SEXUAL BEHAVIOR OF THE MALE CAMEL (CAMELUS DROMEDARIOUS) AND SOME STUDIES ON SEMEN

A Thesis

Submitted in Partial Fulfilment of the Requirement for the degree of

MASTER OF VETERINARY SCIENCE.

(Obstetrics and Gynaecology including Artificial Insemination)

BY

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B. V. Sc. & A. H.

COLLEGE OF VETERINARY AND ANIMAL SCIENCE,
BIKANER. UNIVERSITY OF UDAIPUR.

1971

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CERTIFICATE I

Dated July 1st 1971

This is to certify that this Thesis entitled SEXUAL BEHAVIOR OF THE MALE CAMEL (CAMELUS DROMEDARIOUS) AND SOME STUDIES ON SEMEN, submitted for the degree of M.V.Sc. in the subject, Obstetrics and Gynaecology including Artificial Insemination of the University of Udaipur, is a bonafied research work carried out by SHRI ABDUL AZIZ KHAN, under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation has been fully acknowledged.

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Dated 5.11.71

This is to certify that the Thesis entitled, SEXUAL BEHAVIOR OF THE MALE CAMEL (CAMELUS DROMEDARIOUS) AND SOME STUDIES ON SEMEN, submitted by Shri ABDUL AZIZ KAHN to the University of Udaipur in partial fulfilment of the requirements for the degree of M.V.Sc. in the Subject of Obstetrics and Gynaecology including Artificial Insemination has been approved by the Students Advisory Committee after an oral examination on the same in Collaboration with an External Examiner.

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(ABDUL AZIZ KHAN)

Abdul Aziz Khan

INTRODUCTION

Fig. No.1 Bikaneri Male Camel
(Camelus dromedarius)

I N T R O D U C T I O N

Camel is perhaps the most important and useful animal for the desert area, both for riding as well as for transport. It is suitable for arid zones because it can withstand draught and can live for days together without taking water.

There are two species of camels, (a) The two humped camel (Camelus bacterianus) which is a strong and heavy camel and is found in Central Asia, Russia, Mongolia and Turkey and (b) The one humped camel (Camelus dromedarius) the Arabian form, found in Southern Asia and North Africa. Camels are also prevalent in South America and Australia.

Camel is a seasonal breeder. The breeding season of camel is known as " Musth " in India, Hej in " Arabic " and " Waghogh " in Somali Land. In India the rut occures in winter, when the male camel is let loose in herd to serve the females. One bull camel can serve 40 to 50 she camel in one seasons.

Artificial insermination is a revolutionary step in the breeding of the species. If this method of breeding could be applied to camel breeding, perhaps it could pay rich dividends.

Artificial insemination includes

(a). The collection of the semen from the male animals.

(b). Evaluation of the semen.

(c). Dilution and preservation of the semen.

(d). Insemination of this semen into the reperoductive tract of the female.

From above it appears that the first step towards starting artificial insemination in camels is to collect semen from bull camel. As such studies have been under taken to collect semen and study its different characteristies. Alongwith this study an attempt has also been made to study the male sexual behavior and some of the changes that occur in the ~~be~~ blood of the male camel during rutting and non-rutting seasons.

REVIEW OF LITERATURE

SEXUAL BEHAVIOR :

The sexual behavior of an adult male with a fully receptive female covers all stage of sexual activity from interest in the female to normal copulation and ejaculation. In the broad sense of the term, sexual behavior consists of (a) the mating desire (sex libido) and (b) the ability to copulate.

According to Macirone and Walton (1938) the sexual behavior was influenced by both internal and external factors. Internal factors included physiological, psychological and physical conditions and the external factors comprised climatic and nutritional conditions, disease and the suitability of the sexual object.

Leese (1927) reported that 'Rut' was known as "Musth" in India, "Hej" in Arabic and "Waghogh" in Somaliland. According to this author the rutting season in the Northern Hemisphere at a distance from the equator, was reoughly the later half of the cold weather, generally from December to March. In Sahara it extended from September to January; whilest in Somaliland, it occured at different times in different districts, Sometimes twice a year, generally in June, or in September, October and November, chiefly depending on the best grazing periods. In Jubaland, camels came in 'Musth' at any time of the year, but particularly during and after the "big" and "small" rains, Jubaland

camels rarely became musth while working. In Australia the rutting time was reported from June to September and probably also in South West Africa. ✓

Hafez (1951); Cairns (1965); and Hulet (1962) studied the sexual behavior in ram and buck and classified it into courtship and copulation. Detailed studies made by them were as under :-

A. Courtship :

i. Pawing the female; hoarse baa or grumble ;

ii. Noising genitial region of the female.

iii. Sniffing female urine, extending neck with upcurled lip.

iv. Running tongue in and out of the mouth.

v. Rubbing against the side of the female ; biting wool of female.

vi. Herding or pushing female away from other males.

B. Copulation :

i. Wiggling tail (rare)

ii. Mounting.

iii. Thrusting movements of hind quarters.

Signoret (1961), Hafez (1960) after studying the sexual behavior of swine reported the following stages for courtship and copulation.

A. Courtship :

When a male approached a sow in oestrus, the following stages were involved .

i. The boar emitted "mating song" (Chant de cour) a regular series of soft, guttural grunts.

ii. He tightly passed his nose against her head, shoulder, or flank and as he reached her genito anal region, his nuzzling generally became more vigorous.

iii. The boar grunted continuously, grinded his teeth, moved his jaws from side to side, and froth appeared at the mouth.

iv. A rhythmic emission of urine was characteristic of the boar during sexual arousal and occured during the preliminary phases of sexual behavior.

B. Mounting :

Boar mounted a female, in the mating stance, immediately. Some boars mounted and dismounted a female repeatedly before coitus; other baors mounted only once and copulated. During mounting, the boar swinged his trunk upward to a nearly vertical position and rested his forefeet on the female.

C. Intromission and ejaculation :

The mounting boar thrusted until the tip of the partially exposed penis extended either the vaginal or rectal orifice. The penis was of fibroclastic type, spirally shaped with a prescrotal sigmoid flexure, and

did not enlarge during erection. During ejaculation, the boar's haunches were clenched together and pressed forward, a muscular wavelike movements of the perineum were visible as anal winking, one of the testis was retracted so that a visible contraction occured one side of the scrotum. Two or three separate waves of semen might be ejaculated before the boar dismounted and slided limply from the back of the female. The penis was retracted into the sheath within several seconds.

Williams (1956); Wierzbwski (1959) while working on the stallion's sexual behavior recorded that during.

i. Courtship :

The stallion smelled the external genitalia and the groin of the mare and extended its neck with an upcurled upper lip. Smelling was accompanied by "Pinching" the stallion grasped with his teeth, the folds of skin near the mare's croup (rump) and held it more or less tightly.

ii. Erection and mounting :

Erection of the penis took place gradually while the stallion was at some distance away from the mare.

iii. Intromission and ejaculation :

Intromission took place after several pelvic oscillations which stimulated the engorgement of the penis with blood, At full erection and after intromission, the glans formed the shape of a basin. Before ejaculation

commenced, the penis was kept quite still adhering tightly to the vaginal wall for some seconds. Then semen, ejaculated with great pressure, entered the uterus directly (Walton 1960). On an average the first ejaculation of semen occured about 13 seconds after intromission. The cessation of the pelvic oscillations was an external sign of the beginning of ejaculation. Rhythmical shrinkings of the urethral muscles passed to the tail muscles, causing characteristic up and down movements of the tail. Most stallions, upon ejaculation, exhibited fast resperation, drooping of the head, and relaxation of the whole body. The stallion then dismounted the mare with a flaccid penis which was soon withdrawn into the prepuce.

Denenberg (1958), Zarrow (1961) and sherman (1960) described the courtship and copulation in the male rabbit as under :-

Courtship :

(a). Chasing : It was the early form of sexual activity observed most frequently, this were often fast and furious.

(b). Tail "flagging" : The buck elevated his haunches, so that he walked with a stiff legged gait, and layed his tail flat along his back, so that he displayed its white under side or scut.

(c). "False retreat" : The buck walked stiffly

view of his elevated tail.

(d). Epuresis : The rabbit emitted jet of urine at the partner in the display.

(e). Mounting.

The sequence of events in the male rabbit were summarized as : Exploration, Smelling, Jiamping, Chin rubbing, mounting, gripping with the teeth, pelvic oscillations, exploratory movement of erect penis, intromission and orgasm with ejaculation.

Kling et.al. (1960) studied the sexual behavior in the cat and observed.

(a). Courtship

i. Oriental towards trail.

ii. Sniff genitalia.

iii. Circling.

iv. Mating call.

(b). Copulation

i. Took neck grip.

ii. Mounted with front legs.

iii. Rubbed with forepaws.

iv. Arched back.

v. Pelvic thrusts.

vi. Penile erection.

vii. Pelvic lunge.

viii. Intromission.

IX. Ejaculation.

X. Penis withdrawn.

XI. Licked penis and forepaws.

Bane (1963) described the sexual act in the bull into the following different stages.

(a). Erection.

(b). Mounting the cow.

(c). Penile movement to locate the vulva.

(d). Actual thrust and

(e). Ejaculation.

Guhl and Gloria (1951) described the stages of the sexual behavior in the birds as :-

i. Sexual approach.

ii. Waltz or wingfluther from the rear.

iii. Mounting and treading.

iv. Moved tails to one side and everted cloaca.

v. Spreaded tail and everted cloaca.

vi. Vents meet.

vii. Ejaculation.

Leese (1927) observed the following symptoms of rutting in the male camel : Constant grinding of the teeth, accumulation of froths at the mouth and ejection of the soft palate. The secretion from the pollglands increased so that a dark redlish fluid, with a disagreable smell, was often seen falling in drops about the neck. The camel was sometimes standing with hindlegs apart, flapping the tail up and down and even emitting semen!

In addition to all these symptons, the animal also

showed a marked pugnacity to other male camels, or those which were also musth, and severe (some times fatal) injuries were often inflicted in the fight which ensued. These injuries were caused by the formidable tushes of the combatants. The injuries took the form of punctured or lacerted wounds about the head, withers, legs or scrotum.

According to Mohan Singh et.al. (1958) the poll glands were only present in camel and absent in other domestic animals. These glands in camel were two large cutaneous glands, Each gland was broader at the base (toward head) and narrower at the apex. The poll glands exhisted only in the male, in which sex they were detectable from very early age. In the male during rutting season their secretion which was of brownish tinge and offensive odour was much augmented. This secretion was often running down the neck.

Pacock (1910) observed that in case of Bactrian camel, poll glands were present both in the male and female. In the London Zoo, these glands were seen active in March in the males, but the glands of the females were not noticeably active during the breeding season. In case of Dromedary camel the glands were found to be active both in males and females. The same author reported that in London Zoo these activities were noticed in the month of June.

Singh et.al.(1964) while working on the Indian camel observed that the male camel was ferocious during the mating season (November to December), and that there was grinding of the teeth and evagination of the soft palate prior to copulation. The male tried to make the female sit by biting her shoulders and by applying pressure on her neck with his own. During copulation both sexes adopted a "Sitting Dog" posture and the male griped the female with his forelegs. Copulation lasted from 7 to 20 minutes.

Charton, (1963) observed that during the period of rut, the soft palate of the dromedary male increased in length and was capable of evagination out side the mouth. The length was greatest from February to March. The same author reported that individual males exhibited variations in the length of the soft palate.

SEMEN COLLECTION :

The development of techniques for semen collection from the demestic animals opened many avenues in breeding management. Several methods were used for semen collection, but many of them were unsatisfactory. Collection of semen with the artificial vagina was the common and most satisfactory method for the bull, ram, stallion, boar and other domestic animals.

Williams (1936) citing Schmaltz, reported that in an

Arabian book published in the fourteenth century, an Arab was reported to have taken semen, by means of a pledget of cotton from the vagina of a mare recently bred to a famous stallion, then by inserting this cotton into the vagina of his own mare, produced conception.

Apparently the first artificial vagina for bulls was designed in Russia and later it was modified by many workers (Kusnetzowa et.al. 1932, Milovanov, 1934, Neuman, 1936, Sorensen, 1938, and Walton, 1938).

The earlier Russian model consisted of a rigid cylinder of rubber, or other material about 24 inches (60 cm) long, having an inside diameter of 2.2 inches (5.5 cm). Inside the cylinder was a thin walled rubber tube, the ends of which were turned back over the outer cylender, forming a water tight jacket. Into one end of the artificial vagina was fitted a graduated glass semen receptacle of slightly smaller diameter than the cylinder. While in use, the jacket was filled through a screw plug hole with water, hot enough to bring the inside of the artificial vagina temperature to a few degrees above the body temperature.

Sorensen (1938) modified the early Russian model. He introduced two models, the first was the English model in which the semen receptacle had a larger volume and the second was the Danish model which had a much shorter

cylinder and the semen receptable was attached by means of a rubber funnel. In both the Danish and the English models the semen receptacle was exposed to light and ambient temperature, and there was danger of cold shock to the spermatozoa, during collection in cold weather.

Salisbury, and Willett (1940) designed an artificial vagina in which the collection receptable was inside the inner liner and thus protected from cold. The general design being similar to that of the earlier models, except for a rubber funnel liner that ran through most of the vagina inside the inner liner and connected to the collection receptacle.

Lambert and Makenzie (1940) designed Missourei model for horses (1966).

Doctor (1966) Pickelt developed a very functional colorado model which incorporated the good features of several previously described models.

Mckenzie (1931) described a simple artificial vagina for boar which consisted of a soft rubber tube (band tubing) 16 inches long, 1 $\frac{3}{16}$ inches inside diameter and 1½ inches out side diameter, one end of which was fitted over the mouth of a test tube or suction flask and the other over a $\frac{15}{8}$ inches key ring. A clamp completed the outfit.

Lambert and Mckenzie (1940) devised an artificial

vagina for boar at the Missouri Agricutural Experimental station. The vagina consisted of an inner tube, $1\frac{5}{16}$ inches in internal diameter and $1\frac{3}{8}$ inches in external diameter, and an outer rubber casing 12 to 15 inches long. An air valve permitted adjustment of pressure.

Sebitcenko (1957) described an electrically heated artificial vagina for boars.

Aamdal et.al., (1958) used a short water heated artificial vagina for semen collection for the boar. This vagina was connected to a pulsating apparatus. At the both ends of jacket, sponge was used.

Niwa (1958) designed a em simillar but slightly shorter vagina. A cone was fitted either internally or externally with a coil of wire or plastic, into which the penis was locked.

Amantea (1914) used an artificial vagina and was apparently the first investigator to use this device for the collection of canine semen. Later the artificial vagina was used by other workers such as Alifanov (1935). Hancock and Rowlands (1949) and Hooder (1950). All these investigators, however, used a bitch in oestrus as a "teaser" at the time of collection.

Harrop (1954) developed a new type of artificial vagina which incorporated a cylindrical bladder between the liner and the lumen of the artificial vagina i.e. the

water space, and which could be operated by a hand pump to impart pulsations to the liner.

Nickolas J. Sojka (1970) developed an artificial vagina for cat. The artificial vagina was a 2ml. rubber bulb pipet with the bulb cut off. The cut end was fitted over a 3x44mm. test tube making a water tight seal. The vagina collecting tube was assembled and placed in the polyethylene bottle (filled with 52°C water giving the vagina a working internal temperature of 44 to 46°C) and the rolled end of the bulb was streched over the rim of the bottle. The opening of the vagina was sparingly lubricated with K-Y jelly.

Kuznecova et.al.(1932) Anderson (1945); Frank (1950) and Terrill (1955) described the artificial vagina for rams.

Paduceva and Maksimov (1934) used artificial vagina for collecting semen from rabbits for studies on physiology of reproduction.

According to report of an internal zoo Yearb (1961) there was a blind camel at Madison, Wisconsin (U.S.A.). The semen was collected from this camel by electro ejaculation and was refrigerated at - 320°F. A female camel was inseminated 3 times before she conceived.

SEMEN CHARACTERISTICS AND METHODS OF EVALUATION :

It has been reported that the semen characteristics

were fairly well associated with the fertility of the males. The semen characteristics studied for its fertility were volume, colour, mass activity, motility, hydrogenion concentration (pH), sperm concentration and live and dead sperm percentage.

VOLUME :

The volume of bull semen has been recorded by Lagerlof (1934); Herman and Swanson (1944); Herman and Ragsdale (1939); Leopard, Stuart and Foster (1941); Green, Comstock and Winters (1939); Kumaran (1939); (1939); (1944); (1949); Veeramani Ayyar (1944); Lasley and Bogart (1948); Shukla and Bhattacharaya (1949). According to these workers it ranged from 0.3 to 9ml.

Marshall and Hammond (1944); Berliner (1940); Berliner (1946); Lambert and Mckenzie (1940); Day (1940); Davis and Cole (1939); recorded the semen volume in stallion. It ranged from 40 to 600ml.

In their study on buffalo semen, Bhattacharya (1955) and Mahmoud (1952) stated the volume range from 1.2 to 6.0ml.

Salzman (1940) while working on the Asses semen estimated its semen volume at 54ml.

Moskovits (1934); Milovanov (1934); recorded the semen volume of the ram, and reported its ~~was~~ range from 1 to 2ml.

Milovanov (1936) while working on the semen quality of boar stated that its volume ranged from 150 to 400ml.

Lambert and Mckenzie (1937); Harrop (1955); recorded the semen volume in the dog, from 2 to 9ml.

Nickolas J. Sojka (1970) collected the semen from a tom cat and reported that the volume was 0.05ml.

Lambert and Mckenzie (1939) reported the semen volume in the rabbit as ranging from 0.4 to 6.5ml. (most common volume was 0.7ml.).

Starkov (1933-34) worked on the semen evaluation in the fox and reported the semen volume range from .1 to 4.5; average 1.5ml.

Mccartney (1956) reported the semen volume, from 0.1 to 0.8ml. in the turkey.

Lambert and Mckenzie (1946) recorded the semen volume in the fowl. As per these authors it ranged from 0.1 to 1.5ml. (most common 0.6ml.).

Watanabe (1957) reported the semen volume of 0.3ml. in duck (Osaka).

Lasley and Bogart (1943) concluded that the semen volume was highly correlated with total sperm but not with the other characters in 12 Hereford bulls.

Anderson (1941) indicated that the dairy bulls gave larger ejaculate than the beef bulls. Lagerlof (1936)

suggested that the size of the ejaculate might be related to the size of the bull, as Herman and Swanson (1941) had also observed.

Anderson (1940) recorded that the volume was usually smaller in young bulls than in adults bulls. He also reported that the second ejaculate collected shortly after the first was usually larger. Lagerlof (1934) noted that the amount of semen was usually normal in a bull with impaired fertility. in epididymitis, however, the amount was usually smaller than normal.

However according to Milovanov (1936) there was no direct relationship between live weight and the semen vol"

COLOUR :

Maule (1946?) cited the colour appearance of the semen in the different species; in the bull the colour was opaque, whitish or whitish yellow fluid of milky or milky-creamy ; stallion : whitish opaque; Ram : creamy; Goat : white cream and Lemon coloured, dog : watery grey to milky white ; boar : greyish to milky white; Buffalo : milky white with a very light tinge of blue.

According to Anderson, the thicker and more cream-like the ejaculates was, the higher was the concentration of spermatozoa, and inversely, a thiner more watery, less opaque fluid of a bluish white colour contained a smaller concentration of spermatozoa.

HYDROGEN ION CONCENTRATION :

Webster (1934-39) and Milovanov (1934) reported the pH of semen in bull. As per these authors, it ranged from 6.0 to 7.5 .

Comstock and Brady (1937) & Webster (1937) reported while working on the ram semen, that the pH ranged from 6.85 to 6.9 .

Kushwaha et.al.(1955); & Sayed and Oloufa (1957 b) reported that the pH of the buffalo bull semen ranged from 6.7 to 6.8 .

Prabhu and Sharma (1954) observed that when a number of semen collections were made in rapid succession from a buffalo bull, the pH shifted from the acid to the alkalive range.

Milovanov (1936); Penikov (1955); & Macleod and Mc Gee (1950); recorded the pH of stallion semen. The ranged was found from 6.2 to 7.8 and the mean 7.4 .

Harrop (1955) found that the pH of normal dog semen varied from 5.8 to 6.9 if taken immediately after collection. The average figure was 6.75. He also reported that if the individual fractions of an ejaculate were tested separately, the results recorded were : 1st fraction 6.37, send (2nd) fraction 6.10, 3rd fraction 7.20 .

Boneher et.al.(1958) reported that in dog the pH varied according to the method of collection, use of an artificial vagina without a teaser bitch, 6.59 ; hand

manipulation without a teaser, 6.52; hand manipulation with a teaser, 6.72 .

Lambert and Mckenzie (1946) while working on the rabbit semen, reported its range from 6.8 to 7.5 .

Starkov (1933-34) reported that the pH of fox's semen, ranged from 6.2 to 6.4 .

Lambert and Mckenzie (1952) recorded the pH in the fowl ~~recorded its~~ Which ranged from 6.3 to 7.8 .

Milovanov (1934) was perhaps the first worker to report that the pH of the bull semen was usually acidic (6.5 to 6.8) but with an increase in the amount of the accessory secretions it became neutral or even alkaline 7.0 to 7.5 .

Webster (1939 a) in pH tests on bull semen, observed a relationship between pH and fertility. He suggested that the probably fertile range was from 6.0 to 7.5, with samples between 7.0 and 7.5 of very doubtful low fertility. The pH of the semen of the abnormal bulls was investigated by Anderson (1942). An alkaline reaction was characteristic of typical cases of epididymitis, and of bulls with small testes. The alkalinity was also associated with a decrease in the concentrations or absence of spermatozoa.

Anderson (1946) took two ejaculates one after the other from fertile bulls; the second ejaculate was usually more acidic than the first, and this change in reaction

was in general, associated with the better quality of the second ejaculate in that there was greater concentration of spermatozoa of higher motility.

Davis and William (1939) described that the concentration of spermatozoa in the bull, decreased from 1st to 3rd ejaculate, and in this case the mean pH also decreased from the 1st to the 3rd ejaculate. In sterile bulls, the pH of successive ejaculates became increasingly alkaline.

Webster (1934-35); Mckenzie and Berline (1937) ; indicated that alkaline reaction in the ram semen was associated with sterility. Webster (1939); also observed that the distinctly acid ejaculates, were of high fertility and that as the degree of acidity decreased towards the neutral point the fertility also decreased.

Terril (1937) observed that the ejaculates giving an acid reaction to litmus in ram, were definately superior to those giving an alkaline reaction.

Pecnikov (1955) reported that in case of horse the pH was unaffected by age and it showed no correlation with spermatozoal motility, survival or concentration or with numbers of spermatozoa per ejaculate.

