MEASUREMENT OF SPERMATOZOA RELATED TO FERTILITY OF BUCKS AND BODY WEIGHT OF PROGENY

BY

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Department of Animal Breeding and Genetics
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1990

Dedicated
to my
Revered Parents

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Bhubaneswar,
May 31, 1990.

C E R T I F I C A T E

This is to certify that the thesis entitled, " MEASUREMENT OF SPERMATOZOA RELATED TO FERTILITY OF BUCKS AND BODY WEIGHT OF PROGENY," submitted for the degree of Master of Veterinary Science in the subject of Animal Breeding and Genetics of the Orissa University of Agriculture and Technology, Bhubaneswar is a faithful record of bonafide and original research work carried out by Susanta Kumar Dash under my guidance and supervision and that no part of the thesis has been submitted for any other degree or diploma.

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

(B.N. Patro)

Advisor.

CERTIFICATE - II

This is to certify that this thesis entitled, "MEASUREMENT OF SPERMATOZOA RELATED TO FERTILITY OF BUCKS AND BODY WEIGHT OF PROGENY" submitted by Susanta Kumar Dash to the Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the degree of Master of Veterinary Science in the subject of Animal Breeding and Genetics has been approved by the Student's Advisory Committee after an oral examination on the same in collaboration with an external examiner.

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Major Advisor

31/7/90.

External Examiner

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CHAPTER - I

INTRODUCTION

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

The goat, *Capra hircus* is probably the first ruminant (Masson, 1981) whose domestication occurred in South Asia about 9000 years ago (Read, 1959). India heads the list among the countries of the world, so far, the goat population is concerned. Though several animals and birds are used for table purpose, goat serves as one of the main sources (like broiler poultry) in our country. Several schemes and projects on goats are being implemented in our country to increase the goat population.

In addition to meeting the increased demand for goat meat this will also raise the economic status of the rural mass through goat raising. Rearing of meat type goats by feeding grains is uneconomic. So goat owners like to maintain their animals through browsing. Goat farming will therefore, thrive well in those areas where sufficient browsing facilities are available. A goat scheme was launched at Bhubaneswar for breeding the Ganjam and Black Bengal breeds by providing identical feeding conditions as they would have received in village environment.

The main objective in keeping these goat breeds is to produce meat. So to obtain high profit through sale of meat, a higher body weight at slaughter age is needed. As birth weight, 3 months and 6 months body weights are positively correlated with the market weight of the goat, improvement in these traits should be brought about to improve the weight at slaughter age. Fertility is an important traits both in males and females with regard to propagation of the species. Goat farming for meat production will be economically viable if high rate reproduction is maintained. Infertility in some bucks is a common observation, especially, in summer months. Enough work on the fertility of bucks is lacking. The fertility of buck depends on its genetic constitution and semen quality. The phenotype of the spermatozoa along with the sperm motility and live sperm percentage may indicate the genetic potentiality of the buck with respect to fertility.

The spermatozoa of the buck have flat shape, hence different measurements of its surface can be taken easily. In the present study different measurements like head length, head breadth, head circumference, head area, head shape, middle piece length, middle piece breadth middle piece area, spermatozoan length alongwith motility and live sperm percentage were taken to describe the phenotype of the spermatozoa in buck semen. The above measurements were also utilised to predict the fertility of the buck. Prediction of fertility from spermatozoan dimensions and semen quality would be very beneficial in farm practice because a buck can be evaluated for its fertility before crossing with the does. This would save much expenditure and time and early selection of breeding bucks will be possible.

The body weight which is the most important character in the progeny is the result of the genetic constitution of the animal and the environment to which it is exposed. All individuals in a farm are usually maintained in similar environments and therefore, the difference in genetic constitution is more important. The sire transmits 50 % of the genes in the progeny. Presumably, the genetic constitution of the sire for body weight may modify the phenotype of thespermatozoa to some extent, because the genes are carried by the spermatozoa. So any attempt for prediction of body weight in the progeny from the spermatozoan measurements of the sire is not unjustified.

Since spermatozoan measurements are likely to vary with individual spermatozoa, frequency of collection, physiological condition of the buck, age, season etc. average measurement of several spermatozoa of a buck ejaculated at different times may be taken to be more realistic. Considering the above facts the present work is designed with the following objectives:

i. To determine the different dimensions of the bucks spermatozoa.

ii. To correlate the fertility rate with dimensional and semen characters of the buck.

iii. To correlatethe birth weight, 3 months weight and 6 months weight of the kid with dimensional measurements of buck semen.

iv. To predict the fertility and body weight of the progeny from the dimensional characters of the buck spermatozoa.

CHAPTER - II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Various workers have measured the dimensions of spermatozoa in different species of farm animals. Their reports are reviewed below :

Spermatozoan dimensions :

Head length : Braden (1959) recorded interstrain differences in the length of spermatozoan head of mouse. The observations provided further evidence that the morphological characters of gametes were directly or indirectly determined by genotype of the animal.

Tomar et al.(1964) Studied the head length of spermatozoa in fertile bull semen and found that showed normal distribution.

Biswas et al. (1975) reported the presence of a possible relationship between the body weight and the spermatozoan head length of the crossbred bulls.

Srivastava et al. (1980) reported the average head length of spermatozoa of Jamnapari and Barbari bucks to be 8.24 μ and 8.40 μ, respectively. They observed that the head length varied significantly between ejaculates within animals. A seasonal variation in sperm head length was also reported by them in Barbari goats.

Lal and Pant (1982) observed a significant variation in the head length of spermatozoa between Rambouillet, Soviet Merino, Nali and Chokla rams.

Bardoli and Sharma (1983) reported the sperm head length of Assam buck as 8.109 ± 0.012 µ and that of Beetal and Saanen bucks as 8.139 ± 0.037 µ and 8.155 ± 0.024 µ, respectively. They also observed a significant variation for spermatozoan head length in the above breeds.

Mishra and Mukherjee (1984) studied the spermatozoa of Barbari, Jamnapari, Beetal and Black Bengal bucks and found that the head length of sperm ranged from 7.89 to 8.12 µ. They observed nonsignificant difference in head length of spermatozoa between above breeds.

Head breadth : Braden (1959) recorded the inter-strain difference in the head breadth of bull spermatozoa.

Beatty and Sharma (1960) observed significant strain differences in head breadths of spermatozoa of bulls. But they were of opinion that age and weight of the male did not influence on the sperm head breadth.

Rajwar and Mukherjee (1969) observed that temperature and shock altered the head breadth of bull spermatozoa.

Pant *et al.* (1973) reported that head breadth was influenced by body weight but not by age and it has a positive correlation with the body size of the bull.

Srivastava et al. (1980) reported no significant difference in sperm head breadth between Barbari and Jamnapari breed of buck. They also reported that head breadth varied significantly between ejaculates within animal and between autumn and winter seasons in Barbari breed.

Bandopadhya et al. (1983) reported that there was a significant variation in spermatozoan measurements like head breadth between different collections within the bulls but there was no significant variation between the different stapes of the process of deep freezing.

Bardoli and Sharma (1983) found out that the average sperm head width of Assam, Beetal and Saanan bucks were 2.106 ± 0.007 μ, 2.163 ± 0.008 μ, and 2.117 ± 0.009 μ, respectively. They also reported the maximum head widths as 4.126 ± 0.09 μ, 4.072 ± 0.045 μ and 4.107 ± 0.037 μ in Assam, Beetal and Saanen bucks respectively. They concluded that there was significant difference in maximum head width between breeds.

Mishra and Mukherjee (1984) studied the spermatozoa of Barbari, Jamnapari, Black Bengal and Beetal bucks. They found that head width ranged from 4.27 to 4.32 μ. They also observed significant difference in head breadth amongh males within breeds.

Head area : Mukherjee and Kumar (1971) reported significant and positive correlation between the head area and the conception rate in Hariana bulls.

Srivastava et al. (1980) reported no significant difference between breeds in sperm head area, analysing the spermatozoa of Barbari and Jamnapari bucks. They also recorded that thead area varied significantly between ejaculates within animals and between autumn and winter seasons (measured in Barbari breed only).

Lal and Pant (1982) measured the head area of ovine spermatozoa to range from 35.34 to 36.74 μ^2. They also concluded that for head area there was significant variation between rams.

Lal and Pant (1984) observed that variation between genotypes, rams and collections were significant for head area. They also reported a significant correlation (0.51) of ram fertility with sperm head area.

Mishra and Mukherjee (1984) measured the head area of spermatozoa of Barbari, Jamnapari, Black Bengal and Beetal bucks and found that it ranged from 29.11 to 30.84 μ^2. They also found that the difference between breeds was nonsignificant. There was significant difference in head area among males within breeds.

Head shape : Lal and Pant (1982) reported that the head shape index of rams ranged from 1.64 to 1.66. They also observed that there was significant variation between rams for head shape.

Middle piece length: Braden (1959) reported that the morphological characters of the spermatozoa were directly or indirectly determined by the genotype of the animal.

