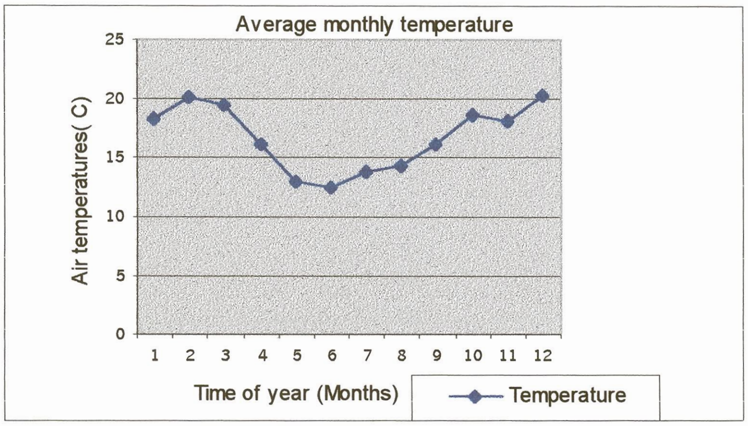
CHAPTER 4

RESULTS AND DISCUSSION

In mammals, nutrients are utilized by the tissues involved in the maintenance and growth during which body reserves, including energy stores (lipids), glucose reserves (glycogen), and amino acids reserves (labile protein), are established.

Seasonality of reproduction is a common feature in sheep and goat breeds in the temperate latitudes, and photoperiod appears to be the key factor controlling reproduction (Shelton, 1978, Ortavant *et al*, 1985, Mellado *et al*, 1991, Chemineau *et al*, 1992, Webb *at al*, 1998). Livestock in the tropics have characteristically low fertility due to tropical degradation particularly in winter season (Bonsma, 1980). Sexual behaviour and semen production of bucks are influenced by several factors such as individual characteristics (breeding and age), environment (photoperiod and temperature) and management (nutrition, social environment), which result in large variations in their reproductive capacity throughout their lifespan. Environment and, in particular, heat stress leads to a lower feed intake, due to the animal seeking shade so that less heat is produced (MacKinnon *et al* 1990). In tropical environmental conditions, emphasis should be placed on improved management, nutrition and possibly cross-breeding to improve reproduction efficiency.

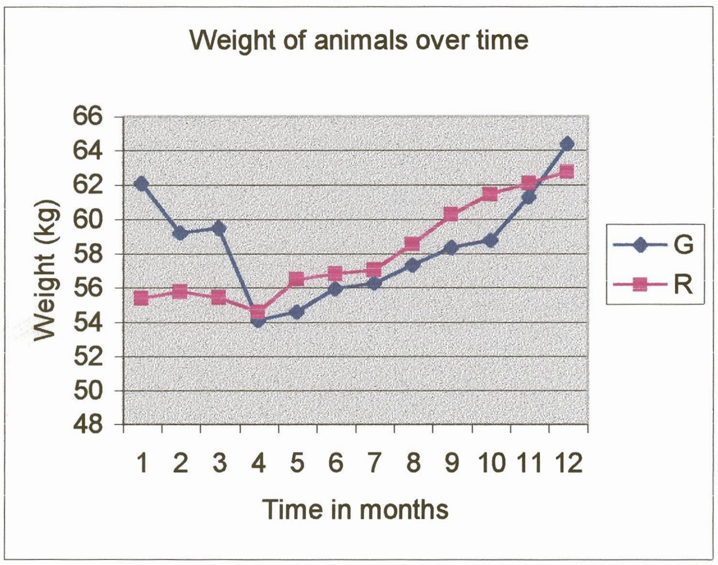
Figure 4, Ambient temperature distribution over a period of one year (January - December 2000)



Monthly distribution of air temperatures and its effects on reproduction over a period of twelve months.

The effects of month of the year on the body conditioning of the male Gorno Altai and the rural indigenous bucks is depicted in Figure 4.1.

Figure 4.1: Effect of time on body weight for the Gorno Altai and rural indigenous buck breeds.



Body weight is correlated to scrotal circumference and this is a function of birth mass, pre-weaning growth rates as well as age (Roca *et al*, 1992). This suggests that a larger scrotal circumference (early puberty) and faster growth rate is compatible in young animals. From Table 4.1. it has been shown that time of the year (months) had significant ($P<0.05$) influence on the body weight of the bucks under the prevalent condition. Within the Gorno Altai, there has been a decrease in body weight during the beginning of Autumn until the end of winter season. Such decrease in body weight of the bucks is related to increase sexual activeness when buck are entering into their usual breeding season.

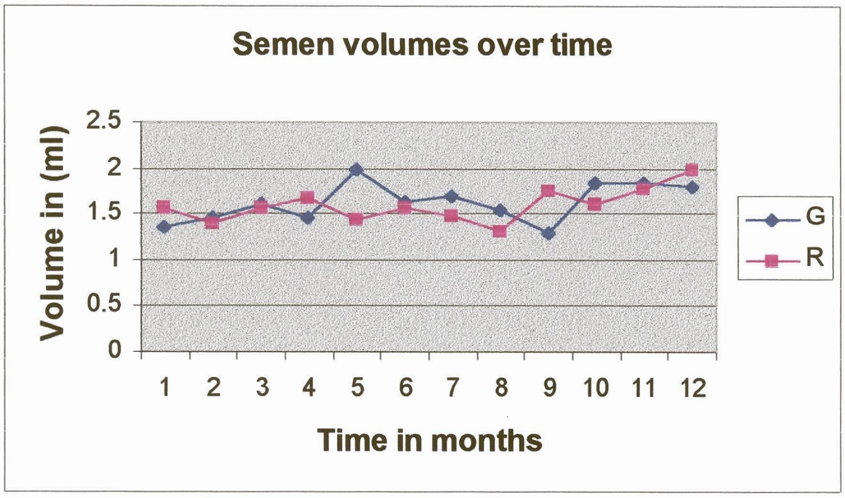
Body condition relates to weight and, for the two breeds, there was no significant variation in body weight that could have led to the increase or decrease in semen production. Climatic conditions that were thought to have an impact on the quality and quantity of forage available were the main reasons causing a greater variation in body weight.

Body weight increases with age. According to Swanepoel and Heyns (1986) an increase in body weight leads to an increase in the body size of the animal. This increase in body size suggests that there is an increased deposition of body fat that would result in improved fertility and the production of good quality semen of the bucks.

The ability of the buck to maintain its body weight without jeorpadazing its fertility status increases with age, and that is reflected by improved semen production during the time of forage unavailability. Reports in the literature are controversial concerning the relationship of excess body conditioning or feeding, excess energy and fertility especially in tropical environments (Roca *et al*, 1992).

There is a tendency for the bucks to loose weight during the breeding season due to spending a considerable amount of time courting and fighting. This has also been confirmed by Tomkins and Bryant (1976). It appears to be a standard rule that males during the breeding season lose weight and will eventually have decreased fertility. Those gaining weight duringt breeding are expected to show improved fertility. In Figure 1.1, it can be seen that it may seem profitable to condition score 55.95±6.4) in Gorno Altai bucks during the breeding season as there is a marked decrease in weight changes over a period of one year with the resultant increase in weight after the breeding season. A constant maintenance in body weight of the animals can be attributed to the constant distribution of the light and temperature within the region which affect forage production.

Figure 4.2 Effect of season (Time) on semen volume.



Spermatogenesis is a continuous phenomenon which produces spermatozoa. For breeding soundness and sperm production, scrotal circumference is an important component for examining the reproductive potential of males (Maree, 1979). The size of the testes also has an impact on the quality and quantity of semen produced. In the post-pubertal period, testicular volume increases as body weight increases. A strong correlation exists between body weight and testicular volume. This direct relationship has been observed in bulls by Hahn (1969). It was further stated that the correlation is stronger in the young animals than in the adult, where semen production is subject to various external factors. In Figure 4.2, there is a significant variation in the volume of semen produced between the two breeds with the Gorno Altai (2±0.52), (1.55±0.24) producing more ($P<0.05$) semen than the indigenous breeds (1.43±0.4), (1.32±0.15) only during May and August respectively. The indigenous breed also showed a increased semen volume in these months and September which was ultimately maintained until the summer months. Such variation was also observed during the beginning of September with a significant ($P<0.05$) increase in the indigenous bucks (1.77±0.3) than the Gorno Altai (1.28±0.25) semen production.

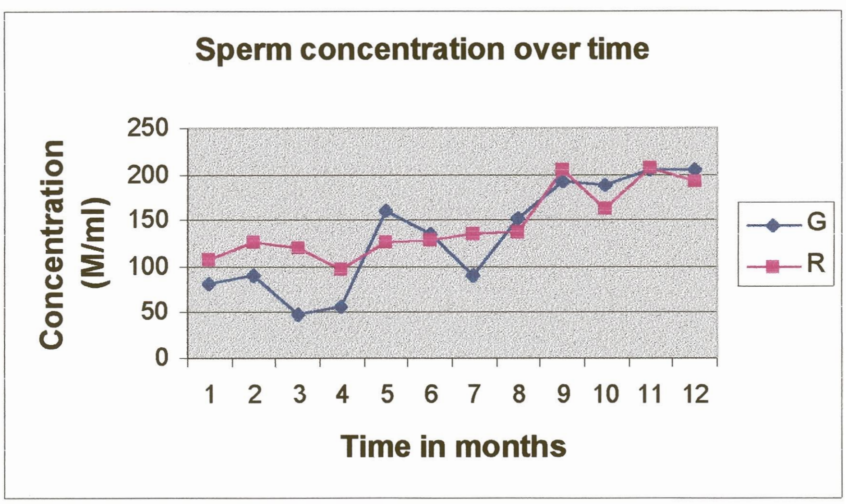
There has been a tendency for semen volumes to fluctuate among the indigenous bucks in response to increased pasture availability.

