagic. Nasal and ocular discharges and muscle rigors may occur. Calf camels develop mild diarrhea between 15 and 45 days postpartum and it continues for around 9 days. Treatment of the diarrhea is supportive, using oral electrolyte replacements, and calcium chloride and glucose intravenously as well as antibiotic therapies.

Bezoars (hair ball disease)

Davaa et al. (1987) reported that calf camels can be affected by this disease. The hairballs in calf camels consist of their mother's hair, which they have eaten and food mass.

White muscle disease of calf camels

Sodnomdarjaa (1987) reported that Mongolian calf camels can suffer from white muscle disease when their dams received selenium/vitamin E deficient feed from pasture before or during gestation. White muscle disease is attributed to a deficiency of selenium and vitamin E that inhibits large amounts of unsaturated fatty acids due to a disorder of the camel's metabolism. The delayed type of white muscle disease is associated with both cardiac and skeletal muscle. Affected calf camels may move stiffly with an arched back and an abnormal walk, where their forelimbs have a pronounced limp but their hind limbs are dysfunctional. The affected calf camels tend to sit down like dogs. The cardiac type of the disease may result in sudden death within 2-3 days after birth, always with involvement of the myocardium. Some calf camels show progressive cardiac failure and dyspnea.

Commonly, the affected muscle is pale and dry and usually shows distinct longitudinal striations or a pronounced chalky whiteness due to abnormal calcium deposition, but sometimes this may be diffuse. Cardiac lesions occur as well-defined sub-endocardial lesions. Affected calf camels may be given sodium selenite and vitamin E in solution. 1 per cent of sodium selenite solution should be injected subcutaneously at 1millitre per kiloggram of body weight. Another recommended remedy is 3 per cent of alfa-tocopherol at 50-100 milliltre per day in total for least 10 days (Sodnomdarjaa, 1987).

Alimentary hypotrophy of calf camels

Average camel losses are 4.8 per cent of the total camel number that were counted at the beginning of the previous year. Of these losses more than 30 per cent are yearling camels. According to Erdenebileg (2000), 13 per cent of new born calf camels suffer from hypotrophy and will not survive their first harsh winter and spring.

Etiology

A herder's questionnaire survey showed that hypotrophy of calf camels is caused by inefficient camel breeding management (about 35 per cent of the problem), a lack of mother milk and feed supply shortage (40 per cent), and diseases of both mother and their calves (25 per cent).

Influence of mother's milk supply on calf camel growth

Camel milk yield is high during the first month after birth, but it decreases after April due to a shorter grazing period of female camels. Initially the female camel tends to her newborn and does not use distant rangeland for around 14 days after birth. Milk degradation is also related to low levels of rangeland pasture during the birthing season. Camel milk increases from May because some areas have soil with high moisture content and new grasses begin to grow. Erdenebileg (2000) studied two groups of calf camels with similar body weights and growth rates but their mothers' milk yield were different. After two months, the calf camels with higher yielding dams had an extra 8 per cent body weight, 9.6 per cent greater chest circumference

and 5.5 per cent greater metacarpal circumference compared to the control group. It was shown that the quantity of camel milk available is the main factor influencing calf camel growth.

Influence of grazing time on hypotrophy of calf camels

Erdenebileg (2000) found that calf camels use pasture for an average of 7.8 ± 1.75 hours per day and they stayed on leashes for 16.2 ± 2.3 hours per day in milking time during summer. Erdenebileg selected two groups, one was a control group that used pasture for 7 hours per day, and the other was an experimental group that used pasture for 12 hours. Two months after the trial started, calf camels in the experimental group had more than a 9.9 per cent increase in body length and chest circumference, and 11.9 per cent heavier body weights than the control group ($P<0.02$-0.001). This shows that grazing time has a positive influence on calf camel growth.

Influence of herders' activities on the hypotrophy of calf camels

Erdenebileg (2000) conducted a study of calf camel growth during normal herders' activities by studying a herder named Jijee who is an award winning Mongolian laborer. Jijee initiated a method for raising calf camels involving both suckling from the dam, while allowing time for the dam to graze in distant areas as well. This method is used for creating higher quality milk and food supply and it extends the grazing period. Before the study, the growth of Jijee's calf camels and regular herders were the same. Jijee's calf camels, which were subject to the 'semi-suckling' method, were 22.4 per cent heavier than their contemporaries after three months, and more than 34.6 per cent heavier at seven months of age. This suggests that herders' activities influence calf camel growth.

Influence of weather conditions on hypotrophy of calf camels

Drought, causing feed supply shortage, was considered the most important factor for hypotrophy of calf camels in the Gobi-desert region in a herder survey. The consequences of dry soil, very hot weather and little precipitation in the first and second months of summer are decreased pasture yield and camel milk. This commonly causes hypotrophy in calf camels. Erdenebileg (2000) studied areas with drought. The areas had temperatures 4.5 - 6.3 degrees C higher than average, high soil temperatures, low levels of precipitation (5.1 – 15 millimetres lower than average), a pasture yield 2.7 times lower than average, and had 3-4 hot days with temperatures of 30 degrees C or more. Four month old calf camels in the drought areas had a reduction in body height (7 per cent), body length (7.7 per cent), chest circumference (9.4 per cent), body weight (24.4 per cent) and milk yield in mothers (2.7 times lower) compared to calf camels of the same age in the normal area ($P<0.01$-0.001). During drought, not only is the calf camels' growth and development decreased, but some biochemical values are also decreased. Specifically, calf camels in the area with drought have an 8.3 per cent reduction in total serum protein and a 4 per cent reduction in blood urea relative to similar calf camels in the normal area. This suggests that calf camels in drought areas have disorders of protein exchange caused by a deficiency of pastoral grasses and camel milk. Furthermore, blood serum of calf camel in the area with drought were 13.7 per cent lower in inorganic phosphorus, 29.7 per cent lower in total calcium and 20.4 per cent lower in ionized calcium than calf camels in the normal area. Calf camel serum has a calcium to phosphorus ratio of 1.56 ± 0.04 per cent in this area. This supports the hypothesis that calf camels in drought areas have mineral exchange disorders.