Mukherjee and Singh (1966) reported that the middle piece length was related to metabolic activity of spermatozoa and varied only between bulls and was influenced by genetic factors rather than seasons.

Srivastava *et al.* (1980) observed no significant difference between breeds with respect to middle piece length of the spermatozoa.

Mishra and Mukherjee (1981) measured the spermatozoan middle piece length of Barbari buck to be $11.891 \pm 0.132 \mu$.

Lal and Pant (1982) observed that variation between rams was significant for middle piece length.

Bardoli and Sharma (1983) measured the spermatozoan middle piece length of Assam, Beetal and Saanen bucks to be 12.056 $\pm$ 0.046 μ, 11.931 $\pm$ 0.021 μ and 12.056 $\pm$ 0.64 μ respectively. They reported that the middle piece length variation to be non significant between breeds.

Lal and Pant (1984) observed that variation between genotypes of rams and collections were significant for middle piece length.

Mishra and Mukherjee (1984) reported that the average middle piece length of spermatozoa in Barbari, Jamnapari Black Bengal and Beetal goats were 12.39, 12.52, 11.91 and 12.46 μ respectively.

Middle piece breadth : Pant and Mukherjee (1973) reported no influence of breed on the middle piece breadth of buffalo spermatozoa.

Srivastava *et al.* (1980) reported no significant difference between breeds with respect to midpiece width of spermatozoa of goats.

Lal and Pant (1984) observed that the variation between genotypes and collections were significant on midpiece breadth of spermatozoa of rams.

Mishra and Mukherjee (1984) measured the midpiece breadth of Barbari bucks to be 0.685 ± 0.11 µ.

Midpiece area : Beatty and Sharma (1960) observed a significant strain difference for all dimensional characters except middle peice area of sperm. They were however, of the opinion that the age and weight of the male appeared to have no effect on the measurements of spermatozoan midpiece area.

Mishra and Mukherjee (1981) measured the midpiece area of Barbari buck spermatozoa to be 8.137 ± 0.121 µ. They also reported that midpiece area was significantly higher in spermatozoa stored in oxygen than in air or nitrogen.

Tail length : Deka and Rao (1980) reported that tail length varied significantly between breed groups.

Bardoli and Sharma (1983) found that the tail length of Assam, Beetal and Saanen bucks averaged 38.427 ± 0.074 µ, 37.975 ± 0.077 µ and 38.045 ± 0.074 µ, respectively.

Semen characteristics :

Motility : Kodgali (1962) observed that there was highly significant variation in motility of bull semen between different seasons. Cole season being the best followed by rainy and summer.

Abdel-Raouf (1965) reported that motile spermatozoa increased significantly with age of bulls.

Tripathy and Prabhu (1968) observed no effect of season on initial sperm motility in Hariana bulls.

Prasad <u>et</u> <u>al</u>. (1970) recorded that semen volume and sperm motility were significantly higher in adults than in 9 months old bucks.

Rao and Rao (1975) observed higher motility of spermatozoa in semen collected druing Novermber to January than during May to July in bovines.

Kang and Chung (1976) reported that sperm motility index in Korean native goats higher in Nov-Jan. than in July-Sept. Correlation between sperm concentration and motility was negative. Sperm motility was positively correlated with ejaculate volume and P^H .

Vinha (1979) measured the forward motility of Anglo-Nubian, Marota and Moxoto breeds of goats to be 76.22 %, 68.33 % and 62.75 %, respectively. The difference between Moxoto and other two breeds being significant.

Cetinkaya (1980) reported that sperm motility of Angora goat was 66 % and after dilution and freezing its motility decreased to 40 to 55 % after 48 hours.

Saxena and Tripathy (1980) reported the initial motility of Jamnapari semen to be 72.62 ± 1.06 %. The forward motility was 3.78 ± 0.07 (scale 0-5).

Mann (1981) observed that forward motility of spermatozoa of African dwarf goat was 77.28 ± 7.75 %.

Mohan <u>et al</u>. (1981) reported significant difference between bucks so far as the motility of sperm is concerned.

Chaudry <u>et al</u>. (1984) observed that sperm motility of Barbari buck ranged from 65 to 80 %. Higher ambient temperature and humidity was related to lower motility.

El. Sayed <u>et al</u>. (1983) reported that proportion of motile spermatozoa in Baladi goats were 61.12 % and 64.75 % for first and second ejaculates, respectively.

Borgohain <u>et al</u>. (1985) observed that sperm motility was highly significantly affected by diluent and storage time of semen.

Mittal (1985) reported that season had no significant effect on spermatozoan motility of Jamnapari bucks under arid conditions.

Mittal (1986) reported that motile spermatozoa was lower in crossbreds than the purebred goats.

Mittal (1987) recorded that the motility of Beetal and Marwari bucks ranged from 76.0 to 82.0 % and 82.1 to 85.8 %, respectively. There was no significant difference between breeds.

Rahman and Kandil (1987) reported that spermatozoan motility was significantly higher in autumn than in spring and summer seasons.

<u>Live sperm percentage</u> : Patil and Raja (1978) showed that proportion of live spermatozoa was 61.38 % in Malbari bucks and was not significantly affected by season.

Saxena and Tripathy (1980) reported that live sperm percentage of Jamnapari buck was 77.65 ± 1.04 %.

Mittal (1982) found that live sperm percentage was higher in winter and lower in summer indicating significant effect of season on the percentage of live sperm in Barbari bucks.

Sinha and Singh (1982) recorded the percentage of live spermatozoa to be 85.45 and 85.50 % in Black Bengal and Saanan bucks, respectively.

El. Sayed (1983) recorded the proportion of live spermatozoa of Baladi male goats to be 69.74 and 72.44 % for 1st and 2nd ejaculates, respectively.

Mishra and Mukherjee (1984) recorded the live spermotozoa to be 55.19 %, 59.08 %, 67.41 % and 73.13 % in Barbari, Jamnapari, Black Bengal and Beetal bucks, respectively.

Borgohain et al. (1985) observed the live sperm percentage in Assam local and Beetal bucks to be 87.57 ± 0.34 % and 88.49 ± 0.31 %, respectively. The live sperm percentage differed significantly between breeds and between months in Beetal bucks. The lowest percentage of live sperm was observed in the month of January corresponding to the ambient temperature.

Singh et al. (1985) found the percentage of live spermatozoa to be 75.30 ± 3.33 and 78.37 ± 1.76 % in Jamnapari and Barbari bucks and percentage of live spermatozoa was not significant.

Mittal (1986) reported that live sperm percentage was lower in crossbreds than the purebred bucks.

Mittal (1987) recorded that the live sperm of Beetal and Marwari buck ranged from 74.0 to 78.0 % and 78.8 to 81.7 percent respectively. No significant difference was present between breeds.

Relationship of fertility with spermatozoan measurements:

Fertility with sperm head length: Mukherjee and Kumar (1971) reported that a significant correlation between spermatozoan head length and fertility (68.07%) existed in Hariana bulls.

Biswas et al. (1975) reported that the coefficient of correlation between head length and fertility was significant. Hence, head length may be used in predicting fertility in bulls.

Sinha and Mukherjee (1976) observed no significant correlation between various dimensional characteristics of cock spermatozoa and fertility.

Lal and Pant (1984) recorded significant correlation of ram fertility with sperm head length (0.50).

Fertility with sperm head breadth : Mukherjee and Kumar (1971) stated that the head breadth was of least importance for predicting fertilising capacity of bull spermatozoa in Hariana cattle.

Biswas et al. (1975) found no relationship between head breadth and fertility of bull.

Lal and Pant (1984) reported significant correlation or ram fertility with sperm head breadth.

__Fertility with head area:__ Mukherjee and Singh (1967) observed that reduction in spermatozoan head area was associated with reduction in the fertility capacity of spermatozoa by reducing the amount of oxygen.

Mukherjee and Kumar (1971) found significant positive correlation of sperm head area with conception rate in Hariana bulls.

Biswas _et al_. (1975) stated that head area of spermatozoa was of little importance in prediction of fertility of bull.

Lal and Pant (1984) reported significant correlations of fertility with sperm head area in rams.

__Fertility with head shape:__ Mukherjee and Kumar (1971) found a significant and positive correlation of sperm head shape with conception rate in Hariana bulls.

Rajendra Kumar _et al_. (1977) found that spermatozoan head shape may be a better criterion for predicting fertility of buffalo bulls.

__Fertility with middle piece length:__ Mukherjee and Kumar (1971) recorded that middle piece length of spermatozoa was least important in prediction of fertilising capacity of Hariana bull.

Fertility with middle piece breadth: Mukherjee and Kumar (1971) observed that middle piece breadth of Hariana bull spermatozoa was directly correlated with the conception rate. They also reported that the correlation of middle piece breadth with conception rate was more than that of live sperm % with conception rate.

Fertility with middle piece area: Mukherjee and Kumar (1971) reported no significant correlation between middle piece area and conception rate in Hariana bulls.