This semen response is also affected by an increased availability of nutrients in spring, compared to winter when the forage begins to degenerate. When forage production increases at the onset of spring, it is accompanied by an increase in the body weight of the animals. When electroejaculation is employed as a means of collecting semen, it should be borne in mind that the differences in the volumes of the semen in different months could also be attributed to the skill of the electroejaculator operator. As they are subjected to the tropical environmental conditions, the volume of semen produced will vary from season to season especially in seasonal breeders such as the Gorno altai.

Scrotal circumference as an indicator of testes size is highly correlated with sperm production in growing males (Rossouw, 1975, Curtis and Amman 1981, Coulter, 1982).

Many factors such as breed, age, season and body mass influences testes size and scrotal circumference so that they have a negative or a positive impact on the quality of semen produced (Makarechian *et al*, 1984).

Figure 4.3 Effects of months on sperm concentration.



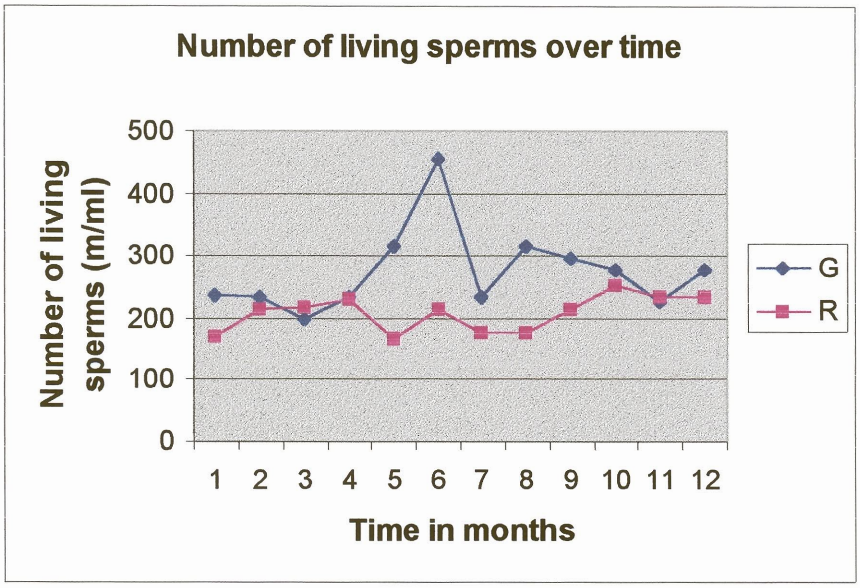
Bucks with good quality semen contain 2.5-5.0 x10^9 spermatozoa/ ml. In South African climatic conditions there are two breeding seasons per annum i.e the autumn and the spring breeding season. Fig 4.3 indicates a gradual increase in sperm concentration (numbers) with the two genotypes over a one year period. There is a highly significant differences ($P<0.05$) in sperm concentration between the indigenous bucks (121.5±64.02) than in Gorno Altai bucks (48.17±21.87) that occurrs only during March as the beginning of autumn. Such a significant variation has only been observed in the indigenous breed that produces more sperm than the Gorno altai. The decrease in sperm output from February and March can be attributed to the increased mating pressure.

Figure 4.3 shows a sudden decrease in the sperm concentration of the ejaculate. This also explains the effects of increased mating leading to increased volumes of ejaculates but reduced cell numbers per milliliter. Figure 4.3 also indicates the tendency of sperm numbers to increase (464.33±201.2) in winter especially for the Gorno Altai than the indigenous buck (221±104.9) breeds. Between the two breeds of bucks, there is a gradual increase in the number of sperm from the winter until the December, when the ambient temperature reaches its peak.

Neely *et al* (1982) indicated scrotal measurements to have a high positive genetic correlation with testes size, weight and total sperm production. This finding is supported by Amann and Almquist (1961) and Almquist *et al* (1961). Daily spermatozoan output was found to be correlated to testis weight in the rabbit. The selection for greater scrotal circumference and diameter should thus result in an increased testes size, weight and total sperm output.

During the winter season, there was a sharp increase in the total number of sperm produced for the seasonal breeders. Figure 4.3 indicates that season has a positive influence on the numbers of sperm produced within the breed especially the Gorno Altai. Spermatozoa output is also correlated with both scrotal circumference and testis weight in bulls (Willet and Ohms 1955; 1957).

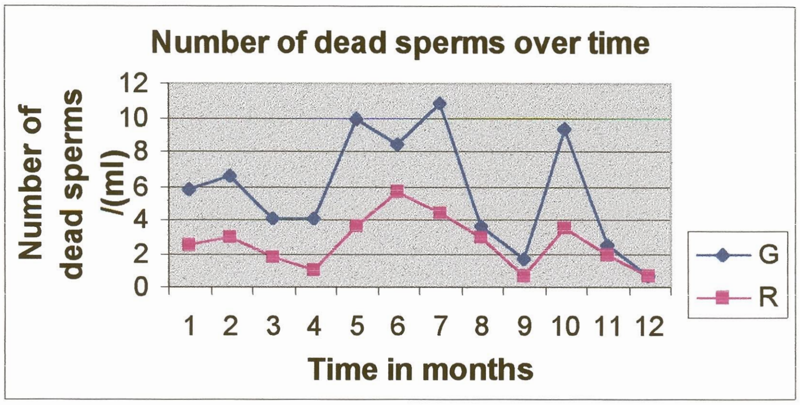
Figure 4.4 Effect of season on spermatozoa produced



There should be an increase in the number of live spermatozoa and a decrease in the abnormal sperm from birth to the adult stage in bucks. The presence of cytoplasmic droplets is an indication of poor epididymal maturation occuring in the testes. Figure 4.4 indicates a significant increase (455.83±204.9) and (215.67±100.6) in the number of live spermatozoa produced in the months of May and June in both Gorno Altai and the indigenous bucks respectively. In both months the Gorno Altai have shown a capability of producing more live sperm than the indigenous breeds. Spermatogenesis is a process that is affected by fluctuations in air temperature, with decreasing testicular activity during the hot months. Figure 4.4 also indicates the significant differences in live sperm for the Gorno Altai and the indigenous breeds responding positively to reduced photoperiod. Such increases in the number of live spermatozoa can be attributed to the short day period. This demonstrates that photoperiodism has a positive influence on the number of live spermatozoa.

In comparison, Figure 4.4 reflects a much more stable production of the number of live sperm in the indigenous breeds and this shows that, under tropical conditions. Gorno Altai have the ability to produce good quality spermatozoa, maintaning fertility in a foreign environment. An increase in the number of live spermatozoa is also dictated by an increase in the total number of spermatozoa in the ejaculate.

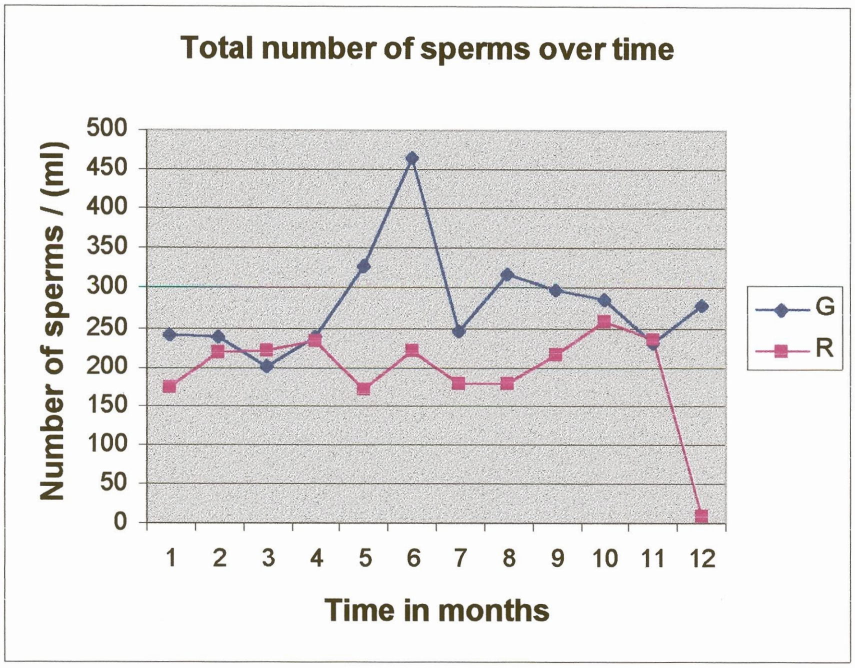
Figure 4.5 Effect of season on the number of sperm mortalities



Dead spermatozoa in an ejaculte lead to the complete failure of fertilization and reproduction. The death of sperm can be fuelled by a number of factors such as infection and high temperatures. In Figure 4.5, there is a constant production of the dead spermatozoa (5.8±3.5) with no significant variation, especially during the non breeding season-with a marked increase during the breeding season from the sexual quiescent stage in Gorno Altai. An increase in volume of ejaculate during the breeding season also increases the number of spermatozoa that are dead.

