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CAMEL HEALTH Chapter 1 and 2

Ch-1. INTRODUCTION

- Camels are mammals with **long legs**, a **big-lipped snout** and a **humped back**.
- There are **two types** of camels:

1. dromedary camels, which have **one hump**, and
2. Bactrian camels, which have **two humps**.

- Camels' **humps** consist of **stored fat,** which they **can metabolize** when **food** and **water** is **scarce**.
- In addition to their humps, camels have other ways to adapt to their environment.
- They have a **third, clear eyelid** that protects their eyes from **blowing sand**.
- **Two rows of long lashes** also protect their eyes. Sand up the nose can be a problem for

- Humans have used camels as a means of **transport** for thousands of years.
- They can carry about **170** -- **270 kilograms** on their backs, according to national geography .

- This earned these **beasts of burden** a nickname, "**ships of the desert**.“
- **Domestic camels** are often the main source of **meat**, **milk** and **even**

Introduction

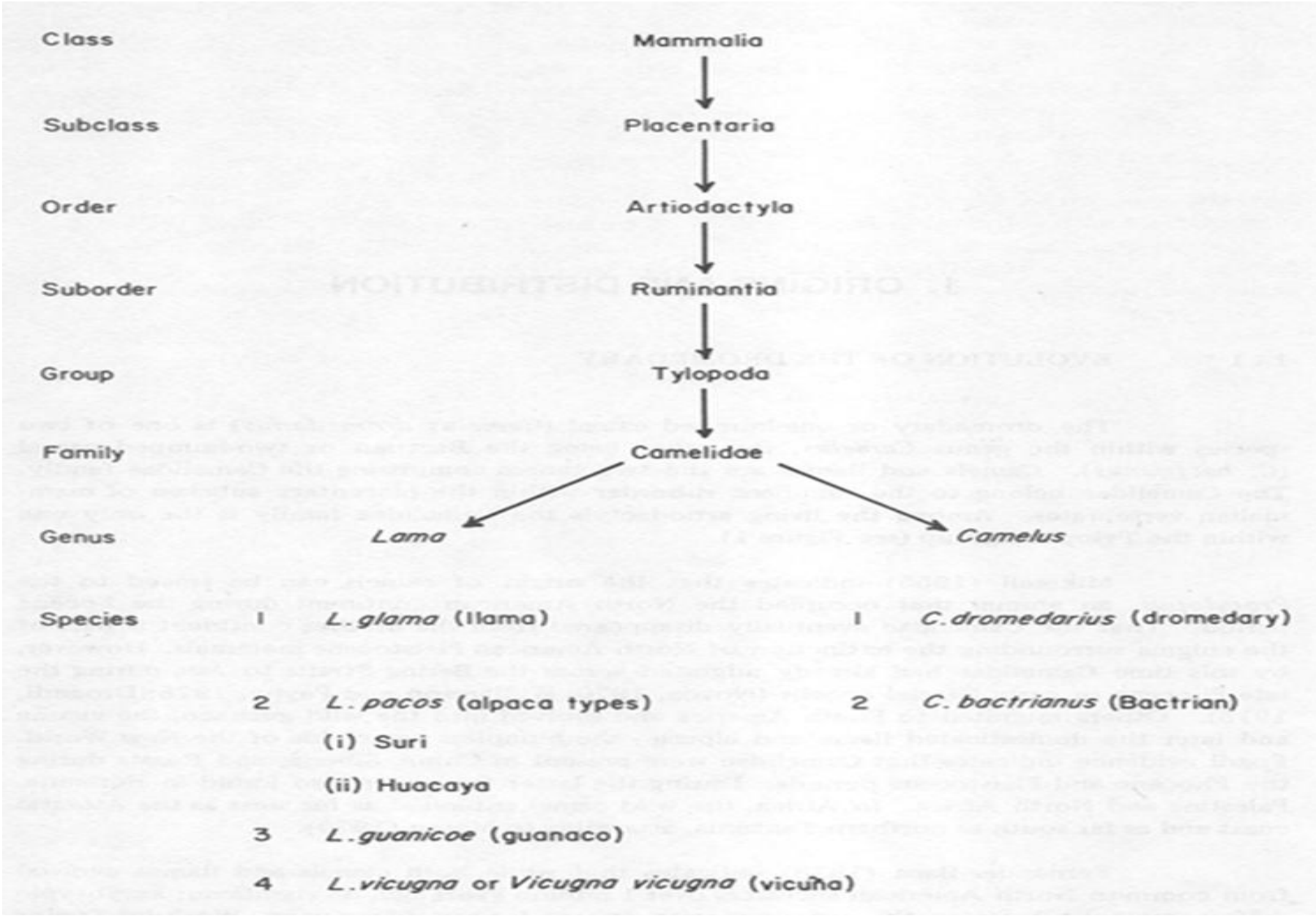
- **Origins and distribution**
- **1.1. Evolution of the dromedary**
- The dromedary or **one-humped c**amel *(Camelus dromedarius)* is one of two species within the genus *Camelus,* the other being the Bactrian or **two-humped camel***(C. bactrianus).*

- **Camelus** and **llamas** are the **two genera** comprising the **Camelidae family**.

- The **Camelidae** belong to the **ruminantia suborder** within the **placentaria** subclass of mammalian vertebrates.

- Among the living **artiodactyls** the **Camelidae family** is the only one within the **Tylopoda group** (see Figure 1).

Figure 1. *Representation of the classification of the dromedary and other Camelidae.*



Cont,d

- The **origin** of camels can be **traced** to the ***Protylopus*** *(*is an extinct genus of camel that lived during middle to late **Eocene period** in North America).

- **Eocene period** (From 58 million to 40 million years ago; **presence of modern mammals**).

- The Camelidae eventually **disappeared** from the **mother continent** is part of the **enigma** surrounding the **extinction** of North American **Pleistocene mammals** (2 million to 11 thousand years ago; extensive **glaciation** of the northern hemisphere; **the time of human evolution**).

Evolution of the dromedary

- However, by this time Camelidae had already migrated across the **Bering Straits to Asia** during the late **Pliocene** (From 13 million to 2 million years ago)

Others **migrated** to South America and **evolved** into

- The **wild guanaco (wild llama)**,
- The **vicuna (similar to guanaco)** and later the domesticated **llama** and **alpaca** (the humpless cameloids of the New World).

- Fossil evidence indicates that **Camelidae** were present in **China**, **Siberia**, and **Russia** during the **Pliocene** and **Pleistocene** periods.

- During the latter they were also found in **Rumania**, **Palestine** and **North Africa.**

- In **Africa**, the wild camel extended as far west as the **Atlantic coast** and as far south as **northern**

- While both **camelus** and **llamas** evolved from common North American ancestors over **1 million** years ago, **no significant karyotypic (chromosomal makeup of a somatic cell) differences** exist between the various species.

- The **guanaco (Wild llama),** the **Bactrian camel** and the **dromedary** each have **74 chromosomes**, similar to the number found in the **llama, alpaca, guanaco** and **vicuna.**

- The evolutionary changes that **occurred** were due to **single gene**

- The **earliest Old World camels**, which probably reached North Africa, were more closely related to the **two-humped camel *(Camelus bactrianus).***

- This **North African stock,** however, **became extinct**, and the subsequent **reintroduction of** the camel to the continent involved the **dromedary instead.**

- The modern one-humped camel or dromedary (the latter name derives from the Greek ***dromados***, meaning "running") is generally thought to have evolved from the **two-humped Bactrian species**.

- This theory is partly based on **embryological evidence** showing that during **prenatal development** the dromedary **foetus** actually has two humps, while a **vestigial** anterior hump is present in the adult.

- The one-humped species probably **evolved** in one of the **hotter** and

- Today the two species **can** and **often do interbreed**, and on the basis of the fertility of the hybrids some authors have advocated **amalgamating** them into one species with two varieties.
- In areas of bordering distribution, such as north Punjab, Persia and Afghanistan, the **phenotypic differences** between the two types tend to **diminish** as a result of the **crossbreeding** between them.

- The two-humped camel (*C. bactrianus)* is generally a long-haired sturdy animal, powerfully built and adapted to rigorous, cold climates.
- It is capable of **marching** in snow-covered mountains.
- The two-humped camel is found in Turkestan and throughout central Asia and in the **extremely cold northern deserts**.

- The species developed in the part of Afghanistan; hence it spread through **Asia, China, Turkestan** and **Russia.**

- The **first homeland** of the Bactrian was the **border of Iran** and **the USSR** (Union of Soviet Socialist Republics).