Relationship of fertility with semen characteristics:

Fertility with motility: Blom (1950) stated that motility below 50 per cent was often associated with low conception rate and poor fertility.

Lasley (1951) recorded a high significant correlation between the percentage of progressive motile spermatozoa in fresh semen and the fertility of bull.

Erb *et al.* (1956) reported initial motility of bull semen to be closely related with the fertility of bull.

Zemjanis (1970) stated that motility studied soon after collection was identified commonly as a measure of fertilising ability of sperm.

Schlote and Munks (1981) noted that the genetic correlation between conception rate and semen motility was 0.25 in bulls.

Fertility with live sperm percentage: Stone *et al.* (1950) reported a positive correlation of 0.69 between fertility and live sperm percentage of bull semen.

Lasley (1951) recorded that the semen with more than 30 per cent dead spermatozoa reduced the fertility rate in bulls.

Bishop *et al.* (1954) noted a high and significant inverse relationship between fertility and incidence of dead spermatozoa.

Bonnadonna and Kann (1955) reported the highest conception rate of 70.2% when the number of live spermatozoa was 1200 to 1400 million/cubic centimeter in undiluted semen.

CHAPTER - III

MATERIALS AND METHODS

MATERIALS AND METHODS

Source

The present study was undertaken on the goats maintained in the ICAR adhoc scheme " Evolution of a meat type goat suitable to Orissa condition" operating in O.U.A.T. at Bhubaneswar. Data on 120 progeny of 17 bucks belonging to Ganjam and Black Bengal breeds were available for calculating the fertility of bucks and body weights of the progeny. Body weight at 3 stages i.e. at birth, 3 months and 6 months were considered in the study. The spermatozoan measurements and semen quality of the bucks were studied.

Management of the flock

The goat in the scheme are maintained entirely on browsing in the near by Jungle and hillock side as per the technical programme of the scheme. All the animals are left loose for browsing in the morning hours and housed in late afternoon after return. Feeding of perpared feed is done in scarcity period when browsing facility is minimum, especially, in summer season and a part of rainy season. Mineral mixture supplement and salt licking is provided to the animals daily. Special care is taken for the pregnant animals and kids. Fodder leaves like Ingadulcis (Manila tamarind) and Soobabul are fed to these animals in the farm when not left for browsing. Besides, young kids were given extraneous milk feeding when it is felt that dam's milk is insufficient. Heat detection of the does by teasers in the morning and afternoon is a routine practice in the farm. Whenever a doe is found to be in heat the alloted buck is mated to it. Routine vaccination, deworming and disease control measures are followed in the farm as per standards.

Estimation of fertility

In the present study, estimation of fertility of a buck was based on the ability of a buck to impregnate the does in oestrus. The rate of fertility was expressed in percentage by taking the ratio of the number of does which conceived when served by a buck and the number of actual inseminations or services made by the same buck.

Body weight of the progeny

The body weights were expressed in kilograms(Kg). Body weight of the kids of each buck was considered at 3 stages i.e. at birth, 3 months and 6 months of age. The bucks of a particular breed were used on does of same or different breed resulting in purebred or cross-bred progeny. The body weight of the kids of a particular buck would therefore, be influenced by the breed of the dam. In order to eliminate the effect of breed of the dam correction of the body weights of kids was undertaken. The corrected weight is expressed as below:

$$x_{ij} = X_{ij} \pm (\bar{X}_i - \bar{\bar{X}})$$

where X_{ij} - Individual uncorrected body weight.

x_{ij} - Individual corrected body weight.

$\bar{X}_i$ - Mean body weight of the kids of i'th breed of dam.

$\bar{\bar{X}}$ - Mean of the $\bar{X}_i$.

After correction for the breed of the dam the mean of corrected body weights of the progeny belonging to individual bucks were subjected for further analysis.

<u>Collection of semen</u>

Semen samples were collected from the bucks with modified artificial vagina. A doe in oestrus was used as dummy for collection. The prepucial orifice of the buck was cleaned. The artificial vagina was prepared by filling it with water at 45° to 55° centigrade and air was blown in to it to get the required pressure. Finally it was lubricated for use in semen collection. After mounting, the buck executed a pronounced thrust usually accompanied with ejaculation. In some cases a second thrust resulted in ejaculation. Immediately after collection the semen samples were evaluated under a microscope.

Staining procedure for measurement of spermatozoa

For dimensional study, semen samples were stained with Eosin-Nigrosin stain. One drop of the semen sample was added to two drops of stain and three smears were drawn on three different grease free glass slides from each sample. Two semen samples from each buck were taken, so six smears were obtained from a single buck. Out of six slides best five were studied for spermatozoan measurements. Spermatozoa did not take stain and looked white against the brownish black background on stained slides. Six straight spermatozoa were taken at random from each slide for study.

The following spermatozoan measurements and sperm characteristics were taken.

1. Spermatozoan length
2. Head circumference
3. Head length
4. Head breadth
5. Head area
6. Head shape
7. Middle piece length
8. Middle piece breadth
9. Middle piece area
10. Motility
11. Live sperm count (percentage)

Measurement of spermatozoan dimensions

The stained slides were put under oil imersion lense of a binocular microscope, fitted with a bellow type camera at the position of eyepiece. A viewer of size 17cm. X 12cm. was attached to the camera in order to get the magnified image of spermatozoa. The image of spermatozoa was sketched out on a cellophane paper, which was fixed on the viewer glass by an adhesive tape. Six such spermatozoa sketches were taken from each smear, therefore, 30 spermatozoan measurements were available for each buck.

The sketch of internal scale of the stage micrometer was also drawn alongwith the spermatozoa. On the cellophane paper this sketch was divided by the actual length of the micrometer to know the extent of magnification. The spermatozoan dimensions were calculated by the dividing the enlarged measurements on cellophane paper by the times of magnification so obtained.

The methods of measuring the different dimensions of the spermatozoa were given below:

Spermatozoan length : It was measured from the apex to the tail of spermatozoa. It was expressed in microns (μ) .

Head circumference : A silk thread was kept around the outer line of the sketch of spermatozoan head. Head circumference was taken as the length of the thread required divided by the times of magnification. It was expressed in microns (μ).

Head length : Head length was measured from the apex to the middle of the base line of spermatozoan head. It was expressed in microns (μ).

Head breadth : Breadth of head was measured by passing a transparent plastic scale from base to the apex of spermatozoan head, keeping the scale parallel to base line. The maximum breadth of the spermatozoan head recorded as the head breadth. It was expressed in microns (μ).

Head area : It was measured by the help of a graph paper. The number of squares covered by the periphery of head was counted for the measurement of head area. Part squares within the periphery were taken as full if half or more of it was enclosed within, other-wise it was not included in counting. Each small square of the graph was one square mm. only. Head area was expressed in sqare microns (μ^2).

Head shape : Head shape was calculated as the ratio of head length and head breadth. (Pant and Mukherjee, 1971).

Middle piece length: It was measured from the base of head upto the annulus by a plastic transparent scale along the long axis. It was expressed in microns(μ)

Middle piece area : It was calculated by the help of a graph paper as in case of head area. It was expressed in square microns (μ^2).

Middle piece breadth : It was taken by dividing the middle piece area by middle piece length. It was expressed in microns (μ).

<u>Estimation of semen characteristics:</u>

Motility : Immediately after collection of semen one drop of the semen sample was taken on a clean grease free glass slide, kept at 37^o centigrade. A cover slip was put over it and examined under low power of the microscope to determine the sperm motility in semen samples. It was expressed in percentage (%).

Live sperm count : The staining procedure followed for this purpose was as follows :

In a wooden box one 60 watt electric bulb was fitted. The top of the box was kept open. A glass plate maintained at a temperature of 37^{o}c on the slide surface and stain solution. One drop of collected semen was mixed with one drop of stain solution in a watch glass over the glass plate and kept for 20-25 seconds. Two smears were prepared from each semen sample and dried in air. These slides were examined under oil immension lens and live spermatozoa were counted. The dead spermatozoa took pink stain where as the live spermatozoa didnot take the stain. Partially stained spermatozoa were also taken as dead. 100 spermatozoa were counted from each slide to determine the live sperm count which was expressed in percentage.

Stain used for live sperm count : Eosin and Nigrosine stain was used for staining. Stain prepared as per Blom (1950) in the following manner.

One gram of Eosin (B) (W.S.) and 5 grams of Nigrosine (W.S.) stains were mixed with 100 c.c. of 3 % sodium citrate dehydrate solution in a water bath maintained at 70°c. A small amount of thymol was added to the stain solution as preservative. The stain was kept for 48 hours in the water bath for maturation. Then the prepared stain was kept in a refrigerator for future use.

Statistical analysis:

All the measurements on the spermatozoa, the semen characteristics, fertility and body weights of kids were corrected for the effect of breed as per the proceedure mentioned for correcting body weights. The corrected data were subjected for further statistical analysis. Motility, live sperm count and fertility, which were expressed in percentage were transformed to the corresponding angles.