As a result of the shorter photoperiod, (Figure 4.5), an increase in the number of dead spermatozoa were recorded from April until September in the Gorno Altai than the indigenous bucks. There was a sudden reduction in the number of dead cells during August month. This could suggest that, during winter, when spermatozoa are exposed to cold shock, the survival capacity is shortened by exposure to extremely low ambient temperatures. During winter months, it has also been observed that the number of tailless spermatozoa increased. This can be associated with the increased production of the immature spermatozoa due to sexual pressures in the Gorno Altai bucks.

Figure 4.6 Effect of season on the total number of spermatozoa produced



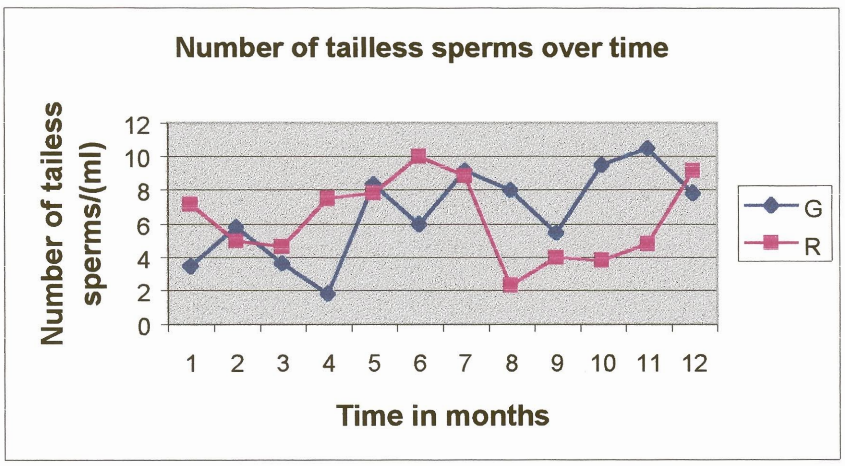
The number of spermatozoa produced by the adult bucks are correlated with the size of the testes (12 X 10^6 spermatozoa/ gram of testicular parenchima). The quality and quantity of semen, however, is modified during the year by environmental factors, mainly day light length. The increase of the number of the sperm within an ejaculate could lead to the improvement of conception rates in females.

Large semen volumes with low numbers of sperm culminate in the failure of the fertilization process. Figure 4.6 shows a constant production of spermatozoa in the two breeds during the summer months. Total sperm numbers differed significantly ($P<0.05$) at the beginning of May, with the Gorno Altai showing an increase in the total number of sperms produced, compared with the indigenous counterparts. One contributing factor in this regard has been identified as the influence of low temperatures and shortenned day light length in the tropical environment at that time on the Gorno Altai.

There was a tendency for the Gorno Altai to produce more spermatozoa during the winter, months as they are seasonal breeders compared to the indigenous bucks. This is another indicator of animals that are quality sperm producers during the winter periods because of their coating that regulate temperature changes. An increase in the number of sperm produced as observed from winter until the end of spring-with a sudden reduction in sperm numbers when temperature began to rise. Indigenous bucks also demonstrated an increase in the number of sperm produced irrespective of the increase in the environmental temperatures. This corresponds to an increase in the production of the number of dead spermatozoa during this particular season.

After heat shocks, Gorno Altai bucks demonstrated an ability to recover gradually in terms of the number of spermatozoa produced, until full recovery was attained in February and March early during the breeding season.

Figure 4.7 Effect of season on the number of tailless spermatozoa

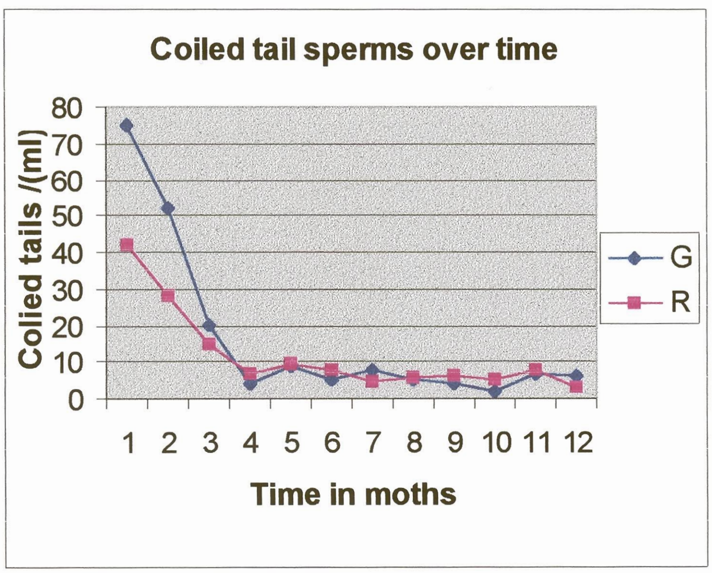


Failure of females to conceive is also a factor contributed to by the male. Large numbers of sperm without tails have a negative effect on the reproduction capacity of all animal species. An increase in temperature and reduced availability of feeds are alo major contributors to the production of tailless, immature and deformed spermatozoa.It has long been known that some inherited sperm defects are assocaited with infertility (Taylor, 1995). Land (1978), confirmed that the most common cases of abnormalities are detached sperm heads in Guernsey cattle and abnormal acrosomes in Friesland bulls.

Within the two goat breeds under evaluation, there was a slight increase in the number of tailless spermatozoa in Gorno Altai at the onset of August (late winter), when temperatures started to rise. It has been suggested that a cause is the high demand in the number of sperm needed for fertilization during the breeding season. Figure 4.7, also shows a significant ($P<0.05$), increase in the number of tailless spermatozoa from the beginning of September to December in Gorno Altai bucks (8±8.2). Such an increase in the number of tailless spermatozoa has been attributed to the high temperature effects (Roca *et al*, 1992; Tegegne *et al*, 1994). It suggests that high tempertures have a negative effect on the quality of semen produced in a certain environment.

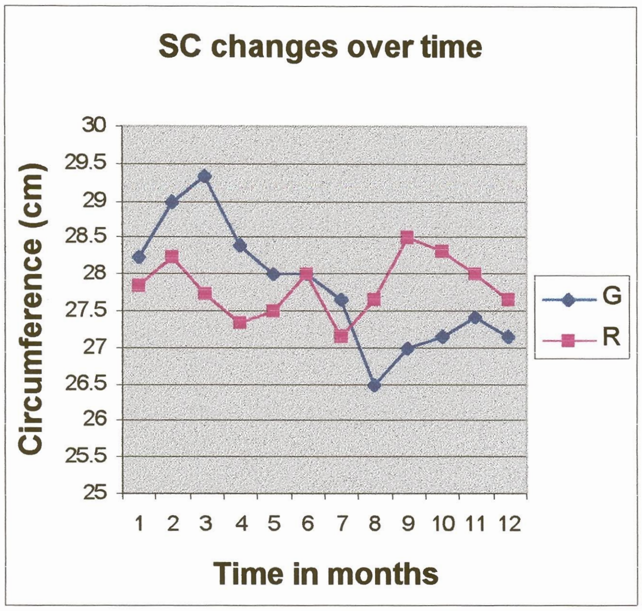
This also gives an indication that indigenous goats are more fertile due to quick recovery regardless,of temperature.

Figure 4.8 Effect of season on the number of coil-tailed spermatozoa



Normal spermatozoa have a tail or a flagella to swim or move towards the ovum. Females fail to conceive as a result of large numbers of spermatozoa deposited in the vagina lacking motility. Such tail defects e,g coiled tails are formed as a consequence of abrupt changes in temperature. Although there were no significant difference between the two breed regarding the tail defects during January and February, big differences in the number of coiled tail sperms between the Gorno altai and the indigenous breeds existed for December, January and February (Roca et al, 1992).

Figure 4.9. Effect of season on scrotal circumference of Gorno Altai and S.A Indigenous bucks.



Scrotal circumference is highly correlated with testes weight and sperm output in growing bulls and also to the percentage of normal sperms (Coulter, 1982). An increase in scrotal circumference also increases the possibility of the production of quality semen (Tegegne *et al*, 1994; Roca *et al*, 1992).

The pattern of testicular development, endocrine function and semen traits are influenced by genetic and environmental factors such as disease, nutrition, season and lactation (Rekwott *et al*, 1998, Hernandez *et al*, 1991, Godfrey *et al* 1990). In Figure 4.9, a constant increase and decrease in the scrotal circumference of the Gorno Altai breed was apparent with significant ($P<0.05$) scrotal changes (29.3 ± 1.4) taking place during March. In the two breeds, there was an apparent increase in scrotal size in March (onset of the breeding season). This increase in scrotal size is associated with the increased production of sperm and the spermatozoa storage in the epididymis, as these breeds entered into a season of increased sexual activity. Figure 4.9 also shows that, during winter (June and July), scrotal circumference is reduced until it recovers, with the approaching next breeding season.

