SEASONAL VARIATION IN REPRODUCTIVE ACTIVITY OF INDIGENOUS CATTLE OF NORTHERN NIGERIA

BY

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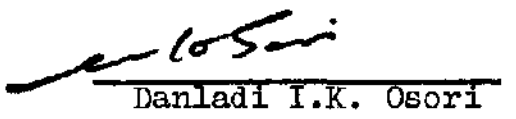
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DECLARATION

This is to certify that the work reported in this thesis was carried out by myself in the Theriogeneology Section, Department of Veterinary Surgery and Medicine, Ahmadu Bello University and in Bauchi, North-East State under the supervision of Professor Raimund Zemjanis.

The work of others is acknowledged and referenced. No part of this thesis has been submitted elsewhere for a degree or diploma.



Danladi I.K. Osori

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D E D I C A T I O N

This Thesis is dedicated to the Memory of my brother Dr. Sabo Kadiri Mohamadu Osori who died on the 3rd of January, 1975 less than six months after graduating in veterinary medicine from Ahmadu Bello University. And to the memory of my father Alhaji K. M. Osori, my mother Nana Ayishatu Osori, my father-in-law Alhaji Isa Koto, and my mother-in-law Hajiya Fatimatu Isa Koto.

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INTRODUCTION

It has been repeatedly stated that per capita meat consumption in Nigeria ranks low even among the so-called developing countries, not excluding its nearest neighboring countries. The urgent need for increased animal production has been recognised and livestock development programmes have been given a prominent role in the current National Development Plan.

Reproduction, genetic production potential, economically feasible nutrition and management, and disease control are essential and equally important requirements for sound animal production.

Reproduction is the basis for livestock industry. Without adequate reproduction rate, attempts to increase animal production will fail even with advances in genetic upgrading, nutrition and management and disease control. Low annual calf crop not only results in low number of producing units but also affects genetic upgrading by reduced opportunities for culling.

Information on the reproductive performance of indigenous cattle breeds in Nigeria is limited to a few publications concerning government-owned herds and surveys conducted on nomadic herds.

As measured in terms of annual calf crop, calving interval and age at first calving, the reproductive rate is subpar for government herds. In nomadic cattle, it is considerably lower. It is obvious that improving the reproductive rate must constitute the first major step in programmes for increased animal production.

There is practically no information available on the reproductive pattern of indigenous cattle breeds in Nigeria. The available reports indicate peak seasonal sexual activity. The peaks appear to vary depending upon breeds and regions. Seasonal breeding pattern has been reported in breeds originating from Bos Indicus in other African countries and elsewhere in tropical regions.

Preliminary clinical examination has revealed a high incidence of ovarian atrophy in indigenous cattle in Nigeria during the dry season. For better utilization of the limited grazing period, it is important to know if indigenous cattle are seasonal breeders and when is the period of highest fertility. It is equally important to determine if this period is correlated with availability of pasture.

Blood metabolic profile studies have linked levels of certain blood constituents to state of nutrition and

its effect on fertility. Its role in reproduction of indigenous cattle in Nigeria is unknown.

This study was designed to provide answers to the question of seasonal reproductive pattern of the indigenous cow by:

1. Clinical examination of reproductive organs
2. Histological examination of reproductive organs
3. Hematological examination
4. Determination of certain biochemical constituents.

REVIEW OF LITERATURE

Cattle Population

The exact number of cattle in Nigeria is not known (FAO, 1966). It is estimated that 80-90 per cent of the cattle population in Nigeria are nomadic. This is one of the main difficulties in obtaining an exact census. The cattle population has been estimated to be between 8.5 to 11.5 million. The National Livestock Committee Report which was used as basis for the livestock programs of the Third National Development Plan quotes 8.13 million as the official cattle population.

Cattle Breeds in Nigeria

Cattle found in Nigeria, like in most tropical regions, are mainly Zebu type descended from Bos indicus. They are humped and are believed to have migrated from Asia about 8,000 B.C. (Williamson and Payne, 1965).

Zebu cattle in general are multipurpose. Selection for either milking ability or beef production has not been as extensive as in breeds originating from Bos taurus. Mason (1951) pointed out some degree of specialization among the breeds resulting in either milk or beef type. The Indian Sahiwal breed serves as

an example of the dairy type. African Zebu cattle were classified by Joshi et al (1957) on the basis of location and phenotypic characteristics such as absence or presence of hump, location of hump, size of horns and color markings. Zebu cattle in Nigeria belong to the groups of sub-saharan Zebu. N'dama and Kuri type cattle, which are found around Lake Chad serve as prototypes. In general, these cattle are smaller than European breeds. There is wide variation in their mature live weight - from 240 kg for N'dama to 400 kg for the larger breeds. Sokoto Gudali, Bunaji, Rahaji, and Azaouak are the most common breeds in Northern Nigeria.

The White Fulani or Bunaji breed is the most prevalent of all breeds in Northern Nigeria. The majority of Bunaji cattle is owned by nomadic Fulani. In more recent years, there has been a gradual increase in Bunaji herds owned by settled farmers. The body color is light grey with black points, black muzzle and ears and the average height is 129.5 cm behind the hump (Foster, 1960).

Sokoto Gudali is believed to be a more recent breed (Gates, 1952). Because of their greater heat tolerance they are found mainly in drier areas, namely north of the region in which Bunaji predominate. They

are taller and heavier than Bunaji. The body color varies; light dun, grey and white are most prevalent. The muzzle and ears are white. The hump is large and the sheath and dewlap are well-developed. They have a beef type confirmation and gain weight easily. Sokoto Gudali have short horns and are in general more docile than the Bunaji. They excel Bunaji cattle in milk production. Because of this characteristic and better weight gain, Sokoto Gudali are good prospects for beef production.

The Rahaji is a large, humped, reddish-brown breed with very long horns. Rahaji cattle are taller than Sokoto Gudali and Bunaji and can survive in drier areas. They are used mainly for beef as they are poor milk producers. They are difficult to work with but are remarkably intelligent (Williamson and Payne, 1965).

Management Practices

Livestock management involves all branches of livestock production such as feeding, grassland management, health control, housing, reproduction etc., based on the objectives of the industry.

Husbandary Practices

Management systems are classified in many ways. One is based on the intensity of the operation (intensive, semi-intensive, and extensive or nomadic). Another is based on climate of the region such as temperature and duration of rainfall. Each classification has its justifications (Pino, 1968).

In most of tropical countries, where specialized livestock industry is represented by large scale farms as well as "peasant" or subsistence farms, the management programme is governed principally by bioclimatic factors among which availability of feed and water are the most important.

The typical livestock farmer in Nigeria is nomadic rather than settled. Cattle are moved from one area to another in search of feed and water. Distinct rainy and dry seasons result in inadequate year around distribution of feed. The pastoral calender (Van Ray and De Leeuw, 1974) in the Savannah areas of Nigeria follow the rainfall pattern and can be divided in five distinct phases:

1) Seeto (April/May/June) is the stormy period with occasional rains that preceeds the start of the rainy season.

2) Dungu (June/July/August/September) is the wet season and grazing conditions quickly improve. At the peak of the rainfall, Yuka, the herdsmen and their cattle have to move continuously to relatively drier grazing grounds.

3) Yamde and Nyaile (September/October/November/December). This is the hot, dry period following the rains, but forage is still plentiful. Towards the end, however, during Nyaile, decreasing forage is supplemented by crop residues from sorghum, cotton, groundnuts, and cowpeas.

4) Dabunde (December/January/February). This is the harmattan period. Fodder resources become scarcer, and time spent grazing is longer and takes prominence over residue grazing.

5) Chudu (February/March/April). During this period grazing conditions have deteriorated and cattle are dependent on browsing.

This pastoral calender describes the management pattern of settled or semi-normadic Fulani, who practice some cultivation.

Nomadic Fulani, the Bororo, as they are locally called, live in a state of perpetual migration, moving south during the dry season and north during the wet season. Van Ray and De Leeuw, (1974) found that semi-nomadic management provided more for cattle needs in terms of feed and water. Under the semi-nomadic management, the time in which protein requirements are inadequate is shorter. This practice provides more grazing time and readily available water.

Nomadic management has resulted in overgrazing of available land and has reduced availability of forage. This is further aggravated by early maturity of grasses caused by high temperature and humidity with the resultant increase in leaf-stem ratio and consequently, poor quality forage (Bisschop and Groenewald, 1963; Whyte, 1962).

In other parts of the world, inadequacy of forage to provide energy, protein and mineral requirements is made up by supplemental feeding. Deficiency in mineral content in Nigerian forages has been shown by Kapu (1975).

In Nigeria, well-planned grazing, either continuous or rotational, of well-cultivated land and supplemented with concentrates and hay or silage during the dry period, is practiced only in organised institutional or government-owned farms.