Development of pasture use ability of calf camels

Erdenebileg (2000) determined the timeframe of teeth growth, the age of first pasture ingestion, and the timing of first rumination in calf camels.

A calf camel's teeth grow according to the following patterns: two central incisors grow at an average of 7.6 ± 0.42 days, two medial incisors grow at 20.8 ± 0.91 days, and the two lateral incisors grow at 31.2 ± 1.4 days. Calf camels begin to use pasture at 14 - 20 days and the first rumination display occurs at 39.3 ± 0.77 days after birth. The rumination period of a calf camel is 27.1 per cent longer than in a castrated camel and 20.9 per cent longer than in a female camel. Chewing numbers per rumination of calf camels are 47.4 per cent higher than castrated camels and 28.7 per cent higher than female camels.

The clinical findings and diagnosis of calf camels with hypotrophy

The calf camels with hypotrophy have a noticeably lower body height, body length, chest circle and body weight compared with normal calf camels ($P<0.01 - 0.001$). In particular, the hypotrophied calf camels have 89 per cent of the body height, 91.5 per cent of the body length, 82 per cent of the chest and fore hypotrophy circle and 67.8 per cent of the body weight of normal calf camels.

Furthermore, the breathing rate of calf camels with hypotrophy was 17.3 per cent lower and the pulse rate was 20.3 per cent lower than normal calf camels ($P<0.01 - 0.001$). The breathing number and pulse of hypotrophied calf camels shows that the intensity of their air exchange and metabolisms are weak.

The number of blood red cells and hemoglobin concentration of stunted calf camels were found to be lower than normal calf camels ($P<0.05$). It was shown that stunted calf camels suffer from chronic anemia due to poor blood production. The number of total white blood cells of hypotrophied calf camels did not change but the percentage of basophile, eosinophils and neutrophils in the stunted calf camels increased and the percentage of lymphocytes decreased in their white cells ($P<0.05-0.01$). These results suggest that calf camels with hypotrophy have a weak immune system.

Total blood serum protein of stunted calf camels is 9.1 per cent higher than normal calf camels. The albumin fractions were 15.9 per cent lower and gammaglobulins were 12.6 per cent higher than in normal calf camels. In this case, the average albumin to globulin ratio of stunted calf camels decreased by 1.5 ± 0.99 per cent. This suggests that calf camels with hypotrophy may have a protein exchange disorder.

Calf camels with hypotrophy have a serum lower in total calcium, ionized calcium and inorganic phosphorus compared to normal calf camels ($P<0.05 - 0.001$). Ionized calcium was 46 per cent of the total calcium of blood serum of hypotrophy calf camels. The calcium to phosphorus ratio of the blood was 30.8 per cent lower in the hypotrophied calf camels. Studies by Erdenebileg (2000) showed that the total blood cholesterol of stunted calf camels was 42.3 per cent higher than that of normal calf camels. In summary, external measures like body growth and body weight of stunted calf camels were reduced and they suffered from protein and mineral exchange disorders. Their immune system is also likely to be weak.

Criteria for identifying hypotrophy of Mongol Bactrian calf camels have not yet been developed. Eight-month old calf camels are 120 centimetres tall and 89 centimetres long. Their chest circumference is 125 centimetres, their metacarpus circumference is 12 centimetres, and their body weight is less than 120 kilograms. Erdenebileg (2000) suggests that the above external indexes can be used as criteria for calf camels with hypotrophy.

Morphological differences in stunted calf camels

Erdenebileg (2000) studied some morphological and chemical compounds of fore cannon bone (metacarpus) in alimentary hypothrophy versus normal calf camels.

The total length of the cannon bone of calf camels with hypotrophy was 27.75±0.15 centimetres, which is 4.4 per cent longer than normal calf camels. In calf camels with hypotrophy the width of the cannon bone was 0.5 centimetres, the bone circumference was 1.55 centimetres, the bone thickness was 0.16 centimetres and bone medulla was 0.13 centimetres less than normal calf camels. During the hypotrophy, the hypotrophy morphology became longer while their diaphyses and walls became thinner. The weight of the bone of calf camels with hypotrophy was 145 grams less than normal calf camels. The total fat content of the bone for calf camels with hypotrophy was 6.55 ± 0.76 per cent in the proximal epiphyses, 5.72 ± 0.28 per cent in the distal epiphyses and was 1.45 ± 0.6 per cent in the diaphyses. These values equate to 56.2, 43.8, and 32.5 per cent lower than normal calf camels.