SPERM CONCENTRATION :

Lagerlof (1934); Herman and Ragsdale (1939); Mckenzie (1939); Anderson (1940); Terril (1940); Herman and Swanson (1941); Green, Winters and Comstock (1941); Lasley and Bogart (1943); Kumaran (1944); Shukla and Bhattacharya (1949); Shultze and Davis (1949) ; all reported

the sperm concentration in the bull. It ranged from .16 to 2.02 millions per cu.mm.

Moskovits (1934); Milovanov (1934); Terril (1937); recorded the semen concentration in the ram. As per these authors it ranged from 2.0 to 5.7 millions per cu.mm. and the average was 2.85 millions per cu.mm.

Lambert and Mckenzie (1946); while working on the semen quality, recorded that the sperm concentration ranged from 30,000 to 80,000 per cu.mm. in the stallion.

Milovanov (1936); Dodolfo (1934); reported the sperm concentration in the boar. It ranged from .1 to .5 millions per cu.mm.

Harrop (1955); Nooder (1950); Hancock and Rowlands (1949); stated that in case of dog, the concentration ranged from 1.0 to 9.0 millions per cu.mm.

Dussardier and Szumowski (1952), studied the semen quality of goat, and reported that the sperm concentration was 3.6 per cu.mm.

Starkov (1933-34) while working on the fox reproduction, recorded the sperm concentration, which ranged from .34 to 1.2 millions average .66 million per cu.mm.

Lambert and Mckenzie (1946) reported the sperm concentration in the rabbit. It ranged from .1 to 2.0 millions (average .70 millions).

Nickolas (1970) worked on semen quality of the cat, and reported the sperm concentration as 1.1 millions per cu. mm.

Mukherjee and Bhattacharya (1949); Lake (1957) ; reported the semen concentration in poultry, the range was 0.16 to 7.0 millions per cu. mm.

Mccartney worked on turkey semen and stated that the sperm concentration was 7.4 per cu. mm.

Watanable (1957) reported the sperm concentration in the duck, mean was 4.6 millions per cu. mm.

Lagerlof (1946) noted the following effects of disease on the concentration of spermatozoa.

i. With degenerative changes in the testis, the number of spermatozoa was almost normal when the changes were slight, but when the changes were marked the number was much reduced or spermatozoa were absent.

ii. With infective changes or fibrosis of the testis spermatozoa were, as a rule absent or present in small numbers.

iii. With hypoplasia of the testis, the spermatoza were absent or present in very small numbers.

Cummings (1954) found no change in conception rate in ram with initial spermatozoal concentrations ranging from 2.5 to 19×10^8 per ml. although the higher counts appeared to result in higher fertility. Variations in the counts were also reflected in the measurement of resperation and impedance change frequency.

Erb et.al.(1955) reported that a variation in the sperm concentration was the main factor interfering with metabolism tests in bull.

Davis and Cole (1939) noted in horses that the range in number for a single collection was from a few hundread thousand to maximum of 4500 million. This variation was appearently not related to the volume of the ejaculate.

MASS ACTIVITY :

Zemjanis (1962) explained that the mass activity of the microscopic wave pattern or swirl motion reflected the combined effect of sperm cell concentration and the viability of the sperm cells. According to him an acceptable semen sample should have at least 'Good' (+++) wave motion on a scale of ++++ .

Blom (1946) developed a comparing chamber for mass activity, which could also be used for making a rough estimate of the concentration of cells and for observing motility of individual cells. He recommended a classification of seven grades of wave motion. Other workers used a still larger number of categories.

A method of scoring the motility of semen samples was put forward by Herman and Swanson (1941) and subsequently modified by Swanson and Herman (1944), Emmens (1947) described it for use with rabbit semen and

this has been applied to other species.

Cummings (1954) advised the use of phase contrast microscopy for the assessment of semen motility.

INITIAL MOTILITY :

Motility test is considered to provide the most significant information about the quality of the ejaculated semen (Zemjanis, 1962).

Initial motility was considered one of the best signs of viability of sperm (Davis, 1938)

There was no clear evidence that "initial motility" could be closely correlated with fertility, and studies had yielded negative or indefinite results (Cheng et.al(1940) cupps et.al.(1953); Lasley and Bogart (1943); Swanson and Herman (1944).

However, Erb et.al. (1950); Stone et.al.(1950) and Bishop et.al.(1954) were of the opinion that the initial motilitywas more closely correlated with other semen characteristics than with fertility.

Terrill in 1937 noted a range of 0% to 100 % motile sperm for forty four rams (mean 58%). The same author in (1938) while working on 21 rams reported range from 40% to 100% (mean 73%).

The motility for Day's thoroughbreds and pony was from 60% to 100% . On the whole the motility was consistently good for there stallions. Salzman noted a

a mean activity of 0.8 in his investigations.

Lardy and Phillips (1941) reported that in the bull spermatozoa, the glycolytic or fructolytic mechanism provided the energy which sustained motility.

Dubincik (1934) reported that motility of spermatozoa in hypotonic solutions was reduced and often ceased. In hypertonic solutions motility ceased immediately.

LIVE AND DEAD PERCENTAGE :

The determination of the percentage of live sperm in samples was of great practical applications in artificial insemination work. Semen samples were graded on the basis of their live sperm content in conjunction with other quality tests for semen and the breeding worth of males was assessed more satisfactorily. Further this technique was of considerable value in the studies on sperm metabolism.

Several techniques had been introduced in the past for the differential staining of live and dead sperm. Lasley et.al.(1942) first introduced opal blue eosin for the differentiation of live and dead ram sperm which was later modified (Lasley and Bogart, 1943) for use with bull semen.

Crooke and Mandl (1947) introduced revector soluble blue counterstained by neutral red for assessing the viability of humansperms.

Mayer et.al.(1947) involved the fast green eosin

and Shaffer and Almquist (1948) recommended aniline blue eosin for the same purpose.

Blom (1950) introduced nigrosin eosin mixture for the differentiation of live from dead sperm and this technique was subjected to a critical study and modified by Swanson and Bearden (1951).

Bishop et.al.(1954) confirmed that this nigrosin eosin solution was hypotonic to bull semen and had a pH of 8.5 . However, Swanson and Bearden (1951) found that when Blom's method was compared with other treatments there was a significantly higher percentage of dead spermatozoa and the difference was shown to be due to the use of a hypotonic solution. The authors found that 1% eosin B and 5% nigrosin in isotonic citrate buffer gave constant results even when the proportion of semen stain varied from 1:1 to 1:20 and the pH from 6.4 to 8.7 . This finding was in contrast to the results reported by Lasley et.al.(1942) and Mayer et.al.(1951) who had stressed the importance of having the mixture at a constant pH of 6.8 .

Hancock (1957) modified the nigrosin eosin stain with glucose and by this the solution became isotonic. This technique did not differentiate motile from dead non motile spermatozoa but differentiated living from dead spermatozoa.

Hancock and Shaw (1955) demostrated that only the dead spermatozoa agglutinated when a semen sample was treated with a formalin diluent.

Bangham and Hancock (1955) showed that the opacity of a semen suspension could be altered by filtration through a medium of glass beads which filtered out the dead spermatozoa, the change in opacity was found to be significantly related to the percentage of stained spermatozoa in the semen samples tested (r=0.7, P $\angle$ 0.001). A further alternative staining procedure was reported by Bishop and Smiles (1957). Who, using ultraviolet dark ground illumination along with premulin stain, found that dead spermatozoa fluoresce light blue and the living ones remain invisible.

Blackshaw (1958) found that a stain containing congo red and nigrosin gave satisfactory results for ram semen and could be used with advantage to replace eosin nigrosin stains.

Wiggins et.al.(1953) found the percentage of live spermatozoa was not significatly correlated with fertility in ram. The percentage of live spermatozoa, showed a significant correlation of 0.29 (P $<$ 0.01). This was lower, however, than the highest correlation (0.43) found between fertility and the percentage of normal spermatozoa alone.

Prabhu and Bhattacharya (1951) obtained an average of 22.64 and 17.21% dead spermatozoa in the first and second ejaculates respectively while working with Indian buffaloes.

Lasley et.al.(1942) and Lasley and Bogart (1943), using insemination results with beef cattle, reported that semen samples containing less than 50% live spermatozoa were of doubtful fertility.

MORPHOLOGICAL STUDY OF SPERMATOZOA :

Sperm cells were first seen by a Doctor Ham, and his observations were first reported by Antoni Van Leeuwenhock in 1677 soon after the invention of the light microscope.

(a). Normal spermatozoa -

The rapid growth of artificial insemination in farm animals hd had thrown a heavy responsibility on a comparatively small number of males. Many criteria were employed for the evaluation of semen quality. A knowledge of the morphology and the development of sperm was essential for the proper evaluation of semen on the basis of sperm morphology.

The spermatozoa of all mammals, birds and other vertebrates could be easily distinguish from those of others by the shape of the head which have distinctive features.

The head of the stallion sperm when viewed in the flat position was broadest in the middle gradually tapering towards the extremities with the ends being rounded off.

The head of the jack sperm resembled the stallion sperm closely, but was more rounded anteriorly and the base was broader. The point of greatest width also was slightly behind the middle line.

The head of the ram sperm in the flat view was oval in shape with the greatest width about middle of the head.

The head of the buck sperm was about the same length as that of ram but differed markedly in shape. The greatest width rested at about the anterior third of the head and even here it was only slightly broader than at either extremity.

The buffalo bull sperm resemblanced the ram sperm in out line through were shorter and narrower. The head was narrowest at the base, the greatest width lying slightly behind the anterior end.

The head of the boar sperm was larger than other species except the bull, being longer and broader. The greatest width was about the middle from where it narrowed down to the base while anteriorly the width was only slightly less than at the centre.

The head of the spermatozoa of the birds studied was narrower, elongated and cylindrical with an inconspicous, apparently inflexible head. The anterior end of the head was drawn into short, needle like process, while the rest of the head was of uniform thickness.

(b). Percentage of abnormal spermatozoa :

The occurence of pathological or abnormal spermatozoa was demonstrated in a man as early as 1900 by Broman while Williams and Savage (1925) were the pioneers to show that when the semen of a bull or other breeding male, contained a large percentage of pathological spermatozoa, fertility was lowered approximately parallel to the ratio of the defective cells. They considered the morphology of the sperm heads as the greatest single source of information as to the fitness of the cells for reproduction.

Williams and Savage (1927) further showed that fertility was diminished when abnormal spermatozoa exceeded 17 percent.

Lagerlof (1934) found that the count of abnormal spermatozoa lay between 2.4 percent and 17.2 percent with an average of 10.7 percent. Lagerlof (1934) further recognised abnormal types of spermatozoa as giant, dwarf forms, two heads, two tails, loose heads, abnormalities

in the middle piece and distrurbed staining capacity.

Lagerlof (1936) also stated that the detrimental agency which caused the disturbance in spermatozoa formation or brought about degeneration in any of the developed spermatozoa, might also have affected spermatozoa other than those which showed actual changes under the microscope.

Several authors, including Williams and Savage, Lagerlof, Blom and Mercier and Salisbury stressed the importance of primary sperm cell abnormalities whose number rose as a result of faulty spermatogenesis.

Mckenzie and Philips (1934) found abnormal spermatozoa in the earliest ejaculation of the breeding season or following periods of breeding inactivity, from satisfactory rams. These were mostly tailless or with coiled tails. This was considered as a physiological condition rather than a pathological one.

Swanson and Herman (1940) found that bulls of known good breeding efficiency averaged well below 20 percent abnormal spermatozoa. Three sires which were practically sterile had more than 60 percent abnormal forms, and in four, known to be of lower fertility, abnormal spermatozoa ranged from 23 to 37 percent. The same authors (1941) showed that no particular type of abnormality seemed to be associated with reduced fertility. The main difference

between the spermatozoa of good fertility and those of poor fertility were the percentage of teal total abnormal spermatozoa and the uniformity of the size of heads.

Mckenzie and Phillips (1934) and Mckenzie and Berliner (1937) classified the abnormalities in ram as tailless, coiled tails, tapering heads, broken at necks, small and large heads, enlarged middle piece, middle piece bead, filiform middle piece, double heads, double tails and cytoplasmic extrusion at base of head.

Salisbury et.al.(1942) stressed that the determination of the number of morphologically abnormal spermatozoa in a sample of semen could be widely used as a diagnostic aid in identifying certain causes of male sterility.

Blom (1948) considered the abnormalities of spermatozoa as :-

(a). Primary : Occuring due to defective spermatogenesis, and

(b). Secondary : Resulting from the degenerative changes following a normal differentiation of spermatozoa. The incidence of secondary form of abnormalities were more varying, although some of these, as detached heads and bent tails, could be artefects and that they could also be a sign of testis degeneration and therefore be an indication of impaired fertility.

Cupps et.al.(1953) reported a high correlation between percentage of abnormal spermatozoa and fertility.

Cummings (1954) was of the opinion that, as the abnormal sperm contents increased from 2 to about 12 percent, there was a decline in breeding efficiency, but the later showed no change at increasingly high levels of abnormal spermatozoa.

Koriath et.al.(1955) observed a positive but insignificant correlation (r=0.048) between percentage of abnormal spermatozoa and fertility.

Roltensten and Anderson (1956) considered that high level of abnormal spermatozoa was not necessarily indicative of low fertility.

Bonadonna and Possi (1954) described the presence of protoplasmic drops in relation to the various part of the genital tract. They suggested that the progressive movement of the drop from the head to the tail of the spermatozoa was associated with the age of the spermatozoa.

Cambell et.al.(1960) however thought that the frequency of the occurrence of malformed heads was neither associated with lowered fertility nor there was any correlation between frequency of dead sperm and conception rate.

Scinunio et.al.(1954) reported that the semen of low motility and longivity having 13.8 to 46 percent of

tailless spermatozoa was able to fertilize only 38.3 percent of the cows.

Hancock (1955) reported a form of sterility in Guernsey bulls characterized by the separation into heads and tails of the majority of spermatozoa. Some association of this anomaly with the migration of cytiplasmic drop was suggested by the author. The abnormalities increased with the age, averaging 6.4 to 7.8 percent at 2 to 3 years against 10.7 to 12.6 percent at 5½ years. The percentage of abnormalities was higher in the first than in the second ejaculate. The incidence of abnormalities of head, middle piece and tail were equally observed.

Cork Screw spermatozoa were noted by Blom (1950) in semen sample of 6 out of 1088 Red Danish A.I. bulls in Denmark. The abnormality was noted in 2.5 to 25 percent of the spermatozoa from 4 bulls of 15 months to 12 years of age. Four out of six bulls were related, two being half brothers. A genetic factor however could not be reported for want of sufficient data.

Horic et.al.(1964) showed that in bull sperm abnormalities were lowest in April and May while Nagy (1965) reported it to be lowest in August.

Parez and Agache 1967 reported that the percentage of abnormal spermatozoa decreased from puberty to 18 months of age and started to increase at about 84 months.

Vacuoles in the nucleoplasm of sperm were observed by Hnidka and Zibrin (1964) in normal bulls which they atributed to disturbances in the differentiation of nuclear material.

Raja and Nambiar (1962) found a very high incidence of abaxial attachments (72-85) percent out of total abnormalities (82-90 percent) in a Sindhi bull which they thought was a clear cause of steritity in that bull.

Onstad (1963) observed the abaxial attachment in about 60 percent of the sperms of an 18 months old Norweigian Red and White bull which he believed to be of congenital origin.

Savage and Isa (1963) found in semen sample from an apparently infertile bull that approximate 1/5th of the spermatozoa had no covering sheath to the middle piece and some of the defective middle pieces were disintegrating posteriorly into the longitudinal fibres.

Kollikar (1856) was perhaps the first to draw attention to this round body now known as protoplasmic droplet or bead.

Redenz (1924) observed protoplasmic drops on the epididymal sperm and later on ejaculated sperm and found that its position varied with the sperm collected.

Voloskov (1935-36) used Mckenzie and Phillips classification for the stallion spermatozoa. According

to Voloskov, the percentage of deformed spermatozoa normally varied from 25% to 80% and there existed a complete parallelism between the percentage of pathological ge forms and the percentage of foaling. Stallions with over 70% of normal spermatozoa fertilized 60% to 89% of their mares and those with 48% to 52% normal spermatozoa, only 40% to 53% of mares.

Hancock (1957) after studying the boar semen for abnormalities, reported the appearance of protoplasmic droplets.

Phillips (1935) concluded that the sperm morphology of a boar could be taken as an indication of his fertility. Semen of fertile boars did not have more than 20% of abnormal forms. From 20% to 50% abnormalities occurred in semen of boars which produced small litters, dead or mummified foetuses, or from boars which failed to settle their sows. According to Milovanov (1936) normal fertile boars may have upto 30% of abnormal forms.

Madan (1969) after working on the camel epididymal spermatozoa reported the mean percentages of the total sperm abnormalities in the head, body and tail region of the epididymis as 18.04, 18.23 and 19.85 respectively. No significant difference was found in the mean percentage of total sperm abnormalities in the head, body and tail region of the epididymis.

The mean percentage of the anterior protoplasmic droplets, posterior protoplasmic droplets and the dropless spermatozoa in the head region of the epididymis were found as 63.19, 6.28 and 29.73 respectively. In the body region these droplets were found as 21.56, 39.02 and 39.42 respectively, while in the tail region such droplets occurred as 8.88, 36.42 and 54.70 respectively.

BIOMETRICS OF THE SPERMATOZOA :

A tabulated statement of the biometrics data of different spermatozoa of different species as reported by different workers is shown in table No. 1.

Savage, Williams, and Fowler (1927) investigated the relationship between the head lenght of spermatozoa and fertility. They found that in bulls of good fertility the head length showed normal or almost normal distribution and they maintained that the coefficient of variation of head length provided a good indication of fertility, in normal bulls the coefficient was not to exceed 4.

Lagerlof (1934) considered bulls with a coefficient of 4 and under as probably fertile, and those with a coefficient of 4.5 and over with reduced fertility, values from 4 to 4.4 were inconclusive. He found that coefficient of variation in (a). 30 fertile bulls was 3.7 (b) in 15 of doubtful fertility it was 4.8, and (c) in 30 sterile or almost sterile bulls it was 6.2 .

TABLE NO. I

A TABULATED STATEMENT OF THE BIOMETRICS DATA OF DIFFERENT SPERMATOZOA OF DIFFERENT SPECIES AS REPORTED BY DIFFERENT WORKERS IS AS UNDER

S.No.	Animals	Head		Middle piece.	Tail length.	Total length.	Reference.
		Lenght	Width				
1	2	3	4	5	6	7	8
1.	Bull (Gir)	9.40	5.36	14.63	48.90	72.93	Venkata Swami & Vedaneyagam (1962)
2.	Bull	9.126	4.732	12.55	46.28	67.96	Mahmoud (1952).
3.	Bull	9.15	4.25	14.84	45.5	69.49	Bonadonna et.al. (1953).
4.	Bull	9.20	4.50	14.18	45.0	68.38	Roberts (1956).
5.	Bull(Sindhi)	9.17	5.12	13.92	47.98	71.01	Venkata Swami & Vedaneyagam (1962).
6.	Bull(Halikar)	9.51	4.63	13.95	41.32	63.52	-- do --
7.	Bull(Ongole)	8.25	4.63	13.0	41.32	66.39	-- do --
8.	Bull	9.31	5.19	13.29	45.79	68.39	Raouf and Nagar (1965).
9.	Buffalo	7.43	4.26	11.65	42.88	61.96	Mahmoud (1952).
10.	Buffalo	7.31	4.32	11.04	42.56	60.91	Raouf and Nagar (1965).

TABLE NO. I

1.	2	3	4	5	6	7	8
11.	Buffalo	7.31	4.32	11.04	42.56	60.91	Raouf and Nagar (1965).
12.	Buffalo	7.40	4.48	12.41	43.61	63.42	Venkata Swami & Vendanayagam. (1962).
13.	Ram	8.20	4.25	14.0	14.45	62.65	Randall and Friendlander (1950).
14.	Goat	9.07	6.05	-	-	-	Jelam and Nambiar (1965).
15.	Stallion	5.0	2.4	8.0	42.0	55.0	Bielanski (1950).
16.	Stallion	7.0	3.9	9.8	43.0	60.55	Nishikawa et.al. (1951 a).
17.	Stallion	5.0	2.4	8.0	30.0	43.0	Bonadonna and Carelta (1954).
18.	Boar	8.5	4.25	10.0	30.0	48.50	
19.	Ass	6.90	3.96	9.91		64.07	Nishikawa et.al. (1951 b).
20.	Tiger	5.802	3.587	37.828		43.790	

Kolmer and Boerner (1941) stated that the distribution curve depicting the length of the sperm head showed high peak and small base in fertile cases, where as it presented an irregular and flat shape with broader base in infertile subjects.

Anderson (1945) indicated that there was almost normal distribution of head length of sperm in good fertile bull semen.

Pursley and Herman (1950) observed that there were no measurable changes in the head dimensions of spermatozoa in the hypertonic and hypotonic solutions. They considered that there were no observable differences in the head size of spermatozoa in the hypertonic solutions.

Krajne (1964) made biometric studies on bull spermatozoa in relation to fertility and found that less fertile bulls generally showed greater variability of sperm measurements. Fertility was correlated with sperm head length (0.638); coefficient of variation for sperm head width (0.41).

Schillong and Kraine (1964) investigated measurements on bull spermatozoa and their relation to fertility and found that conception rate was correlated with head area (-0.6), head length (-0.64) and head width (0.42) of spermatozoa in the semen used for insemination.

Venkata Swami and Vedanayagam compared the size of the spermatozoa with the age and found that the cells of older bulls were significantly longer in head, middle piece and tail length except head width than those of the younger bulls.

Mukherjee and Dott (1960) found that the head of spermatozoa preserved in E.Y.G. (egg yolk glycerol) for 72 hours was approximately 0.1 micron sherter and 0.17 microns narrower than those of untreated spermatozoa or spermatozoa preserved in E.Y.C. (egg yolk citrate) for the same length of time. This difference was significant. The change was probably due to shrinkage of acrosome. They stated that although the decrease in size of the sperm head preserved in E.Y.G. (egg yolk glycerol) was associated with the decrease in the fertilising capacity of spermatozoa, this was not to be taken as evidence that the shrinkage itself was responsible for the loss in fertilizing power.

Mukherjee and Singh (1966) examined semen samples from four Hariana bulls at all the 4 seasons. (December, March, May and July) and the spermatozoa were measured. Genetic variations between bulls caused 84.47, 67.77 and 81.37 percent of the total variation in head lenghth, head breadth and head shape respectively. Where as season contributed only 2 percent, of the variation.

Head length decreasing and breadth increasing with increase in environmental temperature.

Mahmoud (1952) found 9.126, 4.732, 12.558 and 46.28 microns as head length, head width, middle piece length and tail length respectively of bulls spermatozoa.