Reproductive Performance of Indigenous Cattle

Major forms of Infertility

Infertility of livestock includes anestrus, repeat breeding, abortion, stillbirths, and death of the offspring up to weaning age. Infertility is considered to be the largest single cause of loss in livestock production (Roberts, 1971).

When criteria for cattle fertility are considered in Nigeria it can be expected that the causes of infertility do not differ from factors that cause infertility elsewhere. In addition, there is infertility associated with high temperature at high and low humidities.

Except for a limited number of government herds, reproductive records are practically absent. Consequently there are few reports available which are based on recorded information. For nomadic cattle, which comprise approximately 80-90 per cent of the national herd in Nigeria, only limited surveys have been published.

Anestrus and Estrual Irregularity

Anestrus is believed to be the most important cause of infertility in cattle in temperate zones (Zemjanis et al., 1969; Roberts, 1971). In hand-bred or insemi-

nated herds, anestrus often reflects poor observation of heat signs. True anoestrus is a sign of a variety of conditions that are associated with temperary or permanent absence of ovarian function (Hafez and Jainudeen, 1974).

Anestrus can occur either before service, when a cow fails to come into heat at the planned time of breeding following parturition or when a heifer does not show heat at the planned age for breeding. Post service anestrus occurs when cows are not observed in heat, are presumed to be pregnant but are subsequently found to be non-pregnant. Incidence of anestrus has not been recorded in Nigeria. Age at first calving and calving intervals have been reported (Lamorde and Franti 1973). Thus age at first calving has been found to be high (Lamorde and Weinman (1972). Delayed puberty as reported is associated with absence of sexual activity-anestrus. Available data on calving interval indicate that it is considerably longer than reported for cattle in temperate zones (Lamorde and Franti, 1973; Akpokodje and Bolarinwa, 1974; Pargot, 1975).

The survey conveyed by Lamorde and Franti (1973) found that 16.76% of cows calved once a year, 11.90% calved every other year, and 71.34% calved irregularly.

Anestrus can safely be assumed to be responsible for the extension of calving interval. A high incidence of ovarian atrophy has been found in indigenous cattle at the veterinary clinic at Ahmadu Bello University (Zemjanis, 1975).

The condition commonly referred to as repeat-breeder, is seen in cows which appear to be normal in every respect, yet fail to conceive after repeated breedings to a known fertile bull or inseminations with semen of high quality. Clinical examination may fail to reveal any definite lesion or condition to explain the failure of conception (Roberts, 1971). The causes of conception failure as classified by Zemjanis (1963) are: (i) congenital or genetic anatomical defects of genital tract; (ii) congenital, genetic or acquired defect of ova, spermatozoa or early zygote; (iii) infectious or traumatic inflammatory process; (iv) endocrine dysfunction; and (v) managerial and nutritional deficiencies.

Abortion

Abortion refers to pregnancies which terminate with expulsion from the uterus of a fetus of recognizable size before term. Fetal death is not an essential prelude to abortion (Hafez and Jainudeen, 1974). Many

fertilized ova, embryos or early fetuses may be aborted without being seen especially when the animals are not closely observed (Roberts, 1971).

Abortions are usually caused by agents affecting the fetus or its placental membranes, or both. Any agent causing severe stress reaction may also cause abortion. The various agents causing abortion may be classified as: physical, genetic, nutritional, chemical, hormonal or infectious (Roberts, 1971).

Reports of either incidence or cause of abortion in Nigeria are scanty. According to the annual reports of the veterinary division of the Ministry of Health and Forestry Resources of Northern Nigeria for 1959-63, abortions were confined to Benue Plateau and North-Eastern States (MacGregor, 1959, 1960, 1962, 1963).

Among the infectious diseases of abortion the presence of brucellosis has been reported since 1927 (Banerjee and Bhatty, 1970). They found that in government herds in Northern Nigeria, the incidence of brucellosis in 1934, was 15%, 9% in 1946, 30% in 1947, and 11.8% in 1948. In a herd, the incidence of reactors was found to be higher than the recorded low abortion rate (Birkett, 1951). In the six northern states of Nigeria, Nuru found (1974) an overall reactor rate of

6.0 per cent in nomadic herds and 3.6 per cent incidence in government-owned herds. The highest incidence - 26 to 30 per cent was observed in Kwara State.

Nomadic Fulani cattle owners consider that trypanosomiasis is important cause of abortion after nutritional deficiencies (MacGregor, 1962; Lamorde and Franti, 1973).

Incidence of herds reporting abortion varied from state to state. In local herds, it ranged from 0.9 per cent in North-Western State to 43.1% in North-Eastern State. Abortion was reported in all 10 surveyed Livestock Investigation and Breeding Centres (Lamorde and Franti, 1973; and Nuru, 1974).

Surveys conducted by Lamorde and Weinman (1972) revealed 12.4% abortion rate in local Fulani herds and 3.9% in Government farms. With the exception of sporadic brucellosis serological surveys, there is practically no information on the causes of abortion. In order to assess the overall effect of abortion on cattle industry in Nigeria more work has to be done.

Fertility Indices and Parameters

Age at Puberty

Puberty is the period at which an animal commences sexual activity. It is marked by occurrence of those

constitutional changes whereby two sexes become fully differentiated. At puberty the secondary sexual characteristics become conspicuous and the essential organs of reproduction begin to undergo great increase in size.

The primary cause of the onset of puberty does not rest with the age of the gonads but with the age of the body and the changes occurring in the anterior pituitary gland (Hammond, 1952). Because body development is involved, puberty is delayed if the general body development is restricted by poor nutrition.

Wheat and Broadhurst (1968, 1972) and Wheat 1972 found that the age at first calving for the Bunaji, Rahaji, Azaouak and Sokoto Gudali breeds in L.I.B.Cs. ranged between 33-47 months. Their data was confirmed by Lamorde and Weinman (1972) and Akpokodje and Bolarinwa (1974).

In a summary of survey and recorded data, the average age at first calving was given as 60 months for nomadic cattle and 40 months in LIBC's and government herds (Zemjanis, 1974). In a survey carried out throughout the six northern states Nuru (1974) found that the age at first conception was between 3.3 - 3.7 years in nomadic cattle and 2.5 years in Government farms. This confirmed the earlier figures obtained by Lamorde and Weinman (1972). In a survey they found that age at first oestrus in local herds was 3 years and 22.3 months in

government herds. These findings agreed with the earlier data of Armour et al. (1961) and Knudsen and Sohael (1970). The latter observed, in an experiment involving 128 Bunaji cows, age at first calving varied between 42.6 and 49.4 months. According to Asdell (1964) the age at puberty in Zebu breeds in East Africa, tropical South America and India is the same - 904 $\pm$ 43 days.

Annual Calf Crop

Calf crop is the number of calves produced per year by cows and heifers that have reached breeding age expressed as a percentage.

Information on calf crop in the Nigerian Zebu cattle is based on surveys and limited data from records in government herds. In a survey of 17,158 nomadic cattle Lamorde and Weinman (1972) found that the calf crop among indigenous herds varied between 27 and 55%. According to Nuru (1974), the annual calf crop in nomadic herds was between 34-47%. Johnson (1974), using the records of 74 Bunaji cows in Shika Research Station calculated a calf crop of 62.1%. This agreed with the 67.2% Nuru (1974) obtained in a survey of 10 LIBCs. In 1974, Sohael reported annual calf crop of 100% in Vom.

Calving Interval

Calving interval is the most commonly used fertility index. It is a measure of the period between two subsequent calvings. Extended calving interval may be caused by all major forms of infertility including anoestrus, conception failure, and prenatal deaths. Nevertheless, it is a useful measure for evaluating reproductive performance.

Calving interval has been calculated for indigenous breeds in government farms in Nigeria. Wheat and Broadhurst (1968) found that the calving interval of the Bunaji breed ranged between 388-463 days. The calving interval for Sokoto Gudali was longer, namely 439-496 days (Wheat and Broadhurst 1972). Wheat (1972) reported calving intervals of 423-537 days in Azauak and Rahaji breeds. By analysis of 361 records of Bunaji herds in Shika, Zemjanis (1974) observed average calving interval of 447 days. Akpokodje and Bolarinwa (1974) obtained 454.9 days calving interval from similar analysis carried out at Ibadan. All these data originated from well-managed farms. In regard to nomadic cattle the information which is available is based on surveys. The information gained from Nuru's survey (1974) indicated that calves nursed for 10-12 months and that the first post-partum estrus occurred as late as 15 months following calving. Lamorde and

Franti (1973) reported an annual overall calving rate of 16.76; 11.90 per cent calved every other year and 71.34 per cent calved irregularly. Information on fertility indices such as length of post-parturient inactivity, number of services per conception, and non-return rates is not available for Nigeria.