- The **dromedary** is sometimes referred to as the **Arabian camel**, after the area in which it is thought to have been domesticated and probably most extensively employed.

- Mason (1979) suggests that the dromedary was domesticated in **southern Arabia** around 3000 B.C.

1.2 The dromedary in Africa

- The dromedary was introduced into North Africa (Egypt) from southwest Asia (Arabia and Persia).

- Once in Africa, the camel spread west and southwards from Egypt.
- According to FAO (1979) statistics, there are about **17 million camels** in the world, of which **12 million are found in Africa** and **4.9 million in Asia**.

- Of this estimated world population, **15.1 million** are believed to be **one-humped camels** and **1.9 two-humped**.

- The **world population** of camels is not increasing very rapidly, mainly owing to the decrease in numbers in the non-tropical areas (Williamson and Payne, 1978).

- However, 70% of the **world's** camels are still found within **the tropics** and over 90% of the African herd are present in this region.

- The **African population** is thought to be **increasing slightly**, especially

- Today the dromedary is found in **substantial numbers** in the following African countries:
- Algeria, Chad, Djibouti, Egypt, Ethiopia, Kenya, Libya, Mali, Mauritania, Morocco, Niger, Nigeria, Senegal, Somalia, Sudan, Tunisia, Upper Volta and West Sahara.

- It is noteworthy that the five neighbouring countries of Somalia, Ethiopia, Sudan, Kenya and Djibouti together contain 84% of African camels and over half (60.1%) the world's camel population, while Africa as a whole contains **72%.**

- In **northern Kenya** as in some other areas, however, numbers are **declining**, since the camel is being replaced by other **domestic species**

1.2.2 Classification

- Leese (1927) classified dromedaries according to **their natural breeding areas** into

(i) **hill camels**, small compact muscular animals fit for work bagger, and

(ii) **plains camels**, larger animals subdivided into **riverine** and **desert** types.

- The **riverine camels** are **heavy** bagger with **slow movements,**
- while the **desert types** are light and typical of most **riding animals.**
- He also identifies a third group,

(iii). **intermediate** between **hill** and **plains** animals.

- It has been shown that **dromedaries** can also be classified into **three groups** according to **their morphology:**
- (i) the **brachymorphic dromedary,** a large and heavy animal typified by the **Egyptian caravan camels**;
- (ii) the **mesomorphic dromedary**, a lighter animal **illustrated by the Libyan camel** and
- (iii) the **dolichomorphic dromedary**, to which group belong the lean(inclined), **swift(fast)** animals common among the Saharan peoples.
- The **first two groups comprise** what is

- Cole (1975), writing about the dromedaries of Arabia, distinguishes three types:

¬ the **beast of burden** (**baggager**),

¬ the **riding** and

¬ the **milking** camel.

- Within each of these broad classes there are numerous breeds and types of dromedary, which have been **bred** and **raised** by man to **suit local conditions**.

- Man's **role in evolving** these various types has, however, been **secondary to the genetic** and **environmental pressures** on both the dromedary and the Bactrian camel.

- The names of the dromedary breeds and types found in Africa often reflect
- the **locality** or **country** where the animals are raised,
- the **people who breed them** or simply
- the animals' **colour,** rather than any division into work, riding or milking breeds.

- It is thus possible for the same camel types, with a common **ancestry** but occupying different geographical areas, to be labelled as **two**

Ethiopia

- In Ethiopia camel types are commonly referred to by the **colour of their coat.**
- Thus **the Grain** is a **tawny coloured** baggage camel of the Habab, Ad Shekh, Ad Temeryam, Ad Moalim and Ad Saora **tribes**.
- **The Cajeh** is a **reddish animal** of the Beni Amer from the **Khor Baraka** region.
- It is **intermediate** between the Bishari of Sudan and the Grain, and is used more as a pack animal.
- **The Danakil** is a native of the desert of the same name.
- Other camel types of mixed breeding (especially Arab blood) are found in small

2. Reproductive performance

- The level of fertility in domestic animals results from a number of interacting factors,
- some of which have a **genetic basis** while others are **environmental in origin**.

- In most domesticated species much research has been undertaken to discover how these factors operate, but unfortunately thorough investigations of this kind have not so far been carried out for the dromedary.

- Based on the available literature, an attempt is made here to explain some aspects of the reproductive anatomy, physiology and

Chapter 2:- Reproduction and Behavior of camel

- **2.1 Anatomy and physiology of Male and female reproductive organs**
- **2.1.1. The Male Reproductive organs**

A. Scrotum and testis

- The scrotum lies high in the perineal region, as in the dog or the boar, not pendulous as in the bull or the ram.
- However, in a few cases the scrotal sac is somewhat elongated and consequently the testicles are situated in a similar manner to those in the bull.
- A **faint- line**, representing the raphe scroti, divides the scrotum into two parts. Each testis is separately situated in its own compartment which is sparsely covered with hair.
- The camel testes have been described as being broadly similar to those of the horse, although

- The testicles are oval in shape and lie obliquely with their long axes running cranioventrally.
- Both testes have limited mobility and normally they present a soft consistency.
- Normally the right testicle is smaller than the left one due to an enlarged pampiniform plexus on the left side
- Marked increase in testicular weight, dimensions and volume of the testis between the ages of 5 and 10 years.
- Seasonal changes in testicular size have been observed; during the rutting season an increase in size occurs. Which means being **smallest** during the **summer** and **largest in spring**.
- It also **increases** in size during the **breeding season.**
- Season has influence on the number of **germinal cells**, **spermatogonia**, **spermatids** and **sperm cells**, implying that the non-breeding season of the camel is char-zed by **reduced spermatogenesis** rather than complete a spermatogenesis, as is found in some **non-**

- In this respect the Arabian **camel studied** was found to be **very similar** to the **ram**.
- The fluctuation in sperm cell numbers was confirmed in the quantitative studies of Osman and El-Azab (1974).
- They found that the testes of the camel are not only small for the size of the animal compared with other species,
- but also contain fewer cells per gram of testicular tissue when compared with the bull, buffalo, ram and boar.
- **Estimated daily** spermatozoa production rates in Egyptian and Sudanese camels were 8.1 and 5.6 ($x10^9$) cells **during the spring**,
- while **in the autumn** they were 4.2 and 3.2 ($x10^9$) cells.
- These values are **much lower** than the figure of

- Leese (1927) described camel sperm cells as resembling those of the ram.
- Khan and Kholi (1973a) studied the physical characteristics of camel spermatozoa and gave the following data:
  - head length, 5.35 (5.08—6.35);
  - head width, 3.42 (3.17—3.81);
  - tail length, 35.62 (34.2—37.5); and
  - overall length of the sperm, 48.37 (46.9—50.8).
- The posterior border of the camel testis is convex and free.
- The anterior surface is flattened, except where the epididymis attaches to the anterior-dorsal point.
- Here the efferent ducts emerge from the gonadal interior.

Male organs...cont,d

B. Epididymis and ductus deferens

- **Epididymis**
- As in other species the epididymis has three parts: **head, body** and **tail**.
- The epididymal ligament makes a very tight connection between the testis and the epididymal tail.
- Studies on histological and the histochemical characteristics of the different regions of the epididymis of the adult camels indicate there are changes in the histochemical activity correlated with the **rutting season** which is due to maturation and storage of sperm.
- The body of the epididymis accounts for almost 50 percent of the total epididymal weight.
- It differs from other species in the fact that

Male organs…cont,d

- **Vas deference**
- Vas(vessel)deferens is the excretory duct of the testis which conveys spermatozoa from the tail of the epididymis to the pelvic urethra and which sometimes unites with the excretory duct of the seminal vesicle to form the ejaculatory duct; called also **ductus deferens**.
- The vas deferens of the camel is remarkably twisted for much of its initial course, but becomes fairly straight towards the end portion.
- This peculiarity results in a thickened spermatic cord, which is relatively long and houses the vas deferens, the pampiniform plexus, spermatic artery, nerves, lymphatics and the internal cremaster muscle.