The total ash content in the metacarpus of calf camels with hypotrophy was 38.6 ± 0.76 per cent in proximal epiphysis, 37.0 ± 3.36 per cent in distal epiphysis and 30.8 ± 0.16 per cent in diaphysis. These are 20.45; 2.8; 2.54 per cent lower than in normal calf camels. The above studies suggest that degradation of minerals in the metacarpi are influenced by latent osteodystrophy and identified some macro- and microelements in the metacarpi of calf camels. Minerals are not the same in different parts of the cannon bone, such as epiphyses and diaphyses. The distal, proximal epiphyses and diaphyses of the cannon bone in calf camels with hypotrophy have 4.6 - 27.1 per cent less calcium, 0.77 - 21.2 per cent less phosphorus and 15.03 - 26.46 per cent less magnesium than normal calf camels. The distal epiphysis of the bone in calf camels with hypotrophy has 25.75 per cent less sodium, 71.25 per cent less potassium and 7.01 per cent less zinc than normal calf camels. It has been demonstrated that the metacarpus of calf camels with hypotrophy has a deep morphological change, such as shortages of calcium, phosphorus, potassium, zinc and magnesium. The demineralization of the metacarpus begins in the distal epiphysis. This means total fat, ash, calcium, phosphorus, magnesium, sodium, potassium and zinc of the distal epiphysis decrease.

Control of hypotrophy for calf camels

Calf camels typically lose 7.67 per cent of their body weight under pastoral condition when their mothers are milked in winter and spring. In contrast, calf camels, when covered with blankets lose only 2.7 per cent of their body weight. Their body weight can even be increased by 10.2 per cent using supplemental feed (at 0.2 Russian feed units) during winter and spring.

Davaa (1994) classified some surgical diseases of Mongol Bactrian camels. Mongolian camel researchers (Davaa, 1968; Namsraijav, 1979; Davaa, Orgil, 1980

1981, 1987, 1989, 1998) have developed topography anatomy, surgical approaches and methods of local and general anaesthesia for Mongol camels.

Difficult labor of she-camels

Dr. Orgil (1987) conducted studies on reasons and forms of difficult labor of she-camels and developed methods of its treatment. 83.4 per cent of difficult labor of she-camels is related to abnormal positions of the fetus' legs. The normal presentation camel's fetus is fore legs with nose in passage and dorsal presentations.

During a difficult labor one should conduct a clinal investigation by vaginal cavity and identify the position, size and presentation of the fetus and whether the fetus is alive or dead. Before treatment of a difficult labor spinal anesthesia should be used on the camel (Orgil, 1987).

Some essential vessels for bloodletting of Mongol camels

In order to treat and improve camel's metabolism some researchers used an bloodletting (Andrei, Orgil, 1995, 1998). They described 11 main vessels for suitable of bloodletting in Mongol camels.

Upper orbital artery- /a. supraorbitalis/ the artery go out through above foramen of orbit. Mongolian herders called "tsakhilgaan" means electric. Should 0.5 cm deep strike by special middle knife.

Indication: Inflammanation of eye, tearing. Hair falling disease from head and face, various edema of this region.

Lower tongue artery- /a. sublingualis / under tongue located two bluish vessels. At first lift up the tongue after then 0.3-0.5 centimeter deep strike the vessel.

Indications: glossitis, bloat of rumen, edema around the tongue and gingiva, camel pheumonia.

Inter bone fissure on the upper jaw /fissura intercostalis/ inter bone fissure that is located between upper jawbone and nasal bone of head in all classes of camels. Dr. Davaa (1968) developed methods of washing for nasal cavities through this fissure. .

Jugullar vien- /v.jugularis/ the vessel located in jugullar fossa.

Indication: Camels emacations, some metabolic diseases "Jilven" called camel's diseases. The camels sitting down and 1 cm deep strike to the vessel, take 0.8-1.5 liter blood.

Thoracoventral nerve / n. thoracoventralis / nomadic herders called "Huusun haa" the point located on back fossa of scapulohumeral joint. In this area make an incision up to 6 centimetres deep in adult camels and 1.5-2 centimetres in young camels depending on their body conditions.

Indication: limping on the fore legs, discoordinated movement of fore legs.

Superficial cannon artery- /a. metacarpea volaris superficialis/ located under skin at 10-15 centimetres above the pastern joint and between the diaphysis of the metacarpus and digital flexsor muscle.

Indication: It is more suitable vessel for injection of medicine (Namsraijav, 1979).

Lateral digital veins(ramus vv. digitalis lateralis) 5-6 cm deep located behind of 3 th phalanga of digital bone and between fatten and scale pads of feet.

Indication: Hematome in the feet of camels, edeme in pad of feet, any types of limping.

Superficial thoracic veins (v. thoracica subcutania) in camels its conspicuous cpirse in the subcutaneous tissue of the ventral throax. Its common name is "spur vein" in Mongolian this is called "Duruuluh", meaning stirrup iron.

Indications: In order to intensify metabolism, disorders of blood circulations.

Medial saphenous veins (v. saphena medialis) - the vein that runs a superfial course over the medial aspect of the ventral side of thigh.

Indications: Camel diseases called "Jilven" , limping on hind legs, injury of loins.

Lateral saphenous veins (saphena lateralis) - this vein is conspicuous in camels as it runs proximally in the subcutoneous tissue above the hock and shin bones.

Indications: Paresis of hind legs, rupture of loin muscles.