The reproductive pattern

There is reported evidence that indigenous breeds have a seasonal breeding pattern. Lamorde and Weinman (1972) and Lamorde and Franti (1973) concluded from their surveys that calving is confined primarily to early wet season. Steinbach and Balogun (1971) analysed 8,971 records of a government farm in Ibadan and deduced that in Keteku cattle most conceptions occurred between February and June in Southern Nigeria. The peak sexual activity appeared to vary between breeds and regions of Nigeria (Wheat and Broadhurst, 1972; Wheat, 1972; Zemjanis, 1974). Validity of these observations is biased by the apparent use of predetermined restricted breeding period in the herds studied. More work is needed to establish the existence or absence of a seasonal breeding pattern.

Reproductive Performance of Zebu (Bos Indicus) Cattle in Africa and Other Tropical Countries

Indigenous cattle in Egypt are derived from early crosses between Hamatic cattle, Asian Zebu and Shorthorn (Rendel, 1968). El-Itriby and Asker (1958) reported average age of 37.7 months at first calving in 30 animals on a government farm. In 1965, Mahadevan calculated the age at first calving in Zebu breeds of East Africa - Nganda; small East African Zebu, Boran and Jiddu. The age at first calving was found to be 42, 43 and 40 months, respectively. Also in six areas of Botswana with more than two thousand cattle each Reed et al. (1974) observed that the age at first calving ranged from 3½ to nearly 4½ years. In Sudan the average age at first calving of 125 animals was 66.7 months with a range between 30 and 96 months (Osman, 1972).

Calving Interval

In India, Amble and Jain (1967) analysed the records of 60 Sahiwal cows in Ambala Military farm and 58 cows on a similar farm at Meerut and found the average calving interval to be 392 and 450 days, respectively. In East Africa, Mahadevan (1965) reported the calving interval to be 420 days for Ngana breed, 362 days for small East

African Zebu, and 382 days for Boran. Rakha et al. (1970) in supplemented Central African cattle found calving intervals of 379 days and 425 days for Angoni and Africander breeds, respectively. Pargot (1975) summarized the average calving intervals of several African breeds of Zebu as follows: Sudanese 12-24 months; Abyssinian 11-14 months; East African Shorthorned Zebu 11-14 months; Shorthorned Puehl Zebu 27-36 months; Sahelian Zebu 10-18 months if the animals became pregnant while lactating; the interval was 19-27 months if they did not conceive during lactation.

Annual Calf Crop

Rakha et al. (1970) reported an overall calving rate of 83%, 65%, 83% and 54% for Angori, Africander, Mashona, and Hereford breeds, respectively. They reported that these figures were higher than the national average. In a study covering three years, Wilson (1946) observed that the annual calf crop ranged between 27.5-31.2% in Zebu cows of Nyasaland. Reed et al. (1974) calculated the calving rate in Botswana varied between 39.8 and 51.6% in approximately 12,000 cattle.

Reproductive Pattern

There is evidence that the Zebu cattle have periods of peak sexual activity. Osman (1972) using data from Gazal Gawazat herd in Sudan, observed that cows which calved during the rainy season (July-October) required more services per conception than those calving during the rest of the year, while those calving during the dry months (March-June) needed the least number of services per conception.

Wilson (1946) analysed data from central Nyasaland and concluded that calving was seasonal; the majority of calves being born during June to September each year. Rakha and Igboeli (1971) studied 40 cows out of which 20 received normal plane of nutrition (balanced ration) and the remaining 20 were kept on low plane of nutrition over a period of one year. They observed that 55% of the animals of the latter group ceased cycling before the end of the experimental period. No seasonal effect were observed in either the estrus cycle or period in the normal plane group. In two government farms in Ceylon- Ridiyagama and Tamankuduwa - Buvanendran et al. (1971) observed a seasonal peak in calving that was linked with rainfall and feed availability.

Estrous Cycle

Reports on cyclic activity of the Zebu in Africa are few. Rakha et al. (1970) observed 333 estrous cycles in 50 sexually mature cattle of Central Africa. They reported that the normal estrous cycle averaged 21.89, 22.68 and 24.25 days for Angoni, Barotse, and Boran breeds, respectively. The average length of estrous periods in these breeds were 16.3, 17.4 and 14.8 hours. Ovulation occurred on the average 31.5 hours from the onset of estrus.

Anderson (1944) found that the average length of the estrous cycle in the purebred East African Zebu was 23 days and that the estrous period was only 4.8 hours. Plaese et al. (1970) studied 592 estrous cycles in Brahma cattle and found that the average length was 27.7 days and the mean length of the oestrous period was 6.7 hours.

Environment and Reproductive Performance

Climate

Bonsma (1958) defined the optimum physical environment for cattle, sheep and buffaloes as one that has an air

temperature between 13-18°C, relative humidity between 60-70%, wind velocity of 5-8 kilometers per hour, a medium level of solar radiation - about the level obtainable in the subtropical latitudes in spring and fall, fertile soil, evenly distributed rainfall, and an environment free of disease. Such an ideal environment does not exist. One extreme variable alone can disturb the balance.

Air Temperature

This is probably the most important single bio-climatic environmental factor. Temperature is a relative term indicating heat quantity or degree of molecular activity.

Atmospheric Humidity

This is determined by the water vapor content of the atmosphere. Humidity influences animals ability to adjust to drastic changes in air temperature. The rate of cooling by evaporation from the skin and respiratory organs depends largely upon the relative humidity.

High humidity affects livestock production by lowering feed quality and accentuating mineral deficiency in soil and forages. Debilitation lowers resistance to

disease. High humidity provides suitable habitat for free-living disease organisms, insects and other vectors of infective agents. Increase in humidity predisposes skin to bacterial, fungal, and ectoparasitic diseases. Prevalence of dermatophilosis, tick infestation and other skin problems is highest during the wet season in Northern Nigeria (Bida, 1973). When both temperature and humidity are high, the quality of feed is low because of more rapid growth. Early maturity of forages results in increased lignin content and reduction in both nitrogen and carbohydrate content. Dry matter content is also reduced by high humidity. Consequently, animals have to consume higher than normal quantity of feed to satisfy their nutritional requirements (MacDowell, 1972).

Rainfall

Major effects of rainfall in Nigeria is indirect. It influences feed availability and creates an environment favouring disease and parasitism. Seasonal distribution of the annual rainfall determines the extent to which soil moisture is available for production of forage. This effect is modified by soil condition, vegetation cover, and the rate of evapo-transpiration.

Seasonal rainfall pattern determines the amount of feed that can be produced and the length of time when high quality forage is available. The grazing pattern, requirements for stored and supplementary feed, and choice of the most useful system of feed preservation are also influenced by the distribution of rainfall (McDowell, 1972).

Photoperiod

The effect of photoperiod, another variable in the physical environment, on animal production is not clear. It is believed, however, that the effect of longer day-light is mediated through increased wakefulness and metabolic activity and consequently, in higher feed intake. Steinbach and Balogun (1971) associated seasonal variation in calving rate to variation of photoperiod. The highest rate was associated with the shorter photoperiod.

Soil

Soils of most of Nigeria are old and weathered. The level of organic matter as the result of heavy rainfall, coupled with high temperature is low. In Nigeria, particularly the northern states, the environment is less than ideal. The fact that animals exist in this environment, however, is indicative of their ability to adapt.

The extremely hot climate, the uneven distribution of rainfall, low soil fertility, and inadequate availability of nutrients all the year round, create major obstacles to livestock production (McDowell 1966).

The Consequence of Thermal Stress

General effect

The physiology and the endocrine function of the cow in a hot environment has been reviewed by Bianca (1965) and MacFarlane (1963), respectively.

One of the first noticeable responses of livestock to thermal stress is decrease in feed intake. The extent of the depression appears to be directly related to the stress. Johnson (1967) noted that lactating cows exhibited depression of appetite at 25°C and the depression became marked with rising temperature until at 40°C when feed intake virtually stopped. Brobeck (1948, 1960), proposed possible hypothalamic mechanism of this reduction in feed intake with rise in temperature. Along with reduced feed intake, the time spent grazing was also decreased (Larkin, 1954).

Depression in feed intake is governed by other variables: (1) well-fed animals loose their appetite earlier, and (ii) the type of feed, whether concentrate or roughage (Ragsdale et al, 1950, 1951; Payne and Hancock 1957). Depression in feed intake is also depended on breed (Allen et al., 1963; Rogerson et al., 1968). They found Bos taurus to be more susceptible than the Zebu breeds.

Wright (1954) considered that growth rate was depressed by thermal stress. Zebu breeds such as Kankareg and Sahiwal were considerably larger in cooler areas. Shelton (1956) demonstrated that British breeds of cattle gained less weight daily in tropical Australia than they did in temperate latitudes. Payne and Hancock (1957) used identical twins to eliminate genetic variables; one twin was kept in a hot region-Fiji, and the other in cooler New Zealand. All twins received the same ration. At the end of the trial the live-weight gain and body length of the twins in the hot environment were less.