C. Male Accessory Glands

- The camel has a **prostate**, **two ampullae ductus deferentis** and **two bulbourethral** (Cowper's) glands but no seminal vesicles (Leese (1927) and Tayeb (1948) described the **presence** of the **prostate gland** and the **absence** of **seminal vesicles**).
- The **prostate gland** consists of a massive body which is **discoid shaped** (a flat circular shape) made of two lobes joined by **one isthmus (A cord-like tissue)** and is located on the dorsal aspect of the pelvic urethra and a small disseminated part. It averages, 3–7 × 5 cm and is **dark yellow** in colour.
- The pelvic urethra is glandular. The cells of the glands are of the **mucous** type. The bulbourethral glands are almond shaped and are located on either side of the terminal portion of the pelvic urethra

- Tayeb also described a **dilated end** of the vas deferens in an area generally occupied by the **ampulla**, which is usually described in a similar manner.
- The terminal end of the ductus deferens is enlarged to form an ampulla. Peripheral, central and submucosal glands open directly into the lumen of the ductus deferens.
- He also notes the additional presence of the **bulbo-urethral (Cowper's)** gland.
- The two units of the gland are located on either side of the terminal portion of the pelvic urethra.
- They are **whitish**, **almond-shaped** organs measuring **2.5 × 1.2 cm.**
- Ampullary glands probably secrete carbohydrate-protein complexes.

Male organs…cont,d

D. Penis and prepuce

- The **fibroelastic** penis of the camel is about 60 cm long.
- The diameter decreases from the root towards the glans penis. It is directed backwards when flaccid.
- In contrast to the bull, the camel has a pre-scrotal sigmoid flexure that lies ventral to the cranial border of the pelvic bone.
- Lateral to the caudal convexity of the flexure is the site where the retractor penis is inserted into the tunica albuginea.
- The size of the corpus cavernosum penis is

- Along its ventral aspect the spiralled glans penis is curved giving it a hook shape.
- A well-defined neck is present and the bulk of the glans penis is formed by a cartilaginous tube which does not reach the free end.
- The external urethral process is in the form of a slender, but inflexibly sharp process.
- Externally the penis is covered by a triangular shaped sheath, the prepuce, which opens to the rear.
- Backwards of the sheath are four vestigal teats. Because of the backwards facing sheath, the male camel urinates towards the rear, but erection of the organ for copulation is accompanied by the effects of

- An interesting aspect of the copulatory organ of the male camel is the **shape of its penile sheath**.
- Early accounts of the structure present it as a **voluminous**, **conical organ** hanging from the **abdomen** like a **large mammary gland**.

- The point of the **penile sheath** is directed posteriorly and carries a **very narrow orifice** about **1.84 cm** in diameter (Mobarak et al, 1972).

- Leese (1927) commented that this

- The penis is hidden in its non-erectile state. It is a firm, cylindrical organ whose diameter generally decreases from the root towards the free end (glans penis).

- The average diameters of the root, middle and glans penis parts are given as 2.23, 1.64 and 0.42 cm by Mobarak et al (1972).

- **A prescrotal sigmoid flexure** is characteristic of the camel penis, dividing the organ into **pre-**, **post-** and **intra-sigmoid portions**.

- The average lengths of the three were estimated by Tayeb (1948) as **17.5, 17.5** and **25 cm**, giving a total length of **60 cm.**
- Leese (1927), and more recently Mobarak et al (1972), give average total lengths of **67.5 cm**

- The blood supply of the male camel genitalia is similar to that of **the bull** and its nerve supply is typical of most **domestic species.**

- The **camel penis** is in general of the **fibrous type**, though some vascular elements are observed at the **root** and **terminal parts.**

- Mobarak et al (1972) classify the camel penis as **intermediate** between the **fibrous** and **vascular types**.
- The **urethral body,** however, consists primarily of **vascularized tissue**.

2.1.2. Male Physiology and Sexual Behavior

I. Puberty and senility

- Puberty in the male camel occurs between 3 to 4 years of age. However, males reach their full reproductive potential at 5 to 6 years of age.
- By 15 to 20 years of age, reproductive potential declines.
- **Seasonal changes**
- The camels are only sexually active for a few months each year, the so called **rutting**.
- The time of the rutting season differs from region to region.
- Rutting may occur throughout the year at the equator, because there are no marked seasonal differences in temperature and

- Weight of testicles changes varies with age and season.
- These variations are correlated with the number of spermatozoa in the epididymis and with the circulating testosterone levels.
- These parameters reach their maximum levels from late December to the end of March.
- The structures and the histochemical content of the male accessory glands show markedly pronounced seasonal alterations.
- There is an inactive phase during summer and full activity during winter.
- A marked decrease in fructose and citric acid levels in castrated animals observed in which the glands showed a decreased activity in comparison with intact animals.

- Moreover, the neurosecretory cells of the anterior pituitary gland are more active during the rutting season than during the rest of the year.
- The histological and the histochemical structure of the pars distalis of the pituitary of the one-humped male camel show seasonal variation in cell frequency and activity.
- Higher incidence and activity of the gonadotropins during the mating season in spring support the hypothesis that day length is the primary factor controlling the reproductive cycle in this species.

- **Sexual behavior**
- Normally camels are tame and calm animals. During the rutting season both males and females become more aggressive.
- Their breeding activity lasts for 50 to 100 days. When the male becomes sexually aroused, the lips become wet with foaming saliva.
- The teeth grind continuously and a typical sound is uttered.
- The one-humped camel extrudes the soft palate, the **dulaa**, makes a bubbling sound and bends his head slightly backwards to display the bushy hair under his chin.
- The dulaa arises from the oroventral portion of the soft palate and is filled with air from the trachea. Two-humped (bactrian) camels do not have a dulaa.

- The legs are often spread apart. The penis is rhythmically beaten with the tail and urine is sporadically splashed on the tail and whisked on the back.
- Urine of rutting males contains a high concentration of testosterone, probably together with pheromones.
- Male camels have two tubulo-alveolar glands (**poll glands**) in the occipital region.
- The poll glands are present at birth. During the period of high testosterone levels, the poll glands secret a coffee-coloured and acrid smelling fluid that seems to attract the female.
- The androgen concentrations in the fluid of the poll glands are exactly the same as in the blood.
- During copulation the secretion is at

- **Copulation**
- The male in rut searches for the female in heat. He smells first the female genitalia, shows a flehmen and bites the female in the genital area, hump and neck, often causing bleeding wounds.
- The restless animal extrudes the dulaa with roaring sounds and forces her on the neck to lie down or bites her in the stifle-joints.
- If she refuses, he might force her with great violence, often causing wounds and even fractures.
- Copulation takes place in a sitting position. The male camel moves over sitting female until his front legs are on her shoulders.
- The male flexes all joints of the hind legs in a dog-like sitting position behind the female.
- Then he pushes himself slowly forward until his genitalia are near hers and the tip of the penis, now directed cranially, is searching for the vulval cleft.

- The penis is rotated until the tip enters the vulva and is inserted into the vagina. Some owners help at this stage. The male makes several pushing movements with resting phases in between. He drools and grunts all the time.
- The female flexes her head repeatedly towards the male's head. The female squeals and grunts continuously.
- Copulation lasts on an average for about 11 to 24 minutes. After copulation the male slips sideways off the female.
- It is often observed that other females surround the copulating pair and lie beside them and that another female may also try to mount the couple.

2.1.2. The Female Reproductive System

- The reproductive tract of the female camel has **some affinity** with that of **the horse**.

A. The ovaries

- The ovaries in the non-pregnant dromedary camel are oval, flattened and lobulated organs. The size and shape of the ovaries vary with their content of follicles and corpora lutea.
- Elongated narrow ovaries or semi-circular ones are not uncommon. The surface of the ovary is irregular.
- The irregularity is mainly due to the presence of multiple small follicles or the presence of corpora lutea.
- The colour of the ovary ranges from light red to various shades of pink.
- The size and weight of the ovaries are affected by the **age**, the **size of the animal** and the **stage of the reproductive cycle**.

- The **size** and **weight** of the **gonads** are influenced by the **stage of the reproductive cycle**, i.e. by **ovarian activity.**
- The mesosalpinx and the mesovarium together form a very well developed bursa which closely invests the ovary.
- Medially there is an opening in the bursa which leads to the fimbriae.
- The ovaries of non-pregnant camels are situated in the caudal part of the lumbar region, i.e. just in front of the pelvic brim or may be inside the pelvic cavity.
- In all cases examination of the ovaries is an important part of the gynaecological examination but they are often difficult to find.

- On many occasions they were found hidden beneath the uterus, so unless the uterus is retracted and rolled from side to side the ovaries would be missed.
- In the bactrian camel the ovary is flat and somewhat elliptical in shape.
- They are located on the lateral side of the anterior end of the uterine horn, in the vicinity of the anterior brim of the pubis.
- Shalash (1965) described the gonads as fairly flattened organs with numerous **ovisacs,** giving them the **appearance** of a **bunch of grapes.**

Ovary of Camel

- The size and weight of the gonads are influenced by the stage of the reproductive cycle, i.e. by ovarian activity.
- the gonads as fairly flattened organs with numerous ovisacs, giving them the appearance of a bunch of grapes.
- They are reddish in colour and each is enclosed in an ovarian bursa.