8.4 Conclusions

In Mongolia researchers conducted a wide range studies on etiology, clinical findings, treatment and control of selected infectious and non-infectouis diseases of Mongol Bactrian Camels. Camel diseases have some special features that related Mongolian ecological, meteriological conditions and pasture animal husbandry. Most camel diseases occur due to contagious infections and metabolic disorders.

REFERENCES

A. In Mongolian

1. Andrei S., Sanjaatogtokh R. 1984. Transformation of camel teeth by aging. J. Agriculture, #3, p. 46-51.
2. Andrei S., Orgil D. Reviews of traditional Mongolian bloodletting treaphies. Booklet, UB., 1995 ,40 p.
3. Andrei S., Orgil D. 1995. Veterinary traditional five kinds of treaphies. Booklet, UB., 76 p.
4. Andrei S. 2000. Comparative anatomy of animal bones. Booklet, UB., 34 p.
5. Andrei S., Baterdene A. 1998. Measurements of body size and head bone of wild Bactrian camel. In proceeding of Mongolian State University of Agriculture (MSUA) , #28, p. 69-78.
6. Adiya U. 1980. Identifying of camel proper herd structure in Gobi. In proceeding of MSUA, #12, p.49.
7. Baatar B. Results of studies on finding phatogenic microbes in healty camel organs. In proceeding of Research Intitute of Animal Husbandry (RIAH), 18, 1970, p. 111.
8. Baatar B. Results of studies on effect of phatogenic microbes during camel diarrhea. In proceeding of RIAH # 18, 1970, p. 103.
9. Baatar Ts. Survey on camel helminths at digestive organs in Gobi region. Research report at RIAH, UB., 1975.
10. Baldan T. 2000. Productivity parameters of Mongol camel. Dissertatioin, UB., 120p.
11. Baldan T. 2001. Subtypes of Mongol camels. Book, UB., 95 p.
12. Baldan T. Theoritical and practice approachs of Mongol camel breeding. Book, UB., 2005, 228 page.
13. Badamdorj D., Erdenebaatar B., Batsuuri L. 1999. Special feature of endocrine regulations of reproductive physiology in she-camels. In booklet Camel studies-2, UB., 20-24 p.
14. Badamdorj D., Erdenebaatar B., Batsuuri L. 1999. Study on activation possiblilities of she-camel ovary. In booklet Camel studies-2, UB., 25-37 p.
15. Badamdorj D., Erdenebaatar B. 1999. Ovulation mechanism of she-camel. In booklet Camel studies-2, UB., 51-61 p.
16. Badamdorj D., Batsuuri L., Khan jinlin, Tsend-Ayush M. 2002. Possibility of biotechnology in camel husbandry. Jounal for animnal breeder's assiociation, #2, p.47-49.
17. Badamdorj D., Batsuuri L. 2002. Possibility of conservation of male camel semen.In booklet Camels and market, UB., p.37-42.
18. Bandi N. 1992. Seasonal variations of protein-carbohydrate some parameters in Mongol camel. Proceeding of Veterinary Faculty, #1, UB., p.61-65.
19. Battogtokh B.1968. Blood serum crude protein and its fractions. Proceeding of MSUA, p.25-27
20. Bayasgalan B., Tainert Werner 1990. Result of study on drug experiment against camel nasal bots. Proceeding of Research Institute of Veterinary (RIV), # 2, p. 67-70.

21. Biichee N. Camel calf rearing recommendation. Handout, Dalanzadgad, 1981, p. 28-30.
22. Biichee N. 1980. Pre-results of studies on camel calf growth and development. Proceeding of Gobi regional agricultural station (GRAS), # 1, p. 45-49.
23. Biichee N. 1989. Behaviour changes of camel calf during use pasture plants. Proceeding of Research Institute for Gobi Regional Pastoral Animal Husbandry (RIGRPAH) #6, p. 31-37.
24. Biichee N. 1990. She-camel calving. J.Agriculture, #1, p.33
25. Biichee N. 1998. Racing speed of Mongol camel.Booklet of Camel Studies-1, UB., p. 107-109.
26. Biichee N. Camel calf rearing methods in Gobi region. Dissertation, UB., 136 p.
27. Bor T. 1989. Some features of behavior of Mongol Bactrian camel. Proceeding of RIGRPAH, #6, p. 22-27.
28. Buyankhishig D. 1990. Features of Mongol camel grazing and alimenttation. Booklet for Camel studies-1, p. 72-88.
29. Buyankhishig D. 1990. Results of studies on protein and carbohydrate metabolism in Mongol Bactrian camel. Booklet Camel study-1, p.-20-35
30. Begz G. Traditional methods of camel treatment. 1969, J.Agriculture, # 3, p.36.
31. Begzsuren S., Damdinsuren S. 1999. Ship of Desert book. UB.,165 p.
32. Bekh-Ochir J., Dashsuren D., Khukhuu A. 1976. Camel influence. J.Agriculture, #2, p. 53.
33. Byambaa B., Dash Mu., Tarasevich I.V. 1994. Exotic rickettsial diseases. Booklet, UB., p. 18-37.
34. Davaa J. 1966. Infection experinment in goat by camel *Mycobacterium paratuberculosis* pure culture. Proceeding of RIAH, #15, p. 79-87.
35. Davaa R. 1987. Camel necrobaccillosis. Proceeding of MSUA, #23, p. 9-11.
36. Davaa R., Orgil D. 1980. Results of studies on camel anesthesia. J.Agriculture,#5, p. 31-33.
37. Davaa R., Tarav J. 1987. Camel calf bezoar disease. J.Agriculture, #1, p.45.
38. Davaa R., Gurjav Kh., Orgil D. 1987. Method of novokine block at camel's lumbar nerves. Proceeding of MSUA, #23, p.154-156.
39. Dagvadorj D. 1969. Studies of yield of camel fat tussies. Proceeding of MSUA, #10, p.-52.
40. Damdin J. 1985. Through pathways of rare animals. J. Science and life, UB., 25 p.
41. Dargia R. 1979. Development prespective of camel husbandry. Proceeding of GRAS, #5, p.37-40.
42. Dash M. 1952. Mongolian camel. J. Science and life, #3-4.
43. Dash Mu. 1968. Tick activation time in Gobi. J.Agriculture, #1, p.41-45.
44. Dashdondog Ts. 1958. Issues of camel husbandry management. J.Agriculture, #6, p. 41-45.