Under controlled laboratory conditions Ragsdale et al. (1957) compared the growth rate between two Shorthorn and three Zebu breeds at 10°C and 27°C. They found that, although there was little difference between the two breeds at 10°C and 27°C, Zebus gained 32% more weight

than Shorthorns in fifteen months. Zebus gained equally well at both temperatures.

Thermal stress and Reproduction

It has been difficult to assess the direct effect of ambient temperature on reproduction. In such an assessment, the association between temperature, photoperiod, rainfall, relative humidity, and availability of nutrients must also be considered as well as behavioral changes associated with thermal changes. Several reviews have been written on the influence of temperature on reproduction in mammals (Fryer et al., 1958; Ulberg, 1967; Dutt, 1959; Fallon, 1962; Hafez, 1964, 1967; Bianca, 1965, Gangwar et al., 1965; Waites, 1968; Vincent, 1972).

High environmental temperature can cause a decline in reproductive performance of both male and female cows. Possible sites affected include spermatogenesis, ovogenesis, libido, estrus, ovulation, fertilization, implantation, embryo survival, gestation length, and mothering ability (Hafez, 1964).

Moore & Quick (1924) were the first to demonstrate that germinal epithelium was inactivated by elevation of temperature. Young (1927), found absence of successful breeding in guinea-pig for 6-8 weeks following exposure

to heat. Several reports (Seath and Staples, 1941; Erb et al., 1942; Fryer et al. 1958; Kelly and Hurst, 1963; De Alba and Riera, 1966) have indicated that quality of bull semen usually declined in summer.

When puberty is reached, high environmental temperature has a deleterious effect on semen quality (Casady et al., 1953; Johnston et al., 1963). The latter found also that Zebu breeds were more resistant to effects of high temperature. This was confirmed by Skinner and Louw (1966).

The effect of temperature on performance of the cow seems to affect most stages of the reproductive cycle. Dale et al. (1959) suggested that delay in puberty may be indirect and associated with retarded growth due to reduced food intake when the temperature is high. Dutt (1959) placed three groups of ewes (sheared, unsheared and mixed), on the 12th day of estrous cycle, in a hot environment (90°F) and sacrificed them three days post breeding. Percentage of recovered abnormal ova was higher than in similar groups of control animals under natural condition. In this study environmental temperature was the only variable. Dutt (1959) concluded that integrity and subsequent suitability of such ova to be fertilized and further

developed was affected by elevated temperatures. Under field conditions higher yield of abnormal ova were harvested during summer months in a survey in New Zealand (Hulet et al., 1956). Transitory infertility observed in many mammalian females when exposed to high ambient temperatures, especially if accompanied by high humidity, is due to thermal stress (Ulberg, 1958; Ryle, 1961; Hafez, 1964; Ulberg and Burfening, 1967).

Genetics and Reproductive Performances

The role of hereditary factors in infertility in cattle has been reviewed by a number of workers (Gilmore, 1949; Rollinson, 1955; Johansson, 1960; Lagerlof, 1963). Foote (1970) concluded that heritability of reproductive efficiency as measured by non-return rate, number of services per conception, first service conception rate, and calving interval, is low. There is, however, a number of reproductive congenital anomalies which are genetically transmitted (Tanabe and Almquist, 1967; Leipold et al., 1972). There is no evidence that these are more prevalent in Zebu cattle and that they, as such, provide explanation for the disparity in the reproductive efficiency between the Zebu and temperate breeds.

Nutrition and Reproductive Performance

Among the acquired factors causing infertility, nutrition has received considerable attention. It is noteworthy that nomadic Fulani cattle owners in Nigeria consider undernutrition as the most important cause of low reproductive performance (Lamorde and Franti, 1973).

Low Energy Level

In farm animals, undernutrition delays onset of puberty and leads to impaired fertility in mature animals. Heat symptoms become noticeable at older age in under-fed animals when compared to their better-fed counter-parts (Joubert, 1954a, Carroll and Hoerlein, 1966).

Reid (1960), who subjected cattle to low, medium and high level of nutrition from birth to the time of first calving found that cattle on the higher level of nutrition reached puberty earlier than those on the lower level although their size at puberty was not statis-tically different. Similar results have been obtained by other workers (Joubert, 1954b, Sorenson et al., 1959).

The effect of undernutrition on the estrous cycle was investigated by Joubert (1954b) using 28 cows, 14 under high plane of nutrition and 14 under low plane of

nutrition observed that after puberty estrus in the group under the higher plane of nutrition became regular much earlier than the group under low plane nutrition. Hill et al. (1970) observed that the estrous cycle was longer in animals under low plane of nutrition. This was confirmed by Lamond (1970). In cows, when availability of feed varied with season, sexual activity was observed to follow the pattern of variation. When availability of feed is low cattle loose weight and when weight loss reached a critical level, their sexual activity became irregular (Lamond, 1970).

Effect of level of nutrition on reproductive phenomena in adult cows was studied by Wiltbank, et al. (1962). He studied performance of cows prior to and after calving and exposed them to the following low or high level rations: high-high; high-low; low-high; and low-low. Cows in the high level groups produced heavier calves. Feeding level had no effect on uterine involution. Pre-calving feeding level was more important in the appearance of post-calving estrus although both pre-/and post-calving levels were important. Conception rate was somewhat lower in cows on low energy level after calving. Hill et al., (1970) found that feeding 85% of maintenance level requirement of energy and

protein to heifers resulted in: (1) lower levels of plasma progesterone; (2) reduced number of medium-sized ovarian follicles; (3) reduced weight of copora lutea; (4) lower proportion of normal fertilized ova; and (5) altered length of the estrous cycle. Ovarian atrophy has been reported in chronically undernourished women (Stephen and Allen, 1941). The mechanism by which undernutrition causes ovarian atrophy and altered estrous cycles is not clear.

High Energy Level

Overfeeding has been incriminated as a cause of infertility. Hansen and Steensberg (1950) divided 238 Red Danish heifers into three groups at 16 days of age and fed them at high, normal and low nutritional levels until they had their first calf, after which they were all kept under similar conditions for the rest of their life. The high plane group had fewer calves, and more were culled due to infertility than from the other two groups. This lent support to the association of fatty deposits on ovaries with inadequate follicular activity in sterile animals on high nutritional level (Loeb, 1921). Reid (1960) found that cows on a high plane of nutrition required more services per conception than those on a lower level.

Protein

Under efficient management, qualitative or quantitative protein deficiencies are uncommon. However, in situations where inanition or underfeeding is complicated by vitamin A and phosphorus deficiency, protein deficiency may arise (Moustgaard, 1969; Roberts, 1971). During the dry season in Northern Nigeria the quality of pasture is poor in essential nutrients and protein deficiency can be expected to occur because cattle cannot satisfy their protein requirement by grazing (Kapu, 1975). The effect of protein deficiency manifests itself indirectly. With protein deficiency animals usually loose appetite and the effect on reproduction is due to resultant undernutrition (Wiltbank et al., 1965; Dawson, 1970).

Mechanism of protein deficiency effect

The fact that gonadotropins are proteins made the anterior pituitary a target for explaining the reduction in ovarian activity and ovulation associated with protein deficiency (Leathem, 1961, 1966). In the rat, protein deficiency resulted in decreased hypophyseal gonadatropin content (Cole et al., 1932; Leathem, 1961). On the other hand, Srebnik et al. (1960) observed that absence of dietary protein in female rats

caused a moderate increase in hypophyseal FSH content and no change in the level of ICSH.

However, the protein quality and amino acid content are also important. Thus when maize was the only source of protein, estrus and ovulation were reduced. This effect was corrected by administration of lysine an amino acid not found in maize (Reid, 1949).

Protein deficiency does not prevent the rat ovaries from responding to gonadotropins (Srebnik, et al 1958; Leathem, 1961). The duration and extent of deficiency can prevent ovaries from responding to gonadotropins (Leathem, 1961, 1966; Widdowson et al., 1964).

Adequate protein has been found to be necessary for maintenance of pregnancy although the mechanism of action is unknown.

High protein feeding has adverse effect on bovine fertility (Hewett, 1971, 1974; Morrow et al., 1972; Blowey, et al., 1973). Lotthammer (1974) found a higher incidence of postparturient endometritis and anestrus in cows fed high protein rations.