Raouf and Naggar (1965), (as quoted by Madan, 1969) examined ejaculated and epididymal spermatozoa of 7 and 10 camels respectively. The average measurements of 17 camels in microns of head length, anterior head width, length of middle piece and tail were 5.620 ± 0.0267, 2.917 ± 0.173, 7.341 ± 0.343 and 34.228 ± 2.741 respectively. They found that the sperm were smaller than spermatozoa of the bull and buffalo. The head shape was elleptical rather than ovoid as in spermatozoa of the other Artiodactyla.

Madan (1969) had taken the biometry of 2100 epididymal spermatozoa out of 21 camels at random,&found that the,

(a). Head width : The head width varied from 1.76 to 3.822 microns. The averages of 21 camels ranged from 2.787 to 3.22 microns. The mean head width was 3.030 microns.

(b). Head length : The head length varied from 4.41 microns to 6.762 microns. The averages ranged from 5.583 to 5.982 microns and the mean reported was as 5.802 microns.

(c). Middle piece length : The middle piece length varied from 5.880 to 8.820 microns, the ranged from 7.041 to

7.929 microns, the mean value was 7.3185 microns.

(d). Tail length : The mean length of tail was 35.933 microns.

(e). Total length : Total length of spermatozoa varied from 45.958 to 54.360 microns, ranged from 46.007 to 54.280 microns, the mean value of total length was 49.084 microns.

Velhankar (1967) measured 5.082, 3.587 and 37.828 microns as head length, head width and tail length (inclusive of middle piece) respectively of Tiger spermatozoa.

HAEMATOLOGY :

Harvey (1616) regarded blood as a "living element of body", the first to live and last to die", while Swammerdana (1758) discovered the presence of red blood cells in frog and lice.

Whartons Jone (1846) divided the white blood corpuscles into granular and nongranular types.

Vierorat (1852) produced a dilution technique for determination of red cell count and gave the figure of five million cells per cubic millimeter for the male human objects.

Banerjee et.al.(1962) worked on healthy male camels, aged 7-17 years. The animals were not in the rut period. The different values reported were as follows :-

(a). Erythrocytes : 7.24 million per cu.mm.

(b). Haemoglobin : 13.1 gm. 100 ml.

(c). Leucocytes : 18,000 per cu.mm.

(d). Neutrophil : 51 %

(e). Eosinophil : 6 %

(f). Basophil : .05%

(g). Lymphocyte : 40 %

(h). Monocyte : 3 %

They had also reported that in the one humped Indian Camel, the number of red cells was less.

Gordon, et.al.(1947) reported that castration in male rats was followed by a decrease in the red cell count, where as this caused an increase in the female rats. In castrated females the administration of estradiol benzoate caused a drop in the elevated counts, while testosterone produced a rise in the castrated males.

Gurney et.al.(1965) reported that androgens increased the production of erythropoietin by enhancing the activity of the renal erythropoietic.

Irvine (1958) should we that in case of horse, there was increase in the number of erythrocytes due to conditions of temperament.

Newson and Chitty (1962) suggested that there was a drop in the haemoglobin level in the short tailed vole, (microtus agrestis) in early spring just before the

breeding season and there was increase rate of erythrocytes.

Gordon (1955) reported that under the conditions of stress the adrenal cortical secretion depressed the number of circulating eosinophils and lymphocytes and led to an elevation in the number of circulating neutrophils.

CHOLESTEROL :

Michel Eugne Chevruel (1815) first discovered the cholesterol as cholesterine (Greek : Chole, bile and stereos, solid) in man and animal bile. Later it was reported by Lacanu (1838) in human blood and by Couerbe (1846) in the brain tissue.

Sterols are found in all living organisms in varying amounts. The adrenals (particularly the cortex) and nervous system are high in sterols. Liver, kidney and lung are of intermediate content, and low levels occur in muscular and connective tissue (Cornetius and Kaneko, 1963).

Wotiz et.al.(1955), Staunwhite and Samules (1956) considered cholesterol and acetate as the precursers in the biosynthesis of testosterone by the testis.

The data collected by Knapstein et.al.(1968) suggested that testis were able in vivo to synthesized steroid hormones, in human beings from acetate, as well as cholesterol.

It has been shown that age, sex, breed, lactation,

diet, pregnancy etc. affect serum cholesterol levels both in man and animals.

Kelly (1968) indicated that in case of cattle, the females are reported to have higher blood serum cholesterol than in bull. It was observed that in case of cattle, plasma cholesterol levels were higher in winter than in summer.

Setty and Razdan (1966) reported high blood cholesterol level during humid season as compared to winter season.

Hafeedz et.al.(1958) observed a reciprocal association between blood cholesterol and atmospharic temperature in buffalo cows.

Heldonreieb et.al.(1967) observed that the pigs had higher blood cholesterol levels during winter than during late summer or fall. Hannon and young (1959) also reported a significant increase in serum cholesterol levels in rats exposed to cold.

According to Steiner et.al.(1955) administration of estrogen in man depressed blood serum cholesterol levels where as androgens elevated the levels. In cockrels androgens had no effect on hypercholesteremia produced by estrogens.

Myasnikov, 1965 observed that while administration of testosterone propionate reduced blood cholesterol levels in rabbits; castration increased serum cholesterol.

MATERIAL AND METHODS

MATERIALS AND METHODS

The present study was conducted on fifteen male camels (Camelus dromedarius) of Bikaneri breed. The animals were healthy and clinically free from disease. Their age ranged from 4 to 16 years. All the animals belonged to the state camel breeding farm and were getting the same scale of ration except the three which were let loose in the herd along with females in rut. The study was conducted during the period from septermber,1970 to february, 1971 and included the following details.

1. Sexual behavior
   - A. Signs of rut.
   - B. Act of copulation.
2. Semen studies
   - A. Collection of semen with the help of an artificial vagina.
   - B. Volume.
   - C. Colour.
   - D. Hydrogen ion concentration (pH)
   - E. Mass activity.
   - F. Motility.
   - G. Sperm concentration.
   - H. Live and dead percentage.
   - I. Morphological studies.
   - J. Biometry of the spermatozoa.
3. Haematological studies before and during rut :

A. Total erythrocytic count.

B. Total leucocytic count.

C. Haemoglobin content.

D. Differential leucocytic count.

4. Blood serum cholesterol estimation before and during rut.

1. Sexual behavior

A. Signs of rut :

The following points were noted.

i. Duration of rut.

ii. Body condition of the bull camel.

iii. General behavior of the bull camel which was classified as :-

(a). Furious.

(b). Strong.

(c). Mild.

iv. Intake of food and water.

v. Grunting and gurgling sound.

vi. Secretion of the salivary glands.

vii. Secretion of the poll glands.

viii. Ejection of the soft palate.

IX. Typical posture while standing.

X . Up and down movements of tail.

XI. Act of micturition.

B. Act of copulation :

Separate studies were conducted for natural and hand mating.

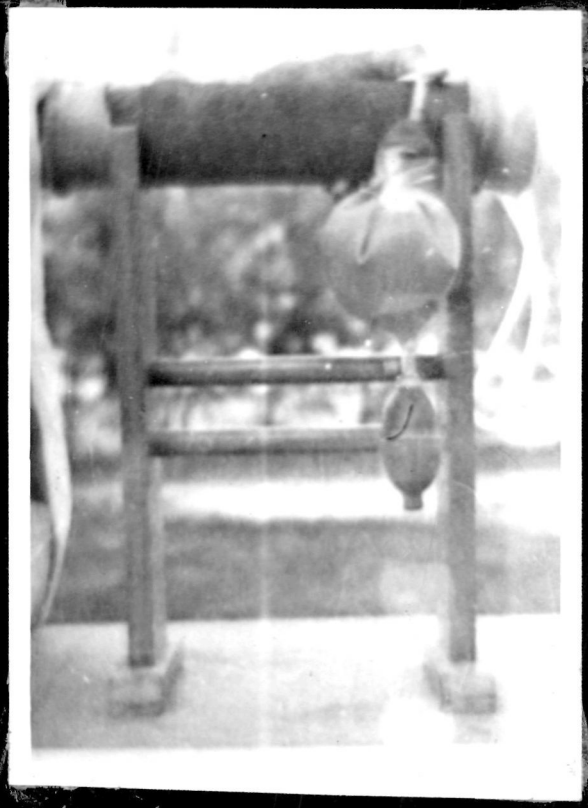


Fig.No.2 Boar's artificial Vagina used for Semen collection in Camel.

(a). Natural service :

When the male and female (in rut) were moving freely in the herd. It included -

i. Courtship.

ii. Efforts of the bull camel to make the she camel sit on the ground.

iii. Mounting.

iv. Penile movements of the bull camel to locate the vulva.

v. Mating.

vi. Posture of the male in relation to the female during mating.

vii. Total copulation time.

viii. Ejaculation.

IX. Position of the bull camel after ejaculation.

B. Hand service :

It comprised of

i. Mounting.

ii. Penile movements to locate vulva.

iii. Copulation time.

iv. Body movements during copulation.

v. Ejaculation.

vi. Position of the bull after ejaculation.

2. Semen studies :

(a). Collection of the semen with the help of an artificial vagina :

For collection of semen a boar's artificial vagina was used. The temperature of the artificial vagina was

maintained between 38.0 to 38.5°C. The technique of collection included the following details.

i. Preparation of the bull and she camels :

The bull camel was well prepared before semen collection by cleaning the area around the prepuce. The she camel was secured in sitting position on a clean, free of dirt ground. A pillow cushion was tied on the posterior part of the hump of the female camel to avoid damage, from the chest pad of the bull camel.

ii. Collection in the artificial vagina :

A teaser (female camel) was used for taking the collection. The bull camel was well excited and allowed to mount only when there was good erection. The artificial vagina was held firmly in the right hand of the operator and the pulsation apparatus was held by an assistant. Both persons stood on the right side of the teaser.

After the bull had mounted the teaser and taken the position of coitus, the sheath was held gently by the operator in his left hand (right handed operator) and the penis directed into the opening of the artificial vagina. At this stage the assistant worked with the pulsation pump and provided the required pulsations. With the rhythmic waves of pulsation coming from the pulsation pump, the male camel copulated. The ejaculate was collected in the 20 ml . graduated collection tube attached to the other end of the artificial vagina.

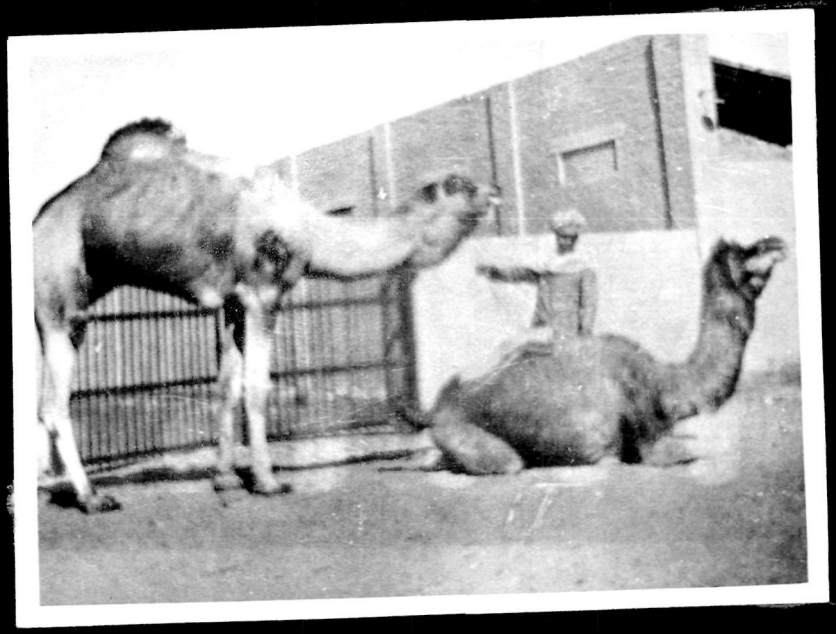


Fig.No.3 Hand service (during semen collection) Male & female both are under control.

Fig.No.4 Bull camel stands over the female by placing his fore limbs one on each side of her shoulder.

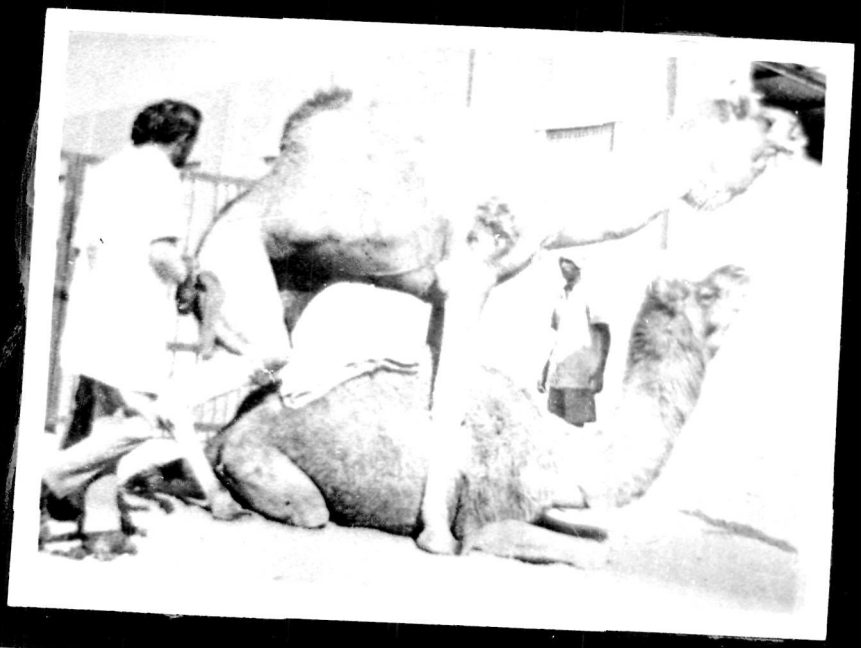


Fig.No.5 Bull camel gradually sits on the she camel by folding his hind limbs, while the fore limbs are straight.

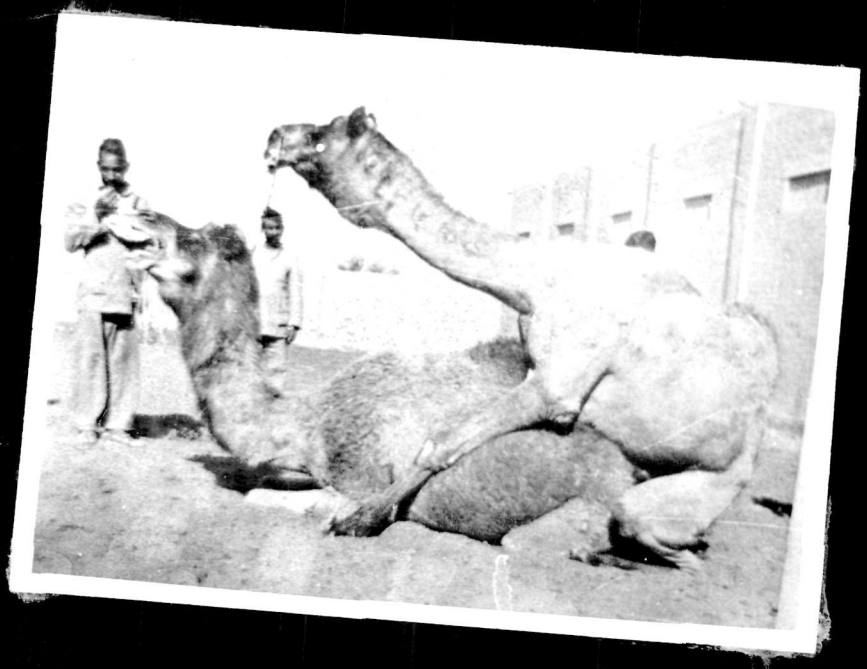


Fig.No.6 Posture of the bull camel in relation to the female during copulation.

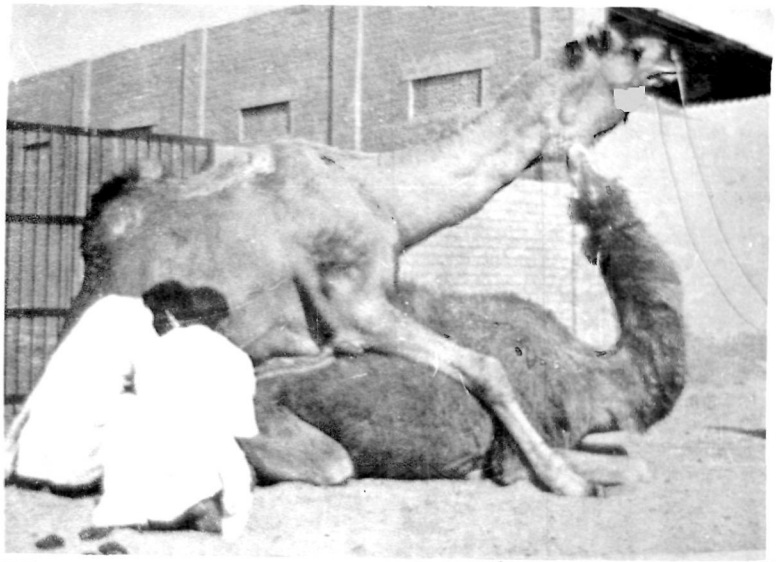


Fig.No.7 Collection technique
Sitting position of the operator
& the assistant during collection.

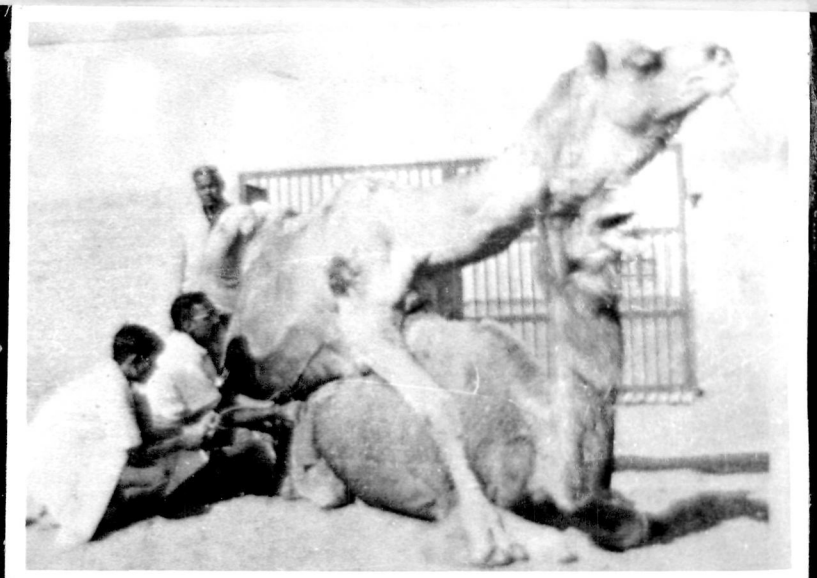


Fig.No.8 Operator holds the sheath in left
hand while the A.V. was held in righthand.

Fig.No.9 Position of the bull camel at
the time of ejaculations.

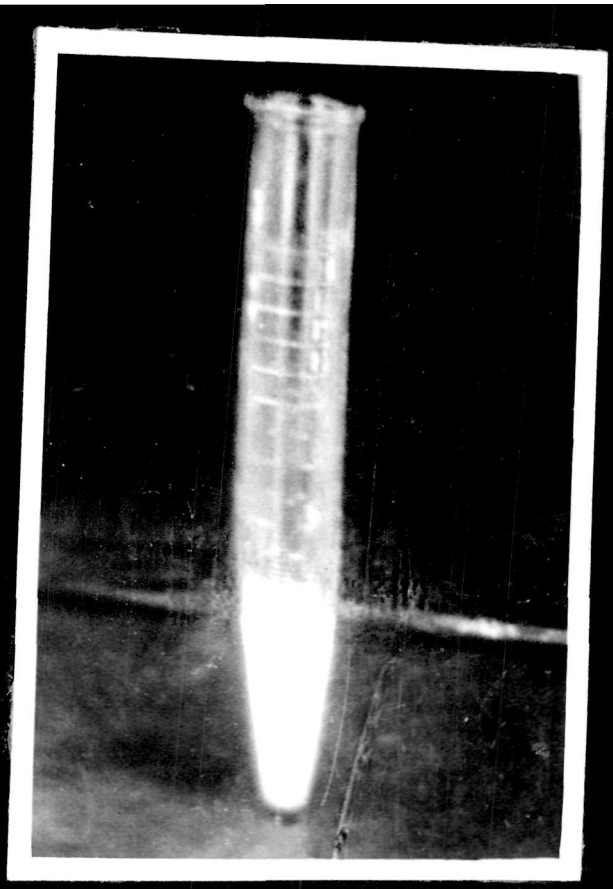


Fig.No.10 Macroscopic appearance of the camel semen.

Fig.No.11 Immediate semen evaluation in the barn.

Precautions :

1. In order to avoid the hand of the operator getting parallised due to pressure exerted by the bull camel against the hind quarter of the female during coitus, frequent gentle finger massage of the abdomen of the bull camel was resorted.

2. After ejaculation the bull camel got exhausted and usually fell down on the same side where the artificial vagina was applied. Care was taken to avoid accidents at this time.

B. Volume :

Total ejaculate was recorded in millilitres directly from the graduated collection tube, upto the tenth decimal place (0.1 ml. divisions).

C. Colour :

The colour of the ejaculate was recorded macroscopically from the collection tube.

D. Mass activity :

The movements of the spermatozoa in mass in the ejaculated fluid were judged, according to the nature of wave formation. For this a small but uniform drop of fresh ejaculate was placed on a clean, dry, warm glass slide (temperature about 38 to 38.5°C) and examined, without a coverslip, under low power with reduced light.

The results were recorded as under, keeping in view the pattern recommended by Palsson (1965).

1. No wave motion 0
2. Slow waves +
3. Rapid waves ++
4. Strong and rapid waves +++
5. Very strong and vigorous waves ++++

E. Initial motility :

A drop of fresh semen was diluted (1:1) with physiological normal saline solution on the warm, dry and clean slide. A coverslip was placed on the diluted semen and examined under high power.

The estimation of the motility was made by observing the approximate percentage of spermatozoa showing progressive movements. For rating, the following scale was employed.

Grade

5. Above 80% spermatozoa were motile (Excellent)
4. 60 to 80% spermatozoa were motile (Good)
3. 40 to 60% spermatozoa were motile (Fair)
2. 20 to 40% spermatozoa were motile (Poor)
1. 10 to 20% spermatozoa were motile (Oscillating)
0. 0 to 10% spermatozoa were motile (Non-Motile)

F. Hydrogen ion concentration (pH)

Hydrogen ion concentration was determined with the help of a B.D.H. Capillary "pH" comparator by using Bromo Thymol Blue indicator.