45. Dashdendev D. 1967. Studies on physicial and chemical composition of camel milk during their lactation period. Proceeding of MSUA, #9, p.-25-30.
46. Dorjpurev S. 1966. Blood testing result of camels which suffered by unknown disease.J.Agriculture, #2, p. 45.
47. Yondondorj A. 1989. Some results of studies on camel diarrhea disease. Proceeding of RIGRPAH, UB., #6, p. 72-76.
48. Yondondorj A., Dashtseren Ts., Baatar B., Lundaa Ts., Khukhuu A., Tserenbat L. 1986. Camel abscess. J.Agriculture, #6, p. 41.
49. Jadambaa Sh., Batsukh Ts., Baigalmaa P. 2000 Treatment effect of mare and camel milk on humen chronic hepatitis. Proceeding of Mongolian Technical University, #8, 17-21 p.
50. Jambaldorj D. 2000. Camels origin sky mini glossary. UB., 186 p.
51. Jambaajamts B. 1986. Metrological reviews of Umnugobi province. Dalanzadgad, 155 p.
52. Jamiyanjav Ts. 1978. Veterinary operative surgery. UB., State Publishing House, p. 344-345.
53. Zanaa M. 1964. Control on camel disease. J.Agriculture, #2, p. 37.
54. Indra R., Osorkhaan I. 1987. Industrial processing technologies of camel milk. J.Agriculture, #1,
55. Indra R., Tseveenjav D. 1990. Mongol Bactrian camel. J.Agriculture, #6, p.20-23.
56. Indra R., Magash A., Biichee N.1998. Camel research. UB., 303 p.
57. Ipatenko N.G. 1966. Reason of camel unknown disease. J.Agriculture, #3, p. 32.
58. Lhagva U. 1998. Influinces of hot weater conditions on camel grazing. J.Mongolian Veterinary,#3, p. 11-14
59. Lhagva U. 1998. Influinces of cold weater conditions on camel grazing. J.Mongolian Veterinary,#3, p. 16-18
60. Lhagva L. 1999. Camel infectious diseases. Booklet, 46 p.
61. Lhagvasuren D. 1956. Clinic investigation of camel diseases and some camel diseases. State publishing house, p. 40.
62. Luvsan B. 1968. Studies on biological and husbandry properties of Mongolian camel. UB., 67 p.
63. Luvsan B. 1975. Camel husbandry of Mongolia. UB., 112 p.
64. Luvsan B. 1986. Breeding directions of camel herds. UB., 92 p
65. Luvsan B. 1989. Growth of camel hair. Proceeding of RIGRPAH,#6, UB., p. 62-65.
66. Luvsan B. 1989. Feature of camel grazing. Proceeding of RIGRPAH, #6, UB., p.67-68.
67. Luvsan B. 1982. Unraveling mysteries of camels. J.Agriculture, #3, 14-18 p.
68. Luvsannyam G., Lhagva L. 1990. Camel abscess disease. J.Agriculture, #4, p. 42.
69. Manvelyan M., Bataa R. 1975. Diplococcial infection of camel calf. J.Agriculture, #1, p. 23.
70. Moyobuu D. 1969. Improvement of efficiency of animal husbandry in Gobi region.J.Agriculture, #3.