A tendency within the indigenous bucks, in a reduction of scrotal circumference was recorded during the non-breeding season. This is also attributed to the lower production of spermatozoa. This fact is emphasized by the findings of Coulter (1982), who reported an increase in scrotal circumference to increase the probability of yearling bullsin having acceptable semen quality. Body weight and scrotal circumference increase with age in both the goat genotypes.

Season affected changes in scrotal circumference in both the goat genotypes during the month of March-with the introduction of shorter photoperiods. Table 4.9 depicts a significant (P<0.05) variation at the beginning of autumn. The difference could be initiated by the approaching breeding season for the Gorno Altai (seasonal breeders), when the day light length starts getting shorter, with the commencement of the breeding season. Table 4.9 shows a gradual increase in the scrotal circumference of the Gorno Altai compared to the indigenous bucks during March, followed by a gradual decrease during the subsequent months. Variation in the scrotal size of the indigenous bucks can also possibly be attributed to the skill of an operator.

The rural indigenous buck maintains a constant scrotal circumference during all the seasons. Fields *et al* (1982) found little difference in post-pubertal testicular development between genotypes. Perry *et al* (1991) reported no differences in the patterns of testicular development between different genotypes. Table 4.9 indicates that the two goat genotypes react differently to season with respect to semen volume and sperm concentration. Goats with a small scrotal circumference of less than 25 cm do not produce semen of satisfactory quality (Coulter *et al*, 1987). Knight *et al* (1984) postulated that in general, semen have been found to have medium to low heritability.

Although data on the effect of season on semen trait is not consistent, Tegegne *et al* (1994) stated that, semen characteristics of Boran bulls were highest during the short rainy season and lowest during the dry season. The present findings of this trial are also supported by Tegegne *at al* (1994), who observed that Boran bulls had better semen traits than Boran X Fresian bulls during the dry season and *vice versa.* Genotypes differences were minimal during the short rainy season.

Seasonal differences in semen traits and daily sperm production have been reported for different breeds of bulls (Field *et al* 1979, Wildeus *et al* 1984, Cardoso and Godinho 1985, Godfrey *et al* 1990, Goswan *et al* 1991). In contrast, Hernandez *et al* (1991) were not able to detect seasonal variation in semen traits for 4 Zebu breeds in Mexico. Table 4.9 indicate that testicular growth and semen quality were more affected during the hotter months in Gorno Altai breeds than in the indigenous goat breeds. Godfrey *et al* (1990) reported that season and location accounted for differences in semen quality and endocrine functions in Herefords and Brahman bulls. In tropical regions testicular function, semen output and quality, and mating behaviour of bucks can vary from season to season, depending mainly on the availability and quality of feed and climatic conditions.

Figure 4.10 Effect of season on the number of spermatozoa broken at the neck

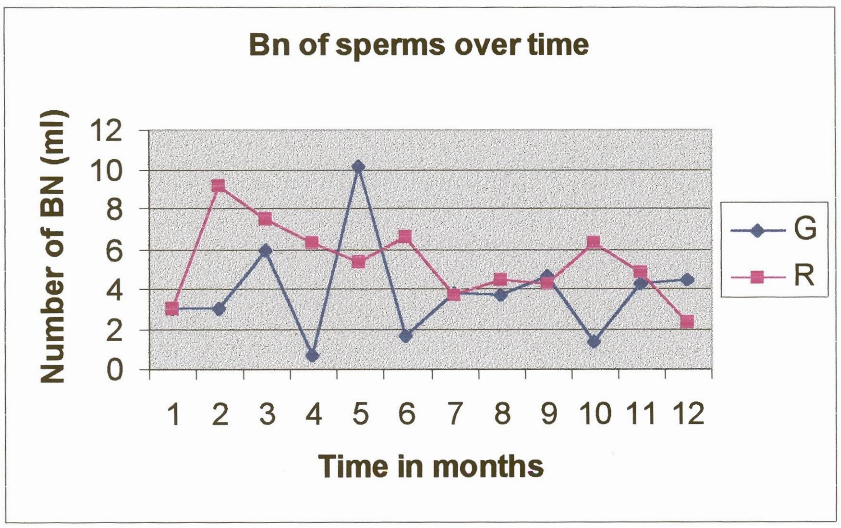
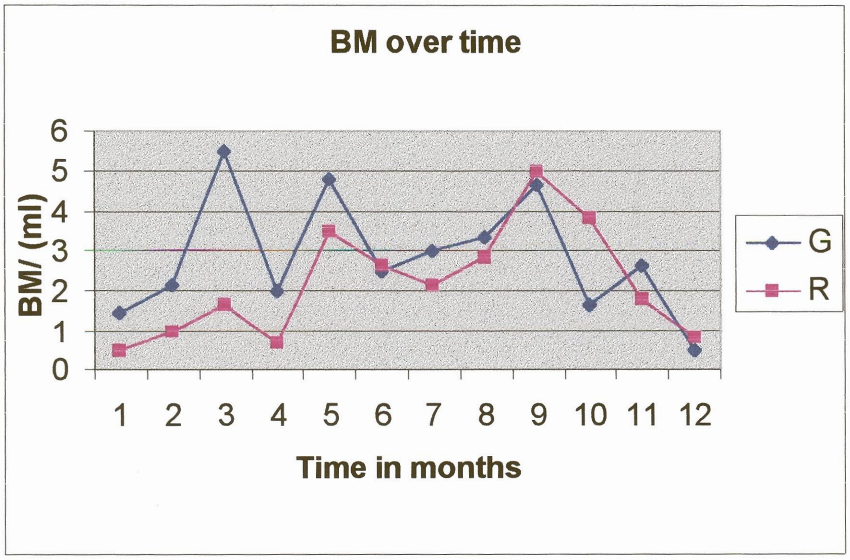


Figure 4.11 Effect of season on the number of spermatozoa broken at the mid-piece



The maturity stage of the spermatozoa plays a vital role in regulating the durability of the sperm. An increase in the number of sperm produced due to high sexual demands leads to an increase in the number of sperm abnormalities (Tegegne *et al*, 1994; Roca *et al*, 1992). (Figure 4.7, Figure 4.10, Figure 4.11). Figure 4.10 shows a significant variation in the number of sperms produced and broken at the neck. Such abnormalities are more pronounced in the Gorno Altai than the indigenous bucks, particularly in the months of June and October. All of these sperm abnormalities can be attributed to changes in ambient temperature. Figure 4.11 indicates no significant variation between the two breeds in terms of the number of spermatozoa produced when broken at mid-piece.

Temperature differences, whether cold or hot have a particular influence on the morphological state of the spermatozoa (Roca et al, 1992; Tegegne et al, 1994). An increased sexual desire activates spermatogenesis, resulting in the production of poor quality sperm. Significant ($P<0.05$) differences have been observed during June and October for the two goat breeds. There is a tendency in the Gorno Altai for an increase in the number of spermatozoa that are broken at the neck when the ambient temperature rises.

A tendency has also been observed in the Gorno Altai and the indigenous bucks regarding a higher incidence of spermatozoa that are broken at mid-piece during the breeding season. This phenomenon is also attributed to highly increased environmental temperatures (Tegegne *et al*, 1984).

For all the reproductive parameters studied, there was individual variation between bucks. Variation in semen quality throughout the year took place in a similar manner for each individual, irrespective of whether data was evaluated monthly or seasonally. It was also found that a similar seasonal pattern in a tropical zone showed the existence of a positive relationship existing between testis diameter and the photoperiod in male goats.

Although ambient temperature has been found to be a secondary factor that influences testes size in temperate climates, it indicates an obvious correlation with seasonal changes in scrotal diameter. It suggests that day length is not the only factor likely to affect testes size throughout the year. It is very difficult to promote day length as a primary inductor of seasonality in the geographic areas where seasonal variation in photoperiod is not so intense. In such circumstances testicular regression and recovery should be attributed to other climatic factors such as those which can change with the season such as ambient temperature and humidity.

Bongso *et al* (1982) postulated that in addition to day length, the influence of nutritional levels and their change with the season should not be ignored, as testes size has been reported to be slightly influenced by body weight and to be closely related to body growth. Similar results have been obtained in studies carried out on male goats in other subtropical and tropical climates.