G. Sperm concentration :

The spermatozoa were counted using improved neubaur haemocytometer. The following method was followed.

i. Complete and even distribution of the spermatozoa in the seminal fluid

It was seen that the camel semen did not dissolve in the diluting fluid until and unless, it was first kept in the incubator at 37°C for about 18 to 24 hours. Hence the estimation was done on the second day.

ii. Dilution and charging of haemocytometer

The semen was thoroughly mixed everytime before drawing it into the red cell pipette. The semen was drawn with great accuracy to the 0.5 mark and the diluting (2 % eosin normal saline) fluid was drawn upto 101 mark to give 200 times dilution of semen in the pipette. The pipette was then gently rotated for proper mixing for about 2 to 3 minutes. Then the haemocytometer was charged with this diluted fluid.

iii. Counting of spermatozoa

The four corner squares and central square of the central large square were used for counting the spermatozoa, using 10 X eye piece under high power. Spermatozoa lying on the lines were counted only when they were on the top and left lines. The total number of spermatozoa of 5 squares were counted and multiplied by 10,000 and result expressed as million per cubic millimeter

of semen.

H. Live and dead sperm percentage :

The percentage of live and dead spermatozoa in the ejaculate, was studied by using Eosin Nigrosin stain.

The staining solution was prepared as under : -

Nigrosin solution	150 ml.
Eosin yellow (G.T.Gurr)	5 gm.
Stock buffer solution	30 ml.
Stock glucose solution	30 ml.
Water	300 ml.

Nigrosin solution :

20 gm Nigrosin (G.T. Gurr) was added to 100 ml distilled water and dissolved under boiling

Stock buffer solution :

$Na_2 HPO_4 2H_2O$	21.682 gm.	200 ml.
Water to	500 ml.	
$KH_2 PO_4$	22.254 gm.	80 ml.
Water to	500 ml.	

Stock glucose solution :

Glucose 483 gm.

Water to 500ml.

Staining technique :

i. The ejaculate and the staining mixture were kept at the same temperature i.e. 31°C to 37°C by

immersing them in a water bath.

ii. A drop of semen was mixed with 3 drops of staining solution in a dry, clean test tube and allowed to stand for half to one minute.

iii. From No.ii a moderately thin smear was prepared with the help of another slide and allowed to dry in air.

iv. The film was examined under high power objective of the microscope. The living spermatozoae were unstained, while the dead one's took the pink stain. The intermediate forms of staining were counted as dead. In all 500 spermatozoa were counted from each ejaculate.

I. Morphologically abnormal spermatozoa

i. Composition of staining solution (Williams Stains).

(a). Carbol fuchsin eosin

I. Stock solution

Fuchsin 10 gm.

96% alcohol 100 ml.

II. Mixing staining solution

Stock solution 10 ml.

5% phenol solution 100 ml.

III. Final stain which was used for staining

Mixing staining solution 50 c.c.

Saturated alcoholic of bluish eosin 25 c.c. This final solution was kept for at least 14 days for maturation and then filtered.

(b). Loeffler's methylene blue

Saturated solution of methylene blue in alcohol - 30 ml.

0.01% aqueous KOH-100 ml.

Preparation and staining of the semen smears

Semen smears were -

i. Made on clean, dry, grease free glass slides.

ii. Dried in air and fixed on the flame.

iii. Passed through absolute alcohol for 3 to 4 minutes.

iv. Treated with ½% chloramine solution for 1 to 2 minutes until the mucus was removed and the smears were fairly cleared.

v. Washed in distilled water and then passed through 96% alcohol.

vi. Stained with carbol fuchsin eosin for 2 to 10 minutes.

vii. Again washed in water.

viii. Counter stained with Loeffler's methylene blue for 5 seconds and then thoroughly washed in distilled water. The dried smears were then examined under high power objective of the microscope.

Abnormal sperm percentage :

For determination of abnormal spermatozoa percentage in the ejaculate, the smears prepared and stained with Williams stain were used.

The abnormalities were estimated by counting 500 spermatozoa from each ejaculate.

The following abnormilities were studied

(a) Head

i. Maga head.

ii. Micro head

iii. Filliform head

iv. Pyriform head

v. Tapering head

vi. Loosening of galea capatis.

(b). Middle piece

i. Abaxial attachment of middle piece.

ii. Double middle piece.

iii. Swollen middle piece.

iv. Short middle piece.

v. Cork screw middle piece.

vi. Bent middle piece.

vii. Filliform middle piece.

viii. Proximal protoplasmic droplet.

IX. Distal protoplasmic droplet.

(c). Tail

i. Bent tail

ii. Coiled tail

iii. Loop tail

iv. Short tail

v. Kinky tail

J. Biometry of spermatozoa :

The direct method of measurements, using an ocular and stage micrometer, was employed, for the determination of the size of the component parts of the spermatozoa. Both the micrometers used were the product of Erma, Tokyo (Japan). The standardization of the ocular scale and all the measurement of the spermatozoa were done under ' ASCO ' research microscope using a 20 X eye piece and high power objective.

First of all the ocular scale was standardized. During the standardization of the ocular scale by calibration with the stage micrometer, it was found that 59 division of the ocular scale were equivalent to 15 divisions of the stage micrometer. The value of one division of the ocular scale was calculated as below :-

59 divisions of the ocular scale.	=	15 divisions of the stage micrometer.
1 division of the ocular scale.	=	$\frac{15}{59}$ divisions of the stage micrometer.
1 division of the stage micrometer.	=	0.01 mm. or 10 microns
1 division of the ocular scale.	=	$\frac{15}{59} \times 10$ or 2.54

Thus the magnification was found to be 2.54 or in other words 1 division of the ocular scale was equivalent to 2.54 microns.

Seventy five well stained, normal, straight spermatozoa were measured from each ejaculate. Thus the a total of 3600 spermatozoa were measured. The average measurements of the component parts of the spermatozoa were then calculated.

3. Haematological studies before and during rut

A. Blood collection

For haematological studies and cholesterol estimation, 5ml. blood was collected from each animal from the jugular vein in each of the two test tubes. One sample was used for serum cholesterol estimation and the other for haematological studies. The sample for haematological studies contained 0.5 mg. to 1.0mg. E.D.T.A. (Disodium salt of ethylene diamine tetra acetic acid) as an anticoagulent. The blood after collection was thoroughly mixed with the anticoagulent for about one minute by gently rotating the tubes between the palms of both the hands. The serum was separated from the clot by centrifusing at 1200 r.p.m.

While haematological studies were done on the same day, cholesterol estimation was done on the next day.

B. Analysis of Blood

The blood was analysed for the following values:-

i. Total erythrocytic count.

ii. Total leucocytic count.

iii. Haemoglonin content.

iv. Differential leucocytic count for :-

(a). Lymphocytes

(b). Monocytes.

(c). Neutrophils.

(d). Eosinophils.

(e). Basophils.

i. Total erythrocytic count.

The erythrocytes were counted by using improved neubaur haemocytometer (A.O. spencer bright line haemocytometer) as described by Napier and Das Gupta (1946) The following steps were taken for red cell count.

(a). Dilution and charging of haemocytometer :

The blood was thoroughly mixed every time before drawing it into the red cell pipette. The blood was drawn with great accuracy to the 0.5 mark. Slight excess of blood above the 0.5 mark was drawn down by touching the point of the pipette with a filter paper. The diluting fluid was drawn upto 101 mark, to give 200 times dilution of blood, in the pipette. The pipette was then gently rotated for porper mixing for about 3 minutes. The haemocytometer was then charged with this diluted fluid.

(b). Counting of Erythrocytes :

The four corner squares and central square of the central large square were used for counting the blood corpuscles, using 10X eye piece under high power, corpuscles lying on the lines were counted only when they were on the top and left lines. The total number of corpuscles of 5 squares were counted and multiplied by 10,000. Results were expressed as million of R.B.C. per cubic millimeter of blood.

ii. Total leucocytic count

The total leucocytes were counted with the same method as used for the erythrocytic count.

(a). Dilution and charging of haemocytometer :

The blood was thoroughly mixed before drawing it in white blood cell pipette. The blood was sucked to the 0.5 mark in the pipette. After this the diluting fluid was drawn to the 0.11 mark and the pipette was gently rotated between the palms for proper mixing. The haemocytometer was charged in a similar manner as for erythrocytic count.

(b). Counting of leucocytes :

The leucocytes were counted in each of the four large corner squares. The cells within four corner squares of ruled area were added and the results were expressed as thousands per cubic millimeter of blood.

iii. Haemoglobin content

Haemoglobin was estimated by sahli's haemoglobinometer. The caliberated tube was filled to the level of lowest graduation with N/10 hydrochloric acid with the help of glass dropper. The haemoglobinometer pipette was filled with blood to the 20 cu.mm. mark. Excess of blood was drawn down by using filter paper on the tip of the haemoglobinometer pipette. Now the blood was slowly expelled into the tube containing N/10

hydrochloric acid. The blood was mixed thoroughly with hydrochloric acid by sucking it back into the haemoglobinometer pipette and blowing it out into the haemometer tube several times. The tube was allowed to stand for ½ an hour after thorough mixing. Now this haematin solution was diluted with distilled water until the colour matches with that of standard brown glass of the haemoglobinometer. The readings were taken in grams per 100ml of blood.

iv. Differential leucocytic count

For differential leucocytic count a smear was prepared within fifteen minutes after bleeding. The smears were stained with Giemsa's stain and the leucocytes counted by the "Battle" field" method (Mac Gregor, 1940). In all 200 cells were counted and the percentage of lymphocytes, neutrophils, monocytes, eosinophils and basophils was calculated.

4. Estimation of blood serum cholesterol :

Numerous methods have been used for the quantitative estimation of blood cholesterol but a method developed by MacIntyre and Ralston (1954) was comparatively easy and required only 0.1 ml. of serum. Besides being precise, it could be analysed even in an ordinary laboratory. As such this method was used for the present studies.

Reagents :

i. Chromatographic grade (Merck) glacial acetic acid :-

This glacial acetic acid was free from aldehyde.

ii. 10 % Ferric chloride solution :

10 gm. of ferric chloride ($Fecl_3\ 6H_2O$) was disolued in 100 ml. of glacial acetic acid.

iii. Colour reagent :

0.5ml. of 10% Ferric chloride solution was added to 7.5ml. of concentrated sulphuric acid in a dry flask. The solution was mixed and diluted to 50ml. with concentrated sulphuric acid. A clear and light yellow fluid was obtained which gradually turned colourless. This reagent was prepared fresh each day.

iv. Cholesterol stock solution :

The stock standard solution was prepared by dissolving 100mg. pure, dry cholesterol in 100ml. glacial acetic acid. This contained one mg. cholesterol per ml. of solution.

v. Cholesterol working standard :

20ml. of the stock standard solution was diluted to 100ml. with glacial acetic acid. This solution contained 0.2mg. cholesterol per ml.

Procedure :

0.1ml. serum was transferred to test tube and to this was added 6ml. glacial acetic acid. A slight turbidity occured. The solution was filtered and 3ml. of filterate was transferred to alarge test tube. The volume was made upto 6ml. by adding 3ml. of glacial acetic acid.

Simultaneously a standard and a blank were also prepared. For standard solution one ml. of working cholesterol standard was taken in a test tube to which was added 5ml. of glacial acetic acid. The blank was prepared by using 0.1ml. distilled water in place of serum and 6ml. glacial acetic acid was added to each test tube, The whole set of test tubes was then kept in an ice cold water bath. 4ml. of colour reagent was added to each test tube which resulted in the formation of a layer below the acetic acid. To ensure even heat distribution the test tubes were shaken atonce thoroughly and placed in racks to attain room temperature. A light to dark pinkish colour appeared in all the test tubes except in the blank reagent.

Readings were taken at 570 mμ by using 55 μ filter on Klett - Summerson photo electric colorimeter after setting it at 0 with blank reagent. The total cholesterol was then calculated by using the follwowing formula.

$$\text{Total cholesterol} = \frac{\text{Reading of test sample}}{\text{Reading of standard}} \times \frac{0.2 \times 100}{0.1}$$

mg. cholesterol per 100ml. serum x 2*mg. cholesterol per 100ml. serum.

(* The concentration was multiplied by two because only half of the filterate was taken).

RESULTS AND DISCUSSION

SEXUAL BEHAVIOR :

It included the studies on ;

A. Signs of rut.

B. Act of copulation.

A. Signs of rut :-

Sexual behavior was studied on seven male camels, out of which five showed all the external signs of rut, while two did not show any signs of rut, except that they ahad an increased secretion of the poll glands.

The detailed observations made regarding the siggs of rut, were as under:-

(a). Duration of rut :

The bull camels No. AH07 & 119 each aged eleven years and which were let loose in the herd along with the she camels, exhibited signs of rut from the middle of October to the middle of March.

Two camels, No.446 & 529, which were each six and eleven years old, and one which was sixteen years of age, showed the signs of rut from the first week of November to the end of February. These bulls were not let loose in the herd but were tied up e in their stables.

Of the three camels, aged six years each and which had approximately the same size, body weight and general health ; one showed the signs of rut while two did not show any sign of rut. The one that showed signs of rut,

had a little darker coat colour than the other two.

It was observed that those bulls which were let loose in the herd, exhibited the signs of rut some what earlier and remained in rut also for a longer period than those which were not let loose in the herd.

It was also seen that the age did not influence the commencement of rut. This is in agreement with Leese (1927). However coat colour may have had some influence on it.

Duration of the ~~urr~~ rutting season is in agreement with the work of Mathur (1960). However Leese (1927) and Singh et. al. (1964) have reported differently.

Though Leese (1927) had reported a bull camel of two years age, showing all the signs of rut, yet in the present study there was not a single male camel in the age range of 2 to 5 years which showed the signs of rut.

(b). Body condition :-

Those bull camels which were let loose in the herd, lost much of their weight and became weak and emaciated as compared to those which were not let loose in the herd. Two camels which did not exhibit signs of rut, did not lose weight.

This may be so because the camels in rut did not take their normal ration, as they were always sexually excited, being all the time with the females.

This is in agreement with Leese (1927) .

(c). General behavior :

During rut all the bull camels showed varied degrees of external signs.

Three bull camels were furious because they charged other persons, as well as to the owner. When these bulls were used for work, they were difficult to handle. They were each eleven years old and were let loose in the herd.

One bull camel, which was six years old, exhibited strong signs of rut but was not furious. This camel was also let loose in the herd.

Another camel, which was sixteen years old, exhibited mild signs of rut.

It appears that the age may be related to the intensity of rutting signs exhibited by the animals. Mathure animals were furious as compared to the younger and older stock.

All the bulls in rut were hostile to each other, when two bull camels in rut were let loose in the herd, they fought continuously till the weaker one ran away from the herd or left the herd.

Leese (1927) and Singh et. al. (1964) have reported that all the bulls were furious during rut, but this has not been observed in the present study.

(d). Intake of food and water :

During rut, all the bulls which exhibited

signs of rut, took very little food and water. Bulls which were let loose in the herd, did not take food even upto ten to twenty days continuously, because they were busy in controlling the females. Through out, day and night, they were encircling the herd, so that no single female may escape from the herd or another bull camel may join the herd.

This is in agreement with Leese (1927).

(e). Sounds produced during rut :-

The bull camel produced two types of sounds.

i. Metalic sound :

It was a friction sound, produced by grinding the lower molars to the upper molars by lateral movements of the lower jaw. This was present even at the time of copulation.

ii. Gurgling sound :-

This sound was produced by belching the air. The animal took his head and neck close to the hump and at the same time protruded the soft palate from the corner of his mouth.

The gurgling sound and the grinding of the teeth have also been reported by Leese (1927); Singh et. al. (1964) and Mathur (1960).

(f). Secretion of the Salivary glands :-

All the bull camels, exhibiting signs of rut,

produced profuse secretion of the salivary glands. The saliva came out from the mouth, at the time of the ejection of the soft palate and remained on the sides of the mouth in the form of froth.

This is in agreement with the findings of Leese (1927) Singh et.al.(1964) and Mathur (1960) .

(g). Secretion of the poll glands :-

In all the seven camels studied, secretion of the poll glands was copious. The secretion was dark redish in colour with disagreable smell and it fell on both sides of the neck e in the form of small drops. The quantity of secretion was more in the older camels as compared to those which were younger. However the secretion of the poll glands was present in camels, which showed the signs of rut, as well as those which did not show any signs of rut.

The secretion of the poll glands is also reported by Leese (1927); Mohan Singh (1958); Pockock (1910); Mathur (1960); and Singh et.al. (1964).

(h). Ejection of the soft palate :-

In five camels ejection of the soft palate was present but was absent in two camels, which did not exhibit the external signs of rut.

Ejection of the soft palate was observed generally on the right side, but some times it occured on the left

side also.(Fig. No. 1).

This is in agreement with Leese (1927) ; Mathur (1960); Charton (1963) and Singh et.al.(1964).

(i). Typical posture while standing :-

During sexual excitement all the bull camels assumed a typical posture. The camel stretched his hind legs wide apart, assumed a crouching posture and made false jerky movements with his pelvis. While doing so, the animal brought his head and neck close to the hump. (Fig. No. 1).

This finding is in agreement with Leese (1927) and Mathur (1960).

(j). Up and down movements of the tail :-

All the bull camels did up and down movements of tail and lashed it vigourously on their testies and the genital organs. By doing so they stimulated their own genital organs. (Fig. No. 1).

Mathur (1960) has also reported this.

(k). Act of micturition :-

At the time of sexual excitement the bull camels micturated intermitently. The urine was emitted rhythmically in spurts, indicating the sexual arousal of the male camel. This urine was also broadcasted by the animal by up and down movements of his tail.

This is in accordance with the finding of Mathur (1960).

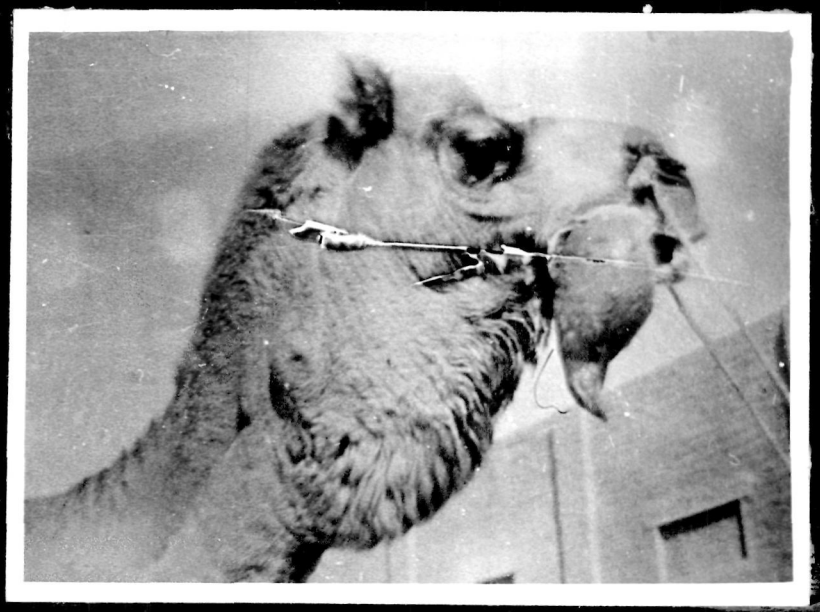


Fig.No.12 Ejection of the soft palate.
(External signs of rut).

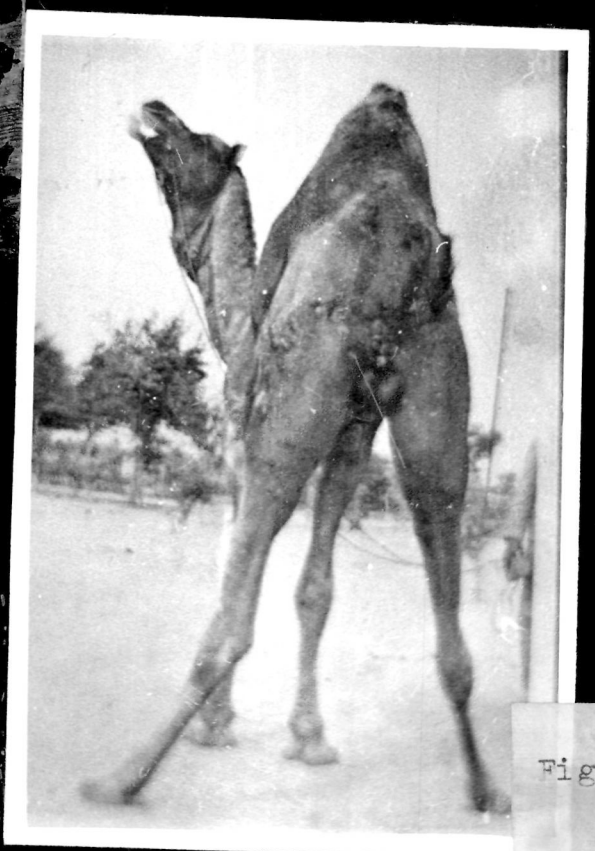


Fig.13.

Fig.No.13 Bull camel assumes a typical posture hind legs are stretched

Fig.No.14 Bull camel vigourously lashes the tail on the genital organs to stimulate them.

B. ACT OF COPULATION :

It was observed and recorded in ;

I. Natural service.

II. Hand service.

I. Natural service :-

The following details were observed

(a). Courtship :

Bull camel while moving freely in the herd, first tried to detect the estrus in the female by smelling her external genitalia and the groin. After smelling, he extended his head and neck with upcurled lips. Smelling, was invariably accompanied by "Pinching" (biting the female). Some time the male bit the female so hard that it resulted in bleeding. The usual place of biting was the Vulvar lips or the posterior part of the hump.

(b). Efforts of the bull camel to make the she camel sit on the ground :

After detection of estrus, the bull camel made the she camel sit on the ground and followed the following procedure.

i. Bull camel tightly passed his nose against her head and followed down to her shoulder, flank and as he reached her genitoanal region, his nuzzling generally became more vigorous.

ii. The bull stimulated the vulva of the

Fig.No.15 Act of copulation(Natural)
Courtship: The bull camel puts his neck on the hind portion of the she camel and pressed downwords thus putting his full weight on the she camel.