71. Myagmar J. 1974. Camel dictyocaulosis. J.Agriculture, #2, p.41-43.
72. Navaanchimed M.1954. Milk productivity of Mongol Bactrian camel.Proceeding of MSUA, #4.
73. Namsrai D. 1980. Mineral requerment of camels and needs of mineral fodder for camels. Research report, Bulgan, 87 p.
74. Namsraijav D. 1971. Innervation of forelegs of Mongol camel. Proceeding of MSUA, #14, page 70-73.
75. Namsraijav D. 1974. Nerve-vessels bundle of Mongol camel foreleg and pathways to them. Proceeding of MSUA, #12, p.148-154.
76. Namkhaidorj B. 1978. Camel nasal bots. J.Agriculture, #3, p. 46.
77. Namshir N. 1988 Causal agents of camel brucellosis. Proceeding of Actual problems of veterinary conference, UB., p. 7.
78. Namshir N. 1992. Control methods against camel brucellosis. Proceeding of Actual problems of Gobi regional veterinary, Mandalgobi, p.9.
79. Namshir N. 1987. Cause of camel limping. J.Agriculture, #5, p 52.
80. Namshir N. 1990 Prevention and control of camel brucellosis. Research reports, UB.
81. Namshir N. 1982. Regional anatomy of camel internal organs. J.Agriculture, #3, p. 25.
82. Nansalmaa Ts. 1998.Herder household production management. Dissertation, UB., p.165
83. Nansalmaa Ts. 1989. Time spent shearing wool of camels. Proceeding of RIGRPAH,#6, UB., p.65-67.
84. Nansalmaa Ts. 2001. Camel husbandry management in gobi herder household. Booklet of Camel-market, UB., p.66-73.
85. Orgil D. 1990. Obstrical supports for difficult labor of she-camels. UB., 25p.
86. Orgil D. 1988. Cesarian section in she-camel. Proceeding of MSUA, #24, p. 154-157.
87. Orgil D., Davaa R. 1981. General and spinal narcosis of camels. J.Agriculture, #4, p. 31-33.
88. Orgil D., Alimaa D., Bolortuya Ch. 1999. Camel ophthalmology. Camel Studies booklet, p. 47-50.
89. Osorkhaan U.1982. Camel milk processing technologies. J.Agriculture, #1, 14-18 p.
90. Osorkhaan U. 1979. Quality and composition of camel milk and its dairy products. Proceeding of RIGRPAH,#5, UB., p.55-64.
91. Oyuntsetseg B. 1991. Biogeochemical studies of Orog lake bassien. Analysis and review booklet, 16-17p.
92. Purevragchaa Sh. 1991. Subtype identification document for Tukhum Tungalag camel. UB, handwriring document.
93. Sanjmyatav 1995. Petrogliphs of Mongolia. Book, UB., 196 p.
94. Sodnomdarjaa A. 1963. Distinctive of camel autopsy for phatological examnation. Research review booklet, UB., p. 28.
95. Sodnomdarjaa A. 1987. White muscle disease of calf camel. J.Agriculture, #2, p.59.

96. Sukhbaatar D. 1979. Morphology of genitral organs of bull camel. Proceeding of GRAS, #5, UB., p. 65-67.
97. Sukhbaatar D. 1979. Posibilities of improvement of camel mating. Proceding of GRAS, #5, p.101-103.
98. Tumurjav M. 1989. Pastoral Mongolian livestock. UB.,400 pages.
99. Camel disease section. 1998. in book of Mongolian herd management, UB., p.47-53.
100. Ulambayar O. 1997. Hind legs paresis of camels. J. Mongolian veterinary, #4, p. 28.
101. Diabolism sutra. Manuscripts.
102. Khugulbuu Kh. 1977. Traditional herder customs of animal consume for transport. State publishing house, UB., p. 36-48.
103. Khukhuu A. 1988. Treathment of contagious ecthym in camel calf. Booklet of animal treatment during Dzud, Undurkhaan, p. 69-71.
104. Khukhuu A. 1985. Camel disease and its control. J.Agriculture, #6, p. 23.
105. Khukhuu A., Dashsuren Ts. 1985. Camel contigious ecthym. J.Agriculture, #6, p. 23.
106. Khukhuu A., Tserendorj Sh., Bazartseren Ts., Norinpil A. 2000. Control against outbreak of foot and mouth disease in Western Gobi province. J, Mongolian Veterinary, #3, p.15-17.
107. Tsogttuya Ch. 1979. Influence of intestinal diarrhea in loses of camel calf. Booklet of scientific innovation to livestock practices, Dalanzadgad, p.68-72.
108. Tsogttuya Ch. 1983. Camel calf dyspepsia or intestinal disorder.J.Agriculture, #1,p. 20-22.
109. Tsogttuya Ch. 1980. Survey on intestinal disorder, its treatments of camel calf. Reshearch report, Bulgan, p.52.
110. Tsevelvaanchigdorj Sh. 1992. Camel diseases treatment sutra. UB., p. 9-15.
111. Tsevegmed B. 1971. Breeding physiology of bull camel. Proceeding of GRAS, #2, p. 44-50.
112. Tsevegmed B. 1969. Breeding physiology of she-camel. Proceeding of RIAH, #18, p. 81-87.
113. Tseveenjav D. 1971. Productivity of Galbiin Gobi red camel. Proceeding of GRAS, #2, p.65-67.
114. Tseveenjav D. 1990. Basics of camel husbandry in Mongolia. State publishing house, UB., 161 pages.
115. Tsedev L. 1967. Camel *Parabronema* infestation. J.Agriculture, #3, p. 23.
116. Tsedev N. 1978. Camel diseases its preventions. In first camel herder's conference. State publishing house, UB., p. 68.
117. Tsedev N., Bayasgalan B. 1989. Treatment of camel mange. Proceeding of RIGRPAH, #6, UB., p. 68-69.
118. Tsedev N. Janchiv G. 1973. Influince of chorephose in camels. J.Agriculture, # 3, p.49-51.
119. Tsedevsuren B. 1981. Camel de-worming by chorephose and phenothiazine. J.Agriculture, #4, p.18.
120. Tsedevsuren B. 1980. Helminth faune in digestive organs of camels in Gobi provinces. Research report, p. 67