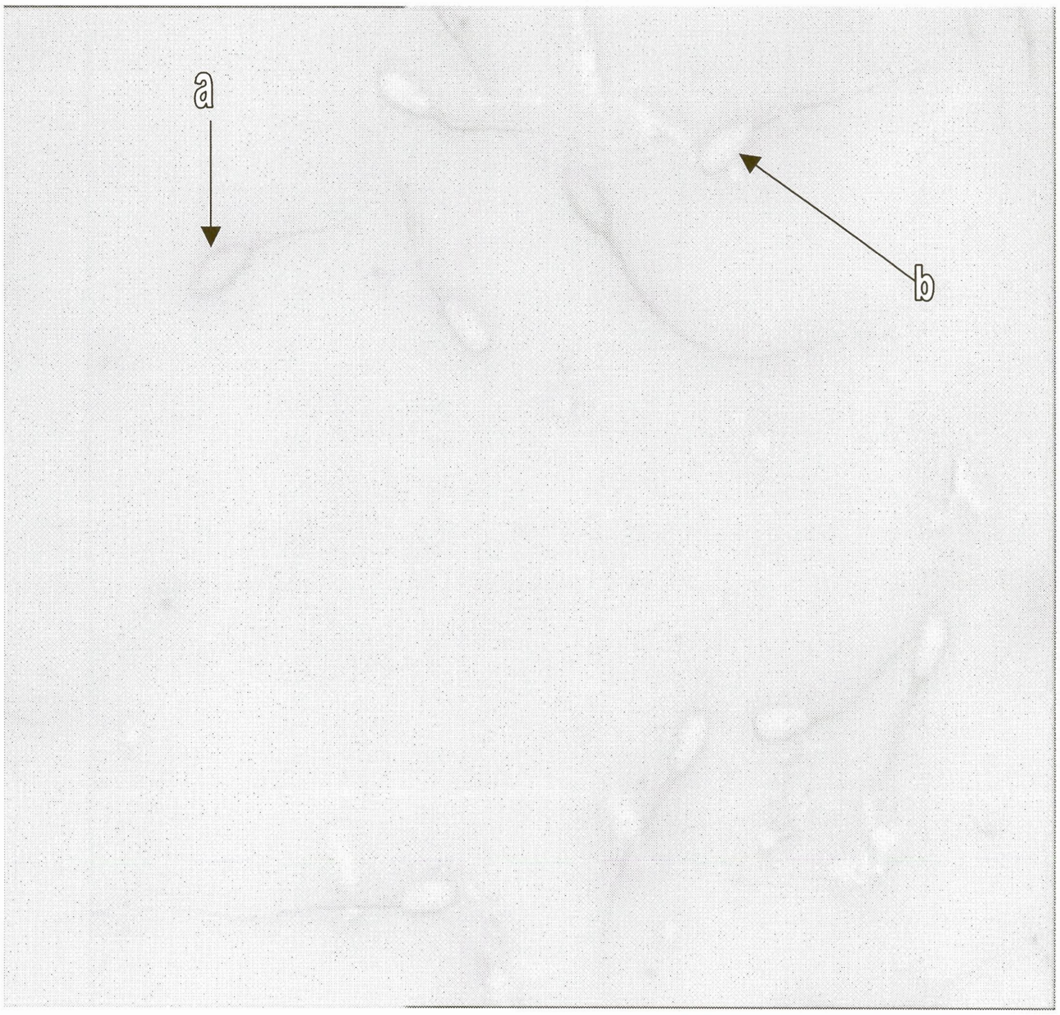
Table 4.1 Correlations on the influence of body weight on semen volume, sperm concentration, % live sperm, colour code and scrotal circumference.

		Weight	Volume	Concentration	% Live
Weight	Person Correlation	1			
	Sig. (2-tailed)	0.0			
	N	152			
Volume	Pearson Correlation	0.067	1		
	Sig. (2-tailed)	0.413	0.0		
	N	152	152		
Concentration	Pearson Correlation	0.089	0.274	1	
	Sig. (2-tailed)	0.278	0.001	0.0	
	N	152	152	152	
% Live	Pearson Correlation	-0.242	0.220	0.323	1
	Sig. (2-tailed)	0.003	0.006	0.000	0.0
	N	152	152	152	152
Colour code	Pearson Correlation	-0.327	0.139	0.323	0.411
	Sig. (2-tailed)	0.000	0.088	0.000	0.000
	N	152	152	152	152
SC	Pearson Correlation	0.098	-0.020	-0.107	-0.101
	Sig. (2-tailed)	0.230	0.810	0.188	0.216
	N	152	152	152	152

Other researchers (Neely *et al*, 1982; Willet and Ohms, 1955; 1957; Almquist, 1961; Almquist *et al*, 1961; Coulter, 1982; Tegegne *et al*, 1984; Roca *et al*, 1992) claimed that there is a strong correlation between body weight and scrotal circumference. In this study, Table 4.1 indicate that body weight did not influence the % live sperm, sperm concentration, wave motion or scrotal circumference in either breed. Although there is no significant correlation in the traits measured in this study, it is important to bear in mind that animals in different geographic locations respond to different environmental stimuli differently.

(Plates) 4.12, *Indication of different types of morphological abnormalities in goat semen as influenced by seasonal variation*

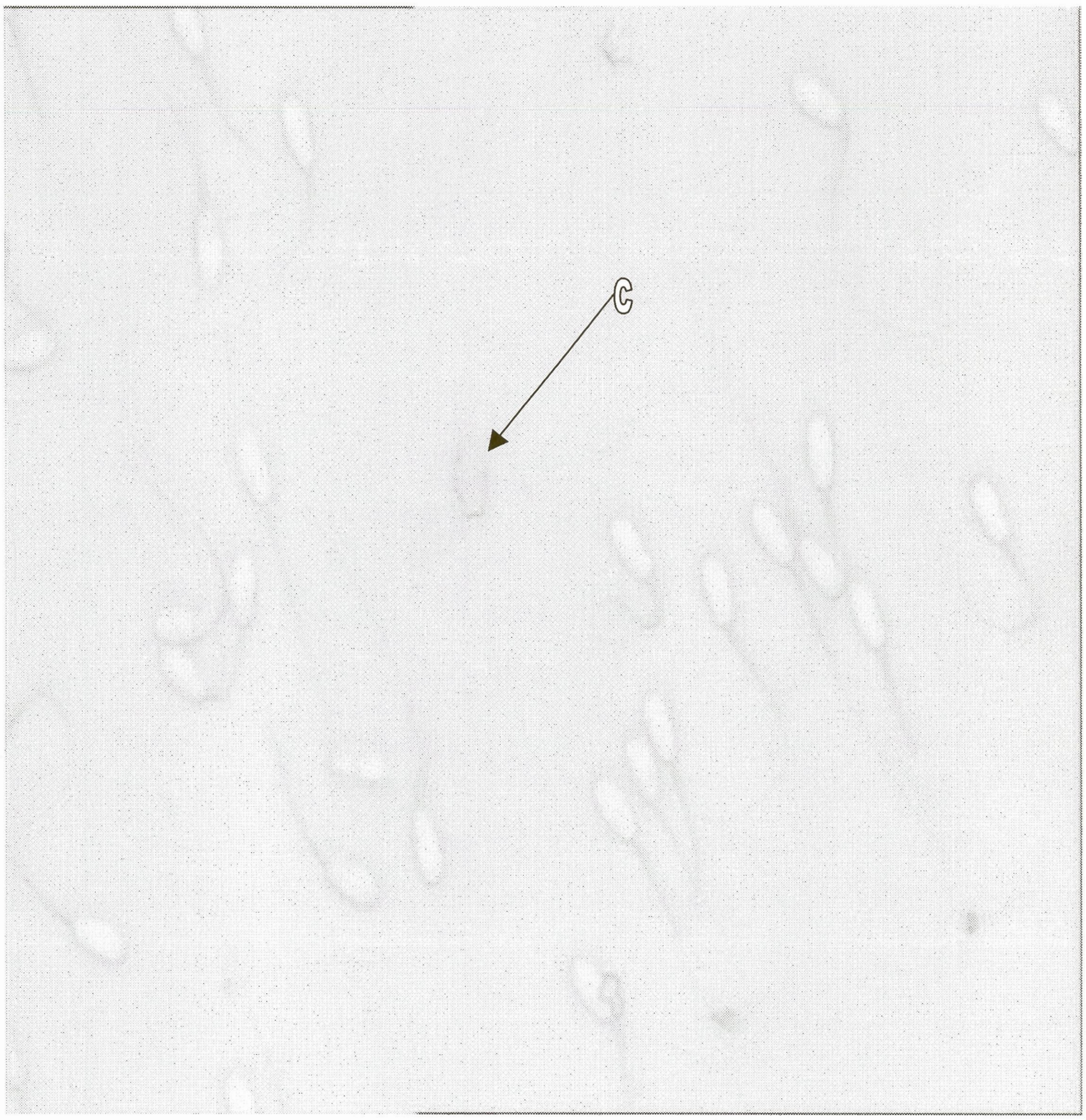
Plate 4.12.1 Dead (coloured red) and live buck sperm