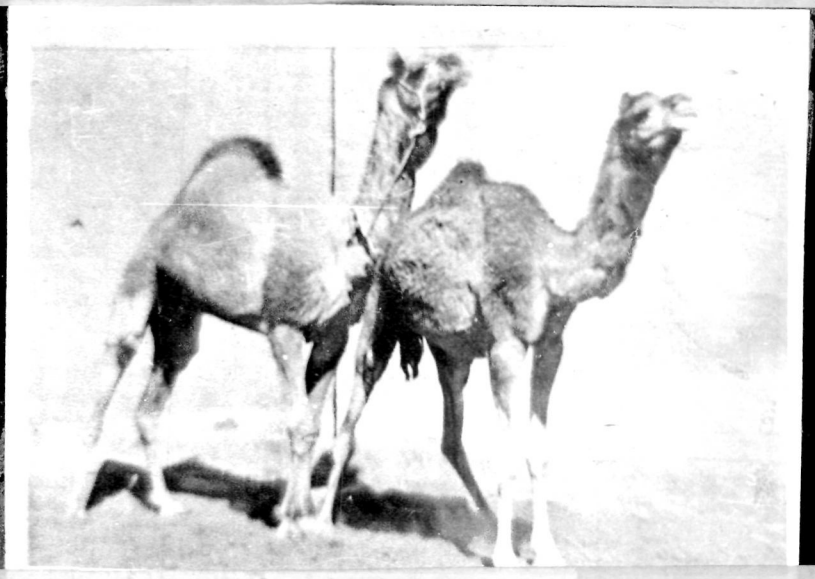


Fig.No.16 Act of Copulation (Natural)
Bull camel stimulates the vulva of she camel.

Fig.No.17 Act of copulation (Natural)
Bull camel bites on the stipe joint of the she camel.

Fig.No.18 Act of copulation (Natural)
Male and female both fall on the ground.

Fig.No.19 Act of copulation (Natureal)
Bull camel takes position for copulation immidiately after falling down.

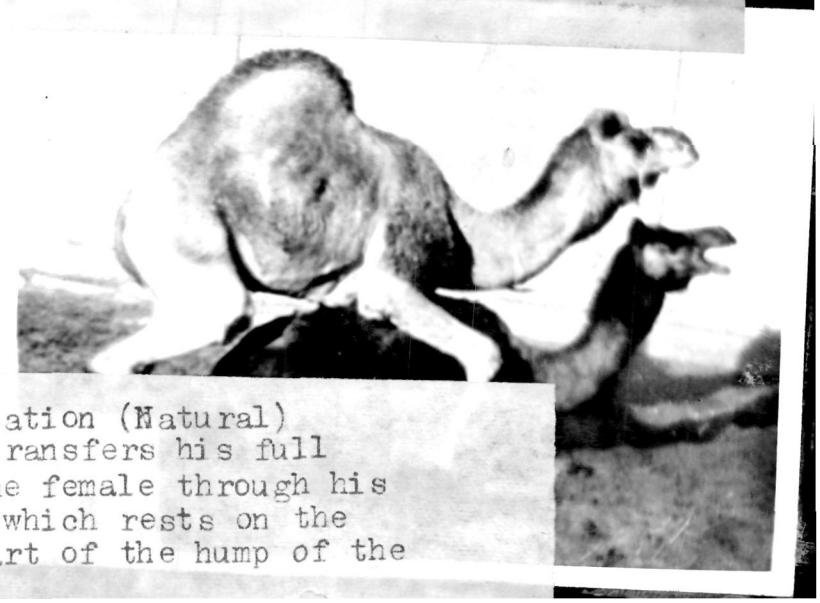


Fig.No.20 Act of copulation (Natural)
Bull camel transfers his full weight on the female through his chest pad, which rests on the posterior part of the hump of the she camel.

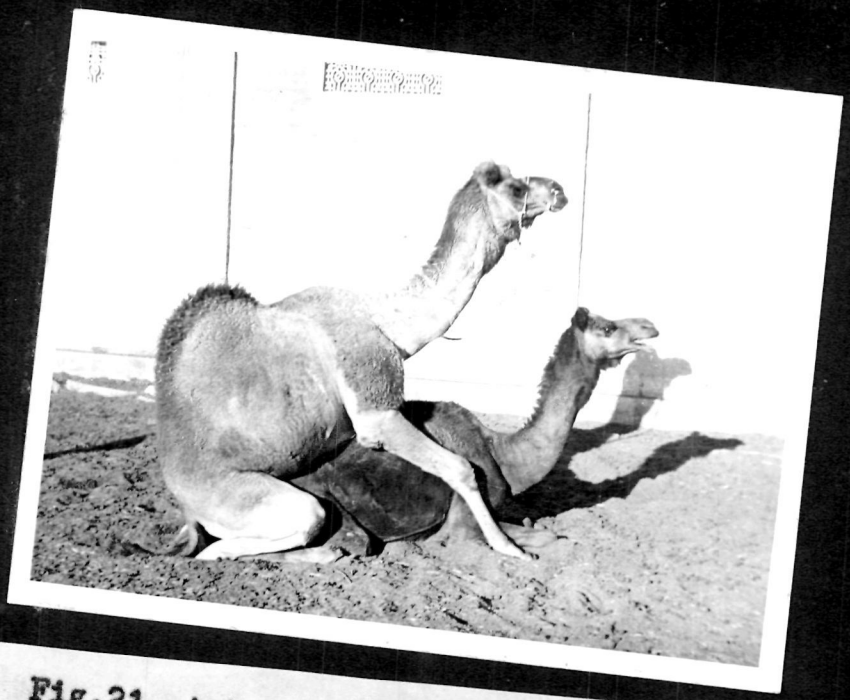


Fig.21. Act of copulation (Natural) Bull camel assumes a typical posture known as the dog sitting position.

Fig.22. Position of the bull camel after ejaculation, the bull camel puts his full weight on the fore-limbs.

she camel by the friction of his neck.

iii. He put his neck on the neck of the she camel and pressed down words thus putting his full weight on the she camel.

iv. If the female failed to oblige, then he bit her on the ~~hock~~ stifle joint which stopped her from walking and she then sat down.

v. As soon as the female sat down, the male often went off balance and fell on the ground, but soon took the position and mounted the female.

This is in agreement with Leese (1927) and Singh et. al. (1964).

(c). Mounting and positioning

This included the following steps.

i. The bull camel stood over the sitting female by placing his fore limbs, one on each side of her shoulder and his hind limbs, one on each side of her pelvis.

ii. Now the bull camel sat down on the female in such a manner that he transfered his full weight on the female though his own chest pad which rested on the rear portion of the hump of the female. In this position the male kepthis fore legs fully extended but folded his hind legs completely. Thus while the whole of his front portion was raised up, he was actually sitting on the

ground through his hind parts.

iii. When bull camel covered the she camel, he squated dog like, with hind limbs flexed and resting on the ground from the heels of the hock, the stifle almost touching the ground, the forelimbs extended one on each side of the she camel with the feet planted on the ground. Both animals were facing the same way.

This is also in accordance with Leese (1927) and Singh et. al. (1964).

(d). Penile movements to locate the vulva.

The bull camel after mounting started the penile movements to locate the vulva. The penis which was found to be rigid and approximately 15 to 20 " long, after full erection, located the vulva by rotating itself spirally on its own longitudinal axis.

(e). Mating :

After the penis had located the vulva, the bull camel gave strong pelvic jerks from time to time by lifting his haunches. His back was now arched.

(f). Posture of the bull camel in relation to the she camel during mating.

During mating, bull camel assumed a typical posture known as the dog sitting position. The relationship of the different male parts to the female was observed as under.

i. The chest pad of the bull camel was related to the posterior part of the hump of the she camel.

ii. The head and neck of the bull camel was fully streched and held high and straight above the neck of the she camel.

iii. The hind parts of the bull camel were pressing tightly against the pelvis of the she camel.

iv. The forelimbs of the bull camel were placed one on each side of the ~~neck~~ thorax of the female and were related to the shoulder region of the she camel.

(g). Total copulation time :

The period from the entry of the penis into the vagina till the completion of the act was recorded as total copulation time. In all 20 matings were recorded. The total copulation time recorded was 10 to 22 minutes (mean 13 minutes).

During one complete act of copulation the bull camel on an average served 3 to 4 times, and every time the entry of the penis into the vagina was gained a fresh. Ejaculation occured at each one of these attempts. After each withdrawl of penis the bull camel took rest for a few moments and then again started the copulation.

The number of intromissions the bull camel had during one act of copulation depended on his sex libido and the period of rest he has had between two acts of

copulation.

The total copulation time is also in agreement with Leese (1927) and Singh et.al. (1964).

(h). Ejaculation :

At the time of ejaculation the bull camel gave a final thrust by raising his hind portion on the hock joints. During this period shivering was also observed in the gluteal and abdominal muscles. The bull camel further arched his back. Strong contractions were also observed in the sheath.

During one act of copulation the bulls ejaculated 3 to 4 times.

(i). Position of the bull camel after ejaculation :

It was observed that after ejaculation, the bull camel either fell down on one side or stood up. After continuous service the bull camel got tired and generally fell down, other-wise he was able to stand up.

II. Hand service.

It was done for the purpose of collection of semen in the artificial vegina. After the female was secured in the recumbent position, the bull camel was allowed to mount under control. The following details were recorded : mounting, penile movements to locate the vulva, copulation time, body movements during copulation, ejaculation and position of the bull after ejaculation.

All the steps metioned were same as have already been discussed before, except the copulation time.

In hand service, the mean for total copulation time was 8 minutes and ranged from 4 to 13 minutes, S.D. 2.38, S.E. 0.36 and C.V. was 29.8 %. In hand service the copulation time was just half as compared to in natural service.

2. SEMEN STUDIES :

It included :-

A. Collection of semen with the help of an artificial vagina -

After observing natural service in camel, it appeared that the bull camel behaved more or less the same way as a boar during service. Hence a boar's vagina complete with pulsation apparatus was tried (Kohli 1970). It proved a success.

The internal temperature of the artificial vagina was set at 38°C to 38.5°C after recording the vaginal temperatures of 20 she camels in heat.

From first camel (No.118) eleven collections were taken, while from other five bull camels eight collection were taken from each. Out of these six camels two were put to use for the first time only.

It was observed that during collection, if the degree of pulsation was too weak or too strong, the

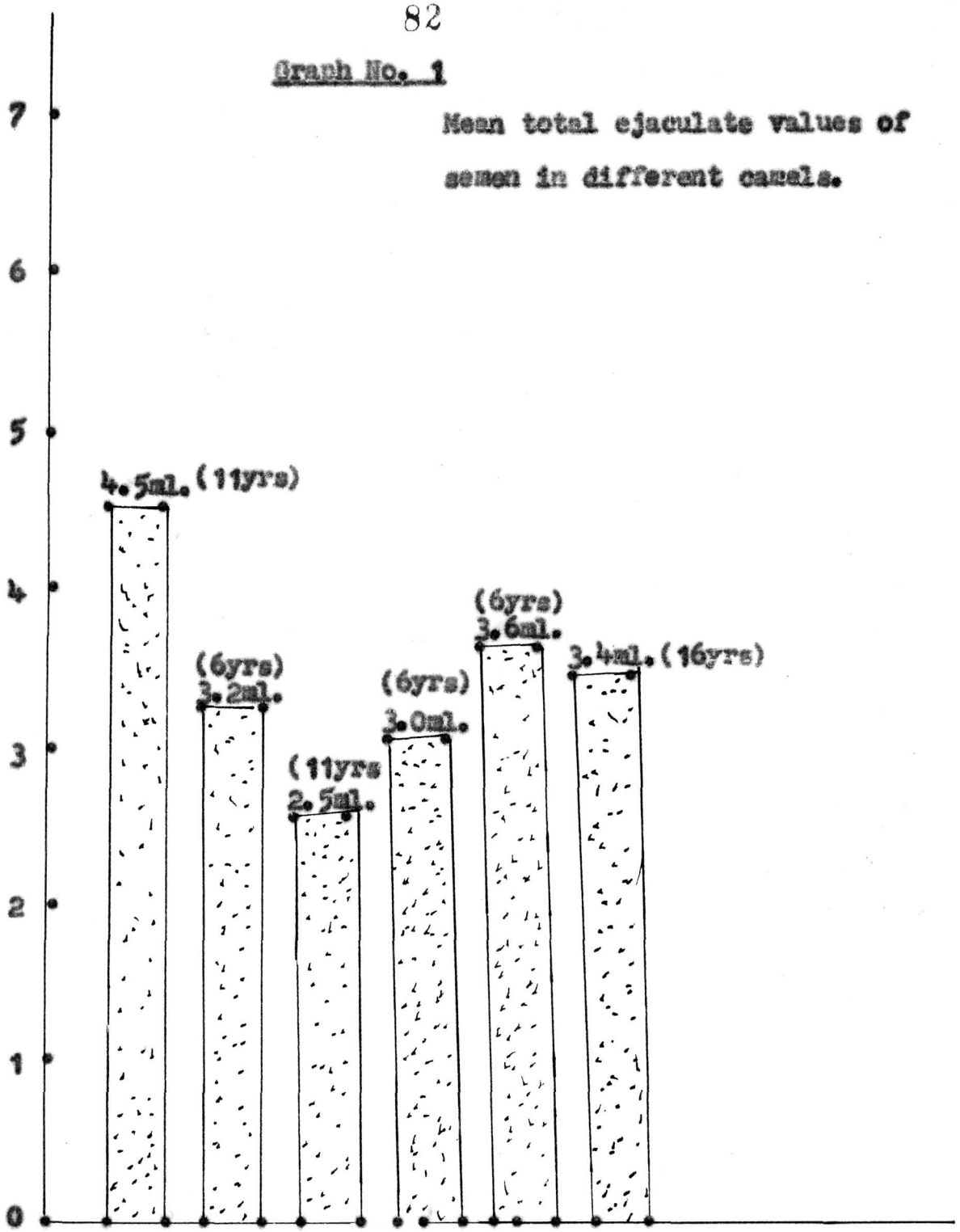
TABLE NO. 2

Details of total ejaculate collected from six bull camels is given as under :

S.No.	Camel No	Age	Range	Mean	Total ejaculate			
					Mean	S.D.	S.E.	C.V.
1.	A (AH07)	11yrs	4 to 5ml.	4.5ml.				
2.	B (459)	6yrs	1 to 7ml.	3.2ml.				
3.	C (119)	11yrs	1 to 4.5ml.	2.5ml.	3.3	1.84	0.2809	56.4
4.	D (445)	6yrs	1 to 5ml.	3.0ml.				
5.	E (446)	6yrs	1.5 to7.0ml.	3.6ml.				
6.	F (GCF 82)	16yrs	1.5to 10ml.	3.4ml.				

Graph No. 1

Mean total ejaculate values of semen in different cases.



Scale :- 1 inch = 1 ml. semen.

ejaculate did not contain any spermatozoa. The bull camel rejected the artificial vagina when its temperature was not between 38°C to 38.5°C.

Two camels which did not show external signs of rut but gave collections and were used for the first time for service, took less time in giving collections as compared to the others.

B. Volume :

In the first trial the total ejaculate (T.E.) was 5ml. and the total time five minutes but it did not contain any spermatozoa. In the second trial the T.E. was 21ml. and the total time 18 minutes, but this also did not contain any spermatozoa. In the third trial also the T.E. collected was 22ml. and the total time 25 minutes, but this also did not contain any spermatozoa.

As the T.E. being obtained was without any spermatozoa and the total time was more than even in natural service, so it was thought that perhaps the artificial vagina temperature fell during this time and this resulted in the absence of spermatozoa. In order to over come this, three artificial vaginas were tried one after the other in the 4th trial. After 40 minutes of continuous trial, the bull camel ejaculated a gelly like material containing spermatozoa but it was contaminated with urine. The volume of this ejaculate was 35ml.

TABLE NO. 3.

Details of pH of semen from six different bull camels.

S.No.	Camel No.	Age	Range	Mean	Total pH			
					Mean	S.D.	S.E.	C.V.
1.	A (AHD7)	11 yrs.	7.4 to 8.4	7.8				
2.	B (459)	6 yrs.	7.6 to 8.0	7.8				
3.	C (119)	11 yrs.	7.6 to 8.8	7.9	7.8	0.38	0.053	4.8
4.	D (445)	6 yrs.	7.4 to 8.2	7.8				
5.	E (446)	6 yrs.	7.4 to 8.2	7.8				
6.	F (G.C.F.82)	16 yrs.	7.2 to 8.2	7.7				

The same pattern of taking collections was followed upto eight ejaculations and during this period the technique of pulsation was improved and perfected.

During the ninth collection, only one artificial vagina was used. At this time the T.E. obtained was 5ml. It was without, urine contamination. After this only one artificial vagina was used for each collection.

In all the six camels the mean volume recorded was 3.1ml. and it ranged from 1 to 10ml. (Table No.2).

From table No.2 it appears that there was slight individual variation on the mean value but the age had no effect on the semen volume.

C. Colour :

The colour of the semen was found to be milky white and of thick viscid consistency. The ejaculate which did not contain spermatozoa had a dirty white colour with watery consistency.

D. Hydrogen ion concentration (pH) :

The mean recorded values for pH were 7.8 and it ranged from 7.2 to 8.8 .

Table No. 3 indicates that there was no individual variation and that the age had also no effect on the pH of semen.

E. Mass activity :

The mass activity was recorded in + (plus) values.

TABLE NO. 4

Mass Activity of eight ejaculates of all the six camels.

S.No.	Camel No	Age	Ejaculates							
			First	Second	Third	Fourth	Fifth	Sixth	Seven	Eight
1.	A	11yrs.	0	0	+	++	0	+	++	+++
2.	B	6yrs.	0	0	+	+	++	+	+	++
3.	C	11yrs.	0	0	+	++	++	++	+++	++
4.	D	6yrs.	0	0	0	0	+	+	++	+
5.	E	6yrs.	0	0	+	+	++	+++	++	++++
6.	F	16yrs.	0	0	0	0	+	++	+++	++++

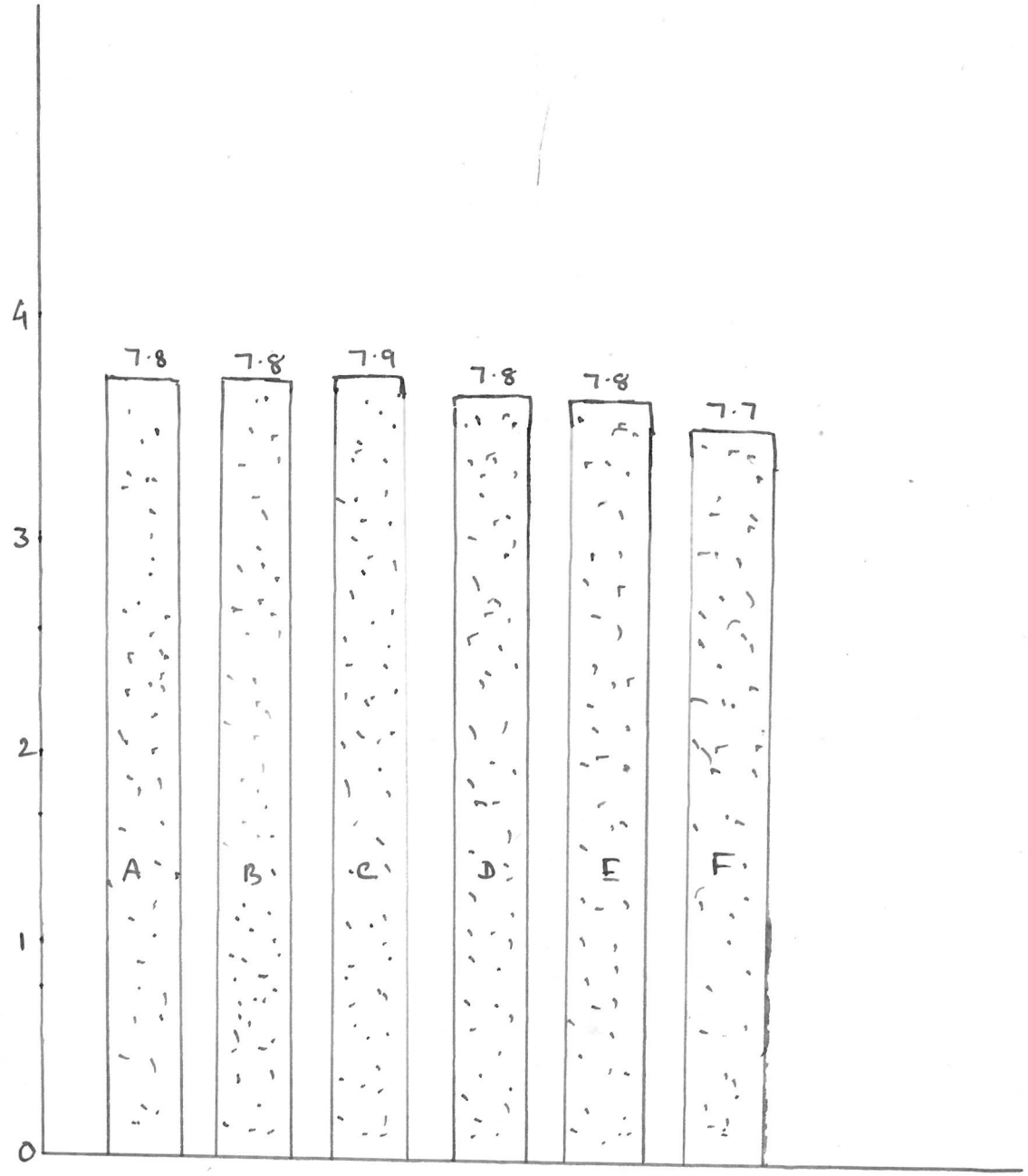
TABLE NO. 5

Initial Motility of eight ejaculates of all the six camels.

S.No.	Camel No	Age	Ejaculates							
			First	Second	Third	Forth	Fifth	Sixth	Seventh	Eighth
1.	A	11yrs.	-	0	0	1	2	0	1	3
2.	B	6yrs.	0	0	1	1	2	1	1	2
3.	C	11yrs.	0	0	1	2	2	2	2	2
4.	D	6yrs.	0	0	0	1	1	1	2	1
5.	E	6yrs.	0	0	1	1	2	3	2	4
6.	F	16yrs.	0	0	0	0	0	2	3	5

Graph No 2

Mean pH values of semen in different camels.



Scale :- 1 inch = 1 pH of Semen.

It ranged from 0 to ++++ .

Table No.4 showes that the mass activity improved gradually after the first three ejaculates.

The camels B (No.459) and D (No.445) which were put to stud for the first time, did not record any improvement in the mass activity even upto eight collections.

F. Initial motility :

The motility ranged from 0 to 5 grades and the figures recorded for all the camels under study are shown in table No. 5.

From table No.5, it appears that upto 3rd ejaculation the motility of the spermatozoa was zero or oscillating but after the third ejaculation, gradual improvement in the motility was recorded.

G. Sperm concentration :

Sperm concentration was recorded in million per ml. The mean values recorded were 189 millions per ml. and it ranged from 70 to 370 millions per ml.

The details of the individual animals are recorded in table No.6.

Table No.6 shows that there was no individual variation and the age had also no effect on the sperm concentration.

Total ejaculate was found to be inversely related to the sperm concentration, because it was seen that when

TABLE NO. 6

Details of sperm concentration in six camels.