121. Tsedevsuren B. 1982. Retention of a meconium. J.Agriculture, #1, p. 35.
122. Tsedevsuren B. 1980. Camel helminth infestation and its intensification.J.Agriculture, # 4..
123. Tserendash Ch. 1969. Suitable temperature of serum inactivation at complement fixed reaction for diagnosis of camel brucellosis. Proceeding of RIAH, #18, p. 88-91.
124. Tserenpuntsag Sh. 1969. Camel meat productivity, its meat composition and methods of identifying camel meat quality.Dissertation, UB.,390 pages.
125. Tserenpuntsag Sh. 1971. Camel productivities. UB., 52 pages.
126. Tserenpuntsag Sh.1987. Camel milk processing methods. J.News of Academy of Science, #1
127. Tserenpuntsag Sh. 1974. Composition of camel dried meat. Proceeding of MSUA, #14, p.96-103.
128. Tserenpuntsag Sh., Purev San., Tsevegmed G. 1975. Camel. Book, UB., 213 pages.
129. Tsetseg-Ulzii L. 1985. Influince of supplemental fodder on body growth and productivities of Mongol camels. Research report, Bulgan, 98 pages.
130. Tsetseg-Ulzii L. 1989. Improvement Тэмээний арчилгаа тэжээллэгийг боловсронгуй болгох зарим асуудал. Говийн бүсийн бэлчээрийн Proceeding of МАА-н эрдэм шинжилгээний хүрээлэнгийн бүтээл, УБ., 1989, хууд. 44-45.
131. Sharkhuu G. 1975. Study of camel helminths in western provinces. Research report. UB., 1975.
132. Sharkhuu G. 1982. Parasitic diseases. Book, UB., 96 pages.
133. Sharkhuu G. 1982. Treatment of camel dictiocaulosis. J.Agriculture, #3, p. 26.
134. Sharkhuu G., Dashdorj D., Nyamsuren N. 1982. Tetramesol for treatment of camel helminthosis. J.Agriculture, #4, p. 38.
135. Sharkhuu G. 1989. Helminth faune of wild camels (Camelus Bactrian ferus). Proceeding of RIGRPAH, #6, UB., 1989, p.69-70.
136. Sharkhuu G. Treatment against camel helminthosis. 1989. Proceeding of RIGRPAH, #6, UB., p. 70-72.
137. Erdenebileg U. 1999. Reason and clinic signs of alimentary hypotrophy in camel calf. Camel study booklet,
138. Erdenebileg U. 1991. Reasons of “Juguntukh” diseases in young camels. Research paper, Dalanzadgad, 48 p.
139. Erdenebileg U. 1992. Reasons of “green” diarrhea of camels. Proceeding of RIV, #4, UB.
140. Erdenebileg U. 1995. Some physiological and blood biochemical parameters of camel calf up to yearling during normal pastoral condition and some metabolic disorders. Dissertation, Dalanzadgad, 122 pages.
141. Erdenebileg U.. 2000. Study on alimentary hyphotrophy of camel calf. Research report. Dalanzadgad, 34 pages.
142. Erdenebileg U.. Odkhuu S. 2000. Camel “Jilben” unknown disease: findings on reason and clinical signs. Reseearch report. UB., 15 pages.

143. Erdenebileg U.. 2001. Camel diseases. Textbook, Dalanzadgad, 142 pages.
144. Erdenebileg U.. 2002. Alimentary hyphotrophy of camel calf. Dalanzadgad, 27 pages.
145. Erdenebileg U. Odbayar P. 2003. Camel “Gubruu” disease. Proceeding of conference on theme Gobi regional actual problems of veterinary, p.61-62
146. Yonatov A.A. 1968. Pastoral plants of Mongolia.Textbook, State publishing house, UB., 290pages.

B. Russian

1. Azarov S. 1934. Nomadic animal husbandry in Gobi provinces J. Modern Mongolia, #1
2. Auyrzana T. 1954. Production charaters of Mongolian camel. Publication of Mongolian Commettee, #66, Publishing house of Scientific Academy for USSR, Moscow, p.72-84.
3. Biichee N. 1995. Rearing of calf camel in Gobi region. Abstract of Dissertation, UB., 18 pages.
4. Bekh-Ochir J., Dashtseren Ts. 1978. Study on hemagglutination activity of viruses for camel and horse influenza. Proceeding of annual conference on theme"Actual problems of medical and veterinary virology" UB.,
5. Bekh-Ochir J. 1989. General characters of influenza virus for camel and horse. Abstract of Dissertation, 26 pages.
6. Ganbat O. 1997. Some studies on structure and function of genital organs of Bactrian she-camels and camel abortion. Abstract of Dissertation, 30 pages.
7. Gauke L.K., Davaa J., Tumbaa Ch., Abugaliev R.M. 1964. Camel paratuberculosis.J, Veterinary, #11, p. 115.
8. Gyuk and Gabe. 1870. Travel through Mongolia to Tibet that is capital of Dalai Lama. Second edition, Moscow, p.135-137.
9. Davaa R. 1967. Basic cavities of head in Mongol camels and surgical pathways reach to them. Abstract of Dissertation, Moscow, 21 pages.
10. Davaa R. 1994. Surgical diseases of Mongolian pastoral livestock. Abstract of Doctor dissertation, UB., 1994.
11. Dashtseren Ts., Bekh-Ochir J. 1980. Influenza of camels. Proceeding of presentations for state virological conference, UB., p. 25-27.
12. Dolgushina N.A. 1933. Document of studies on animal husbandry of Bayan-Chandmana mountain’s provinces, Mongolia. Proceeding of Mongolian committee for Scientific Academy of USSR, #7.
13. Dorjpurev S. 1969. Clinical and hemothological parameters of Mongol Bactrian camel, its variations depending on age, gender, seasonal and physiological conditions and some of diseases. Abstract of Dissertation, 15 pages.
14. Jirnov L.V., Iliinskii V.O. 1985. Great Gobi protected area- Большой гобийский заповедник-habitat wild animals in Central Asian Desert. Moscow.
15. Indra R. 1983. Milk productivity and composition of milk of Mongolian livestock. Dolctor Dissertation, Moscow, p.-370.