- Though the **shape**, **size** and **weight(macro scopic properties)** may **differ** from those of other species like:- **Cow, Ewe, Sow , Mare**
- The **microscopic properties** of **both** the **Graffian follicles** and the **corpora lutea (CL)** show **no clear differences.**

B. The Graafian follicles

- The **Graffian follicles** are **randomly** distributed on the **ovarian surface** and may sometimes **(4.82%)** be found **even** in **pregnant animals**.
- The presence of an active corpus luteum does not prevent the development of new follicles.
- This is particularly true at the beginning and at the end of gestation

- The time taken by the Graafian follicle to reach its full mature size varies considerably among individuals and even in the same animal during subsequent cycles.
- On the average the Graafian follicle takes 6 days to reach its maximum size with a range of (2 - 14 days) and range from **1.5 to 3 cm in diameter**, although sizes of **8–9 cm** were also **recorded.**
- Those of the **left** ovary tend **to be slightly larger than those of the right** (**1.24 as against 1.20 cm)** (Shalash, 1965).
- **Follicular activity** in **pregnant camels**, they **assert** that **it decreases** with **advanced gestation.**

- ♣ After reaching maturity, the follicles maintain their size for about 13 days (range 5 – 19 days).
- ♣ Then they regress in 8 days (range 7 - 10 days).
- ♣ The growth of follicles to maturity alternates between the two ovaries, but smaller follicles can always be palpated alongside the leading follicles.
- ♣ The period from the beginning of the development of the Graafian follicle until it reaches maximum size and its regression is referred to as **follicular wave** rather than **oestrous cycle**.
- The CL is thus normally observed **only during pregnancy in the camel.**
- Its **shape varies** between **spherical, elongated and oval.**

- In the bactrian camel the Graafian follicle is round in shape, projects nearly wholly over the surface of the ovary.
- The follicular wave or the follicle cycle in the bactrian camel lasts 14 to 24 days with an average of 19 days.
- It was also found that in 90 percent of the cases a new follicle will start to develop within 5 days of the initial degeneration of the old follicle.

C. The corpus luteum

- Is **a mass of cells** that forms in **an ovary** and is **responsible** for **the production** of the **hormone progesterone** during **early pregnancy.**
- The corpus luteum of pregnancy is either spherical, elongated or oval.
- At the beginning of pregnancy the corpus luteum is soft and appears brownish on section with a central blood clot.
- In the later stages of pregnancy the thecal layer becomes whitish opaque concealing the colour of lutein mass, so

- In the bactrian camel the corpus luteum forms 1 to 2 days after mating.
- The mature corpus luteum is similar to a mature follicle in shape, size and connection with the ovary.
- It takes 5 to 10 days for the corpus luteum to develop to mature size and this is maintained for 3 days.
- If no conception follows the ovulation, it will regress in 10 to 12 days.

- **In early gestation** it has a **flabby consistency**, becoming **larger** and **firmer** as **pregnancy advances.**
- The CL of pregnancy is **light brown** with a **greyish central cavity**, and **variable numbers (one to three) of CL may be found on the same ovary**,

- Their **size varying** from 1.85 to 1.88 cm and their weight from 4.15 to 4.68 gm (Shalash, 1965).

- grown follicle remains for 5–19 days (average 13 days) before regressing over a 7- to 10-day period.
- CL is normally observed during pregnancy in camel. Its shape varies between spherical, elongated and oval, and in early gestation it has a flabby consistency, becoming larger and firmer as pregnancy advances.
- The CL of pregnancy is light brown with a greyish central cavity, and variable numbers (one to three) may be found on the same ovary.
- Copulation apparently triggers the release of the gonadotropins essential for ovulation to occur.

CL OF CAMEL

- Since most CL in the camel are observed **only during pregnancy** or in **the few cases where the uterine opening is patent,** it would appear that **some type of stimulation**, e.g. **copulation,** is necessary **for ovulation** to occur (Shalash, 1965).
- Musa and Abusineina (1978a) confirm that ovulation among **Sudanese dromedaries** is **non-spontaneous, (requiring copulation beforehand**).
- However, even 15 minutes of experimental cervical stimulation by palpation failed to **induce ovulation**,
- The camel is **thus** an **induced ovulator** like the **cat** and the **rabbit.**
- Copulation apparently **triggers** the release of **the**

D. The oviducts

- The oviduct in the camel is 17 - 28 cm long. The isthmus is less coiled than the ampulla and the ovarian part of the fallopian tube.
- The lumen of the ampulla is about 5 mm in diameter at its ovarian opening in the depth of the fimbriae.
- The lumen of the isthmus is 1 - 2 mm in diameter.
- The oviducts are enlarged at the uterine end, possibly allowing prolonged storage of large numbers of spermatozoa.

- The oviducts of the camel are small in diameter (1–2 mm), but become larger at the ovarian end where the fimbria are located.
- The dromedary has a **bicornuate type of uterus**. It is a large organ whose weight may vary from 193.7 to 376.4 gm (Shalash, 1965) depending on the **phase of the oestrous cycle.**
- Generally it is located in the **abdominal cavity,** but Musa and Abusineina (1978b) observed that open **uteri** and those with **early pregnancies** are sometimes **located intrapelvically**.
- However, these observations were based on **per rectum examinations** of recumbent camels

E. The uterus

- The uterus of the camel is bicornuate and is large enough to occupy a position which is partly abdominal and partly pelvic.
- It has a well-developed uterine body from which the two horns diverge and taper anteriorly to give a combined uterine shape intermediate between that of the letters T and Y.
- The endometrium shows irregularly raised mainly longitudinal folds which are more prominent in the right horn, and internally there is a clear median septum. A septum about 6 cm in length separates the two horns posteriorly. The left horn is longer even in the new born. The mucosa is smooth or has chequered folds, but no caruncles
- The **uterus** is **reddish white**, **shiny** and **smooth** with a **short body.**
- Its two horns are closely apposed **externally** but

F. The cervix, vagina and vulva

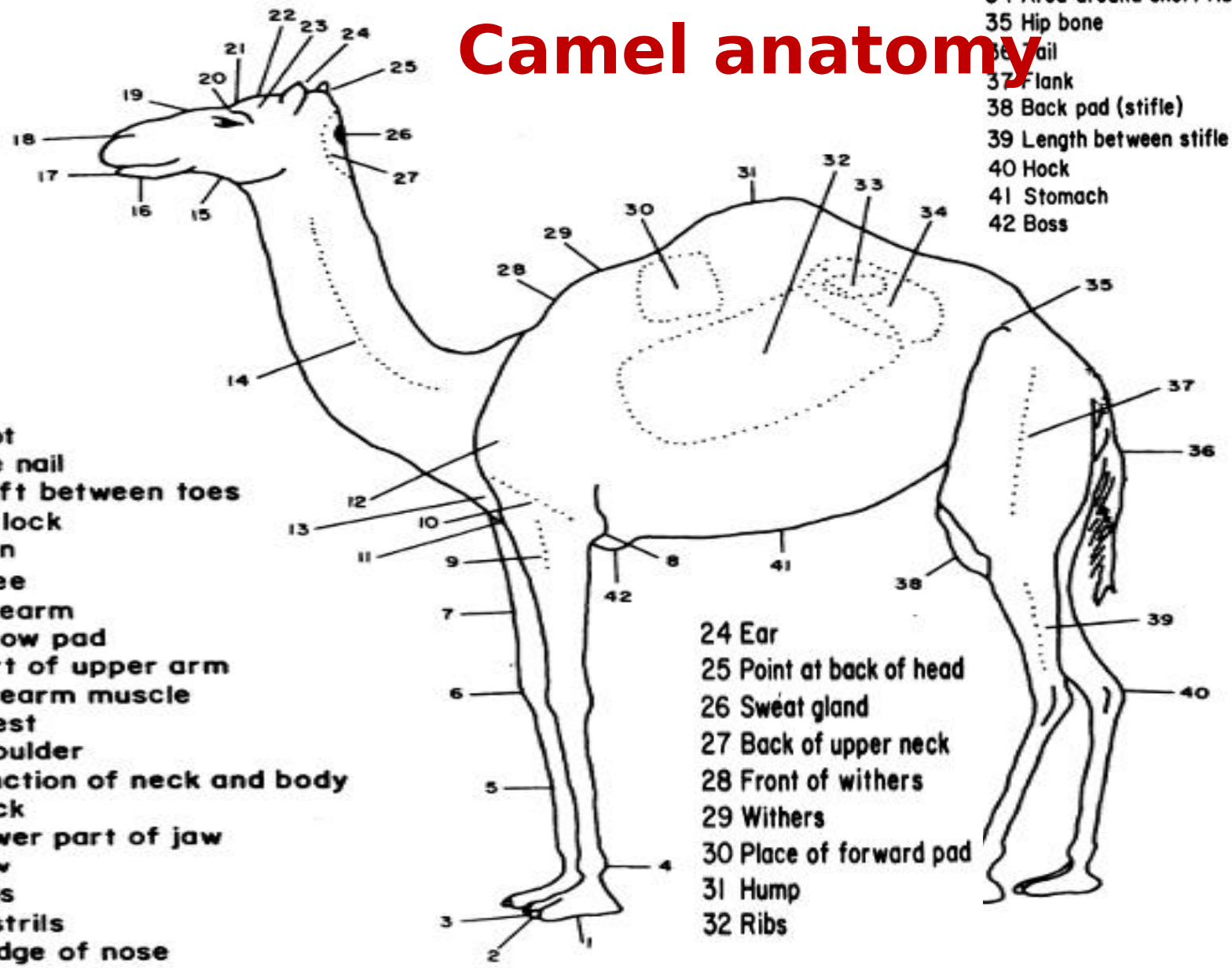
- The cervix is a short structure that tends to protrude for a short distance in the vagina.
- There are about 5 annular mucosal folds in the cervix. The vagina is an elastic organ, reddish in colour. There are both longitudinal and circular mucosal folds in the vaginal wall.
- The vestibulum is about 8 cm long. The clitoris is small. The urethra is short and the opening of the urinary meatus is small.
- In the central floor of the vestibulum there is a suburethral diverticulum, on top of which the urethral orifice is located.
- The hymen or its remnants mark the separation between the vestibulum and the vagina.
- The **camel cervix**, like that of the cow, has a number of **mucosal folds** arranged in **three** or **four rows.**