A multiple regression equation was assumed for each of the dependent variates i.e. fertility, birth weight, 3 months weight and 6 months weight considering 9 independent variates. The independent variates are as follows.

Spermatozoan length	(X_1)
Head circumference	(X_2)
Head length	(X_3)
Head breadth	(X_4)
Head area	(X_5)
Middle piece breadth	(X_6)
Middle piece area	(X_7)
Motility	(X_8)
Live sperm count	(X_9)

The model considered was,

$$Y = a + b_1 X_1 + b_2X_2 + \ldots\ldots\ldots\ldots + b_9X_9$$

where a = 'Y' intercept,

$b_1 \ldots\ldots b_9$ = Partial regression coefficients.

The partial regression coefficients (b_is) were obtained by solving the following linear equations shown in a matrix form.

$$\begin{bmatrix} X_1^2 & X_1X_2 \ldots\ldots & X_1X_9 \\ X_2X_1 & X_2^2 \ldots\ldots & X_2X_9 \\ \vdots & \vdots & \vdots \\ X_9X_1 & X_9X_2 \ldots\ldots & X_9^2 \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_9 \end{bmatrix} = \begin{bmatrix} X_1Y \\ X_2Y \\ \vdots \\ X_9Y \end{bmatrix}$$

$$\begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_9 \end{bmatrix} = \begin{bmatrix} X_1^2 & X_1X_2 \ldots\ldots & X_1X_9 \\ X_2X_1 & X_2^2 \ldots\ldots & X_2X_9 \\ \vdots & \vdots & \vdots \\ X_9X_1 & X_9X_2 \ldots\ldots & X_9^2 \end{bmatrix}^{-1} \begin{bmatrix} X_1Y \\ X_2Y \\ \vdots \\ X_9Y \end{bmatrix}$$

The coefficient of determination (R^2) which was expressed as a square ofthe multiple correlation coefficient (R) was computed as the ratio of. sum of squares due to regression (R.S.S.) and the total sum of squares (T.S.S.).

The partial correlation coefficients were also computed following Snedecor and Cochran (1967). The partial regression coefficients were tested by 't' test as follows,

$$t = \frac{b_i}{\text{S.E. of } b_i}$$

The analysis of the multiple regression equation was conducted at the Statistics department of College of Basic Science and Humanities, Orissa University of Agriculture and Technology, Bhubaneswar with the help of a computer.

CHAPTER - IV

RESULTS

R E S U L T S

The mean and standard error of different spermatozoan measurements viz. spermatozoan length, head circumference, head length, head breadth, head area, head shape, middle piece length, middle piece breadth and middle piece area of Ganjam and Black Bengal bucks were presented in Table 1. The mean and standard error of spermomotility, live sperm percentage, fertility of the bucks, birth weight, weight at 3 months and 6 months of age of kids of individual bucks were tabulated in Table 2.

Spermatozoan length of Ganjam bucks ranged from 56.799 to 57.377 μ with an average of 57.034 $\pm$ 0.06 μ. It ranged from 56.481 to 57.288 μ with an average of 56.932 $\pm$ 0.108 μ in Black Bengal bucks. In order to find out any breed difference, Fischer's 't' test was conducted which showed that spermatozoan length of Ganjam bucks was significantly ($P < 0.01$) more than that of Black Bengal bucks.

The spermatozoan head length of Ganjam bucks ranged from 8.351 to 8.543 μ with the average of 8.462 $\pm$ 0.024 μ, of Black Bengal bucks ranged from 7.909 to 8.151 μ with an average of 8.076 $\pm$ 0.026 μ. There was highly significant difference ($P < 0.01$) between head length of Ganjam and Black Bengal bucks.

The spermatozoan head breadth of Ganjam and Black Bengal bucks ranged from 4.268 to 4.424 μ and 4.265 to 4.404 μ, respectively. The average head breadth was 4.312 $\pm$ 0.018 μ and 4.331 $\pm$ 0.018 μ for Ganjam and Black Bengal bucks, respectively. No significant difference between the two breeds was observed.

The head area of Ganjam buck spermatozoa ranged from 28.216 to 29.786 μ^2 with an average of 29.118 $\pm$ 0.154 μ^2. The range was from 26.874 to 28.857 μ^2 in Black Bengal bucks with an average of 28.096 $\pm$ 0.228 μ^2. It was observed that head area of spermatozoa from Ganjam bucks was significantly ($P \angle 0.01$) more than that of Black Bengal.

The head shape of spermatozoa from Ganjam and Black Bengal bucks ranged from 1.902 to 1.997 and 1.842 to 1.889 μ, respectively. The averages were 1.963 $\pm$ 0.012 and 1.865 $\pm$ 0.006 μ for the 2 breeds, respectively. Head shape of Ganjam bucks was significantly ($P \angle 0.01$) higher than that of Black Bengal bucks.

The Middle piece length of spermatozoa from Ganjam and Black Bengal bucks ranged from 11.786 to 12.067 μ and 11.786 to 12.03 μ, respectively. It averaged 11.958 $\pm$ 0.04 μ and 11.886 $\pm$ 0.032 μ, respectively for the 2 breeds. It was observed that no significant difference in middle piece length was there between the two breeds.

Table 1 Mean, standard error and range of spermatozoan head and middle piece measurements of Ganjam and Black Bengal bucks

Measurements	Ganjam		Black Bengal		Computed
	Mean ± Standard error	Range	Mean ± Standard error.	Range	't' value
Spermatozoan length (U)	57.034 ± 0.06	56.799-57.377	56.932 ± 0.108	56.481-57.288	3.273**
Head circumference (U)	23.614±0.049	23.409-23.818	22.971 ± 0.099	22.457-23.318	5.646**
Head length (U)	8.462 ± 0.024	8.351-8.543	8.076 ± 0.026	7.909- 8.15	10.243**
Head breadth (U)	4.312 ± 0.018	4.25 - 4.424	4.331 ± 0.018	4.265- 4.409	0.69**
Head area (U^2)	29.117 ± 0.154	28.216-29.786	28.096 ± 0.228	26.874-28.857	3.553**
Head shape	1.963 ± 0.012	1.902- 1.997	1.865 ± 0.006	1.842-1 .889	7.538**
Middle piece length (U)	11.958 ± 0.04	11.786-12.048	11.886 ± 0.032	11.787-12.03	1.415 N.S.
Middle piece breadth(U)	0.668 ± 0.006	0.64 - 0.709	0.695 ± 0.002	0.689- 0.703	3.965**
Middle piece area (U^2)	8.258 ± 0.037	8.037- 8.401	8.271 ± 0.034	8.161- 8.389	0.241 N.S.

** = ($P < 0.01$)

N.S.= Not significant

The spermatozoan middle piece breadth of Ganjam bucks ranged from 0.640 to 0.704 μ with an average of 0.668 ± 0.006 μ. In Black Bengal bucks it ranged from 0.689 to 0.703 μ with an average of 0.695 ± 0.002 μ. It was observed that middle piece breadth of Black Bengal bucks was significantly ($P \angle 0.01$) more than that of Ganjam bucks.

The middle piece area of spermatozoa from Ganjam and Black Bengal bucks ranged from 8.037 to 8.401 μ^2 and 8.161 to 8.389 μ^2, respectively. The average middle piece area was 8.258 ± 0.037 μ^2 and 8.271 ± 0.034 μ^2 for Ganjam and Black Bengal bucks, respectively. No significant difference between the two breeds was there with respect to the middle piece area of the spermatozoa.

The motility of spermatozoa from Ganjam and Black Bengal bucks ranged from 75 to 80.5 % and 80.5 to 83.5 %, respectively. The average motility was 78.138 ± 0.690 % and 81.688 ± 0.416 % for Ganjam and Black Bengal bucks, respectively. Motility of the spermatozoa of Black Bengal bucks was significantly ($P \angle 0.01$) higher than that of Ganjam bucks.

Live sperm count of Ganjam and Black Bengal bucks ranged from 81.0 to 87.0 % and 84.167 to 88.5 %, respectively. The average live sperm count was 84.563 ± 0.907 % and 86.083 ± 0.652 % for Ganjam and Black Bengal bucks, respectively. No significant difference was

Table 2 Mean, standard error and range of sperm characteristics, fertility of bucks and body weight of progeny of Ganjam and Black Bengal bucks

Characters	Ganjam		Black Bengal		Computed
	Mean ± Standard error	Range	Mean ± standard error	Range	't' value
Motility (%)	78.183 ± 0.69	75.000-80.500	81.688 ± 0.416	80.500-83.500	3.626**
Live sperm count (%)	84.563 ± 0.907	81.000-87.000	86.083 ± 0.652	84.167-88.500	1.248 N.S.
Fertility (%)	66.493 ± 1.389	57.14 -70.00	58.303 ± 2.955	50.00 -69.23	2.431 *
Birth weight (Kg)	2.329 ± 0.09	1.967- 2.940	2.116 ± 0.045	1.967- 2.333	1.903 N.S.
Weight at 3 month (Kg)	6.156 ± 0.311	5.117- 8.025	6.286 ± 0.336	5.260- 8.330	0.267 N.S.
Weight at 6 month (Kg)	8.748 ± 0.401	6.833-10.860	8.213 ± 0.463	6.875-11.090	0.827 N.S.