Vitamins

Lack of vitamin A appears to affect reproduction adversely in most species (Roberts, 1971). Signs of

avitaminosis A are similar in rat, sheep and cows (Hart and Guilbert, 1933; Reid, 1949). They reported that vitamin A deficiency resulted in anestrus, frequent return to service, abortion, weak calves and retained placenta. The placenta was retained in 8 of 13 Shorthorn cows fed avitamin A deficient diet (Nicholson and Cunningham, 1965). Bargai and Egyed (1964) recorded 121 stillbirths in 312 births in an Israeli beef herd within a six month period. Sera from these cows were low in carotene and vitamin A. Reid (1949) agreed with Hart and Guilbert's (1933) results that cows fed a vitamin A low diet had normal estrus cycles, ovulated and conceived readily. Signs such as weak calves and retained placenta were believed to be manifestations of the higher demands of late pregnancy.

Vitamin E does not affect the estrous cycle or ovarian function in the female rats (Evans and Bishop, 1923). Gullickson et al. (1949) fed a vitamin E deficient diet to 8 bulls and 22 heifers throughout their life time. Reproductive organs developed normally in both sexes and growth was normal. The bulls produced high quality semen and the heifers experienced normal estrous cycles. A total of 30 services produced 25 conceptions but only 19 of these terminated in normal parturition; six cows died before term.

Henke (1935) fed vitamin E to 38 cows with irregular breeding records and compared them to 37 controls. There was no statistical difference in the conception rate between the groups.

Vitamin C

Phillip et al., (1941) reported an increase in plasma ascorbic acid during mid to late estrus in normal cows, whereas repeat breeder cows had no increase. Treatment of 17 repeat breeder cows with ascorbic acid resulted in conception. Christian et al. (1951), however, found no beneficial effect with vitamin C treatment.

Vitamin B

Vitamin B or B complex deficiency is usually accompanied by reduced appetite (Reid, 1949). Rats with vitamin B deficiency have delayed puberty, irregular estrus, and ovarian dysfunction, all signs ordinarily seen with undernutrition (Leathem, 1961).

Vitamin B complex shortage is rare in cows because of the rumen's ability to synthesise these vitamins. The deficiency occurs when the diet is deficient in cobalt or protein (Hignett, 1963).

Vitamin D

Vitamin D deficiency seldom occurs in cattle because of its presence in roughage of any quality and by exposure to sunlight.

Wallis (1943), reported that cows receiving a diet low in vitamin D failed to come into heat. Meites (1953), stated that uncomplicated vitamin D deficiency does not interfere with reproduction. Hignett (1963) concluded from a study involving 787 cows from 39 herds that low vitamin D status will lead to infertility if phosphorus ratio was influenced by the vitamin D status. Conception rate declined when vitamin D level became low.

Mechanism of Vitamin Infertility

Very little work has been done on effect of vitamins on the anterior pituitary. Administration of vitamin B_6 (pyridoxine) has been found to increase the FSH level in the anterior pituitary of rats and a comparatively less increase in LH (Leathem, 1961). He also found that the anterior pituitary gonadotropin content was decreased in rats receiving diets free of vitamin B complex. With vitamin E deficiency cytological changes were seen at the site of LH synthesis.

Mineral Deficiency

Phosphorus

Usually phosphorus deficiency tends to occur when rations are low in protein, under range conditions in drought areas and in areas where the phosphorus content of the soil is low, or when lactating cows are not fed adequate supplements to supply the extra requirement imposed by milk production (Roberts, 1971).

Observations from phosphorus deficient areas are in general agreement that reproductive efficiency is affected by low level of phosphorus (Eckles et al., 1926; Theiler et al. (1928), Hignett and Hignett, 1953). In general, it is believed that reproduction is not affected until clinical signs such as inanition, poor hair coat, depraved and decreased appetite are evident (Roberts, 1971). Black et al. (1943) diagnosed aphosphorosis based on hematological studies of heifers pastured on phosphorus-deficient soil. Heifers that did not receive supplement containing phosphorus had lower fertility as measured by conception rate.

Eckles (1935) indicated that uncomplicated phosphorus deficiency did not cause abnormal estrus. Morrow (1969), however found that phosphorus deficiency resulted

in abnormal estrus and more services per conception. Hignett and Hignett (1951, 1952, 1953) related the infertility associated with phosphorus deficiency to abnormal calcium/phosphorus ratio and vitamin D deficiency. They concluded that infertility was associated with low phosphorus level and high calcium level. Fertility improved when additional phosphorus was supplied in amounts related to milk production. They stated that there is a minimum daily phosphorus requirement for satisfactory fertility in stabled heifers. In contrast, Littlejohn and Lewis (1960), did not find any relationship between calcium and phosphorus ratio and fertility. Although they recorded an increased occurrence of silent but fertile estrus.

Alderman (1963) observed that phosphorus deficiency is seen only under special circumstances. However, with increased emphasis on grazing phosphorus deficiency may become a problem.

Calcium

Available evidence does not associate infertility with calcium deficiency alone (Roberts, 1971). However, when related to phosphorus, calcium is involved in reproductive efficiency as the level of one affects the level of the other (Hignett and Hignett, 1951, 1952, 1953).

Trace Elements

The following trace elements which have been studied in regard to their effect on reproduction are:-

1. Manganese: Rojas et al. (1965) induced infertility in form of delayed ovulation by experimentally-producing manganese deficiency in dairy cattle.

2. Cobalt: Cobalt deficiency results in reduced appetite and lowered hemoglobin content as well as reduced rumen function. It creates a situation that simulates undernutrition (Roberts, 1971).

3. Copper and Iron: Copper and iron deficiency causes or complicates anemia in the cow (Roberts, 1971). Indirectly it causes anestrus, delayed postpartum estrus, and non-functional ovaries (Donaldson et al., 1964).

4. Iodine: Iodine deficiency affects thyroid function and reproduction indirectly by the effect of thyroid on general metabolism. Beneficial effect has been found associated with iodine supplementation in cattle (Moberg, 1961).

5. Sodium: Follis et al. (1942) noted, in rats which received a diet adequate in all respects except for extremely low sodium content, that their ovaries contained fewer and smaller follicles than the controls.

6. Potassium: Orent-keiles and McCollum (1941) fed rats an adequate diet but containing only 0.01 per cent potassium and found that sexual maturity was delayed, estrus rhythm was disturbed and ovulation was irregular. In a study of 50 herds in Sweden Hewett (1971) found a positive correlation of fertility with increase in level of potassium in the pasture.

It is evident that a host of nutritional factors can affect reproductive efficiency. The subject remains controversial because of apparent difficulties created by apparent interrelation and various pathways of nutrients in metabolism. McClure (1965, 1968, 1970) demonstrated that energy intake may, by its effect on the utilization of other nutrients, be a limiting factor.

Blood Profile Studies

Blood profile as a reflection of nutritional state

Hewett (1974) observed variation in all blood components between and within herds and concluded that the variation depended upon the type, quality and intensity of feeding, hygiene and other management factors. He found that some differences in the herds he studied were associated with changes in feed and by its quality and intake.

There are indications that blood composition may be affected by quality and quantity of the ration. Thus serum urea nitrogen and albumin levels were found to vary with the type of silage fed (Little and Manston, 1972). McClure (1970) reported that the plane of nutrition influenced blood glucose levels in dairy cattle. He found that cows fed immature oats or placed on low nutritional plane had low glucose levels. Greig and Boyne (1956), using identical twins showed that cows on a low plane of nutrition had low hemoglobin levels. Preston et al. (1965) and Prewitt et al. (1971) related the level of serum urea nitrogen to protein intake. Dunham and Ward (1971) and Black et al. (1973) found that dietary calcium levels affected serum calcium levels. In Minnesota, Palmer and Eckles (1927) obtained extremely lower plasma phosphorus level in cows which did not receive phosphorus supplement. Morrow (1969) demonstrated that correction of a phosphorus deficient ration resulted in a higher serum phosphorus in Guernsey heifers. In an extensive survey carried out by Hewett (1974) blood components varied from herd to herd and from season to season. These variations appeared to result from variation of energy, protein and mineral levels in the ration.

Blood profile and reproductive performance

There are numerous reports on the influence of energy intake on fertility (Joubert[a,b], 1954; Reid, 1960, Wiltbank et al., 1962; McClure, 1965, 1968; Dunn et al., 1969; Bond and Wiltbank, 1970; Dawson, 1970; Lamond, 1970; Trimberger et al., (1972).

McClure (1968, 1970) provided evidence that low blood glucose levels were associated with low fertility. In a study involving 75 dairy herds Payne et al. (1973) confirmed the relationship between infertility and low blood glucose.

The correlation of low glucose level with infertility has, however, been disputed. Blowey, et al. (1973)in a study involving 12 herds found no relationship between blood glucose and fertility. The observation of Hewett (1974) also failed to demonstrate a direct relationship.

Moustgaard (1969) and Roberts (1971) reviewed literature in regard to the effect of protein intake on fertility. The number of experiments involving protein deficiency alone is limited. Trimberger et al. (1972) concluded that concentrate has a beneficial effect on reproductive performance.