- Like the **cervix of the zebu cow** *(Bos indicus)*, that of the dromedary tends to **hypertrophy and protrude some distance into the vagina**, resulting in the formation of two blind sacs (one dorsal and one ventral).
- Anteriorly, the mucosal folds of the cervical canal form a **prominent crest** which marks the **cranial opening of the cervix**.
- The **vagina** is an **elastic organ** of **reddish colour** measuring **30–35 cm** and lined with mucosal folds posterior to the external cervical opening.
- The **camel vulva** is about **8 cm long**. On its ventral floor it has a **suburethral diverticulum**, on top of which is located the **true urethral orifice.**
- The demarcation between the **vagina** and the

G. Mammary glands

- The udder has four quarters; the front two are separated more distinctly from each other than they are from the two smaller hind quarters.
- The teats are small and have three small openings each.

Camel anatomy



1 Foot
2 Toe nail
3 Cleft between toes
4 Fetlock
5 Shin
6 Knee
7 Forearm
8 Elbow pad
9 Part of upper arm
10 Forearm muscle
11 Chest
12 Shoulder
13 Junction of neck and body
14 Neck
15 Lower part of jaw
16 Jaw
17 Lips
18 Nostrils
19 Bridge of nose
20 Eyebrow
21 Brow
22 Forehead
23 Hollow behind eye

24 Ear
25 Point at back of head
26 Sweat gland
27 Back of upper neck
28 Front of withers
29 Withers
30 Place of forward pad
31 Hump
32 Ribs

33 Short ribs

34 Area around short ribs
35 Hip bone
36 Tail
37 Flank
38 Back pad (stifle)
39 Length between stifle and hock
40 Hock
41 Stomach
42 Boss

2.2 Breeding

- **2. 2. 1 Puberty and sexual maturity**
- **Puberty** is the age at which an animal **first becomes capable of reproduction**,

while at sexual maturity this **capability** is **increased to the optimum level**.

- Wiltbank (1974) **stressed** that the attainment of puberty in cattle is influenced by the age and weight of the animal.

- This principle is well understood and applied for many domestic species.
- Unfortunately the camel has a slow rate of growth (Chatty, 1972) and this genetic handicap, in addition to the general lack of feed supplementation under pastoral management systems, results in advanced ages at puberty for the dromedary.

- Williamson and Payne (1978) estimated that the sexual maturity of dromedaries occurs at 3 years.
- Spencer (1973) observed that the camel of northern Kenya may reach 6 years before getting her first calf.

- Allowing for a year's gestation period, this would give an age of 5 years at first conception.

- Singh (1966) wrote that the age of **first sexual** desire among male camels in India was **2 years** but that full musth was delayed **until 8 years**, although the animals could be sparingly used for service at 6 years.

- Leupold (1968a) is of the view that both sexes attain sexual maturity at **3 years**. However, Khatami (1970) indicated that both the Iranian female and male camel reach **sexual maturity at the age of 5 years**

- The length of the camel's reproductive life varies, but some females continue to breed until **20 years** old.

- When well fed and managed some camels live up to **40 years**, and **in spite** of a calving interval approaching 2 years the camel is still capable of producing as many progeny as most pastoral cattle.

- **The calving interval in camels is prolonged not** only by their **limited breeding season** but also by **the suppression of oestrus** for a long time after parturition.
- **Postpartum oestrus** is normally **delayed for about 1 year**, although a few females come back into heat as early **as 1 month** after parturition (Williamson and Payne, 1978).

- The level of nutrition is a factor here, since when feed supplies are inadequate, maintenance, growth and lactation take priority over reproductive performance, which becomes a physiological luxury.
- At any rate camels usually calve only every other year, or at best twice in 2 years.
- The theoretical maximum annual calving rate is thus 50–80%.

2.2.2 Rutting

- Is be in a **state of sexual excitement**; **of male mammals.**
- Among male camels, which are often **not put to full service** until they **reach 6–8 years**,
- rutting or musth is generally limited to particular periods of the year, as it is in the female.
- It is partly influenced by age and level of nutrition.
- **The breeding season**, which often **coincides** with the **rains,** lasts about 3–5 months on average,

but for some animals, especially older ones,

- The latter authors further observed that there **was no specific rutting season** for animals on **or near the equator** (probably within the tropics),

where rutting may take place **throughout the year.**

- During the **rutting period** the usefulness of the male **as a work animal** is diminished; he loses his appetite, develops occasional diarrhoea and displays abnormal

- **Rutting males** constantly **protrude the mucosa** of their **buccal cavity**, which expands into a balloon-like structure.

- They become **irritable** and **rarely tolerate rivals.**
- **Wind sucking** and **belching** also occur continuously in **rutting stallions,** which attempt to mate with most females, **even those not in oestrus**.

- **Their increased** activity and **lack of appetite** often result in **a loss of condition** at the end of the **breeding season.**

- When many males are **herded together**, usually **only one (the strongest)** will **"develop the rut".**

- If **more than** one develop **the rut a fight** will often build up until the weaker submits and suppresses **his sexual desire** (Singh, 1966).

- Fraser (1968) also considered **the voluntary suppression** of breeding instincts to be related to **the male's**

- **Sexual desire** can be quelled if **rutting males** are **driven hard at work**

- Statistically significant ($P<0.01$) **drop in blood haemoglobin** and an **increase in total leucocytes** during the **breeding season**.

2. 2. 3. Castration

- Males **not reserved** for breeding are often castrated.
- **Castrates** are **more manageable** and make better working animals.
- Cossins (1971) indicated that castration may also be carried out for **meat production purposes.**
- The **ideal age at** which **to castrate** camels **is 4–6 years.**

- Droandi (1936) gives a detailed description of castration methods used by the Arabs.

- The operation may be carried out in any season, provided the animals are healthy enough to withstand **the stress** involved.

- The animal is first hobbled and **turned on its side** or back**, with all its limbs immobilized**.

- **The open castration** method involves the **use of a razor, a palm branch**, **two iron cauterizers and a small rope.**

- **Healing** following **open castration** usually takes **30–40 days**, and there may be **extensive swelling** or **discharge** from **the wound**.

- A **simpler castration** method consists of merely **twisting the spermatic cord**, and in this **case healing occurs more rapidly**, often **requiring only 2 weeks**.

2.2.4. Estrous(Oestrous)

- The **estrous cycle** (British spelling, oestrous) is **the main reproductive cycle** of other species females of non-primate vertebrates, for example rats, mice, horses(camels), pig., etc. **Do not** confuse with "estrus", which is a **phase of the cycle**.