A-Represents (coloured) dead sperm

B-Represents (uncoloured) live sperm

A- Plate 4.12.2 Abnormal acrosome



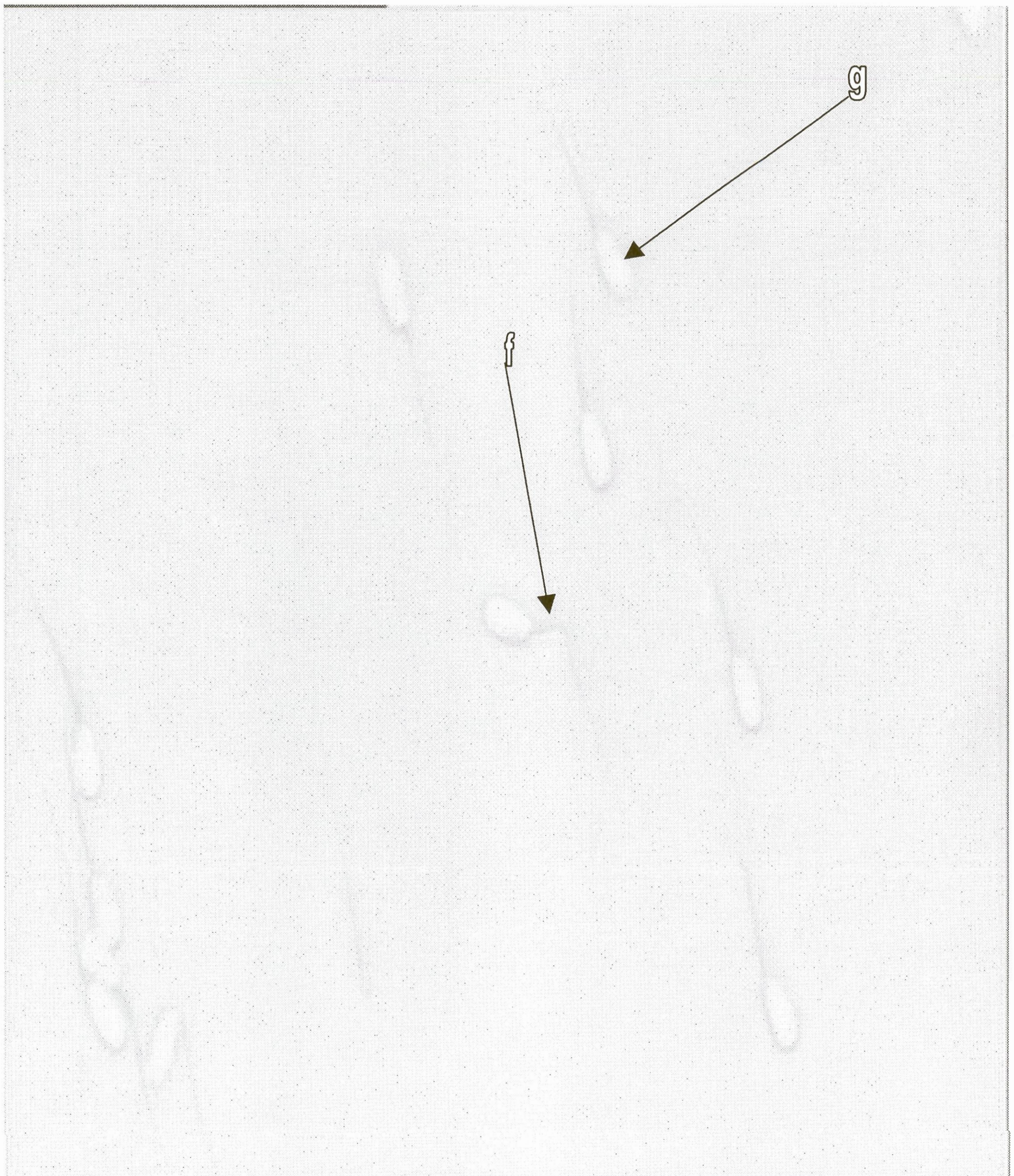
C-An abnormal accrosome on a dead sperm

Plate 4.12.3 Different sperm abnormalities

D-Sperm with a coiled tail

E-Dead sperm

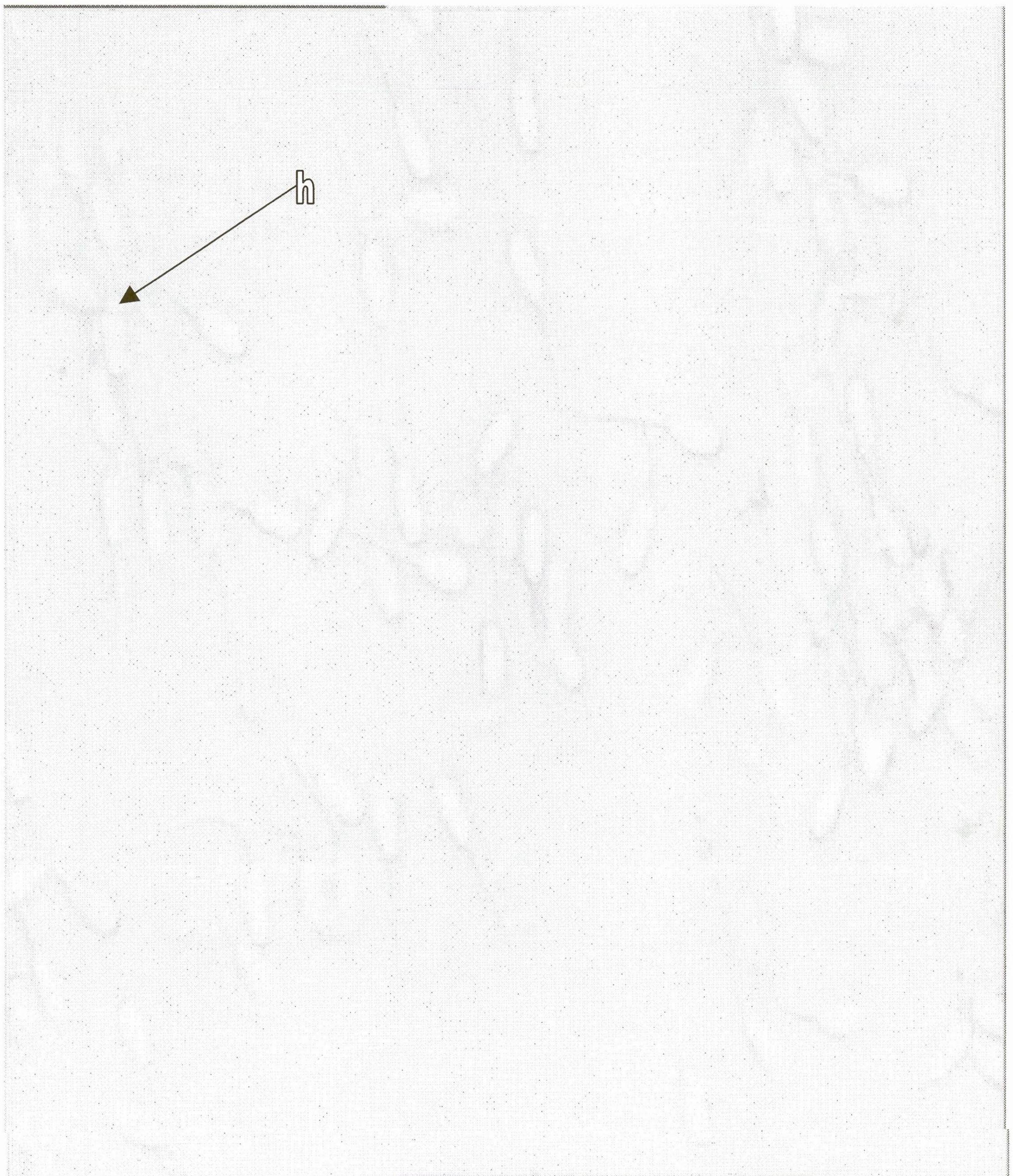
Plate 4.12.4 Broken at mid piece-spermatozoa