S.No.	Camel No	Age	Range (million per ml.)	Mean (million per ml.)	Total sperm concentration			
					Mean	S.D.	S.E.	C.V.
1.	A	11yrs.	150 to 270	230				
2.	B	6yrs.	100 to 370	212				
3.	C	11yrs.	100 to 350	201	189	7.9	1.21	41.79
4.	D	6yrs.	110 to 290	193				
5.	E	6yrs.	70 to 310	154				
6.	F	16yrs.	80 to 290	250				

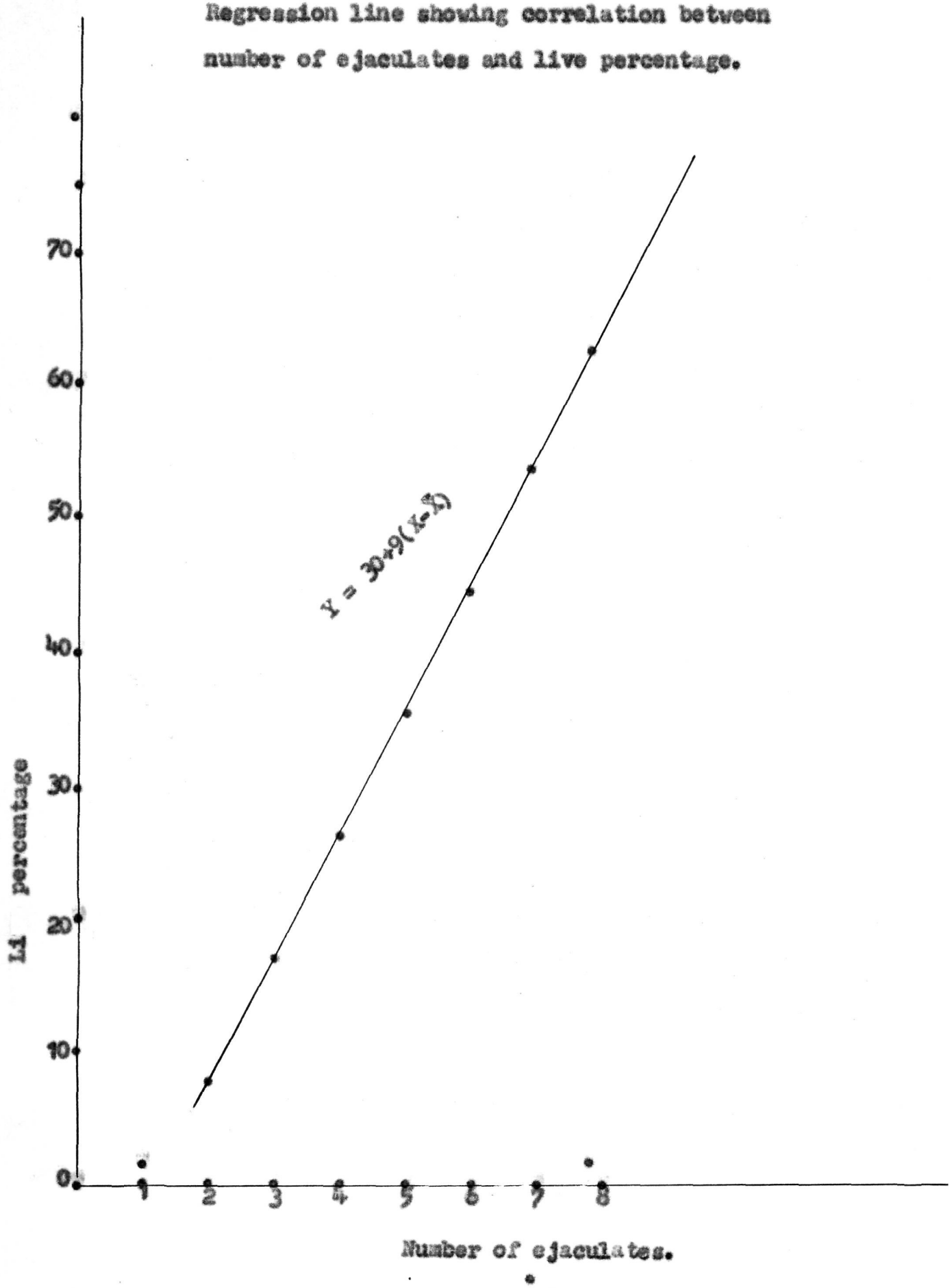
TABLE NO. 7

Percentage of live spermatozoa from eighth ejaculates.

S.No.	Camel No	Age	Ejaculates							
			First	Second	Third	Fourth	Fifth	Sixth	Seven	Eight
1.	A	11yrs.	-	7%	10%	25%	32%	9%	33%	70%
2.	B	6yrs.	14%	15%	22%	39%	45%	32%	35%	44%
3.	C	11yrs.	10%	13%	19%	25%	37%	47%	60%	40%
4.	D	6yrs.	3%	8%	7%	18%	22%	27%	54%	20%
5.	E	6yrs.	3%	9%	15%	25%	43%	66%	53%	80%
6.	F	16yrs.	6%	11%	16%	17%	36%	47%	60%	85%
Mean			7%	10%	16%	24%	34%	38%	47%	63%

Graph No 3.

Regression line showing correlation between number of ejaculates and live percentage.



the volume of the ejaculate was more, the sperm concentration was low (per ml.) and when the volume of the ejaculate was less sperm concentration of more.

H. Live and dead percentage of spermatozoa :

For live and dead percentage, the spermatozoa were stained with nigrosin eosin stain. The live percentage ranged from 3 to 85 percent. The details are shown in table No. 7.

It appears from table No. 7 that in all the bull camels there was gradual increase in the live percentage of spermatozoa from the first ejaculate to the eight ejaculate. The mean value for the first ejaculates was 7% while for the eight ejaculates it was 63% .

At random the minimum live percentage was 3% while the maximum was 85 percent.

The regression line showed that there was a positive correlation between the number of ejaculate and the percentage of live spermatozoa.

I. Morphological studies :

It included -

I. Normal morphological studies :

In general appearence the camel spermatozoa resembled the ram spermatozoa. The head was broad and rather flat at the upper end. It did not taper completely at the lower end. The greatest width was recorded at the

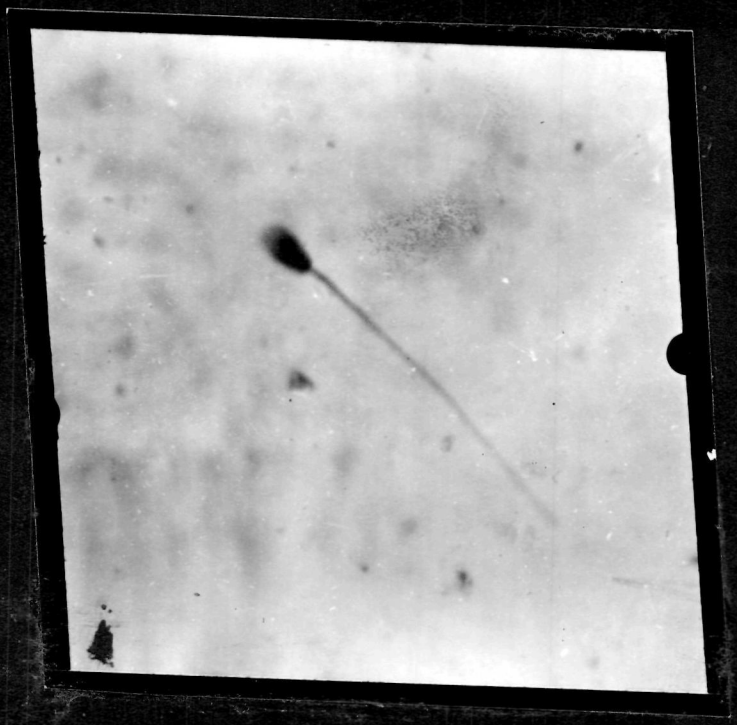


Fig.23. Normal camel spermatozoon, head is broad and rather flat at the upper end, did not taper completely at the lower end.

upper third after which the width started decreasing gradually.

II. Abnormalities of the spermatozoa :

The following abnormalities were detected.

(a). Abnormalities of the head

The total head abnormalities ranged from 2.0 to 6.4 percent, mean 3.75 percent, S.D. 1.02, S.E. 0.147 and C.V. was 27.20 .

The percentage of different head abnormilities recorded was as under :-

i. Micro head 1.2 percent.

ii. Maga head 0.6 percent.

iii. Tapering head 1.0 percent.

iv. Long narrow head 0.6 percent.

v. Loosening of galea capatis 0.2 percent.

vi. Double head 0.1 percent.

(b). Abnormalities of the middle piece

The total middle piece abnormalities ranged from 3.2 to 11 percent, mean 5.4 percent, S.D. 1.65, S.E. 0.239 and C.V. was 30.21 .

The percentage of different middle piece abnormalities recorded was as under :

i. Short middle piece 0.6 percent.

ii. Double middle piece 0.05 percent.

iii. Enlarge middle piece 0.9 percent.

iv. Cork-screw middle piece 0.01 percent.

v. Filliform middle piece 0.5 percent.

vi. Distal droplet 1.2 percent.

Fig.24."Double head"

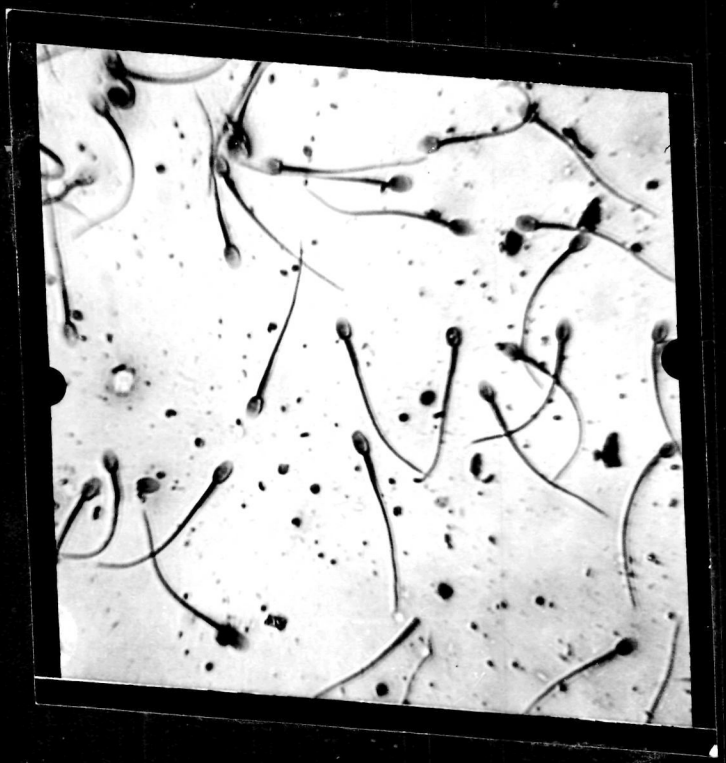


Fig.25. "Tapering head".

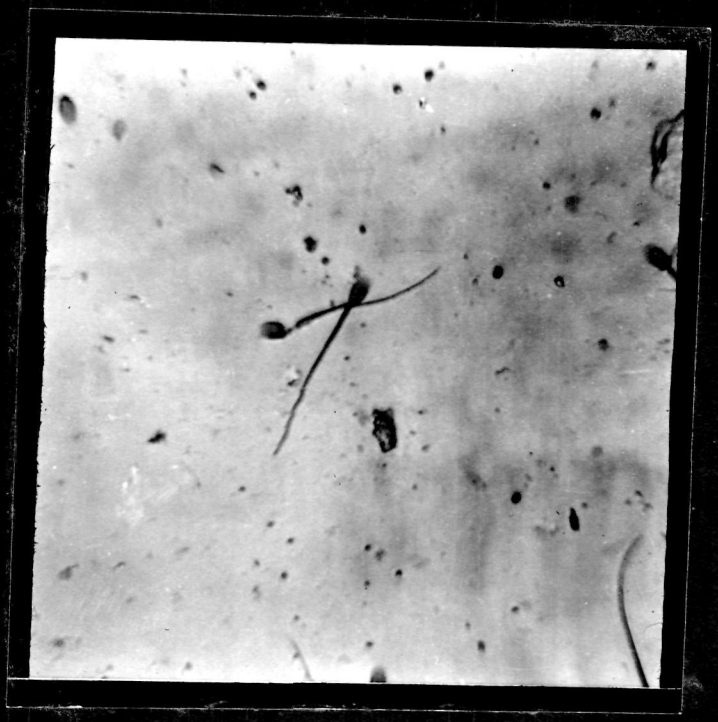


Fig.26. "Broken neck".

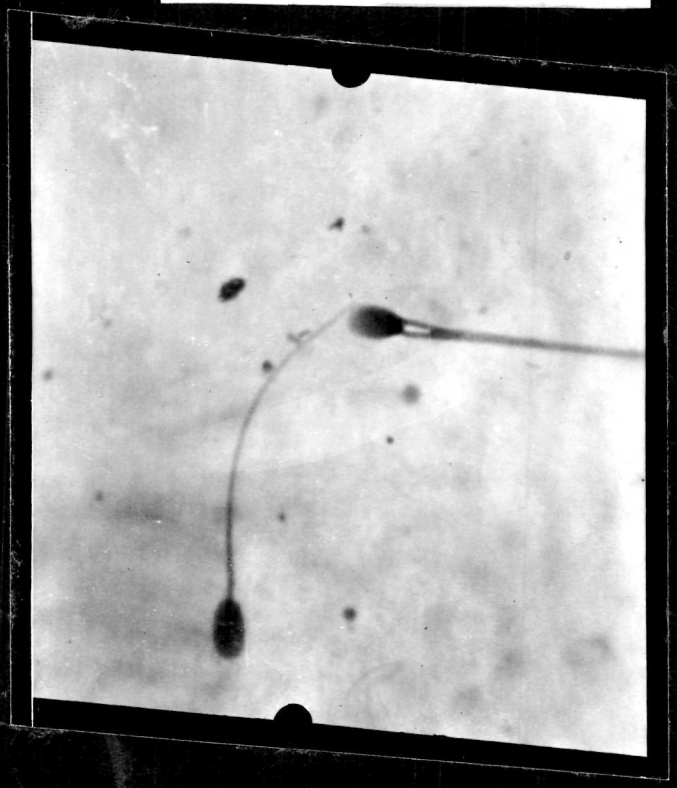


Fig.27. "Double middle piece".

Fig.28. " Bent tails ".

Fig.29. "Protoplasmic droplet".

vii. Proximal droplet 1.1 percent.

viii. Abaxial attachment 0.7 percent.

IX. Bent middle piece 0.3 percent.

(c). Abnormalities of the tail :

The total tail abnormalities ranged from 2.4 to 8.2 percent, mean 4.1 percent, S.D. 0.920, S.E. 0.133 and C.V. was 22.06 .

The percentage of different tail abnormalities recorded was as under :-

i. Kinky tail 0.1 percent.

ii. Bent tail 1.1 percent.

iii. Short tail 0.3 percent.

iv. Coiled tail 1.4 percent.

v. Loop tail 1.2. percent.

Table No. 8 shows that there was no variation in the individual mean of the different camels for the head abnormalities. Age had also no relationship with the head abnormalities.

It appears from table No. 9 that there was also no variation in the individual mean of the different camels for the middle piece abnormalities. Age had also no relationship with the middle piece abnormalities.

It appears from table No. 10 that there was also no variation in the individual mean of the different camels for the tail abnormalities.

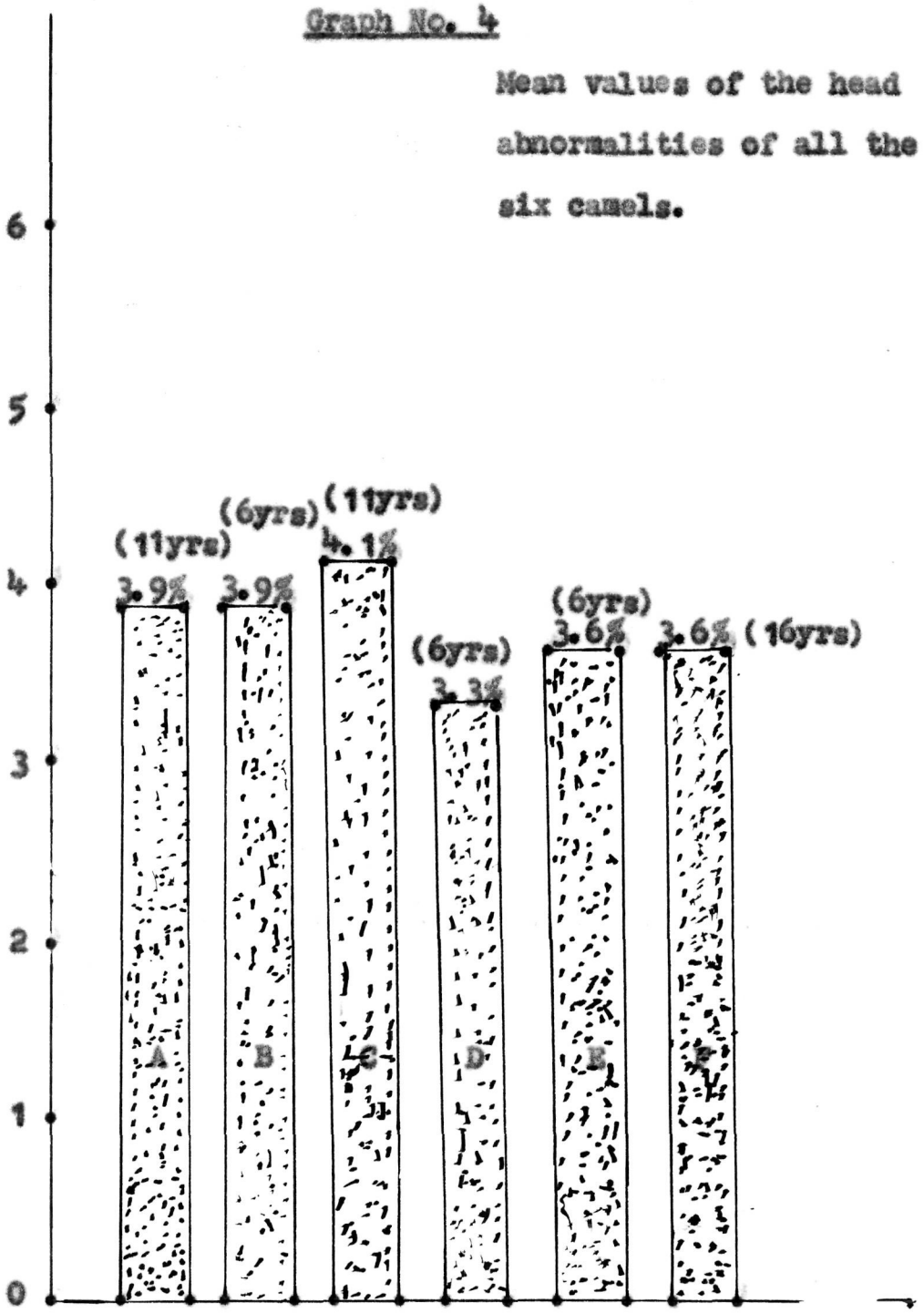
TABLE NO. 8

Abnormalities of the head in different camels.

S.No.	Camel No	Age	Ejaculates								Individual Mean.
			First	Second	Third	Forth	Fifth	Sixth	Seventh	Eighth	
1.	A	11yrs.	6.4	3.4	3.4	3.2	4.8	4.2	3.4	2.8	3.9
2.	B	6yrs.	3.0	3.6	7.2	4.0	2.0	3.8	3.6	3.3	3.9
3.	C	116yrs.	3.2	3.0	4.6	3.6	6.8	5.2	3.8	2.8	4.1
4.	D	6yrs.	2.4	3.8	3.4	3.4 4.6	3.4	3.2	3.8	3.6	3.3
5.	E	6yrs.	4.2	4.4	3.4	4.6	2.4	3.2	4.0	2.8	3.6
6.	F	16yrs.	3.0	4.0	2.6	3.6	3.6	4.2	4.4	3.8	3.6
Total Mean ejaculates wise.			3.6	3.6	4.1	3.6	3.8	4.0	3.6	3.3	3.7

Graph No. 4

Mean values of the head abnormalities of all the six camels.



Total ejaculates.

Scale :- 1 inch = 1 percent abnormalities.

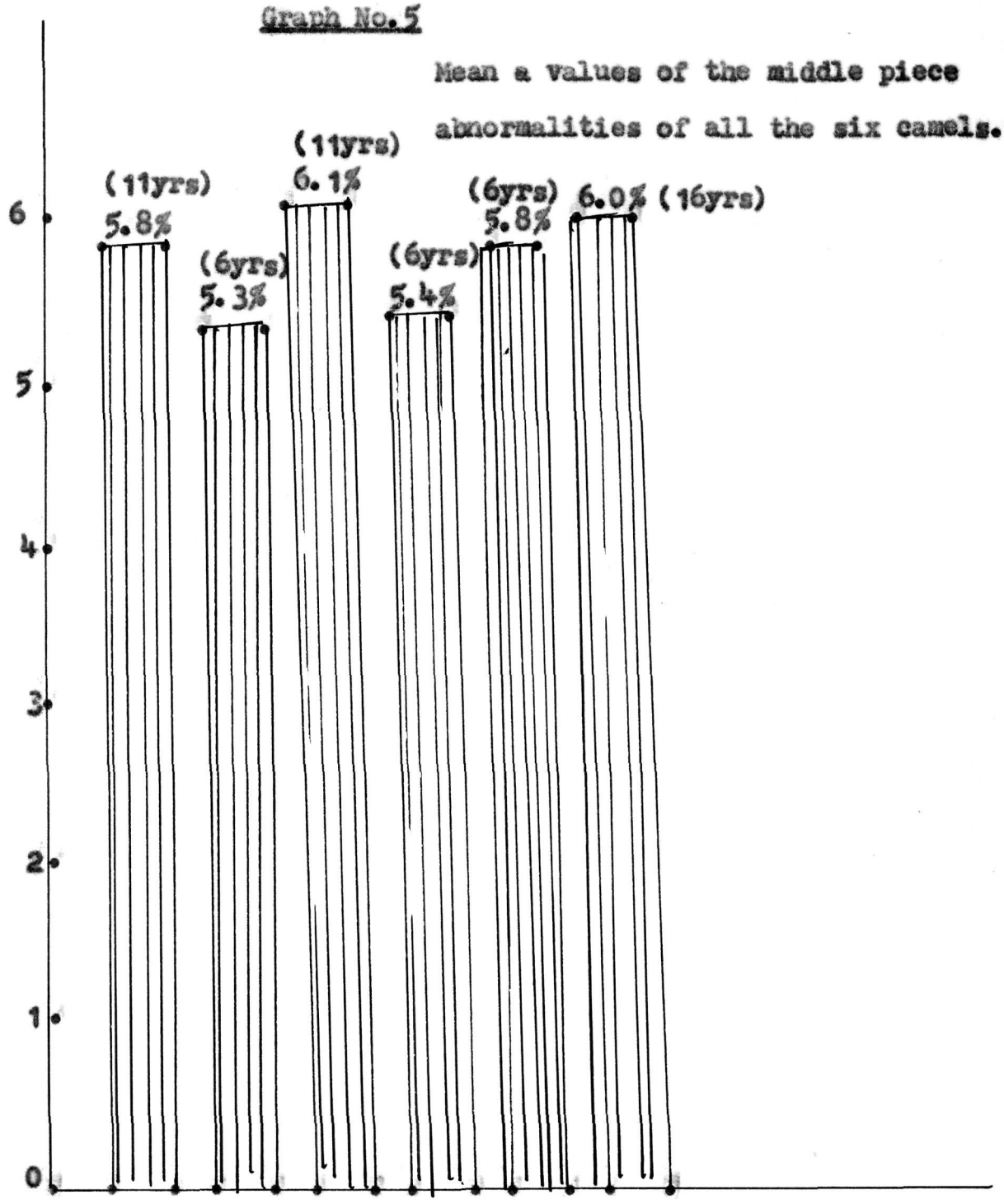
TABLE NO.9

Abnormalities of the middle piece in different camels.