There are also a variety of **different forms**:

- **Polyestrous Animals** - Estrous cycles **throughout** the year **(Cattle, pigs, mice, rats, Russian bacterian camels)**
- **Seasonally Polyestrous Animals** - Animals that have **multiple estrous cycles only** during **certain periods** of the year (horses, sheep, goats, deer, cats, most camels)

Oestrus…Cont,d

- After reaching **sexual maturity** the **female dromedary exhibits regular oestrous cycles**, which nevertheless seem to be limited to particular **periods of the year**.

- However, Nawito et al (1975), cited by Williamson and Payne (1978), imply that the Egyptian dromedary may **conceive at any time of the year**, although there is **still considerable variation** in **conception between seasons.**

- In **India** and much of the **northern hemisphere the breeding season** extends from **November to March**

- It is influenced by the level of nutrition and changes in daylight length, among other factors.

- Altitude and atmospheric humidity may also play a part (Dahl and Hjort, 1976).

- The findings of Shalash (1965) clearly illustrate a breeding periodicity of this kind (see Table 2).

- According to Novoa (1970), indicated that while the domestic Bactrian camels of **Russia** are **polyoestrous**

- Once the breeding season has started the female camel will come into heat every **20–25 days** (average 23.4 days; Joshi et al, 1978).

- **Longer durations**, e.g. 28 days (Musa and Abusineina, 1978a), have also been observed.

- In cattle, these extended oestrous cycles are often associated with **silent** or **unobserved heat periods** and the same may well be true of

- **The oestrous period** itself generally **lasts 4–6 days** (Joshi et al, 1978) although a range of **1–7 days** is given by Parkes (1969).

- Both these findings are **slightly shorter than** the **range of 6–8 days** given for **the Bactrian camel** by Williamson and Payne (1978).

- In a **well organized study** Gupta *et al* (1978) showed that **female camels** in India usually come into **oestrus five times in a breeding season**.

- They remain in **oestrus for 4–5 days**, but

- During the oestrous period the female dromedary shows both **anatomical** and **nervous signs** of heat.

- She is generally **restless**, seeking the **company of the male** and tending to **bleat continuously**.
- She develops a **swollen vulva**, often associated with a **discharge** (Singh, 1963 and 1966).

- Droandi (1915) observed that oestral camel emitted a **penetrating, foul**

- **The 4 Stages (phases) of the Estrous Cycle**
- **Proestrus**
  - follicle enlarges
  - estrogen increases
  - vascularity of the female reproductive tract increases
  - endometrial glands begin to grow
- **Estrus**
  - allows male to mount
  - estrogen decreases
  - LH increase(surge)
  - ovulation 24-48 hr after surge of LH
  - uterine motility high with contractions moving toward oviduct
  - sperm transport is optimal
  - cervical mucus volume increases

- **Metestrus**
  - estrogen low
  - corpus hemorrhagicum present
  - ovulation in cow
  - uterus
    - contractions subside
    - endometrial glands continue to grow and become coiled
    - in cattle bleeding occurs
  - FSH increases, triggering growth of follicles
- **Diestrus**
  - progesterone high
  - FSH low but increases at some point to cause growth of pre-ovulatory follicle
  - Uterus
    - secrets fluid but the volume of fluid decreases over time
    - contraction stop
    - corpus luteum regresses at the end of this period if female is not pregnant

- **Anestrus**
- **Not a stage(phase)** in the estrous cycle, but a prolonged period of sexual rest where the reproductive system is quiescent (not active)

Some Changes During the Estrous Cycle

- **Follicular Phase**
  - Follicles the dominate ovarian structure
  - Estrogen the dominate hormone
- **Luteal Phase**
  - Corpora lutea the dominate ovarian structure
  - Progesterone the dominate hormone

- **Main features of the oestrous cycle in the camel**
- The camel is a **non-spontaneous ovulating** animal and in this respect it is incorrect to apply the term "**oestrous cycle**" as it applies to spontaneous ovulators such as the cow and the mare.
- The ovarian activity during the "cycle" is follicular. Graafian follicle(s) will develop in one or both ovaries reaching a mature size.
- If no copulation occurs it will regress and then another follicle will start developing.
- Usually the left and right ovaries

- **Duration of the follicular wave**
- The duration of the follicular wave varies slightly in relation to geographical locations.
- For example in India the mean length of the cycle was 23.4 days.
- In Egypt it was 24.2 days and in Sudan it was 28 days.
- Oestrus lasts about 4 to 6 days in general.
- The prooestrous phase lasts about 6 days and the atretic phase lasts 7 to 10 days.
- In the bactrian camel the duration of the cycle averages 19 days (range 14 to 24 days), the prooestrous or

2.2.5 Mating

- The **mating behaviour** among **camels differs** from that of other ruminants, and indicated **the essential relationship between conformation** and **mating behaviour.**

- **Copulation often starts** with **courtship** involving a **necking exercise.**

- Khan and Kholi (1973b) indicate that in **courtship** the male may **not only smell the female genitalia** but may even **bite her in this region**, or around the **hump**.

- Bleeding due to **severe bites** is **common**.

- Often **the strong male** may **simply round up the female** and **crouch her after exhaustion for service** (Hartley, 1979).

- Usually the **male induces** the **female into a sitting** position, and those in oestrus, especially those in season for **the first time**, **will readily assume this position**.

- **The male then grasps the female** with **his forelegs**, while **most of his weight rests** on **his buttocks**, with all the joints in **his back legs flexed**.

- The animals thus face in the **same direction**.
- During a **single mating session** the male may **ejaculate three or four times**, each service being preceded by **fresh penile**

- It is **common** for **camel men to aid** the entrance of the male penis into the female genitalia, although males are also believed capable of locating the vulvar opening by themselves by rotating the erect **penis on its longitudinal axis**.

- **In Somalia**, Hartley (1979) noted that **hand service by herdsmen** well known to the **male camel is common.**

- **Copulation** among camels may last for a **short time––12–30 minutes, but** according to Droandi, (1915) **for an hour.**

- Leonard (1894) suggested that mating could **last the whole day**, with breaks for the male to ward off any **external disturbances**.

- Other camels often gather **around** the **copulating couple.**
- At the **end of the mating** act the male tends to gurgle and froth at **the mouth**,

- Using the **artificial vagina** method, Khan and Kholi (1973b and c) estimated the volume of Bikaneri camel **ejaculates** to **average 3.1 ml** (**range 1–10 ml).**

- Though subject to **individual variations** the trait was **unaffected by age.**
- **Semen appeared white in colour** with **a thick viscid consistency and had an average pH of 7. 8** (**range 7.2–8.8).**

- The **mass motility** and **the percentage of spermatozoa** showing

- **Ovulation**
- Ovulation in the camel occurs normally after the coitus and in this respect it resembles that of cat and rabbit.
- It is known that in these animals the neuroendocrine reflex involving the initiation of luteinising hormone release is delayed until coitus occurs.
- Ovulation occurs 32 to 40 hours after copulation under the influence of luteinising hormone (LH).

- In the bactrian camel ovulation also takes place within 36 to 48 hours after coitus. Deposition of a minimum of 1 ml seminal plasma in the vagina or the uterus is required for ovulation to occur.
- Spermatozoa could not induce ovulation. Intramuscular administration of luteinizing hormone (LH), human chorionic gonadotrophone (HCG) and luteinizing hormone-releasing hormone (LH-RH) produced ovulation in a similar manner to that of seminal

- **Signs of heat or oestrus**
- The behavioural changes during heat in the female camel are much less drastic than the changes in the male camel.
- The signs of heat in the female include restlessness, bleating, vulval swelling and mucous vaginal discharge.
- The tail is moved up and down in rapid succession on the approach of the male or when hearing its gurgling

- The vagina at this stage is moist and pink coloured although the degree of wetness decreases as heat progresses.
- The cervix is relaxed and moist. Rectal palpation will reveal that the uterine horns are turgid.
- In the bactrian camel the cervix becomes softer during oestrus admitting one finger.
- The vagina is slippery but no mucus is expelled from the vulva.

- **Pregnancy and foetus**
- **Site of pregnancy**
- The right and left ovaries seem to function equally in the camel.
- In spite of this fact it is observed that 99 percent of pregnancy occurs in the **left** uterine horn.
- Anatomically the left horn is slightly bigger than the right one.
- In the bactrian camel 96.49 percent of foeti were found in the left horn.

- **Embryonic migration**
- Embryonic migration from the right horn to the left horn is very frequent and it seems that this is always the case when ovulation occurs in the right ovary and not in the left.
- Considering the site of pregnancy and the equal functioning of the two ovaries, this brings the incidence of egg migration close to 50 percent.

- **Multiple ovulations**
- Multiple ovulations in the camel are possible; these are represented by multiple corpora lutea in the ovaries.
- In spite of the occurrence of multiple ovulations in the camel, the incidence of twinning is very low.
- This indicates high losses in ova or early embryonic death.