F-Sperm that is broken at the mid piece

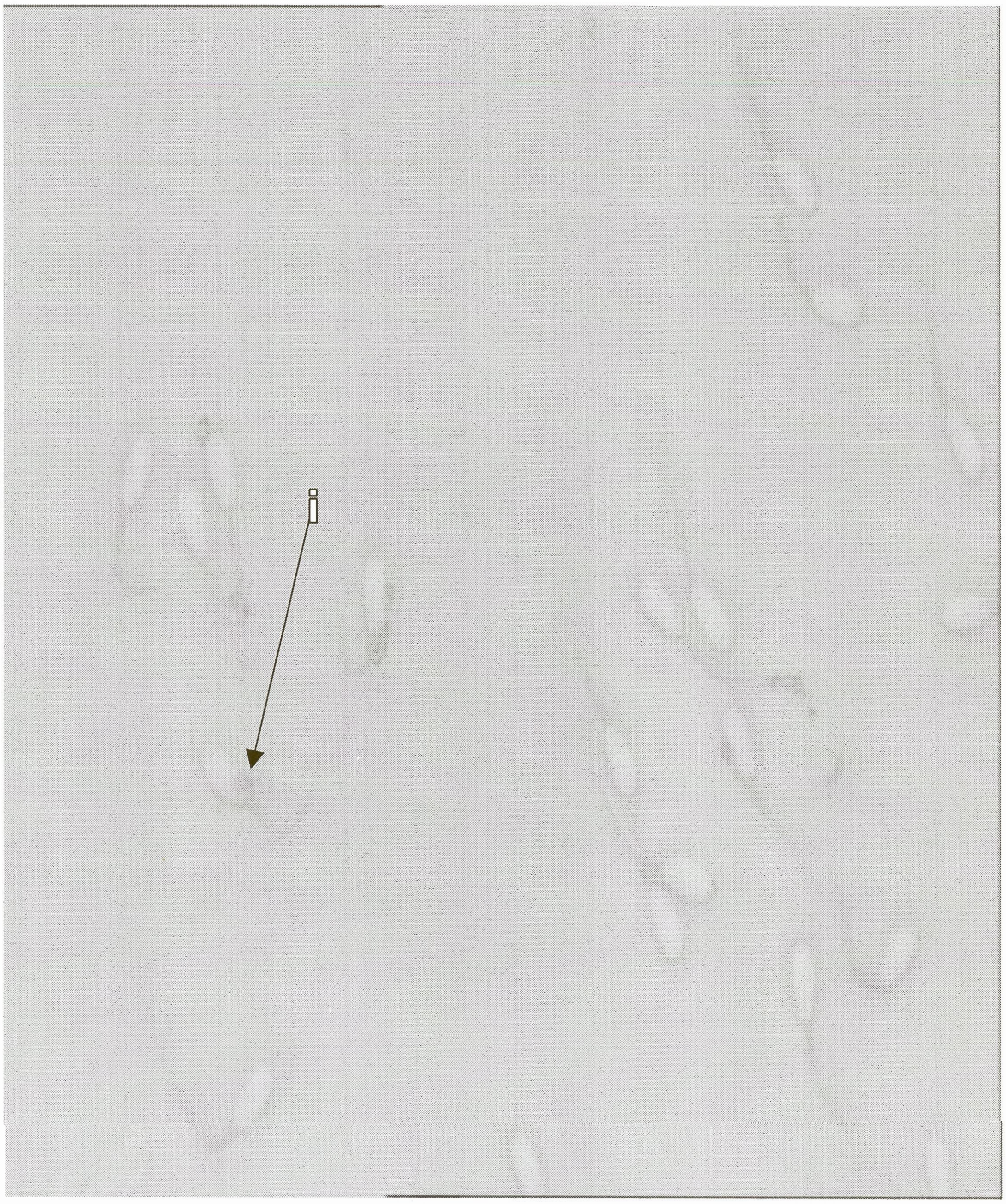
G-Normal sperm

Plate 4.12.5 Coiled-tail spermatozoa



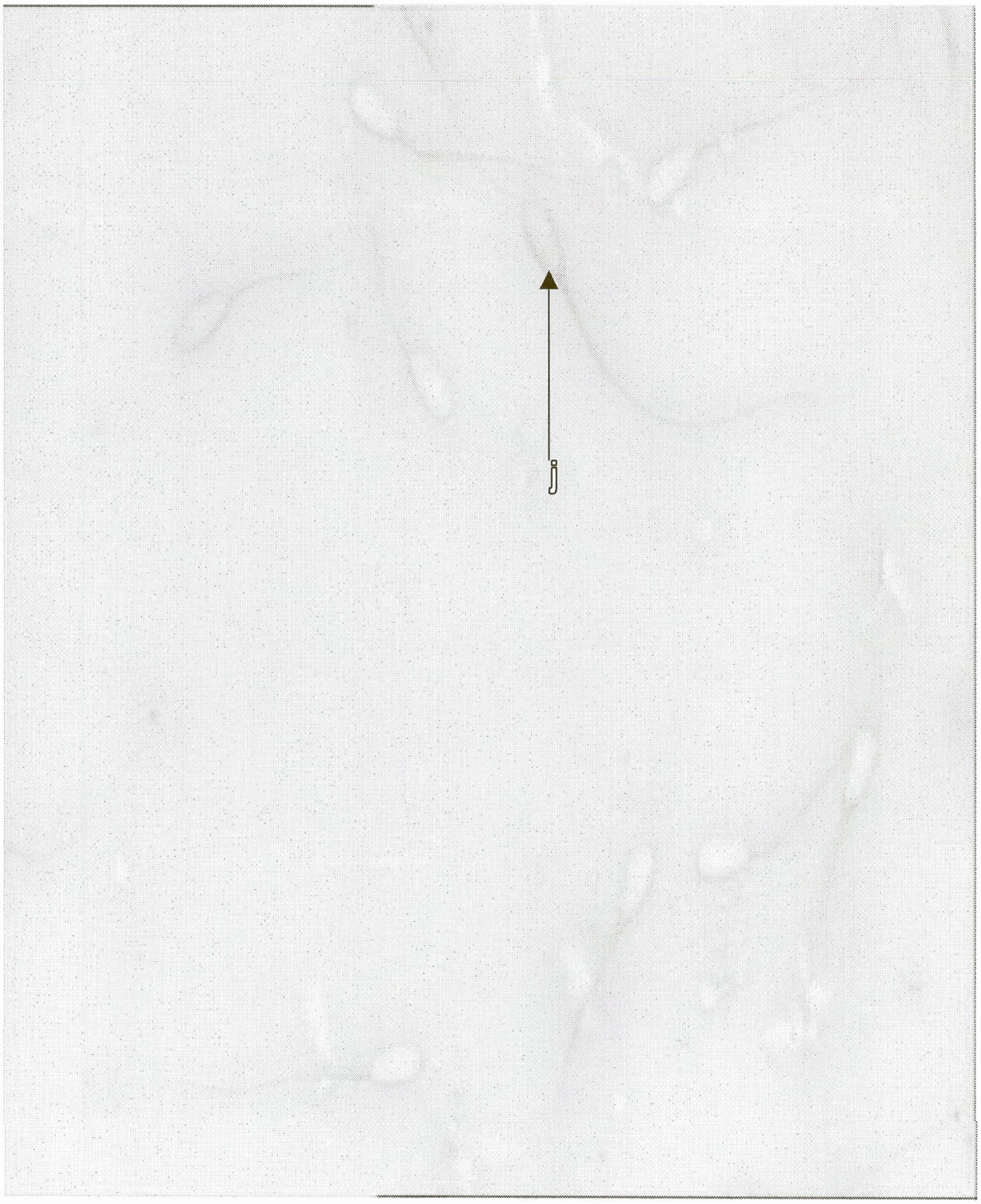
H-Sperm with coiled tail

Plate 4.12.6 Cytoplasmic droplet



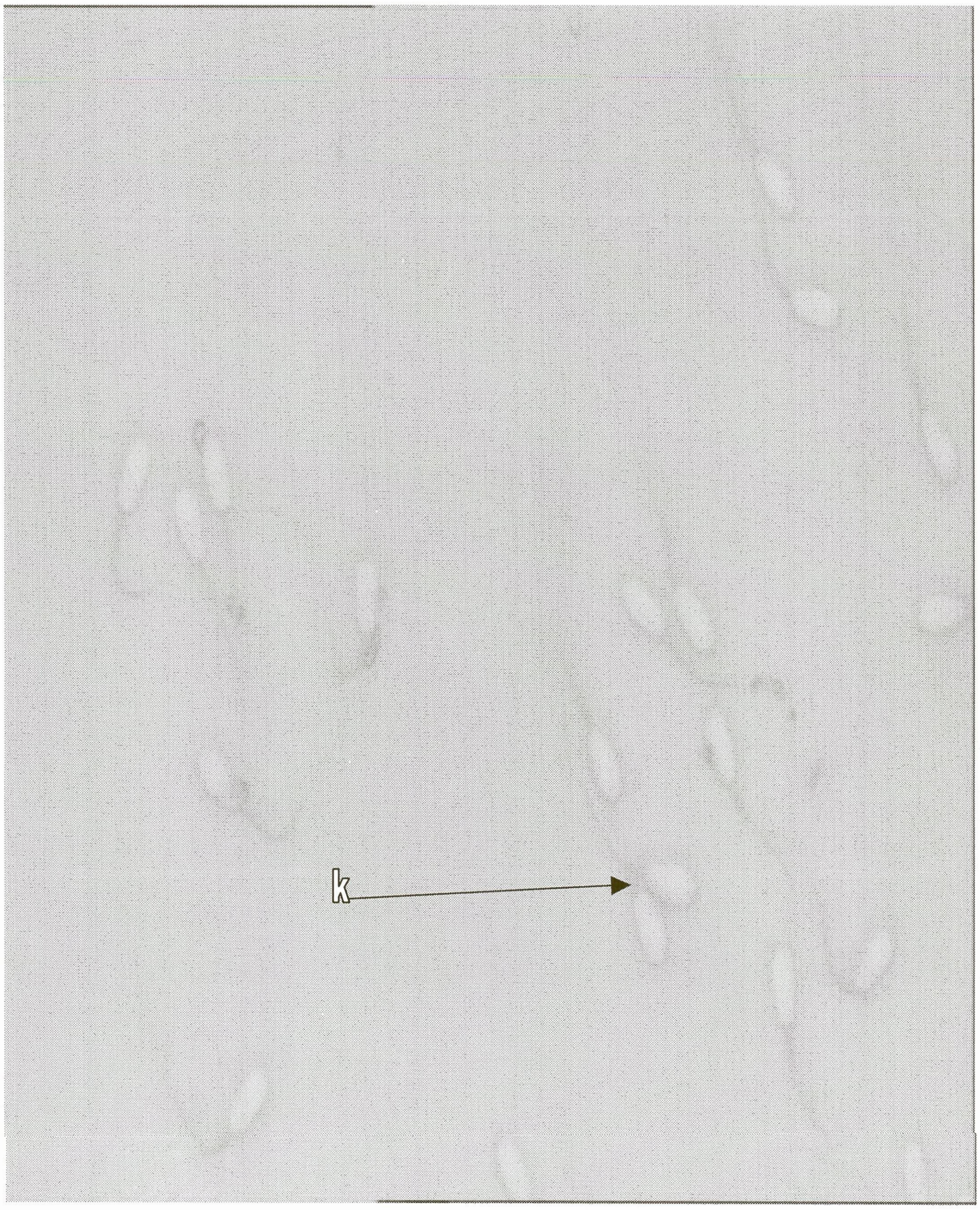
I-Sperm with a cytoplasmic droplet

Plate 4.12.7 Dead spermatozoa



J-dead sperm

Plate 4.12.8 Double headed spermatozoa



K-Sperm with double heads

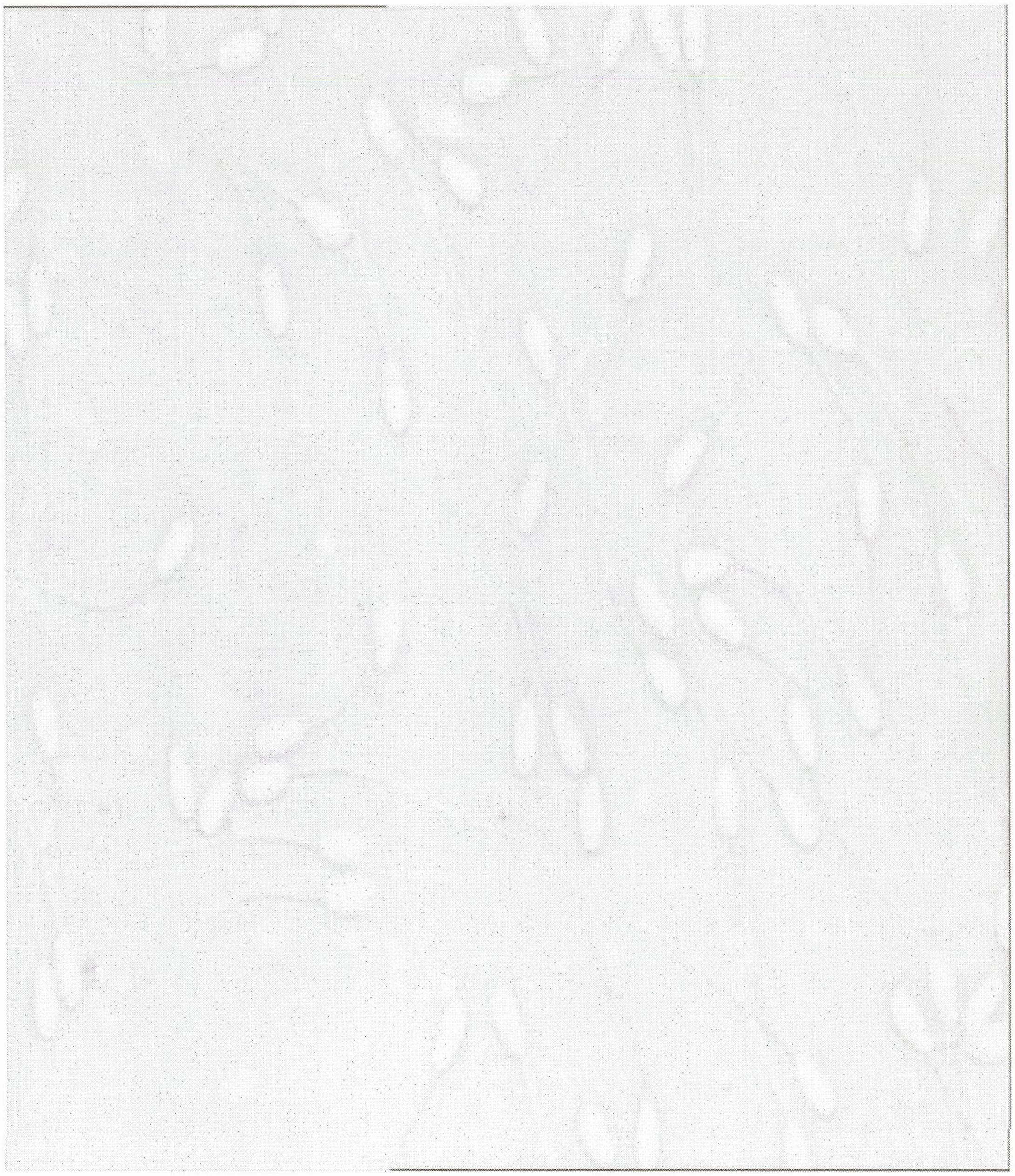