Sparke and Lamond (1968) observed that daily feeding of 3.6 kg concentrate supplement to range

Shorthorn-Devon heifers during the five winter months reduced the age at first calving considerably. Out of the supplemented group 60 percent became pregnant at 2 years of age. Only 2 percent of controls conceived at that age.

Hill et al. (1970) by feeding only 85% of maintenance requirements for energy and protein obtained depression of ovarian activity and reduced fertility. However, Hewett (1971) found a negative correlation between protein intake and fertility and Morrow et al. (1972) concluded that liberal supply of grain resulted in longer calving intervals. A feeding trial conducted by Hansen and Anderson (1973) indicated a negative correlation. They found that the higher the intake of digestible crude protein the longer service interval, more days open and more services per conception required.

In his blood profile studies Hewett (1974) obtained a relationship between high blood total protein or urea nitrogen with lowered fertility.

Numerous reports in the literature indicate that low dietary and serum phosphorus values are associated with lowered fertility (Eckles et al., 1935; Palmer et al., 1941; Hignett and Hignett, 1951, 1952, 1953; Alderman, 1963; Morrow, 1969). However, large scale controlled experiments carried out at Weybridge, England

in 1958 and 1959 did not demonstrate any significant relationship between Ca:P ratio of the diet and fertility although silent heats were recorded (Littlejohn and Lewis, 1960). Hewett (1974) observed that high serum phosphorus may have an adverse effect on reproduction.

Wagner (1962) observed that at a moderately low hemoglobin level without clinical anemia was associated with reduced conception rate and anestrus.

Hewett (1974) associated high potassium level with lowered fertility.

It is obvious that more work is needed to clarify the relationship between levels of blood constituents and reproduction.

MATERIALS AND METHODS

Specimens and clinical data for this investigation were collected at the Galambi Ranch in Bauchi Province of North-East State, Bauchi Meat Factory, and Shika Research Station, Ahmadu Bello University, Zaria.

Bauchi, the Provincial headquarters, lies on latitudes 10° 18' north and 9° 15' east of the Greenwich Meridian. It has an altitude of approximately 1,940 feet above sea level.

The annual rainfall at Bauchi is about 43.2 inches. The months of November, December, January, February and March are practically without any rainfall, while nearly 37 inches of the 43.2 inches annual rainfall falls during the months of June, July, August and September, and with most of the rain in August.

The mean yearly temperature is 89.8°F, the minimum being 66.4°F. April is the hottest month (98.1°F). August is the most humid month (relative humidity 94%) and February is the driest (relative humidity 25%).

Shika is situated 7 miles north of the University town of Samaru, Zaria. It is 11° 11' north of the equator and 07° 38' east of the Greenwich meridian. The altitude is about 2,250 feet above sea level.

The average annual rainfall is 43.86 inches. June, July, August and September are the wettest months. The rainfall distribution pattern, the most humid and the driest months as well as the hottest and coolest months are the same as for Bauchi.

Forty-five cows were randomly selected from the Galambi Ranch. Only clinically normal adults were selected. The selected animals were identified by ear tags.

The herd represented most major breeds of cattle in that part of Nigeria and consisted of ten Bunaji, ten Wadara, twenty-one Aboro, and four Kuri. The age of the animals, based on dental characteristics, ranged from two years to about ten years.

The White Fulani herd at the Shika Research Station was the source of the control cows. Twenty-five cows of corresponding ages were randomly selected for clinical examination and collection of blood samples.

The cattle at the Galambi Ranch were kept under conditions typical for the traditional husbandry methods. The cattle derived their nutrients solely from grazing. There were no supplements fed to these cattle.

The White Fulani herd at the Shika Research Station received supplemental feed all year round. The level during the rainy season when there is adequate grazing was very low. It was increased substantially during the dry months of the year.

Clinical Examination

The 45 cows at the Galambi Ranch were examined rectally every month for 14 months.

The White Fulani herd was examined in April, August, October and December corresponding with the end of the dry season, the middle of the rainy season and the end of the rainy season, and the middle of the dry season, respectively.

The rectal palpation was performed according to the method outlined by Zemjanis (1970). Briefly this involve rotraction and subsequent examination and evaluation of the tubular genitalia and ovaries. Only non-pregnant animals were included in this investigation.

The parameters recorded were;

1. Ovaries;
    a. Length - the distance between the anterior and posterior poles.

b. Width - the distance between the medial and lateral surfaces

c. Height - the distance between the free and attached borders

d. Functional structures:

(i) Follicles - absence, presence, palpable diameter

(ii) Ovulation depression

(iii) Developing corpus luteum - corpus hemmorhagicum

(iv) Fully developed corpus luteum

(v) Regressing corpus luteum

e. Abnormalities - hypoplasia, atrophy, cysts, tumors, etc.

2. Oviducts - abnormalities

3. Uterus

a. Size - normal or dimensions of the abnormal

b. Consistency and tone - turgid, edematous, flaccid or atonic, etc.

c. Abnormalities - hypoplasia, metritis, tumors, etc.

4. Cervix

a. Size - normal or dimensions for the abnormal

b. Abnormalities

Ovaries were considered as functional when they contained follicle(s) with palpable diameter of at least 10 millimeters and any other functional structures. Ovarian atrophy was recorded when the dimensions were 20x5x5 millimeters or less and palpable functional structures were absent.

Gross and Histological Examination of Genital Organs

Collection of Specimens

Reproductive tracts used for these studies were collected at the Bauchi Meat Factory. The cows slaughtered came from the Galambi Ranch, where all other materials for this investigation were obtained. The genital tracts were recovered randomly from cattle presented for slaughter.

Genital tracts were collected in December, January, May, July, August and October. These months represent specific periods of the year in terms of rainfall distribution pattern and availability of forage for grazing. The months of December and January represent the middle of the dry season. October is the month when the rainy season ends and the dry season begins.

The value of slaughter house materials for studies of reproduction and reproductive diseases in the cow has been recognized by Lagerlof and Boyd (1953), Largerlof and Settergren (1953), Settergren and Galloway (1965) and Hartigan et al. (1972).

The reproductive tracts were recovered within one hour following slaughter and examined for any observable gross abnormalities of the ovaries, oviducts, uterine horns, uterine body and cervix.

Gross Examination

Functional ovarian structures such as follicles, ovulation depression, corpus haemorrhagicum and corpus luteum were recorded. When present pregnancies were also recorded.

The following measurements were taken from each genital tract:

1. Ovaries:
    a. Length - distance between anterior and posterior poles of the gonads.
    b. Width - distance between the medial and lateral border.
    c. Height - distance between the attached and free border.

These dimensions were measured with a sliding calipers[a] and recorded in millimeters.

d. Weight - each ovary was weighed with a sliding weight balance[b] and the weight recorded in grams.

2. Oviducts:

The diameters of the oviduct were measured only when gross pathology was evident.

3. Uterus:

a. Length of uterine horns - distance from the utero-oviductal junction and the true uterine bifurcation.

b. Width of the uterine horn latero-medial distance 2.5 centimeters anterior to the dorsal intercornual ligament. The width of the uterine horn were measured with sliding calipers.

c. Thickness of uterine wall - measured at the site the width was measured.

(a), (b) Gallenkamp Ltd., Distributed by Naafco Nigeria Ltd., Lagos.

4. Cervix:
   a. Length - distance between the internal and external os.
   b. Width - measured at the external os and in the middle of the cervix.

Histological Examination

Following physical examination and determination of dimensions samples were obtained for histological examination.

The ovaries were identified and cut in halves before placing in Bouin's fixative solution.

Segments, 3 centimeters long, were taken from the infundibulum, middle portion and at the utero-oviducal junction, respectively.

A section of the uterine wall, 1 centimeter, was removed for histological examination from both horns 2.5 centimeters anterior to the dorsal intercornual ligament. Similar-sized sample of cervical wall was obtained from the middle third of the cervix.

All tissues were fixed in Bouin's solution. According to Rajakoski (1960) fixation in Bouin's solution caused the least shrinkage of follicles and cells among the fixative solutions he compared.

After collection of samples for histological examination, each uterus was dissected for examination for gross pathological changes.

Following the initial fixation, tissues were trimmed and placed in fresh fixative solution.

Preparation and processing

Ovaries

The ovarian halves were cut in half again. Two of the fourths were carefully trimmed for processing.

Oviducts

Each segment was trimmed leaving approximately 0.5 - 0.75 centimeters length for processing.

Uterus and Cervix

The samples were trimmed to obtain segments of the entire wall approximately 0.75 centimeters square. The tissues were processed using Fisher Tissuemation[a] apparatus involving the following steps:

(1) Dehydration by passing the tissues through a series of graded ethanol (from 70 per cent to absolute).