- **Follicular activity during pregnancy**
- The presence of the corpus luteum of pregnancy does not completely prevent growth and development of Graafian follicles.

- However, the incidence was higher during early pregnancy and decreased with advancing gestation until very close to parturition.
-

- **Placenta**
- The placenta in all camelidae is diffuse and epitheliochorial in nature, without cotyledons. In the camel there are three foetal membranes rather than the classical two membranes in the cow and the mare. These are:
- Amnion membrane;
- Allantoic membrane;

- **Epidermal membrane**. This membrane is unique in the camel. It is epidermal in origin and it becomes visually apparent when the foetal length is 41 cm and until the end of gestation
- . It completely encloses the foetus except for the following openings to the amniotic fluid: at the lips, genitalia, anus, teat orifices and hooves of the foetus.
- At birth this membrane comes with the foetus while the other two foetal membranes pass out during the third

- **Presentation**
- The posterior presentations predominate from early pregnancy to a foetal body length of 41 - 50 cm at which point the situation changes to anterior presentation of 51 percent. This trend continues until almost 100 percent anterior presentation is achieved at term.

Gestation length

- The literature concerning the gestation length in the camel is very conflicting compared to variations reported in other species such as the cow or the mare. The average gestation length is 390 + 2 days and it is commonly stated as 12 to 13 months. In the bactrian camel the gestation length averages 402.2 + 11.5 days.

2.3 Gestation

- The **gestation period** of the dromedary is often quoted as **about 1 year**, with a range of **355–389 days** being given by Burgemeister (1975),

- The **breeding season** thus occurs at the **same time of year as the calving or foaling period**.

- The gestation period of the Bactrian

- Various methods have been developed for determining pregnancy and estimating its duration in the camel.

- Mares (1954) observed that female camels tend to dry off naturally after conception.

- Field (1979a) reported that lactation ceased 4–8 weeks after pregnancy in female camels of northern Kenya.

- However, there are also reports of camels continuing to lactate for 12- to

- Whether the latter category of animals were empty or pregnant is unclear, but Knoess (1976) referred to a **pregnant camel** that was **still giving** a considerable **amount of milk.**

- Until it can be established whether or not the camel exhibits **lactational anoestrus**, the **observation cannot** be relied upon as an efficient means of **pregnancy diagnosis**.

- Camels are known to reject further breeding after conception, and oestrous cycles are normally discontinued.

- In cattle, however, **5% of animals** tend to come back into **oestrus in spite of positive conception**, and in camels Shalash (1965) observed **Graffian follicles in 4.82% of pregnant uteri.**

- The **rejection** of breeding **cannot** therefore be used as a **conclusive**

- Mares (1954) concluded that the pregnant camel has a characteristic way of lifting her tail when approached by a male or handled by a man, an observation which Singh (1966) considered a reliable sign of pregnancy.

- Musa and Abusineina (1978b) have nevertheless cast doubt on its accuracy.

- They observed that female camels "cocked" their tails during anoestrus.

- On the other hand, they reported the successful use of rectal palpation to diagnose pregnancy in the camel.
- As it does in cows, the method involves palpation of the uterus, its contents and blood supply.

- The authors found that the presence of one or more well-developed CL was **highly suggestive of pregnancy.**

- They also described the position and characteristics of the uterine arteries in **six camels throughout** the gestation period, comparing their findings with those for the cow.

- Other methods for diagnosing pregnancy in the camel include the ballotement of the foetus through the right flank, a method limited to the later stages of gestation.

- **Ballottement =**A palpatory technique for feeling a floating object in the body.

- Mammary gland hypertrophy may indicate pregnancy in the camel, but like abdominal enlargement and ballotement this indication becomes

- In primiparous females, however, abdominal enlargement may be observed as early as 6 months, but caution should always be exercised in using this method since other conditions (e.g. ascites and flatus) may also cause abdominal enlargement and thus simulate pregnancy.

- Recently, Schels and Mostafawi (1979) have reported good results using the ultrasonic method for pregnancy diagnosis in 15 Iranian camels.

- **Pregnancy diagnosis**
- Various methods could be employed to detect pregnancy in the camel. These include:
- **Rectal palpation:** This is carried out with the camel restrained in the sitting position. The technique thereafter is similar to that employed for the cow.
- **Laboratory methods:** Various laboratory methods can be used. Some of them were of limited success, other are lengthy or not very practical under field conditions.

- Changes in specific gravity and the pH of the cervical mucus after 6 weeks of gestation. The specific gravity increases from 1.00 to 1.014 g and the pH from 7.05 to 8.2.
- **Vaginal temperature**: Not useful because of the great variation in body temperature of the camel.
- **Cuboni test (oestrogen test**): used with limited success during the second half of gestation.
- The technique is the same as for the

- **Gonadotropin test**:
- **Progesterone determination**: Levels of progesterone above 1 ng/M1 are considered high and indicate pregnancy in the camel.
- This method is accurate and can be done from the second week of pregnancy

- **Ultrasound**: This method is accurate from the second month of pregnancy. The probe is applied to the right flank or above the uterus per rectum.

- **Dystocia**
- The incidence of camel dystocia appears to be very low.
- The foetal component of dystocia includes: carpal flexion, lateral deviation of the head and hock and hip flexion. Posterior presentation is uncommon.
- Foetopelvic disproportion, monstrosities and transverse presentations are also rare.
- On the maternal side, uterine inertia occurs to a small extent.
- In dealing with dystocia in the camel it was found that head and limb extension is more difficult to achieve than in the

- However, the camel foetus survives dystocia better than the equine foetus and the camel is a good subject for caesarean section.
- Also foetotomy using Thygensen's embryotome is possible when necessary. Ceasarean section could be performed on the left flank using xylazine sedation and local regional or infiltration anaesthesia.

2.4 Parturition

- Signs of imminent birth in the camel include a relaxation of the sacrosciatic ligaments resulting in **two grooves**, one on either side of the tail.
- The animals become lethargic and develop an **oedematous swelling of the vulva.**
- **Colostrum** can be drawn from the teats, which are **engorged during the last days of gestation.**

- In a study of 17 pregnant camels, Burgemeister (1975) found that the external signs of **imminent parturition in** the camel **were not very pronounced**.

- He noted that **the abdominal pains usually** associated with the onset of dilation were not very severe in the camel.

- However, he also observed that **3–5 hours** before delivery **females** tended to show **agitated behaviour.** They lie down more frequently and **their feeding** becomes **disturbed.**

- Leese (1927) had noted **similar behaviour** to that observed by Burgemeister, but concluded on the contrary that **labour pains** are mor**e pronounced** in the **camel** than in the cow or mare, and added that sometimes it **may be advisable** to tie

- The onset of abdominal pains was taken to indicate the beginning of the first of the three stages of parturition observed by Burgemeister (1975).
- **Parturition** generally occurs with the dam in a lying position, although delivery in the standing position is also possible.
- **Most females** will **deliver** unaided, but **camelmen** are **willing to provide** extra help when necessary.

- The **anterior longitudinal presentation** (forelegs of the foetus being presented first); **dorsal position** (the back of the foetus being directed towards that of the dam) and **extended posture** (all the limb joints being fully extended) were **the norms encountered** in the camels noted by Burgemeister.

- **Parturition**
- Parturition is a continuous process in the camel but it could be viewed under the four classical sub-headings:
- **Preparturient changes**
- These could be summarized as follows:
- Detection of colostrum 4 to 6 days before parturition
- Vulval labiae are swollen
- Relaxation of the sacroisciatic ligaments starts 15 days before parturition - but two shallow grooves, one on each side and distal to the sacrum, due to the relaxation of the sacroisciatic ligaments, are clearly seen 9 days before parturition.

- **First stage of labour**
- First stage of labour is taken from the time of evidence of discomfort and restlessness shown by the animal until the first water bag appears at the vulva.
- This stage could be as short as 3 to 5 hours or as long as 24 hours. The stage is characterized by restlessness, the animal lying on one side and struggling for a short period and then standing again.
- Straining occurs towards the end of this stage at the rate of 1 to 2 minutes. The vaginal and rectal temperature is normal.

- **Second stage of labour**
- The second stage of labour is taken as the time from the appearance of the first water bag until birth is complete.
- This stage is characterized by continuing straining and struggling on the ground from time to time.
- Usually one front leg of the foetus is ahead of the other, foetus is almost always in anterior presentation, in dorsal position and the head is resting on the front legs or sometimes between the legs.