* = ($P < 0.05$)

** = ($P < 0.01$)

N.S. = Not significant

observed between the breeds with respect to this trait.

Fertility of the Ganjam bucks ranged from 57.14 % to 70.0 % with an average of 66.443 ± 1.389 % In Black Bengal bucks it ranged from 50.00 to 69.23 % with an average of 58.303 ± 2.955 %. As per the significance test, it was observed that the fertility of Ganjam bucks was significantly ($P < 0.05$) higher than that of Black Bengal bucks.

The body weights at birth, 3 months and 6 months of age were corrected for the effect of breed of the dam and the mean corrected body weights are presented in Table 2.

The birth weight of kids born to Ganjam bucks ranged from 1.967 to 2.94 Kg. with an average of 2.329 ± 0.09 Kg. The birth weight of kids born to Black Bengal bucks ranged from 1.967 to 2.333 Kg. with an average 2.116 ± 0.045 Kg. There was no significant difference between the birth weight of kids from Ganjam and Black Bengal bucks.

The weight at 3 months of age of kids born to Ganjam and Black Bengal bucks ranged from 5.117 to 8.025 Kg. and 5.26 to 8.33 Kg., respectively. The average weight of kids were 6.156 ± 0.311 Kg. and 6.286 ± 0.336 Kg. for Ganjam and Black Bengal bucks, respectively. The difference between two breeds was not significant in this trait.

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Weight of kids at 6 months of age ranged from 6.833 to 10.86 Kg. and 7.205 to 11.09 Kg. for Ganjam and Black Bengal bucks, respectively. The average weight of kids at 6 months of age were 8.748 ± 0.401 Kg. and 8.213 ± 0.463 Kg. for the 2 breeds, respectively. The brred difference in this case was not statistically significant.

It was designed in the study to correlate the spermatozoan measurements and sperm characters of the bucks with fertility, birth weight, weight at 3 months and weight at 6 months of the kids. Prediction equations were formed for each of the above 4 characters (dependant variate) basing on the partial regression coefficients obtained by taking the spermatozoan measurements and sperm characters as independent variates.

The partial regression and correlation coefficients along with standrad error of regression coefficients are presented in Table 3,4,5 and 6 for the 4 dependant variates, respectively.

Table 3 The correlation and regression coefficients considering fertility of bucks as dependent variate and spermatozoan measurements with sperm characters as independent variates

Independent characters	Correlation coefficient	Partial Regression coefficient	Standard error of Regression coefficient	Computed 't' value
Spermatozoan length	- 0.202	- 12.991	2.805	4.631 **
Head circumference	0.172	9.80	0.977	10.026 **
Head length	0.384	29.962	1.361	22.022 **
Head breadth	- 0.145	- 53.870	1.130	47.706 **
Head area	- 0.041	2.551	0.394	6.474 **
Middle piece breadth	- 0.124	154.999	1.274	121 .634 **
Middle piece area	- 0.188	- 13.889	0.824	16.860 **
Motility	0.265	1.523	1.361	1.118 N.S.
Live sperm percentage	- 0.105	- 7.66	0.547	1.40 N.S.

** = (P $\angle$ 0.01)

N.S. = Not significant

Correlation and multiple regression analysis:

__Fertility__ : The correlation coefficients between fertility and spermotezoan length (X_1), head circumference (X_2), head length (X_3), head breadth (X_4), head area (X_5), middle piece breadth (X_6), middle piece area (X_7), sperm motility (X_8), and live sperm percentage (X_9) were -0.202, 0.172, 0.384, -0.145, -0.004, -0.124, -0.187, 0.265 and -0.105, respectively. The correlation coefficients were not significant (Table 3).

The corresponding figures of partial regression coefficients were -12.991 ± 2.805, 9.700 ± 0.977, 29.962 ± 1.361, -53.870 ± 1.129, 2-551 ± 0.394, 154.999 ± 1.274, -13.889 ± 0.824, 1.522 ± 1.361 and -0.766 ± 0.574, respectively. The partial regression coeffiecients were higher significant ($P < 0.01$) for all characters mentioned above, except sperm motility and live sperm count (Table 3).

The multiple correlation coefficients (R) of fertility with spermatozoan characteristics was found to be 0.751 which was significant. The constant(a) in multiple regression equation for fertility was 440.835 in this analysis. The predic-tion equation for fertility(Y_1)

on the basis of the above spermatozoan measurements and sperm characteristics was as follows :

$$Y_1 = 440.835 - 12.991\ X_1 + 9.8\ X_2 + 29.962\ X_3 - 53.87\ X_4 + 2.851\ X_5 + 154.999\ X_6 - 13.889\ X_7 + 1.522\ X_8 - 0.766\ X_9$$

<u>Progeny weight at birth</u> : The correlation coefficient between progeny weight at brith and spermatozoan length, head circumference, head length, head breadth, head area, middle piece breadth, middle piece area, motility and live sperm percentage were 0.527, 0.317, 0.887, -0.04, 0.171, -0.259, -0.049, 0.701 and 0.528, respectively. The correlation coefficients for spermatozoan length, head length, sperm motility and live sperm percentage were statistically significant (Table 4).

The corresponding figures for partial regression coefficients were 0.184 ± 0.535, 0.258 ± 0.346, 0.925 ± 0.565, 0.922 ± 0.26, -0.295 ± 0.614, -0.053 ± 0.006, 0.065 ± 0.52, 0.058 ± 0.697 and 0.238 ± 0.462, respectively. The regression coefficients were not not significant. (Table

The multiple correlation coefficient (R) of birth weight of progeny with spermatozoan characteristics was found to be 0.574. Testing of multiple regression coefficient by 'F' test revealed that it was significant.

Table 4. The correlation and regression coefficients cosidering brith weight of progeny as dependent variate and spermatozoan measurements with sperm characters as independent variates

Independent characters	Correlation coefficient	Partial Regression coefficient	Standard error of Regression coefficient	Computed 't' value
Spermatozoan length	0.527	0.184	0.535	0.344 N.S.
Head circumference	0.317	0.258	0.346	0.745 N.S.
Head length	0.587	0.925	0.565	1.636 N.S.
Head breadth	- 0.04	0.922	0.260	1.487 N.S.
Head area	0.171	- 0.295	0.614	0.481 N.S.
Middle piece breadth	- 0.259	0.535	0.006	9.063 N.S.
Middle piece area	- 0.485	0.065	0.056	1.254 N.S.
Motility	0.701	0.058	0.697	0.083 N.S.
Live sperm percentage	0.528	0.024	0.462	0.052 N.S.

N.S. = Not significant

The constant(a) in multiple regression equationfor progeny weight at birth was obtained as -23.238. The prediction equation obtained for progeny weight at birth(Y_2) on the basis of several spermatozoan measurements and sperm characteristics was asper the following :

$$Y_2 = -23.238 + 0.184\ X_1 + 0.258\ X_2 + 0.925\ X_3 + 0.922\ X_4 - 0.295\ X_5 - 0.053\ X_6 + 0.065\ X_7 + 0.058\ X_8 + 0.024\ X_9.$$

<u>Progeny weight at 3 months of age</u> : The correlation coefficients between weight of progeny at 3 months of age and spermatozoan length, head circumference, head length, head breadth, head area, middle piece breadth, middle piece area, motility and live sperm percentage were 0.365, 0.264, 0.255, 0.194, 0.251, 0.137, 0.113, 0.192 and 0.013, respectively. The correlation coefficients were not significant (Table 5).

The corresponding figures for partial regression coefficients were 1.496 $\pm$ 0.744, -0.274 $\pm$ 0.064, -1.677 $\pm$ 0.18, -11.558 $\pm$ 0.572, 1.661 $\pm$ 0.606, 21.986 $\pm$ 0.427, -0.884 $\pm$ 0.404, 0.201 $\pm$ 0.424 and -0.253 $\pm$ 0.865, respectively. The partial regression coefficients were highly significant ($P \angle 0.01$) for head circumference, head length, head breadth, middle piece breadth and middle piece area and only significant ($P \angle 0.05$) for head area (Table 5).

Table 5 The correlation and regression coefficients considering 3 months body weight of progeny as dependent variate and spermatozoan measurements with sperm characters as independent variates

Independent characters	Correlation coefficient	Partial Regression coefficient	Standard error of Regression coefficient.	Computed 't' value
Spermatozoan length	0.365	1.469	0.750	1.960 N.S.
Head circumference	0.264	- 0.274	0.065	4.238**
Head length	0.255	- 1.677	0.180	9.320**
Head breadth	0.194	-11.558	0.572	20.193**
Head area	0.251	1.661	0.606	2.741*
Middle pice breadth	0.137	21.986	0.427	51.478**
Middle piece area	0.113	- 2.884	0.404	7.134**
Motility	0.192	0.201	0.424	0.473 N.S.
Live sperm percentage	- 0.135	- 0.253	0.865	0.293 N.S.