16. Kolesnikov V.V. 1940. Sweat glands of Bactrian camel. Proceedin g of Veterinary Institute in Azerbaidjan, #3.
17. Lubsan B. 1971. Productivities and biological special feature of Mongol Bactrian camel in Gobi region, Mongolia. Abstract of Dissertation, Alma-Ata, 26 pages
18. Maiskii I.M. 1920. Mongolia before revolution. Moscow.review booklet.
19. Marco Polo. 1940. Travel notes. Moscow
20. Meleshko A.A. 1937. Camel husbandry in Mongolia. J. Modern Mongolia, #3
21. Meleshko A.A 1936. Measures for improvement of animal husbandry in Gobi region. J. Modern Mongolia, #2, p.63-67.
22. Navaanchimed M. 1954. Productivity of Mongol livestocks. Proceeding of Mongolian committee for Scientific Academy of USSR, #66, Moscow, p. 28-31.
23. Naurzbaiv Kh. 1945. Camel husbandry of Mongolia. Alma-Ata. Handwriring document.
24. Prjevaliskii N.M., 1875. Mongolia and country of Tangut. Three-years travel notes through Eastern Mountain Asia. Moscow.
25. Tserenpuntsag Sh. 1969. Camel meat productivity, its meat composition and methods of identifying camel meat quality. Abstract of Dissertation, UB., 31 pages.
26. Shulijenko I.F. 1954. Livestock husbandry of Mongolia. Moscow, Textbook, 135-151 pages.
27. Ivashkina E.E. 1953. Helminth fauna of Mongol camels. Гельминты верблюдов Монгольской Народной Республики. Abstract of Dissertation, Moscow.
28. Ivavkin V.I. 1955. Helminth fauna of Mongolian livestock. Proceeding of Mongolian committee for Scientific Academy of USSR, #68, Moscow.
29. Moyobuu D., Dashdavaa L., Ipatenko I.G. 1966. Infectious enterotoximia of camels caused by Cl.perfringens types C. J,Veterinary, #11, p. 32-35.
30. Namsraijav D. 1979. Regional anatomy of nerve-vessel's bundles of foreleg in Mongol Bactrian camel and surgical pathways reach to them. Abstract of Dissertation, UB., 28 pages.
31. Oinakhbaiv S. 1965. Aetiological factors of camel infectious pneumonia. J. Veterinary, #6, p.106.
32. Orgil D. 1999. Studies on regional anatomy of Mongol Bactrian camel and grounding of traditional surgical treatment of camels. Abstract of Dissertation , UB., 32 pages.
33. Orgil D. 1987. Obstrical and surgical supports for difficult labor of she-camel. Abstract of Dissertation, UB.,
34. Khadjiiski D. 1969. Bleeding from vagina of Bactrian she-camel. J.Veterinary, #4, p.46-47.
35. Khukhuu A. 1980. Feature of cultivation of camel contagious ecthyme virus on embryo of chickin egg. Proceeding of presentations for state virological 2nd conference.
36. Khukhuu A. 1980. Morphology of virus that isolated from camels suffered by contagious ecthyme. Proceeding of presentations for state virological 3rd conference.

37. Khukhuu A. 1989. Biological features of virus caused by camel contagious ecthyme in Mongolia. Abstract of Dissertation, 27 pages.
38. Khukhuu A. 1980. Treatment of camel contagious ecthyme. Proceeding of presentations for state virological 6th conference.
39. Tsedev N. 1972. Sarcoptic mange of camels and its control and prevention in Mongolia. Abstract of Dissertation, Stavropoli, 26 pages.
40. Tsedev N. 1974. Laboratory diagnosis of sarcoptic mange of camels. J.Veterinary, # 2, p. 114.
41. Tserendash Ch. 1970. Diagnosis of camel brucellosis. J.Veterinary, #1, p. 116
42. Chij V.P. 1936. Camel trypanosomosis in Khovd province, Mongolia. J.Modern Mongolia, #6 , p. 27.
43. Sharkhuu G. 1986. Helminth fauna of domestic and wild ruminants and effective control against helminthiasis of ruminants in Mongolia. Dissertation, Moscow.
44. Shumakovich E.E. 1937. Helminth infestation and other parasitic diseases of domestic livestock in Mongolia. J.Modern Mongolia, #2, 3, page in 82-92, 131-134.
45. Erdenebileg U. 1995. Some physiological and blood biochemical parameters of camel calf up to yearling during normal pastoral condition and some metabolic disorders. Abstract of Dissertation,UB., 24 pages.
46. Lensch J. The two-humped camel/Camelus bactrianus/on FAO website/ p.16, 2000. In eng
47. Erdenebileg U. 2001. Some results of study diseases mongolian camel. In abstract Asian symposium on animal infectious diseases nomads, enviroments & zoonoses, Ulaabaatar, Mongolia 28 p. In eng.