- **Third stage of labour**
- The third stage of labour is taken as the period from the birth of the calf until the foetal membranes are expelled.
- This stage is characterized by straining once every 2 - 3 minutes, rolling on the ground - rest – and rolling again.
- The afterbirth emerges progressively, including large quantities of retained allantoic fluid. When the animal stands this helps to detach the membranes.
- The stage is usually complete in 15 minutes. The foetal membranes are expelled, most of the time inverted.

2.5 Perinatal growth and mortality

- **2.5.1 Birth Weight and Early Growth**
- In a study carried out at a government camel breeding farm in India, Bhargava et al (1965) reported that the smallest calf weighed 26.3 kg, half the weight of the heaviest calf, which was 52.15 kg.
- The average birth weight for males was 38.19 kg and for females 37.19 kg, with a pooled average of 37.23

- In camel, the sex of the calf, the calving sequences and the month of calving apparently had no statistically significant effect on birth weight.
- **The sex of** the calf has, however, often been found significant for other domestic species.
- **Female(heifer) calves weigh 7% less** than **male(bull) calves**.
- **In pigs** Johanson and Rendel (1968) indicated that **male piglets** outweighed **females** by **50 gm,**
- while in sheep **ram lambs** outweighed

- Heredity is another factor affecting prenatal growth, directly via the genotype of the foetus and indirectly through the genotype of the dam.
- A positive correlation exists between maternal body size and age and the prenatal growth rate of the foetus.
- According to Johansson and Rendel (1968) birth weight is influenced by the sum total of factors contributing to the nourishment of the foetus in the uterus.

- Hansard and Berry (1969) summarized the factors influencing the birth weight of animals and estimated that the largest component of variation (36%) is attributable to the combined genotypes of the dam (20%) and foetus (16%), followed by intra-uterine foetal environment (30%), maternal environment (18%), parity (7%), nutrition (6%), sex (2%) and maternal age (1%).
- The exact role of these factors in the camel has not been investigated

- The nutritional status of the dam may also have a direct bearing on foetal growth, a factor which would seem to be important in the camel: poor nutritional levels during gestation may lead to increased perinatal mortality.

- Nevertheless, Musa (1979) studied the development of the camel foetus and its associated growth curve, concluding that there was a striking

2.6 Fertility

- **2.6.1 Fertility Rates**
- Fertility has been defined as the ability of the male and female to produce viable germ cells, mate and conceive, and subsequently give rise to living young (Ensmiger, 1969).
- Many factors, including perinatal losses, influence the overall fertility rate of domestic animals, with the result that rates are difficult to define.

- A significant aid in establishing precise figures is the keeping of proper breeding records, a management practice entirely lacking among camel herders under traditional systems.

- However, it is generally believed that fertility rates in the camel, especially under traditional systems, are low.

- Dahl and Hjort (1976) have noted that even under improved management the fertility rate of camels is very unlikely to be much higher than 50% in pastoral herds.
- The authors, however, quote Russian work in which the fertility level of the Bactrian camel was found to be 65% under ranch conditions, although Keikin (1976) reports the calving rate at a large Soviet camel ranch (4,300 head) as averaging only 40%.

- Contrasting methods of estimating fertility in camels were used by Bremaud (1969) and Wilson (1978).
- The former used direct interviews with the pastoralists, while the latter employed aerial surveys of the various age groups to determine fertility indices

- Bremaud, whose results are partly reproduced in Table 4, estimated the fertility rate of Grabbra and Somali camel herds in Kenya as 34% and 52.25% and quoted Watson's (1969) figure of 41%.
- The results indicate that 80% of animals had a calving interval of at least 2 years, that 73 9o did not rebreed within 12 months of calving and that 74% of young are weaned at 12 or more months of age.
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- However, the data base was very limited, and in the absence of proper breeding records results based on interviews with nomads should in any case be accepted with reservation.
- Bremaud himself confesses a bias in his own results, since calf mortalities remained unaccounted for, and also nomads probably tended to report only on their best-performing females.
- His figures for fertility rates should therefore probably be scaled down. Wilson (1978) gave the calving rate of Darfur camels in southern Sudan as 70%, which seems a very high estimate under pastoral conditions.

2.6.2 Causes of Low Fertility

1. Late Age at First Calving

- Puberty occurs late in the camel, and animals may be 3–5 years or more at sexual maturity. Inadequate weight, resulting from a low plane of nutrition, may well be a cause of delay. Females are commonly withheld from breeding until 4–6 years old.
- Gestation accounts for a further year, with the result that calving frequently occurs for the first time at 5–7 years, considerably later than in cows.
- This factor is partially offset by the camel's longer breeding life

2. Limited Rutting Potential

- Full male musth may in some cases occur only at 8 years, and animals are often not put to full service before 6–8 years.
- In addition it is reported that only one male in the herd develops the rut, while the others suppress their sexual desire.
- This situation, together with a loss of appetite and increased activity noted in males during the breeding season, may lead to a loss of condition and subsequent drop in libido.
- Difficulties in male penetration may

3. Limited Breeding Opportunities

- Although animals near the equator are reported to breed all the year round, the breeding season elsewhere generally appears limited (November to March in the northern hemisphere).
- Length of the breeding season is probably affected by nutrition levels and daylight length, and possibly by other factors such as altitude and air humidity.
- Since gestation usually lasts a year, the breeding season tends to occur at the same time as calving, w/c limiting the number of females able to conceive.
- When prenatal deaths occur,

4. Prolonged Calving Interval

- Camels calve once every other year, or at best twice in 2 years. The result is a low annual calving rate of 50–80%.
- The calving interval is prolonged by
- (i) the lengthy gestation period,
- (ii) the limited breeding season and
- (iii) late postpartum oestrus (frequently 1 year after parturition).

5. Inadequate Nutrition

- Low feed availability, especially in times of drought, may affect overall fertility in a variety of ways, ranging from delayed sexual maturity and a curtailed breeding season to threatened calf viability.
- When feed is scarce, growth and lactation take priority over reproduction, which becomes a physiological luxury.
- Under pastoral systems, competition for milk between calf and man becomes an additional factor.
- Again, colostrum is commonly withheld from calves, depriving them of essential antibodies, while early weaning may check calf growth, increasing susceptibility to disease.
- Conversely, overfeeding may also be a problem in times of plenty, leading to diarrhoea, indigestion and in some cases death.

Management Practices and Perinatal Calf Losses

- Management practices, as well as disease, emerge clearly as a crucial factor in the high calf mortality rate of 30–60%, and doubtless also affect embryonic and foetal losses as well as other aspects of fertility.
- Better and more widespread knowledge of the most favourable time during the oestrous period at which to practise hand mating (the first 1–2 days) might improve conception rates.

- In some herds inbreeding results in genetic abnormalities, especially the decline of low-heritable characters, of which fertility is one.
- Again, animals with reproductive abnormalities such as cryptorchidism, intersexuality and gonadal hypoplasis are not culled as they would be under more sophisticated production systems.

- There is little knowledge of appropriate breeding ratios, and the herding of males together probably has a negative effect on libido.
- Sexual desire may also be quelled if rutting males are driven hard at work.
- In some cases pregnant females are worked up until delivery, and occasionally they may not even be allowed to rest while in labour, leading to an increased risk of abortions and stillbirths, and subsequent reproductive problems.
- At parturition itself, the unskilled intervention of the herdsman can again lead to calf losses. The newborn are delicate and losses in the first 3 weeks of life may be high, especially when nutritional and disease problems arise.
- Premature weaning and the early age at which camels are expected to begin work lead to high mortality within the first 4 years of life.

Disease and Other Factors

- Disease is a major influence on calf losses. Trypanosomiasis, leading to abortions and general debility, is an important contributory factor. Pasteurellosis and salmonellosis are also cited as causes of abortions, while camel pox particularly affects the young once the immunity obtained from colostrum has worn off after the first few months of life. Infections such as pyometra, phimosis and paraphimosis, orchitis and filiarasis directly affect the reproductive tract, as also do abnormalities such as cysts,

- There is a high rate of early embryonic mortality, and twins or triplets occur only with the utmost rarity. Endocrine factors, including insufficient gonadotropins to enhance follicular development and subsequent ovulation, may also contribute to infertility. Again, cystic ovarian degeneration is often associated with hormonal disturbances. Finally, ticks, flies and predators, as well as other infectious diseases, such as anthrax, may play a major role in carrying off the young.

- To sum up, low fertility is clearly one of the major constraints to camel production. It is a problem that must be overcome if herd offtake is to be increased with a view to marketing good quality camel meat.
- At present, what little meat reaches the market is often of low quality, since herdsmen are unwilling to trade off young animals.

Thank you for Attention