Plate 4.12.9 Enlarged head spermatozoa

L-Sperm with an enlarged head

Plate 4.12.10 Live spermatozoa

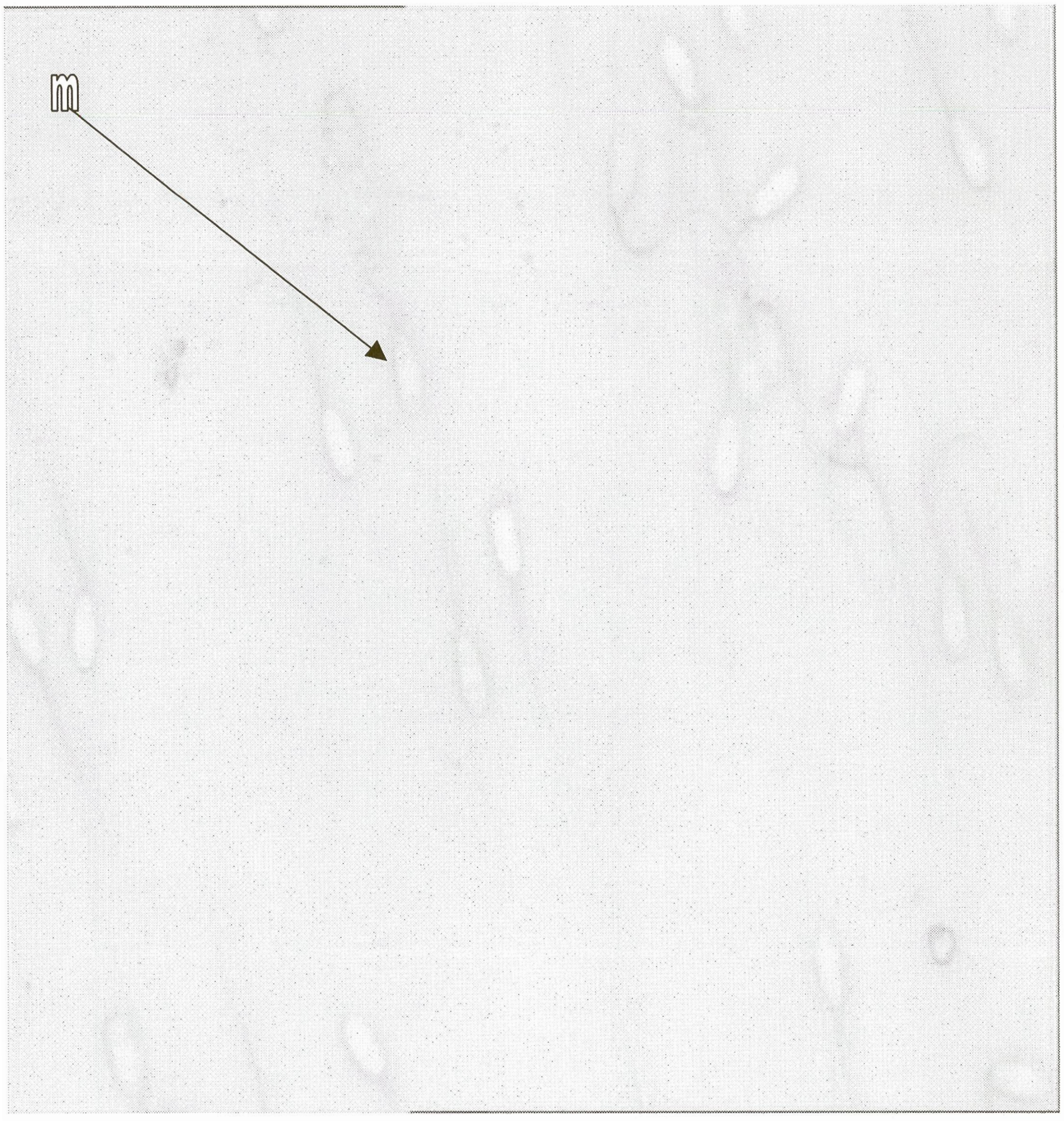
This plate represents live sperm

Plate 4.12.11 Normal sperm



This plate represents normal sperm

Plate 4.12.12 Tapped spermatozoa



M-Sperm with a tapped head

The sketches above represent different structures of sperm morphological abnormalities influencing the reproductive as well as the fertilizing capacity of the bucks.