* = ($P < 0.05$)

** = ($P < 0.01$)

N.S. = Not significant

The multiple correlation coefficient (R) of progeny weight at 3 months with spermatozoan measurements and sperm characters was found to be 0.271 which was not significant. The intercept(a) in multiple regression equation for progeny weight at 3 months was -41.542. The prediction equation of progeny weight at 3 months (Y_3) on the basis of spermatozoan measurements and sperm characteristics was as follows :

$$Y_3 = -41.542 + 1.469 X_1 - 0.274 X_2 - 1.677 X_3 - 11.558 X_4 + 1.661 X_5 + 21.986 X_6 - 2.884 X_7 + 0.201 X_8 - 0.253 X_9.$$

<u>Progeny weight at 6 months of age</u> : In the present study the correlation coefficients of progeny weight at 6 months of age with spermatozoan length, head circumference, head length, head breadth, head area, middle piece breadth, middle piece area, sperm motility and live sperm percentage were 0.27, 0.131, 0.074, 0.085, 0.218, 0.209, 0.247, 0.026 and -0.013, respectively. The correlation coefficients were not significant.

The corresponding figures for partial regression coefficients were 1.814 ± 0.792, -2.354 ± 0.475, -10.093 ± 0.927, -42.974 ± 1.821, 5.443 ± 1.701, 36.811 ± 0.612, -1.419 ± 0.170, 0.365 ± 0.660 and -0.457 ± 1.336, respectively. The partial regression coefficients were highly significant ($P \angle 0.01$) for head circumference, head length, head breadth, head area, middle piece

Table 6 The correlation and regression coefficients considering 6 month body weight of progeny as dependent variate and spermatozoan measurements with sperm characters as independent variates

Independent characters.	Correlation coefficient	Partial Regression coefficient	Standard error of Regrission coefficient	Computed 't' value
Spermatozoan length	0.270	1.814	0.792	2.289 **
Head circumference	0.131	- 2.354	0.475	4.956 **
Head length	0.074	-10.093	0.927	10.886 **
Head breadth	0.085	-42.947	1.821	23.584 **
Head area	0.218	5.443	1.701	3.201 **
Middle piece breadth	0.209	36.811	0.612	60.129 **
Middle piece area	0.247	- 1.419	0.170	8.332 **
Motility	0.026	0.365	0.661	0.553 N.S.
Live sperm percentage	- 0.013	- 0.457	1.336	0.342 N.S.

** = (P ∠ 0.01)

N.S. = Not significant

breadth and middle piece area of the spermatozoa and only significant ($P < 0.05$) for spermatozoan length (Table 6).

The multiple correlation coefficient (R) of body weight at 6 months with the spermatozoan characteristics was found to be 0.439. Significance test for multiple regression revealed that it was not significant. The constant (a) obtained in this analysis for progeny weight at 6 months was 67.675. The prediction equation for progeny weight at 6 months was formed as

$$Y_4 = 67.675 + 1.814\, X_1 - 2.354\, X_2 - 10.093\, X_3 - 42.997\, X_4 + 5.443\, X_5 + 36.811\, X_6 - 1.419 X_7 + 0.365\, X_8 - 0.457\, X_9 .$$

CHAPTER - V

DISCUSSION

D I S C U S S I O N

Spermatozoan length

The spermatozoan head length of Ganjam and Black Bengal bucks presented in Table 1 were 57.034 ± 0.06 μ and 56.932 ± 0.108 μ, respectively. In Assam, Beetal and Saanen bucks, the spermatozoan lengths were 58.843 ± 0.083 μ, 58.127 ± 0.125 μ and 58.310 ± 0.081 μ, respectively (Bardoli and Sharma, 1983). It was reported by Bardoli and Sharma (1983) that there was highly significant difference ($P < 0.01$) in spermatozoan length between breeds, which is in par with the present finding.

Head circumference

The head circumference of spermatozoa from Ganjam and Black Bengal bucks were 23.614 ± 0.049 μ and 22.971 ± 0.099 μ, respectively. The difference between breeds in head circumference was highly significant, ($P < 0.01$). Reports on this trait in goats are very scanty. However, Mohapatra (1987) worked on bull semen and observed a significant difference in spermatozoan head circumference of Jersey and crossbreds.

Head length

The spermatozoan head length from Ganjam and Black Bengal bucks were 8.462 ± 0.024 μ andd 8.076 ± 0.026 μ, respectively. The difference between breeds was highly significant ($P < 0.01$). The average of head length of spermatozoa of Jamnapari and Barbari bucks were 8.24 μ and 3.4 μ, respectively (Srivastava _et al_. 1980). The spermatozoan head length ranged from 7.89 to 8.12 μ (Mishra and Mukherjee, 1984). Significant variation in the head length of spermatozoa was reported by Lal and Pant (1982) and Bardoli and Sharma (1983). No significant difference in head length of spermatozoa between breeds was reported by Mishra and Mukherjee (1984).

Head breadth

The head breadth of spermatozoa averaged 4.312 ± 0.018 μ and 4.331 ± 0.018 μ for Ganjam and Black Bengal bucks, respectively. There was no significant difference between breeds; with respect to this character. (Table 1)

The average spermatozoan head breadth were reported to be 2.106 ± 0.007, 2.163 ± 0.008 and 2.117 ± 0.009 μ for Assam, Beetal and Saanen bucks, respectively (Bardoli and Sharma 1983).

Head breadth of spermatozoa of Barbari, Jamnapari, Black Bengal and Beetal bucks ranged from 4.27 to 4.32 μ (Mishra and Mukherjee, 1984) Significant difference in head breadth was reported by Bardoli and Sharma, (1983), and Mishra and Mukherjee (1984). No significant difference between breeds with respect to this trait was reported by Srivastava et al. (1980) which is similar to the finding of the present investigation.

Head area

The spermatozoan head area of Ganjam and Black Bengal bucks presented in Table 1 were 29.117 $\pm$ 0.154 μ^2 and 28.096 $\pm$ 0.228 μ^2 , respectively. Head area of spermatozoa of Barbari, Jamnapari, Black Bengal and Beetal bucks ranged from 29.11 to 30.84 μ^2 (Mishra and Mukherjee, 1984).

No significant difference in spermatozoan head area between Barbari and Jamnapari bucks was reported by Srivastava et al. (1980) where as, significant variation between breeds of rams was reported by Lal and Pant (1982). Mohapatra (1987) also observed a breed difference between the Jersey and crossbred bulls with respect to spermatozoan head area. The present investigation revealed that there was highly significant ($P < 0.01$)

variation in spermatozoan head area between Ganjam and Black Bengal breeds.

Head shape

The average head shape of spermatozoa of Ganjam and Black Bengal bucks presented in Table 1 were 1.063 ± 0.012 and 1.865 ± 0.006 respectively. It was also seen that highly significant difference existed between the two breeds, with respect to head shape. Significant variation between rams for head shape was reported by Lal and Pant (1982). On the contrary no significant difference between Jersey and Crossbred bulls with respect to this trait was reported by Mohapatra (1987).

Middle piece length

The average middle piece length of spermatozoa of Ganjam and Black Bengal bucks were 11.958 ± 0.04 μ and 11.886 ± 0.032 μ, respectively. There was no significant variation between breeds with respect to middle piece length of spermatozoa.

Spermatozoan middle piece length of Assam, Beetal, and Saanen bucks were 12.056 ± 0.046, 11.931 ± 0.021 and 12.056 ± 0.64 μ, respectively (Bardoli and Sharma, 1983) and that of Barbari, Jamnapari, Black Bengal, and Beetal bucks were 12.30, 12.52, 11.91 and 12.45 μ, respectively (Mishra and Mukherjee, 1984).

No significant variation in middle piece length of spermatozoa between breeds was reported by Srivastava _et al_. (1980) and Bardoli and Sharma(1983) variation between rams with respect to this trait was significant (Lal and Pant, 1982).

Middle piece breadth

The middle piece breadth of spermatozoa of Ganjam and Black Bengal bucks presented in Table 1 were, 0.668 ± 0.006 μ and 0.695 ± 0.002 μ, respectively. Highly significant difference ($P < 0.01$) between the breeds was evident.

Spermatozoan middle piece breadth of Barbari bucks was 0.685 ± 0.11 μ, (Mishra and Mukherjee, 1984). No significant variation between breeds of goats was reported by Srivastava _et al_. (1980).

Middle piece area

The middle piece area of spermatozoa of Ganjam and Black Bengal bucks presented in Table 1 were, 8.258 ± 0.037 μ^2 and 8.271 ± 0.034 μ^2, respectively. No significant difference was there between breeds.