(2) Clearing by two washings with xylol.

The processed tissues were embedded in paraffin using embedding oven[b] at 56-58°C under 400-500 mm mercury negative pressure.

(a), (b). Gallenkamp - Distributor, Naafco, Lagos.

Sectioning and Staining

Prior to sectioning, ovarian tissue blocks were oriented to obtain cross sections parallel and perpendicular to their long axis. The tissue blocks of the oviducts and the walls of the uterus and the cervix were oriented to obtain cross sections perpendicular to their long axis.

The tissues were sectioned with a rotary microtome[(a)] to obtain 7 micron thick sections.

Before staining the sections were subjected to the following procedures (Baker et al., 1960):

(1) Paraffin wax was removed by immersion in xylene for 2-3 minutes.

(2) The sections were transferred to absolute ethanol for 30 seconds to remove xylene. This was repeated to ensure complete removal of xylene.

(3) The sections were passed through 90 per cent and 70 per ethanol dishes for 30 seconds in each dish.

(4) They were then washed in distilled water.

(a) Gallenkamp - Distributor, Naafco, Lagos.

The staining procedure involved staining of sections for 20 minutes in Mayers acid-alum - hematoxylin. They were then washed in running tap water and in acid alcohol until only cell nuclei retained the stain. The sections were then "blued" in running tap water for seven minutes and counterstained with eosin for two minutes. The sections were dehydrated, cleared in the manner discussed and mounted using Gurr's neutral mounting media.

Examination procedure

Ovary

The midline sections from each ovary were selected for examination, first at scanning power then at 100 and 650 magnifications using series 10 Microstar(a).

The number of Graafian follicles were counted in each section and their diameter measured with the aid of an eye piece micrometer(b) Summers and Campbell (19

Atretic follicles in each section were counted according to the criteria described by Marion et al. (1968). They listed:(1) loosening and sloughing of the

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(a) American Optical Corporation,Buffalo N.Y.

(b) Gallenkamp - Distributors Naafco, Lagos.

basal layer of the granulosa; (3) shortening and rounding of the theca interna cells; and (4) presence of Call-Exner bodies.

Other Tissues

The sections from the oviduct, uterus and cervix were examined for any inflammatory changes (Black et al. 1953). The height of the cytoplasm and nucleus of 10 epithelial cells were measured. The uterus slides were also examined for changes described by Cupps (1973) which he associated with impaired fertility. These changes included enlargement of uterine glands with enlarged lumen and degeneration of glandular epithelium. He also described presence of localized modification of the stroma accompanied by infiltration of either eosinophils or lymphocytes.

Blood Chemistry

Blood samples were obtained from 45 cows at Galambi Ranch and 25 white Fulani cows at Shika Research Station at the time of clinical examination.

Jugular blood was collected into three tubes: One contained ethylene diamine tetraacetic acid (EDTA), another sodium flouride while the blood was allowed to coagulate in the third.

Immediately following the blood collection all samples were brought to the laboratory chilled on ice. The transport required 7-8 hours from the Galambi Ranch and 1 hour from Shika Research Station. On arrival at the laboratory the tubes containing sodium fluoride and the tubes in which the blood was allowed to coagulate were centrifuged at 3,500 revolutions per minute for ten minutes to harvest plasma and serum, respectively.

The plasma samples were used for the determination of blood glucose while the serum samples were used to measure total protein, albumin, globulin, calcium, serum inorganic phosphorus, sodium, and potassium concentrations.

Blood Glucose Determination

Blood glucose was determined according to the Nelson-Somogyi Method (1944).

Principle

The method involves colorimetric measurement of cuprous copper that is formed in the following series of reactions:

(A) Proteins are precipitated by alkaline zinc sulphate solution (barium hydroxide zinc sulphate filtrate)

(B) Cuprous ions are formed by heating this filtrate with alkaline copper solution. (C) Addition of arsenomolybdic acid to the cuprous ions results in the formation of a colored complex which is measured photometrically.

Reagents

The following reagents were used:

(i) 5 per cent solution of zinc sulphate(a)

(ii) 0.3 normal barium hydroxide(b) Reagents (i) and (ii) were of equal strength.

(iii) Alkaline tartrate reagent, "Solution A", formed by dissolving 50 grams of sodium carbonate (anhydrous)(c), 40 grams of sodium bicarbonate(d), 50 grams of Rochelle salt(e) and 400 grams of anhydrous sodium sulphate(f) in 1600 milliliters of distilled water. Distilled water was added to give 2 liters of solution; 96 milliliters of solution A at temperature above 20°C were added to 4 ml of solution B. The solution B was prepared by dissolving 75 grams of copper sulphate(g) in distilled water to which 0.25 milliliter of

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(a), (b), (c), (d), (e), (f) and (g) Supplied by Naafco, Lagos.

concentrated sulphuric acid was added. The solution was made up to 500 ml. The resulting mixture was used as the copper tartrate reagent.

(iv) Arsenomolybdate Reagent:

This reagent was prepared by dissolving 25 grams of ammonium molybdate in approximately 450 milliliters of distilled water and adding 21 milliliters of concentrated sulphuric acid(a). The preparation of the reagent was completed by addition of 3 grams of disodium hydrogen arsenate(b) dissolved in 25 milliliters of distilled water. The reagent was kept in water bath at 37°C for 24-48 hours before its use.

(v) Standard glucose solution - 0.1 per cent standard glucose solution was prepared by dissolving 100 milligrams of pure glucose(c) in saturated benzoic acid(d). The solution was made up to 100 milliliters by addition of 0.25 per cent of Benzoic acid. Working standard was prepared by diluting 5 milliliters of the stock standard to 100 ml with 0.25 per cent benzoic acid.

(a)(b)(c) and (d): Supplied by Naafco, Lagos.

Procedure for glucose determination

(i) 0.1 milliliter of fluoridated blood was placed in 3.5 milliliters of distilled water.

(ii) 0.2 milliliter of 0.3 normal barium hydroxide was added to 0.2 milliliters of 5 per cent zinc sulphate. The mixture was shaken and filtered.

(iii) One milliliter of this filtrate, one milliliter of distilled water (blank) and one milliliter of standard glucose solution were pipetted into separate test-tubes.

(iv) One milliliter of water and 2 milliliters of alkaline copper solution were added to each test-tube.

(v) The labelled test-tubes were placed in boiling water bath for 10 minutes. After boiling they were rapidly cooled (1 minute). One milliliter of arsenomolybdate reagent was added to each test tube. Along with this, 4 milliliters of distilled water was added to each test-tube to bring each up to 10 milliliters.

(vi) Each tube was read at 680 millimicrons using Bausch and Lomb Spectronic 20[(a)].

(a) Fisher Scientific Co., Pittsburgh, Pensylvania, USA.

The concentration of blood glucose was calculated as follows:

Milligrams glucose per 100 milliliters

$$= \frac{\text{Reading of Test Samples}}{\text{Reading of Standard}} \times \frac{\text{Conc. of Standard}}{\text{Volume of Serum}} \times 100$$

$$= \frac{\text{Reading of Test Samples}}{\text{Reading of Standard}} \times \frac{0.05}{0.025} \times 100$$

$$= \frac{\text{Reading of Test Samples}}{\text{Reading of Standard}} \times 200$$

Estimation of Serum Total Protein and Albumin-Globulin Ratio

Principle: Biuret method was used for determination of serum total protein and albumin:globulin ratio (Coles, 1967).

The principle is based on the observation that when an alkaline copper reagent reacts with substances whose molecules contain two carbonyl groups joined, either directly or through a single atom of nitrogen or carbon, a blue product, copper-potassium compound, is formed which can be measured colorimetrically.

Reagents:

(i) Biuret Reagent made up with Rochelle Salt- prepared by dissolving potassium sodium tartrate (45 grams), cupric sulphate (15 grams) and potassium iodide (5 grams) in 1000 milliliters of 0.2 normal sodium hydroxide.

(ii) 22.6 per cent sodium sulphate solution. This was prepared by dissolving 226 grams of anhydrous sodium sulphate in one liter of distilled water. This was stored at 37°C in a water bath.

Method

(i) To 0.5 milliliter of serum or working standard 9.5 milliliters of 22.6 percent of sodium sulphate were added and mixed.

(ii) 2 milliliters of this mixture were pipetted into a test-tube marked "T.P" (for total protein determination).

(iii) To the remaining 8 milliliters of the original mixture 2 milliliters of diethyl ether were added and the mixture was shaken 20 times. This mixture was left to stand until fractions of albumin and globulin were formed. The tube was then centrifuged at 2,000 revolutions per minute for 10 minutes.

(iv) Two milliliters were then pipetted out of the clear solution below the globulin layer into a tube marked "Alb" (for albumin determination). Two millilitres were pipetted into a fourth tube marked "Blank"

(v) To all four tubes 8 milliliters of Biuret reagent were added and then mixed.