S.No.	Camel No.	Age	Ejaculates								Individual Mean.
			First	Second	Third	Forth	Fifth	Sixth	Seventh	Eighth	
1.	A	11yrs.	7.4	4.6	5.0	5.6	6.8	5.4	6.4	5.4	5.3
2.	B	6yrs.	5.0	4.6	7.2	5.8	3.2	5.2	6.4	5.2	6.1
3.	C	116yrs.	6.2	3.3	8.6	4.4	11.0	6.3	5.3	4.1	5.4
4.	D	6yrs.	3.8	4.6	5.6	5.6	5.4	6.8	6.0	5.6	5.8
5.	E	6yrs.	7.6	6.2	5.8	5.6	4.8	3.6	4.4	3.6	6.0
6.	F	16yrs.	5.0	5.2	5.8	4.2	7.2	6.2	7.4	6.8	5.8
Total Mean.			5.8	4.7	6.3	5.3	6.4	5.6	6.0	5.2	

Graph No.5

Mean a values of the middle piece abnormalities of all the six camels.



Total ejaculates.

Scale :- 1 inch = 1 percent abnormalities.

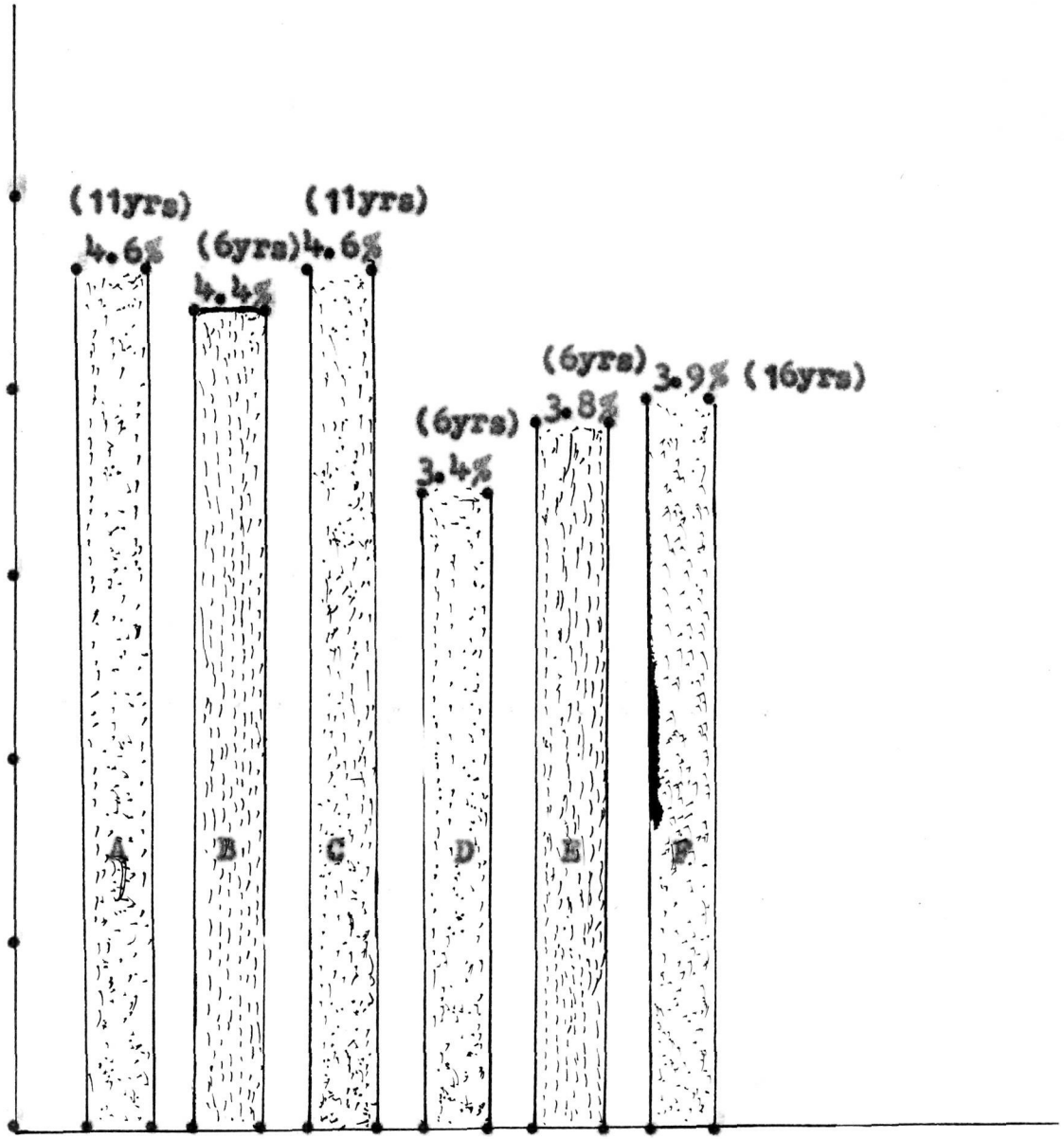
T A B L E NO. 10

Abnormalities of the tail in different camels.

S.No.	Camel No	Age	Ejaculates								Individual Mean.
			First	Second	Third	Forth	Fifth	Sixth	Seventh	Eighth	
1.	A	11yrs.	6.2	3.2	4.4	3.2	8.2	3.8	4.2	3.6	4.6
2.	B	6yrs.	5.2	2.4	6.6	4.8	3.4	3.8	5.0	4.4	4.4
3.	C	11yrs.	2.6	3.8	8.0	3.8	8.2	4.0	3.6	3.4	4.6
4.	D	6yrs.	3.8	2.4	4.2	2.8	3.8	2.4	3.4	3.8	3.4
5.	E	6yrs.	4.0	4.6	4.6	4.4	3.0	3.6	3.0	3.6	3.8
6.	F	16yrs.	3.6	3.6	3.8	3.0	3.6	4.6	5.0	4.0	3.9
Total Mean			4.1	3.2	5.3	3.9	5.0	3.9	4.0	4.6	

Graph No.6

Mean values of the tail abnormalities of all the six camels.



Total ejaculates.

Scale:- 1 inch = 1 percent. abnormalities.

In all the animals there was also no variation in the mean value of the total ejaculate from the first ejaculate to the last ejaculate. Age had also no relationship with the tail abnormalities.

Table No. 8,7 and 10 show that the percentage of the middle piece abnormalities were more as compared to the head and tail abnormalities.

J. Biometry of the spermatozoa :

In all 3600 spermatozoa were measured, 75 from each ejaculate. The biometric studies of the component parts of the spermatozoa showed the following results.

i. Head length

The head length ranged from 5.08 to 6.35 microns. Mean values of head length of 3600 spermatozoa was found to be 5.36 microns.

ii. Head width

The head width ranged from 3.17 to 3.81 microns. The mean head width of 3600 spermatozoa was found to be 3.42 microns.

iii. Middle piece length

The middle piece length ranged from 7.62 to 8.25 microns. The mean middle piece length of 3600 spermatozoa was found to be 7.38 microns.

iv. Tail length

The length of the tail ranged from 34.2 to

TABLE NO. 11

Biometry of the different component parts of spermatozoa

S.No.	Component partsof spermatozoa.	Mean	S.D.	S.E.	C.V.
1.	Head length	5.36microns.	0.06	0.0086	1.11
2.	Head width	3.43microns.	0.06	0.0086	1.7
3.	Middle piece length	7.38microns.	0.39	0.056	5.28
4.	Tail length	35microns.	0.16	0.0231	0.44
5.	Total sperm length	48.37microns.	0.0157	0.00227	0.032

37.5 microns. The mean value of tail length of 3600 spermatozoa was found to be 35.62 microns.

v. Total sperm length

The total length of the spermatozoa ranged from 46.9 to 50.8 microns. The averages of 48 ejaculates ranged from 48.2 to 48.5 microns. Mean value of total length of 3600 spermatozoa was found to be 48.37 microns.

These results seem to be in agreement with Raouf and Naggar (1965) ; and Madan (1969).

The biometric studies show that the head length, head width and middle piece length of the camel spermatozoa are less than that of the bull, (Bonadonna et.al.,(1963); buffalo bull (Mahmoud,1952); ram (Rathore, 1961); goat (Jelam and Nambiar, 1965); boar (Hancock and Roy, 1957); and ass (Nishikawa et.al.) where the head length and width were compared to the stallion spermatozoa, these were found to be more, (Bielanski,1950 Bonadonna and Caretta, 1954). However the middle piece length was less than the stallion spermatozoa.

The tail length was also less than bull, buffalo bull, ram, goat, stallion but it was more than boar's spermatozoa.

Total length of the camel spermatozoa was less than all the domestic animals, except the boar, where it was just similar to it.

3. Haematological studies before and during rut :

It included :-

A. Total erythrocytic count

(a). Before rut

Total erythrocytic count ranged from 7.0 to 11.5 millions per cu.mm. The mean value obtained was 8.8 millions per cu.mm.

(b). During rut

Total erythrocytic count ranged from 6.5 to 9.9 million per cu.mm. The mean was found to be 8.4 millions per cu.mm.

It appears from the table No. 10 that there was slight decrease in the total erythrocytic count during rutting season, but it is not significant.

B. Total Leucocytic count.

(a). Before rut

The total leucocytic count ranged from 6.5 to 13.6 thousands per cu.mm. The mean values obtained were 10.5 thousands per cu.mm.

(b). During rut

The total leucocytic count ranged from 10.5 to 19.2 thousands per cu.mm. The mean value was found to be 14.16 thousands per cu.mm.

It appears from the table No. 12 that there was a highly significant ($P < .01$) increase in the total

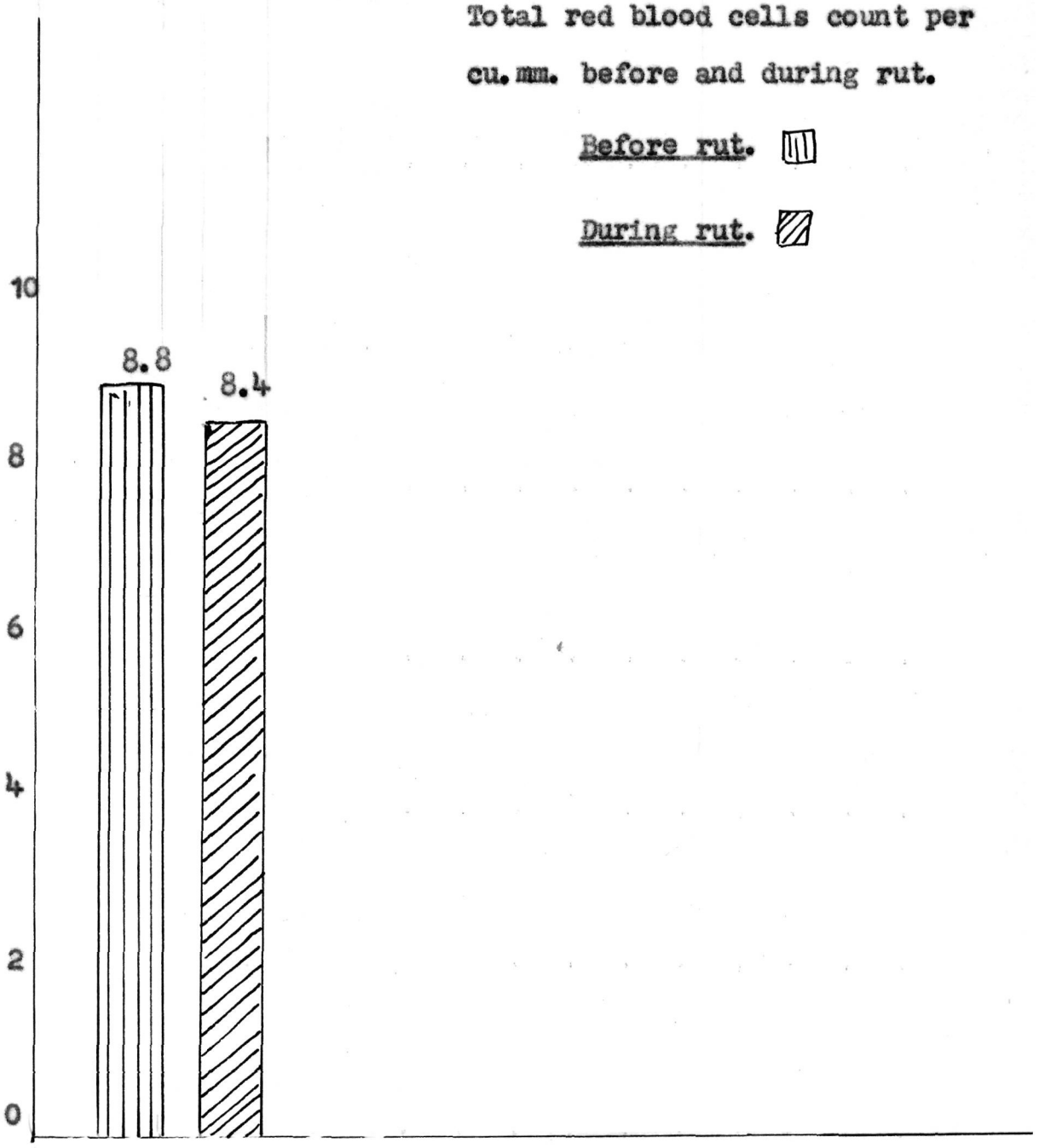
TABLE NO. 12

Mean value of total erythrocytes before and during rut.

S.No.	Period	Total Camel No.	Aged range	Mean (millions per cu.mm.)	S.D.	S.E.	C.V.
1.	Before rut	15	3 to 16yrs.	8.8	1.116	0.29	12.58
2.	During rut	15	3 to 16yrs.	8.4	0.89	0.2355	10.6

Graph No.7

Total red blood cells count per cu.mm. before and during rut.



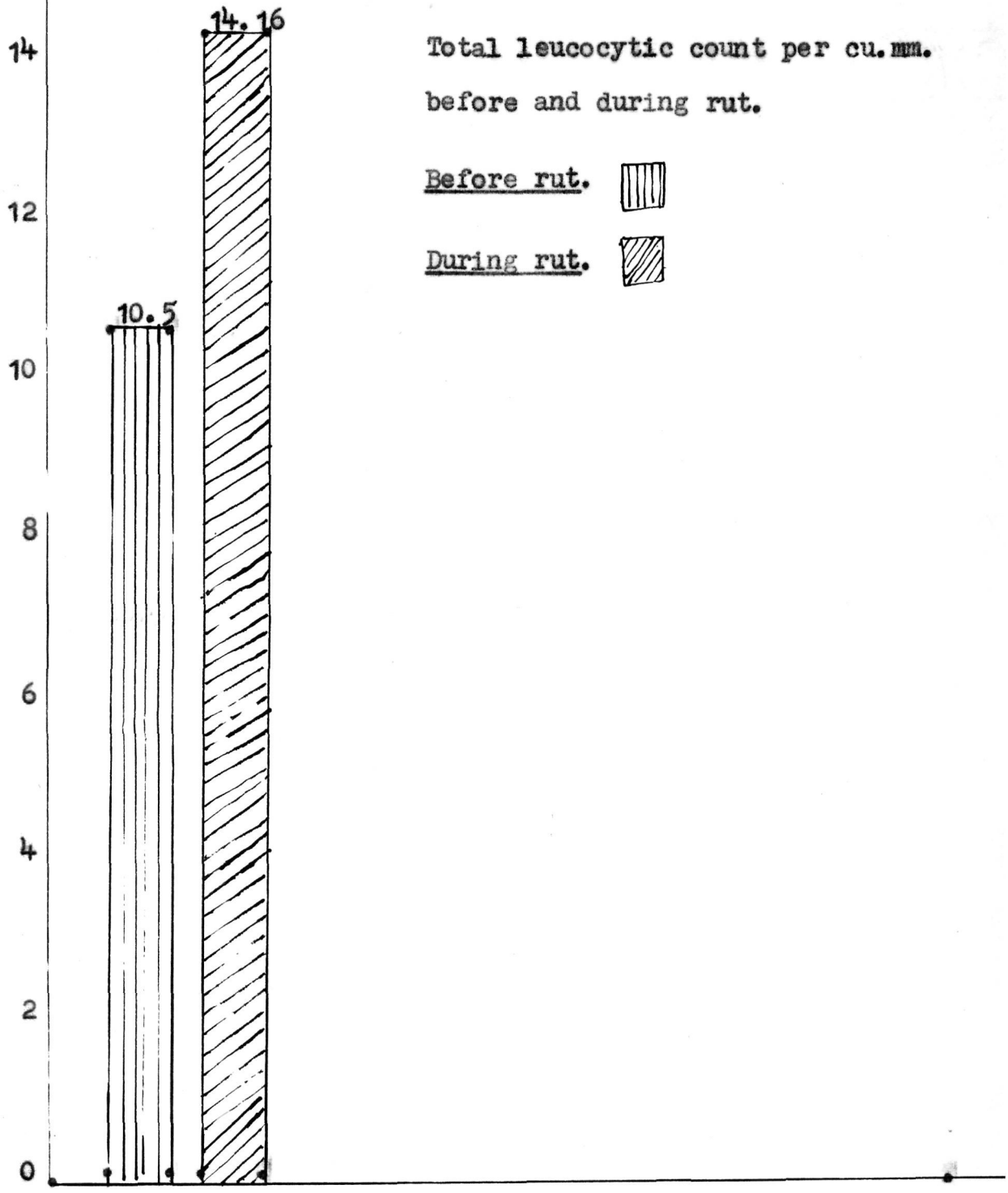
Scale :- 1 inch = 2 millions R.B.C. count per cu.mm.

TABLE NO.13

Mean values of the total leucocytic count before and during rut.

S.No.	Period	Total camel	Age range	Mean thousands per cu.mm.	S.D.	S.E.	C.V.	t.	P.
1.	Before rut	15	3 to 16yrs.	10.5	1.9	0.5018	18.7	5.8	** P < .01
2.	During rut	15	3 to 16yrs.	14.16	3.45	0.9084	24.37		

Graph No.8



Total leucocytic count per cu.mm. before and during rut.

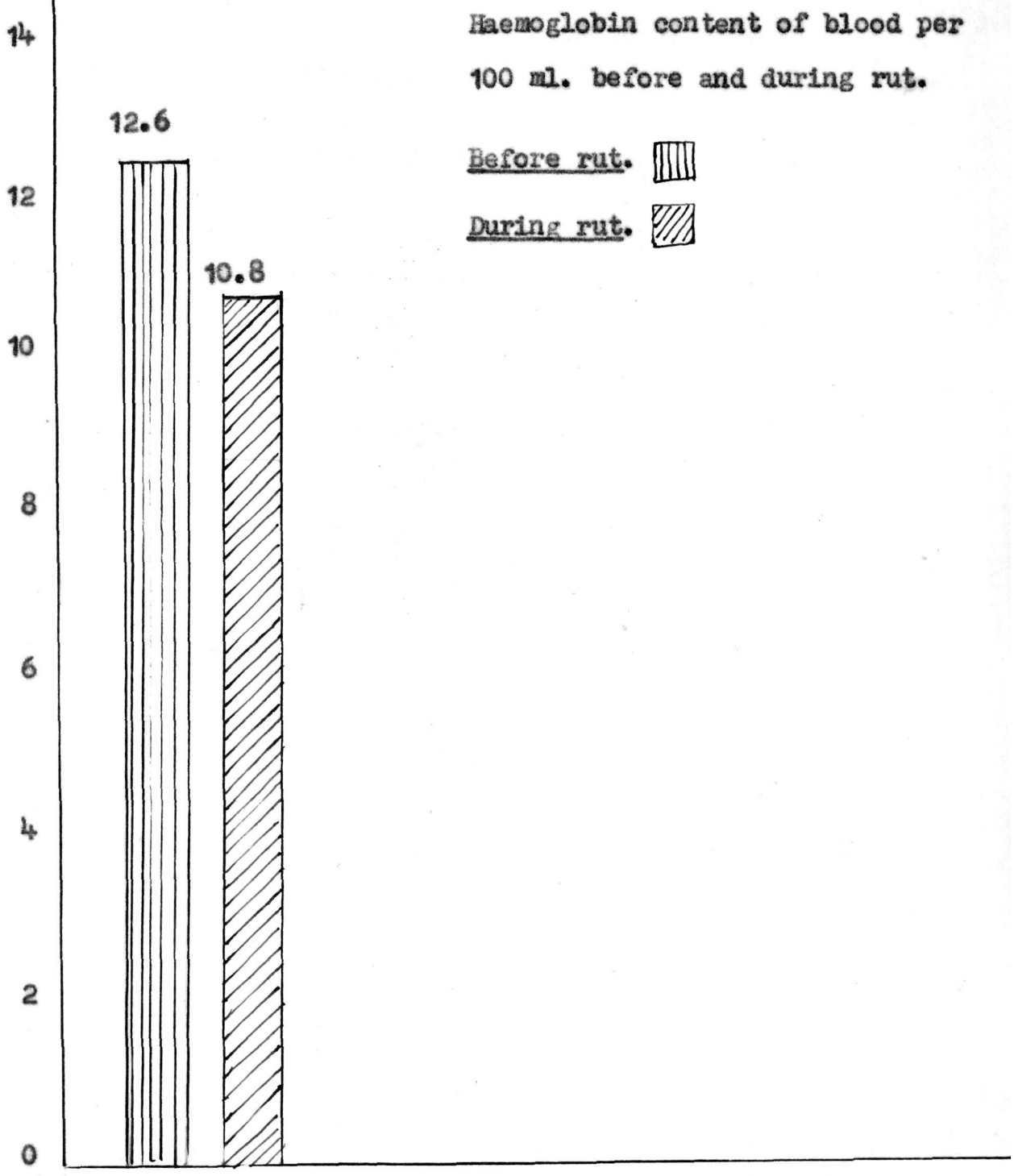
Before rut.