Spermatozoan middle piece area of Barbari bucks was 8.137 ± 0.121 μ^2 (Mishra and Mukherjee, 1981). No significant difference in middle piece area between breeds of bucks was reported by Mishra and Mukherjee(1981) which is in agreement with the present finding.

Motility

Motility of spermatozoa of Ganjam and Black Bengal bucks presented in Table 2 were 78.138 ± 0.69 % and 81.688 ± 0.416 %, respectively. Highly significant variation between the breeds with respect to motility was marked ($P < 0.01$).

The motility of spermatozoa of Anglo-Nubian, Marota and Moxoto breeds of goats were 76.22, 68.33 and 62.75 %, respectively (Vinha, 1979). It was 66 % in Angora goats (Cetinkaya, 1980), 72.62 ± 1.06 % in Jamnapari (Saxena and Tripathy, 1980), and 77.28 ± 7.75 % in African dwarf goats (Mann, 1981).It ranged from 65 to 80 % in Barbari bucks (Chaudry et al. 1983), 61.12 % to 64.75 % in Baladi goats for first and second ejaculates respectively (El. Sayed et al., 1983). 76 to 82 % in Beetal and 82.1 to 85.8 % in Marwari bucks (Mittal, 1987).

Significant difference in motility between breeds was reported by Vinha (1979), Mittal (1986), Mohan et al. (1981) which are in agreement with the present finding.

<u>Live sperm count (%)</u>

The live sperm in spermatozoa of Ganjam and Black Bengal bucks presented in Table 2 were 84.563 ± 0.907 and 86.083 ± 0.652 %, respectively. No significant difference between breeds with respect to this trait was evident.

Live sperm count was 61.38 % in Malbari bucks (Patil and Raja, 1978), 77.65 ± 1.04 % in Jamnapari bucks (Saxena and Tripathy, 1980) 85.45 % in Black Bengal, 85.5 % in Saanen bucks (Sinha and Singh, 1982), 55.19 %, 59.08 %, 67.41 % and 73.13 % in Barbari, Jamnapari, Black Bengal and Beetal bucks, respectively (Mishra and Mukherjee, 1984), 87.57 ± 0.34% in Assam local and 88.49 ± 0.31 % in Beetal bucks (Borgohain <u>et al</u>., 1985). The range of live sperm count was 74.0 to 78.0 % and 78.8 to 81.7 % in Beetal and Marwari bucks, respectively (Mittal, 1987). The live sperm percentage in Black Bengal bucks obtained in the present study is higher compared to other reports.

Significant difference in live sperm % between breeds of bucks was reported by Borgain <u>et al</u>. (1985). and Mittal (1986). However, no significant difference between breeds was observed by Mittal (1987) in Beetal and Marwari bucks, similar to our observation. Mohapatra (1987) did not observe any significant difference between

Jersey and crossbred bucks with respect to live sperm count.

Fertility

The fertility of Ganjam and Black Bengal bucks presented in Table 2 were 66.493 ± 1.389 % and 58.303 ± 2.455 %, respectively. There was significant variation ($P < 0.05$) between Ganjam and Black Bengal breeds with respect to this trait. Reports on the fertility of bucks is not available for comparison.

The fertility status of a buck will be clearly marked if several matings are performed. Younger bucks comparatively have less services so their actual potentiality may not be revealed. In the present study some bucks have few services. It seems to have lowered the mean fertility value.

Birth weight

The birth weight of progeny of Ganjam and Black Bengal bucks were 2.329 ± 0.09 Kg and 2.116 ± 0.045 Kg. respectively. These data were corrected for the effect of breed of dam. No significant variation was observed between breeds.

Montaldo and Juarez (1980) reported the birth weight of kids from French Alpine, Anglo Nubian, Granada, Saanen and Toggenburg breeds to be 3.5, 3.14, 2.64, 3.59 and 3.43 Kg., respectively. Birth weight of Malbar and Saanen X Malbar kids were 1.71 Kg. and 1.88 Kg., respectively (Mukundan et al., 1981). Sarma et al. (1981) recorded the birth weight of Assam Hill kids to be 1.17 Kg. Singh et al. (1984) reported that the birth weight of Jamnapari and Barbari kids were 3.55 Kg. and 2.05 Kg., respectively. Significant difference in birth weight of kids was observed by Montaldo and Juarez (1980) and Singh et al. (1984).

The average birth weight in the present study is with in the range of reported values.

Weight at 3 months of age

The weight of the progeny at 3 months of age presented in Table 2 were 6.156 ± 0.311 Kg. and 6.286 ± 0.366 Kg. for Ganjam and Black Bengal bucks, respectively. Data on this trait were corrected for the effect of breed of dam. No significant difference was observed between breeds.

Sarma et al. (1981) recorded the weight of Assam Hill kids at 3 months of age as 4.75 Kg. Singh et al. (1984) reported that the body weight of Jamnapari and Barbari kids at 3 months of age were 7.45 kg.

and 7.19 Kg., respectively. No significant variation between breeds was observed by them. Comparison of the present results with the published reports indicated that Assam Hill goats has a lower weight at 3 months of age compared to the breeds of goat in Orissa. However, Jamnapari and Barbari goats were heavier at 3 months of age.

Weight at 6 months of age

The weight of the progeny at 6 months of age, presented in Table 2 were 8.748 ± 0.401 Kg. and 8.213 ± 0.463 Kg. for Ganjam and Black Bengal bucks, respectively. No significant difference was there between breeds. Data were corrected the effect of for breed of the dam.

Singh et al. (1984) recorded the body weight of Jamnapari and Barbari kids to be 9.40 Kg. and 8.21Kg., respectively. They observed significant difference between breeds in body weight at 6 months of age.

From the present study it was evident that Ganjam kids are heavier at 6 months of age although, there was no significant difference between the 2 breeds statistically. The barbari goats seemed to be comparable to Black Bengal but Jamnapari animals were heavier which may be due to their larger size. Ganjam kids at 6 months are intermediate between Black Bengal and Jamnapari with respect to body weight.

Correlation and multiple regression analysis of fertility with sperm characters:

The correlation coefficient of fertility with spermatozoan length, presented in Table 3 were -0.202, 0.172 and 0.384, respectively.

The correlation coefficient of fertility with head breadth was -0.145.

Mukherjee and Kumar (1969) and Biswas et al. (1975) reported no relationship between head breadth of spermatozoa and fertility of Hariana bulls. However, Lal and Pant (1984) reported a significant correlation of ram fertility with spermatozoan head breadth.

The correlation coefficient of fertility with head area was -0.041.

Mukherjee and Kumar (1971) and Lan and Pant(1984) reported significant positive correlation of sperm head area with fertility of bulls and rams, respectively. However, Biswas et al. (1975) reported a little importance of head area in prediction of fertility of bulls.

The correlation coefficient of fertility with middle piece breadth was -0.124, in the present study.

Significant positive correlation between middle piece breadth and fertility was reported by Mukherjee and Kumar (1969) in Hariana bulls.

The correlation coefficient of fertility with middle piece area was -0.188.

Mukherjee and Kumar (1969) reported no significant correlation between middle piece area of spermatozoa and fertility of bulls. Reports on goats are not available on this trait.

The correlation coefficient of fertility with sperm motility was found to be 0.265 in the present study.

Reports on this aspect are not available in goats. However, Lasley (1951) and Erb et al. (1956) reported high significant correlation between sperm motility and fertility of bulls.

The correlation coefficient of fertility with live sperm percentage was -0.105.

Stone et al. (1950), Bishop et al. (1954) and Mohapatra (1987) found positive correlations between the live sperm percentage and fertility.

The partial regressio n coefficients of fertility with spermatozoan length (-12.991), head circumference (9.8), head length (29.962), head breadth (-53.87), head area (2.551), middle piece breadth (154.999) and middle piece are (-13.889) were highly significant ($P < 0.01$). The multiple correlation was found to be 0.751. The coefficient of determination was about 56 % Since the multiple correlation coefficient was significant the prediction equation formed for fertility can be effectively utilised to assess the fertility of the bucks before actual matings. This would be very advantageous in farm practice for selection of bucks. The expenditure and time required for taking a decision on a particular buck will be minimised. However, the physical characters and genetic potentiality of the bucks should also be considered alongwith fertility before selection.

Correlation and multiple regression analysis of birth weight with sperm characteristics :

The correlation coefficients of birth weight of progeny with the spermatozoan length (0.527), head length (0.587) and live sperm percentage (0.528), sperm motility (0.701) were significant. However, the correlation coefficients of birth weight of progeny with the spermatozoan head circumference, (0.317), head breadth (0.04), head area (0.172), middle piece breadth (-0.26) and middle piece area (0.49) were not significant.(Table 4)

The partial regression coefficients of birth weight with spermatozoan lenght (0.184), head circumference (0.258), head length (0.925), head breadh (0.922) head area (-0.295), middle piece breadth (-0.053) middle piece area (0.065), motility (0.058), and live sperm percentage (0.024) were utilised for prediction of the birth weight of the progeny.

Reports on the correlation and regression of sperm measurements with progeny weight at birth are not available in goats and other species also. So comparison of the present results with could not be made. The correlations of body weight with spermatozoan length head length, sperm motility and liver sperm count were significant indicating a definite relationship of these traits with the birth weight of the progeny.

The multiple correlation was 0.574 which was significant. The coefficient of determination (R^2) was about 33 %. The prediction equation so constructed may not be very efficient in predicting the birth weight of the progeny of a buck.

Correlation and multiple regression analysis of weight at 3 months of progeny with the sperm characteristics of buck.

The correlation coefficients of weight at 3 months with the spermatozoan length, head circumference, head length, head breadth, head area, middle piece breadth, middle piece area, motility and live sperm percentage were 0.365, 0.264, 0.255, 0.194, 0.251, 0.137, 0.137, 0.113 and 0.192, respectively. No correlation coefficient was significant (Table 5).

The partial regression coefficients between weight at 3 months of progeny and spermatozoan length, head circumference, head length, head breadth, head circumference, head length, head breadth, head area, middle piece breadth, middle piece area, motility and live sperm % were 1.469, -0.274, -1.677, -11.558, 1.661, 21.986, -2.884, 0.201 and -0.253, respectively, of which regression coefficient for head circumference, head length, head breadth, head arëa, middle piece breadth and middle piece were significant. The multiple correlation coefficient was low and not significant.

Reports on the correlation and regression of spermatozoan characters with body weight of the kids at 3 months of age are not available in literature.

So comparison with the present results could not be made. The R^2 was around 7 % in this analysis which indicated that the variation in 3 months body weight of the progeny is very little explained by the spama-tozoan measurement and sperm characteristics of the bucks. So for progeny weight at 3 months the regression equation fitted can not be used effectively for predi-ction purpose.

Correlation and multiple regression analysis of progeny weight at 6 months with sperm characteristics:

The correlation coefficient of weight at 6 months of age of progeny with the spermatozoan length, head circumference, head length, head breadth, head area, middle piece breadth, middle piece area, motility and live sperm percentage were 0.27, 0.131, 0.074, 0.085, 0.218, 0.247, 0.247, 0.026 and -0.013, respecti-vely. No correlation coefficient was significant(Table 6)

The partial regression coefficients between weight at 6 months of age and spermatozoan length (1.814) and head area (5.443) were significant ($P < 0.05$) and partial regression coefficients between weight at 6 months of age and head circumference (-2.354), head lenght (-10.093), head breadth (-42.947), middle piece breadth (36.811) and middle piece area (−1.419) were highly significant (P ∠ 0.01). The pertial regression coefficient between weight at 6 months and motility (0.265) and live sperm percentage (−0.475) were not significant. The multiple correlation coefficient was 0.439.

Reports on the correlation and regression of sperm measurements with 6 months body weight are not available in literature for comparison. The multiple correlation coefficient (R) was not significant. R^2 was about 19.5 % only. So the variation in 6 month body weight is not explainable to a larger extent by the spermatozoan characters considered in the study. Some other factors extraneous to the independent variates in the present study accounted for the major variation in 6 months body weight of progeny.

From the prediction equantions constructed in the present study it is clear that the number of matings of bucks, the number of progeny per buck and the number of bucks should be optimum in order to get the real fertility status of the bucks, the potentiality of the progeny to put up body weight and have sufficient error degrees of freedom, respectively. This would ensure reliable partial regression coefficients which can be used for prediction. The coefficient of determination would also be higher in that case.

CHAPTER - VI

SUMMARY

S U M M A R Y

The present study was carried out on goats maintained in the I.C.A.R. adhoc scheme "Evolution of a meat type goat suitable to Orissa condition" operating in O.U.A.T., at Bhubaneswar. Fresh collected semen from 9 Ganjam and 8 Black Bengal bucks were utilised for the spermatozoan measurements and data on 120 progeny of these bucks were available for calculting fertility and progeny weight of the bucks. Body weight at 3 stages i.e. at birth, 3 months and 6 months of age were considered in the study.

Eosin and Nigrosine stain was used to stain the spermatozoa for studying different measurements and live sperm count (%). One drop of semen sample after collection was used to study the motility. The mean and standard error of different characters was calculated for Ganjam and Black Bengal bucks. Fischer's 't' test was followed to find out any significant breed difference for all the traits.

All the data were corrected for breed effect before calculating the partial regression coefficients. Motility, live sperm count and fertility, which were expressed in percentage (%) were transforred to corresponding angles. Four multiple regression equations were assumed each for fertility of the bucks progeny weight at birth, progeny weight at 3 months and progeny weight at 6 months of age which were dependent variates.

The independent variates were spermatozoan length, head circumference, head length, head breadth, head area, middle piece breadth, middle piece area, motility and live sperm % .

The averages for spermatozoan length, (X_1), headccircumference (X_2), head length (X_3), head breadth (X_4) head area (X_5), head shape, middle piece length, middle piece breadth (X_6), middle piece area (X_7), sperm motility (X_8), live sperm count (X_9), fertility of the bucks, progeny weight at birth, progeny weight at 3 months and progeny weight at 6 months of age were 57.034 $\pm$ 0.06 μ, 23.614 $\pm$ 0.049 μ, 8.462 $\pm$ 0.029 μ, 4.312 $\pm$ 0.018 μ, 29.117 $\pm$ 0.154 μ^2, 1.963 $\pm$ 0.012 μ, 11.958 $\pm$ 0.04 μ, 0.668 $\pm$ 0.006 μ, 8.258 $\pm$ 0.037 μ^2, 78.138 $\pm$ 0.69 %, 84.563 $\pm$ 0.907 % , 66.493 $\pm$ 1.389 % , 2.329 $\pm$ 0.09 Kg., 6.156 $\pm$ 0.311 Kg. and 8.748 $\pm$ 0.401 Kg., respectively for Ganjam breed. The corresponding figures for Black Bengal breed were 56.932 $\pm$ 0.108 μ, 22.971 $\pm$ 0.099 μ, 8.076 $\pm$ 0.026 μ, 4.331 $\pm$ 0.018 μ, 28.096 $\pm$ 0.228 μ, 1.856 $\pm$ 0.006 μ, 11.886 $\pm$ 0.032 μ, 0.695 $\pm$ 0.002 μ, 8.271 $\pm$ 0.034 μ, 81.688 $\pm$ 0.416 % , 86.083 $\pm$ 0.652 % , 58.303 $\pm$ 2.955 % , 2.116 $\pm$ 0.045 Kg., 6.286 $\pm$ 0.336 Kg. and 8.213 $\pm$ 0.463 Kg., respectively. Comparison between Ganjam and Black Bengal breed revealed that breed difference was highly significant ($P < 0.01$) for spermatozoan length, head circumference, head length, head area, head shape, middle piece breadth, and motility. The variation was significant for fertility ($P < 0.05$) but no significant variation was observed between breeds with respect to spermatozoan head breadth, middle piece length, middle piece area, live sperm count, birth weight, weight at 3 months and weight at 6 months of age of progeny.

The multiple correlations obtained for fertility, birth weight, weight at 3 months and 6 months were 0.751, 0.574, 0.270 and 0.439, respectively. The prediction equations obtained for fertility, progeny weight at birth, progeny weight at 3 months and progeny weight at 6 months of the bucks were as follows:

$$\text{Fertility} = 440.8348 - 12.991 X_1 + 9.809 X_2 + 29.962 X_3 - 53.870 X_4 + 2.551 X_5 + 154.999 X_6 - 13.889 X + 1.522 X_8 - 0.766 X_9.$$

$$\text{Birth weight} = -23.238 + 0.184 X_1 + 0.258 X_2 + 0.925 X_3 + 0.922 X_4 - 0.295 X_5 - 0.053 X_6 + 0.065 X_7 + 0.058 X_8 + 0.024 X_9.$$

$$\text{3 months weight} = -41.542 + 1.469 X_1 - 0.274 X_2 - 1.677 X_3 - 11.558 X_4 + 1.661 X_5 + 21.968 X_6 - 2.884 X_7 + 0.201 X_8 - 0.253 X_9.$$

$$\text{6 months weight} = 67.675 + 1.814 X_1 - 2.354 X_2 - 10.093 X_3 - 42.947 X_4 + 5.443 X_5 + 36.811 X_6 - 1.419 X_7 + 0.365 X_8 - 0.457 X_9.$$

CHAPTER - VII

CONCLUSION

C O N C L U S I O N

1. Ganjam and Black Bengal bucks differed significantly with respect to most of the spermatozoan measurements.

2. The individual correlations of the spermatozoan measurements and sperm quality traits with each of fertility, progeny weight at birth, 3 months and 6 months were not significant in most of the cases.

3. The R^2 value for fertility of bucks indicate that it can be predicted effectively before service.

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