During rut.

Scale :- 1 inch = 2 thousands leucocytes per cu.mm.

Graph No. 9

Haemoglobin content of blood per 100 ml. before and during rut.



Scale :- 1 inch = 2 gm. haemoglobin per 100 ml. of blood.

TABLE NO. 14

Mean values of the haemoglobin content per 100 ml. of blood.

S.No.	Period	Total No of Camel.	Age range	Mean per 100ml. of blood	S.D.	S.E.	C.V.	t.	P.
1.	Before rut	15	3 to 16yrs	12.6	0.847	0.222	6.7		
								5.1	P $<$ .01**
2.	During rut	15	3 to 16yrs.	10.8	0.430	0.113	3.9		

leucocytic count recorded during rutting season as compared to the non rutting season.

(c). Haemoglobin content :

(a). Before rut

The haemoglobin content of blood ranged from 11.0 to 14.0 gm. per 100 ml. The mean value obtained was 12.6 gm. per 100 ml. of blood.

(b). During rut

The haemoglobin content of the blood ranged from 9.6 to 11.8 gm. per 100 ml. The mean value was found to be 10.8 gm. per 100 ml. of blood.

Table No. 13 indicates that the decrease in the haemoglobin content recorded during the rutting season was highly significant ($P < .01$). The reason for this could be that during rut the bull camel took less amount of ration as compared to the non rutting season.

D. Differential Leucocytic count

i. Lymphocytes

(a). Before rut

The number of lymphocyte ranged from 43 to 59 percent. The mean value was found to be 51 percent.

(b). During rut

The number of lymphocytes ranged from 47 to 59 percent. The mean value was found to be 53 percent.

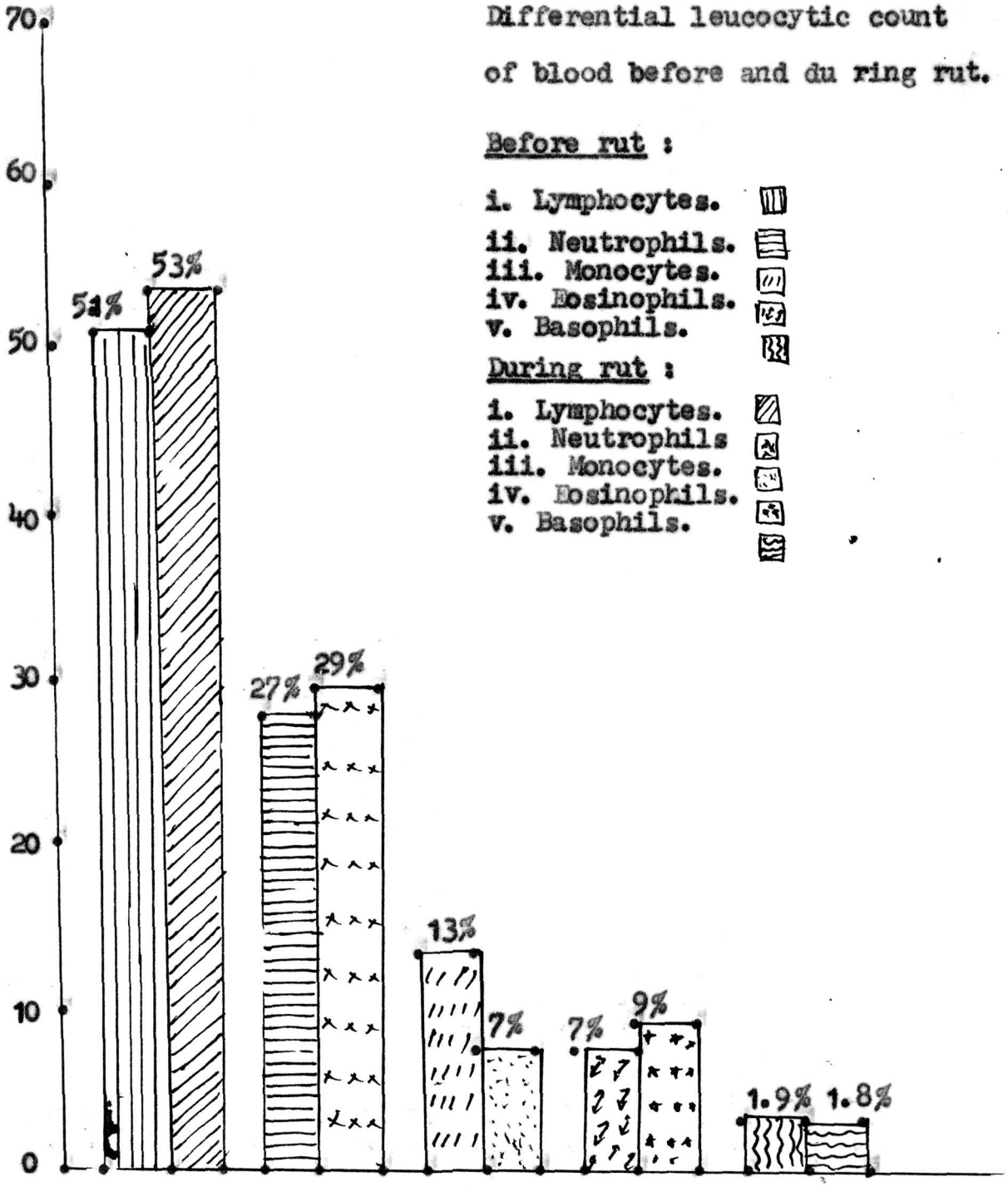
ii. Monocytes

TABLE NO. 15

Mean values of the differential leucocytic count before and during rut.

S.No.	Period	No. of Camels.	Mean				
			Lymphocytes	Monocytes	Neutrophils	Eosinophils	Basophils
1.	Before rut	15	51 %	13 %	27 %	7 %	1.9 %
2.	During rut	15	53 %	7 %	29 %	9 %	1.8 %

Graph No. 10



Differential leucocytic count of blood before and du ring rut.

Before rut :

i. Lymphocytes.
ii. Neutrophils.
iii. Monocytes.
iv. Eosinophils.
v. Basophils.

During rut :

i. Lymphocytes.
ii. Neutrophils
iii. Monocytes.
iv. Eosinophils.
v. Basophils.

Scale :- 1 inch = 10 percent differential leucocytic count.

(a). Before rut

The number for monocytes ranged from 7 to 18 percent. The mean value obtained was 13 percent.

(b). During rut

The number of monocytes range from 5 to 11 percent. The mean value was found to be 7 percent.

iii. Neutrophils

(a). Before rut

The number of neutrophils ranged from 23 to 34 percent. The mean value was found to be 27 percent.

(b). During rut

The number of neutrophils ranged from 24 to 34 percent. The mean value obtained was 29 percent.

iv. Eosinophils

(a). Before rut

The number of eosinophils ranged from 5 to 11 percent. The mean value was found to be 9 percent.

(b). During rut

The number of eosinophils ranged from 4 to 15 percent. The mean value was found to be 9 percent.

v. Basophils

(a). Before rut

The number of basophils ranged from 1 to 3 percent. The mean value was found to be 1.9 percent.

(b). During rut

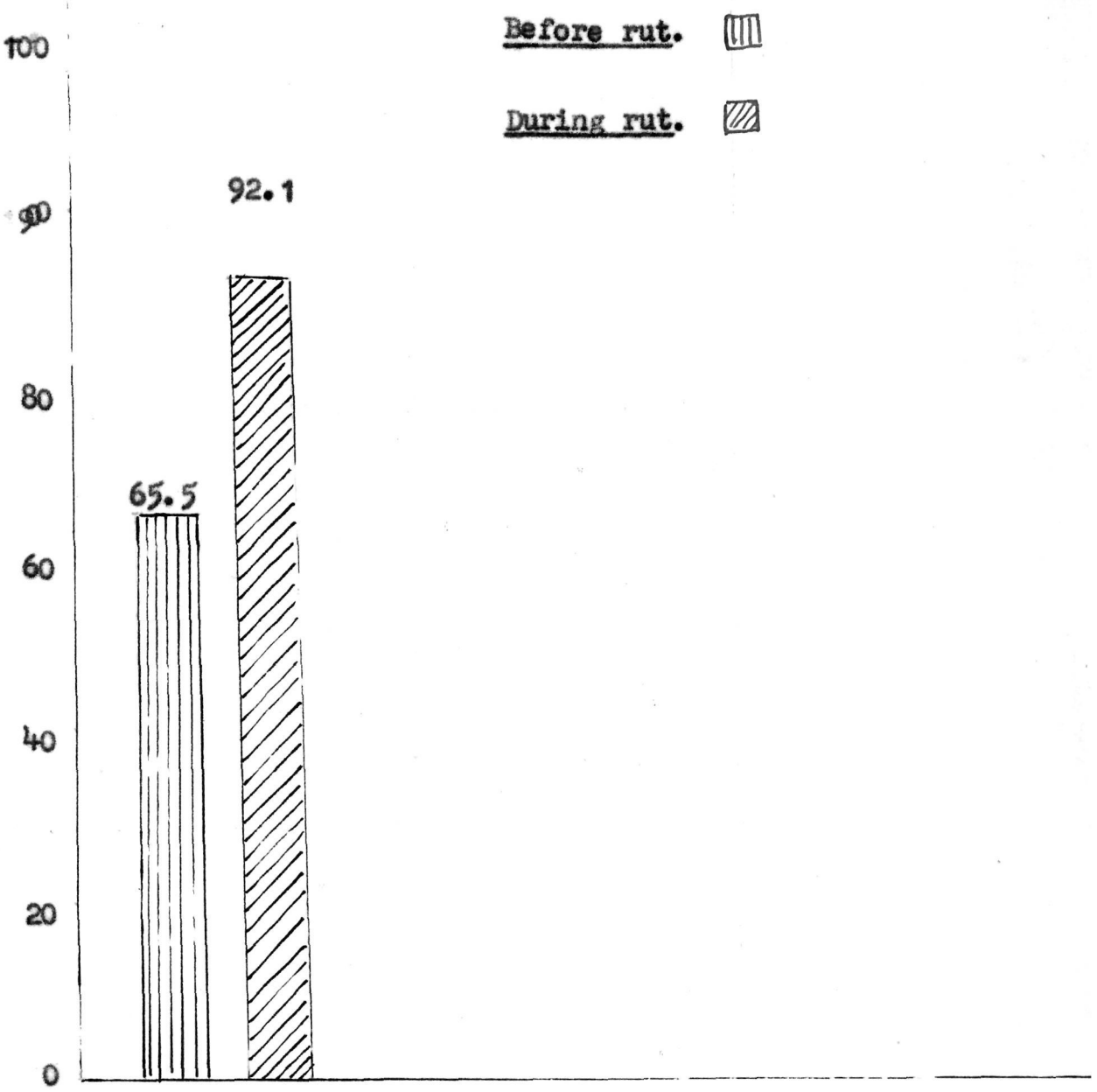
TABLE NO. 16

Mean values of the blood serum cholesterol level before and during rut.

S.No.	Period	No.of Camels	Age range	Mean (milligram-per 100ml.	S.D.	S.E.	C.V.	t.	P.	
1.	Before rut	15	3 to 16yrs.	65.58	24.3	6.39	37.09			
								8.0	P./	.01**
2.	During rut	15	3 to 16yrs.	92.19	6.2	1.69	6.73			

Graph No. 11

Blood serum cholesterol level in bull camels before and during rut.



Scale :- 1 inch = 20 mg. per 100 ml. cholesterol level (in serum).

The number of basophils ranged from 1 to 3 percent. The mean value obtained was 1.8 percent.

From the table No. 14, it appears that there was slight increase in the lymphocytes, eosinophils and neutrophils but decrease in the monocytes, during the rutting season, these results are not significant.

4. Cholesterol :

The serum cholesterol level before and during rut was estimated in the male camel.

(a). Before rut

The mean value for the serum cholesterol was 65.58 mg. per 100 ml. of blood and it ranged from 49.8 to 85.3 mg. per 100 ml. of blood. This level was approximately equal to that found in rabbits (64 mg.%) Maderova (1960).

(b). During rut

The mean value recorded of serum cholesterol was 92.19 and it ranged from 75.3 to 116.3. This level was approximately equal to that reported in sheep (97 mg.%) Maderova (1960).

The above information indicates that there was highly significant increase in serum cholesterol level during rut as shown in table No. 15.

From the available literature it appears, that uptill now, no work has been done on the estimation of

blood cholesterol level in camel.

Lenon and Mixner (1957) reported that plasma cholesterol levels were high in winters than in summers, simillaraly in the case of male camel there was change in cholesterol level before and during rut.

As cholesterol and acetate are reported to be precursers in the biosynthesis of testosterone by the testis (Wotiz et.al. 1955), so it was perhaps one of the reasons for increased level of blood cholesterol during rut.

S U M M A R Y

Studies have been conducted on the sexual behavior, semen characterstics, haematology and blood serum cholesterol levels, in Bikaneri (one humped) camel. For this, work was done at the camel breeding farm Jor-Bir, Bikaner, on 15 male camels.

The studies conducted were as under :-

Sexual behavior included the studies on

A. Signs of rut

Duration of rut recorded was from November to March. It was some what earlier in those bull camels which were let loose in the herd as compared to those that were stabled. During rut the bull camel became weak and emaciated because he did not take his full ration. Following sigsns of rut were recorded.

(a). Sounds: Metalic and gurgling sounds.

(b). Presfuse secretion of the salivary glands.

(c). Ejection of the soft palate.

(d). Typical posture while standing.

(e). Up and down movements of the tail to stimulate the genitalia .

(f). Intermitent micturition.

B. (Act of copulation :

It was observed and recorded in

I. Natural service : It included

(a). Courtship :

Detection of estrus by smelling and pinching of vulva and the groin of the female.

(b). Efforts of the bull camel to make the she camel sit on the ground.

(c). Mounting and positioning:

Bull camel squated dog like, with hind limbs flexed and the forelimbs extended one on each side of the she camel.

(d). Penile movements to locate the vulva :

The penis, after erection, located the vulva by protuding about 4 to 5" out of the prefucial opening and rotating it self spirally on its own longitudinal axis.

(e). Mating :

Bull camel gave strong pelvic jerks by lifting his haunches.

(f). Posture of the bull camel in relation to the she camel during rut :

Bull camel assumed a dog sitting position; chest pad was related to the posterior part of the hump of the she camel, hind parts pressing tightly against the pelvis of the she camel. His neck was fully extended.

(g). Total copulation time :

The total copulation time recorded was 10 to 22 minutes (Mean 13 minutes).

(h). Ejaculation :

Bull camel gave a final thrust by raising his

hind portion on the hock joints. It was accompanied by trembling in the gluteal and abdominal muscles.

(i). Position of the bull camel after ejaculation:

After ejaculation, the bull camel either fell down on one side or stood up.

II. Hand service

In hand service the mean for total copulation time was 8 minutes and it ranged from 4 to 13 minutes. This time was just half as compared to in natural service.

2. Semen studies :

Semen was collected with the help of boar's artificial vagina. Other findings recorded were as under:-

A. Volume : It ranged from 1 to 10ml. mean was 3.1ml.

B. Colour : Milky white and of thick viscid consistency.

C. Hydrogen ion concentration : It ranged from 7.2 to 8.8, mean was 7.8 .

D. Mass activity : It ranged from 0 to (4) ++++.

E. Initial motility : It ranged from 0 to 5 grades.

F. Sperm concentration : It ranged from 70 to 370 millions per ml. and mean was 189 millions per ml.

G. Live and dead percentage of the spermatozoa : At random the minimum live percentage was 3 percent while the maximum was 85 percent and the mean value for first ejaculates was 7 percent while for the eighthejaculates it was 63 percent.

H. Morphological studies :

(a). Abnormalities of head ranged from 2.0 to 6.4 percent; mean was 3.75 percent.

(b). Abnormalities of middle piece ranged from 3.2 to 11 percent; mean was 5.4 percent.

(c). Abnormalities of the tail ranged from 2.8 to 8.2 percent; mean was 4.1 percent.

I. Biometry of the spermatozoa :

i. Head length ranged from 5.08 to 6.35 microns; mean was 5.36 microns.

ii. Head width ranged from 3.17 to 3.81 microns; mean was 3.42 microns.

iii. Middle piece length ranged from 7.62 to 8.25 microns; mean was 7.38 microns.

iv. Tail length ranged from 34.2 to 37.5 microns; mean was 35.62 microns.

v. Total sperm length ranged from 46.9 to 50.8 microns; mean was 48.37 microns.

3. Haematological studies :

(a). Before rut

i. Total erythrocytic count, ranged from 7 to 11.5 millions per cu.mm.; mean was 8.8 million per cu.mm.

ii. Total leucocytic count ranged 6.5 to 13.6 thousands per cu.mm.; mean was 10.5 thousands per cu.mm.

iii. Haemoglobin content, ranged from 11.0 to 14 gm. per 100ml. of blood ; mean was 12.6 gm. per 100 ml. of blood.

iv. Differential leucocytic count :

1. Lymphocytes ranged 43 to 59 percent; mean 51%.

2. Monocytes ranged 7 to 18 percent; mean 13 percent.

3. Neutrophils ranged from 23 to 34 percent; mean 27 percent.

4. Eosinophils ranged from 5 to 11 percent; mean 7 percent.

5. Basophils ranged 1 to 3 percent; mean 1.9 percent.

(b). During rut :

ii. Total leucocytic count ranged from 10.5 to 19.2 thousands per cu.mm.; mean was

iii. Haemoglobin content, ranged from 9.6 to 11.8 gm. per 100ml.; mean was 10.8 gm.per 100ml.

iv. Differential leucocytic count :

1. Lymphocytes ranged from 47 to 59 percent; mean 53 percent.

2. Monocytes ranged from 5 to 11 percent; mean 7 percent.

3. Neutrophils ranged from 24 to 34 percent;

mean 29 percent.

4. Eosinophils ranged from 4 to 15 percent; mean 9 percent.

5. Basophils ranged from 1 to 3 percent; mean 1.9 percent.

4. Blood serum cholesterol estimation :

Observations made were as under :

(a). Before rut

It ranged from 49.8 to 85.3 mg. per 100ml. of blood; mean was 65.58 mg. per 100ml. of blood.

(b). During rut

It ranged from 75.3 to 116.3 mg. per 100 ml. of blood; mean was 92.19 mg. per 100ml. of blood.

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APPENDIX

Appendix No.1

Total ejaculates in six camels.

No. of Ejaculates.	Volume in ml.					
	A 11 yrs.	B 6 yrs.	C 11 yrs.	D 16 yrs.	E 6 yrs.	F 16 yrs.
1	-	7.0	4.0	5.0	7.0	10.0
2	-	5.0	2.0	2.0	5.5	5.0
3	-	4.0	3.0	3.0	3.0	2.5
4	-	2.5	1.5	1.5	2.5	3.0
5	-	1.5	1.0	3.5	4.0	1.6
6	5.0	1.0	4.5	3.5	2.0	1.5
7	4.0	1.0	1.0	4.0	1.5	1.5
8	4.5	3.0	4.5	3.5	3.5	2.0

Mean = 3.1

S.D. = 1.84

S.E. = 0.289

C.V. = 56.4

Appendix No.2.

Hydrogen ion Concentration(pH) of Semen in different six camels.

No.of Ejaculates.	pH					
	A 11 yrs.	B 6 yrs.	C 11 yrs.	D 6 yrs.	E 6 yrs.	F 16 yr
1	7.8	7.6	7.6	8.6	7.4	7.7
2	8.0	7.7	8.0	7.6	7.8	8.0
3	7.6	7.8	7.8	7.4	8.4	8.2
4	8.4	8.2	7.8	7.8	7.8	7.8
5	8.0	8.4	8.4	8.4	7.6	7.2
6	7.8	7.6	7.6	7.8	8.2	8.0
7	7.4	7.6	7.7	8.2	7.7	7.6
8	8.2	7.7	7.8	7.6	7.8	7.7

Mean = 7.8

S.D. = 0.148

S.E. = 0.053

C.V. = 4.84

Appendix No. ~~4~~ 3

Total time for copulation in six camels during collections.

Service No.	Total time in minutes					
	A	B	C	D	E	F
1	-	8	8	7	7	6
2	-	7	9	10	8	6
3	-	11	4	11	12	5
4	-	5	8	6	7	8
5	-	11	6	11	9	4
6	10	8	6	13	12	5
7	11	9	6	5	7	4
8	9	10	8	12	13	6

Appendix No. 4

S.No.	Camel No.	Age.	Before rut.	During rut.	Before rut	During rut	Before rut	During rut.
			RBC Millions cu. mm.	RBC per	WBC Thousands cu. mm.	WBC per	Hb. Grams per hundred ml. blood.	Hb.
1	A	11	8.2	7.8	12.3	13.0	13.4	10.8
2	B	6	8.6	8.5	11.2	13.6	12.2	11.6
3	C	11	8.8	8.9	11.5	12.8	13.6	10.4
4	D	6	9.4	7.7	11.6	19.2	12.8	9.6
5	E	6	9.7	8.9	11.2	18.5	12.6	11.6
6	F	16	8.9	6.5	13.6	13.7	11.6	11.0
7	G	4	7.3	8.7	7.8	15.6	12.8	11.0
8	H	3	7.8	7.1	10.1	17.7	13.2	10.6
9	I	4	8.7	7.9	9.4	12.7	12.4	10.2
10	J	4.5	8.6	8.4	6.6	6.5	14.2	10.6
11	K	5	9.7	9.9	7.9	11.6	14.2	10.2
12	L	5	11.5	11.4	9.8	13.7	11.2	10.2
13	M	4	11.5	8.8	13.0	11.8	14.0	10.2
14	N	3	8.0	8.8	9.0	16.5	11.0	11.6
15	O	5	7.3	8.3	10.5	17.5	14.0	11.8

Appendix No 5.

Blood serum cholesterol level before and during rut.

S.No.	Camel No.	Before rut.	During rut.
1.	A	62.1	85.1
2.	B	85.3	116.3
3.	C	75.6	112.9
4.	D	58.2	81.3
5.	E	56.1	85.1
6.	F	59.5	87.0
7.	H	52.3	58.5
8.	I	67.2	81.2
9.	J	86.2	97.1
10.	K	72.3	75.3
11.	L	48.1	102.4
12.	M	49.8	86.2
13.	N	72.8	116.7
14.	O	69.9	100.8
15.	P	78.3	84.1