(vi) All tubes were read, after standing for 10 minutes, at 450 millimicrons transmission using Bausch and Lomb Spectronic 20. The

reading of "Blank" was adjusted to, 100 per cent transmission; that is, zero.

Calculation

(i) Total Protein

Density of serum x Value of control = Total serum protein.

(ii) Albumin

The above formula was employed substituting the albumin value for the total protein value of control.

(iii) Globulin

Globulin value was obtained by deducting the value of albumin from that of the total proteins. The albumin:globulin ratio was then calculated.

Determination of Inorganic Phosphorus

The inorganic phosphorus levels were determined by the modified Fiske and Subbarow Method (Fiske & Subbarow, 1925).

Principle

The principle involves removal of protein with trichloroacetic acid.

Treatment of filtrate with acid-molybdate which reacts with inorganic phosphate to form phosphomolybdic acid. The phosphomolybdic acid is then reduced with 1,2,4 - aminoaphtholsulphonic acid to give a blue color which is estimated colorimetrically.

Reagents

(i) Trichloroacetic Acid[(a)] 30 percent

(ii) Ammonium molybdate[(b)] 0.0202M was prepared by dissolving 25 milligrams of ammonium molybdate in 700 milliliters of distilled water and by cautious adding of 84 ml of concentrated sulphuric acid. The mixture was cooled and made up to 1000 milliliters with distilled water.

(a) and (b). Supplied by Naafco Ltd., Lagos.

(iii) P- Semidine Reagent[a] (N-phenyl - P - Phenylene diamine hydrochloride). 0.5 gram of P- semidine reagent was placed in a flask. The solid salt was wetted with a few drops of 95% ethanol and then dissolved in 100 milliliters of 1 per cent sodium meta-bisulphite solution. After shaking the solution was filtered. This solution was prepared freshly every day.

(iv) Stock Phosphorus Standard.
Stock phosphorus standard was prepared by dissolving 439 milligrams of potassium hydrogen phosphate in 100 milliliters of distilled water in a volumetric flask. Chloroform was added as preservative.

(v) Working Phosphorus Standard.
1 Milliliter of stock standard was added to 16 milliliters of 30% trichloroacetic acid. The volume was brought up to 100 milliliters by addition of distilled water.

Procedure

(i) 0.5 milliliter of serum was mixed with 1.5 milliliters of distilled water and 3

(a). Supplied for Naafco, Lagos.

milliliters of 30 per cent trichloroacetic acid. After standing for 5 minutes the mixture was centrifuged. The supernatant was saved.

(ii) Three tubes were set up as follows:

(a) "Sample" containing 2 milliliters of supernatant from (i)

(b) "Standard" - 2 milliliters of working standard.

(c) "Blank" - containing 1.2 milliliters of 30 per cent trichloro acetic acid and 0.8 milliliters distilled water.

(iii) To each of these 3 tubes 0.4 milliliter of molybdate reagent was added. After mixing, 4 milliliters of freshly prepared semidine reagent were added.

(iv) The mixture was allowed to stand for 10 minutes before reading at 680 millimicrons using Bausch and Lomb Spectronic 20.

Calculation

Since 2 milliliters of standard solution contained 0.02 milligrams of phosphorus and 2 milliliters of filtrate from (i) were equivalent to 0.2 milliliters of serum, the amount of inorganic phosphorus in 100

milliliters of serum was calculated:

$$\frac{\text{Reading of test}}{\text{Reading of Standard}} \times \text{Mg. P in Standard} = \text{Mg/100 of P in Serum}$$

$$= \frac{\text{Reading of test}}{\text{Reading of standard}} \times \frac{0.2 \times 100}{2} = \text{Mg/100 ml of P in Serum}$$

$$= \frac{\text{Reading of test}}{\text{Reading of standard}} \times 10 = \text{Mg/100 ml of P. in Serum}$$

Determination of Serum Calcium

Serum calcium was determined by the atomic absorption Spectometer method described by Willis (1960[a,b] 1961) using Atomic Absorption Spectrometer Model 306[(a)]

Principle

The principle employed in atomic absorption spectrometry is essentially the same as that employed in flame photometry except that the inability of the flame photometer to utilize more than 1 per cent emmision is corrected for. This allows the atomic absorption spectrometer to be useful for determining of most metals present in biological materials (Lancaster, 1969).

Atoms are activated in a flame to the point when a large percentage of them respond to the radiant energy of their characteristic emission wavelength, and then absorb this energy by a poorly understood process, called resonance.

Reagents

i. Strontium chloride. diluent[(b)]

ii. Calcium standard[(c)] - stock 1000 mg/ml

(a), (b) Distributed by Perkins & Elmer, Norwalk Connecticut - U.S.A.

(c) Calcium Carbonate - supplied by Naafco, Lagos.

iii. Calcium standard - working 100 mg/ml

Procedure

(i) Serum samples were diluted in the ratio of 1:50 using the strontium chloride diluent.

(ii) The concentrations of sample calcium of the standard were read out directly.

Determination of Serum Sodium and Potassium

Serum sodium and potassium was determined by the flame photometer[a] method (King & Wootton, 1956).

Principle

Test solution is passed, under carefully controlled conditions, as a very fine spray into the air supply, to a burner.

In the flame the solution evaporates and dissociates to release its atoms. Some of these atoms are excited into a high energy state and give out emission when they fall back to the ground state. The emission is of a characteristic wavelength and when passed through a suitable filter to a selenium cell or other sensitive element, current is produced in amounts that varies with the concentration of sodium (or other elements) in the solution tested.

Reagents

(i) Standard Stock Sodium. This was prepared by dissolving 11.691 grams of pure sodium chloride[a] in 1000 millilitres of distilled deionized water to give 200 milli-equivalent/liter.

(a) and (b). Supplied by Naafco, Lagos.

Working standard was prepared by diluting 8 milliliters of stock solution in distilled deionized water to give 1 liter. The final concentration of the working standard was 1.6 milli-equivalent per liter.

(ii) Standard Stock Potassium: This was prepared by dissolving 0.745 grams of pure, dry potassium chloride(a) in a liter of distilled deionized water. This solution was equal to 10 milli-equivalent/liter. Working standard was prepared from this solution by further diluting 8 milliliter of stock in distilled deionized water to give 1 liter. To this 7 milliliters of stock sodium were added to obtain 0.08 milli-equivalent/liter.

Procedure for Sodium determination

(i) Preparation of serum sample:- 0.1 milliliter of serum was diluted with 9.9 milliliters of ionized water. This gave a dilution of 1:100.

(ii) Setting of Flame photometer(b):- The gas was turned on and after a few seconds it was lighted. The air pump was started and adjusted to a pressure of 0.7 kg/cm^2 (10 lb/sq in.)

(a) Naafco Scientific Company, Lagos.
and (b)

The gas supply was then adjusted until a number of cones appeared in each hole in the burner cap, approximately $3/16$ inch high. The galvanometer was then turned on.

(iii) Sodium filter was inserted. A sample of deionized water was then aspirated and the zero adjusted. Sodium standard was then aspirated and by means of the sensitivity control the light spot was adjusted to the required deflection (80). This was repeated until the zero and standard readings were constant.

The diluted serum samples were then aspirated and the readings recorded. Between readings deionized water was used to flush the instrument.

Procedure for potassium determination

The procedure used was essentially the same as for sodium determinations except for the use of a potassium filter.

Hematological Examinations

At the time of the regular clinical examination conducted during the months of March, April, June,

August, October, November, December and January, blood samples were taken from the jugular vein of randomly selected animals of the Galambi Ranch. Most of these were the animals used for clinical examination and blood chemistry investigation. Disodium salt of ethylene diamine tetraacetic acid (EDTA) was added to each sample. The samples were conveyed to Zaria in the same manner as blood samples used for blood chemistry studies.

The blood samples were used for the determination of hemoglobin value and packed cell volume.

Hemoglobin Determination

Hemoglobin was determined using the cyanmethemoglobin method on the Beckman D.B. Spectrometer model 140[a] at a wavelength of 540 μ. (Coles, 1967).

Reagents

1. Cyanmethemoglobin

Procedure

(i) 5 milliliters of cyanmethemoglobin[b] diluent was placed in a clean cuvette.

(ii) 0.02 milliliters of blood (sample) was added to the diluent.

(a) Naafco Scientific Company, Lagos

(b) Scientific Product McGraw Park Illinois, U.S.A.

(iii) The cuvettes were stoppered and inverted three times and allowed to stand for 10 minutes.

(iv) The cuvettes were then placed in a spectrophotometer and the percentage transmission at 540 microns recorded.

(v) The hemoglobin value was read on a previously prepared curve.

Packed Cell Volume Determination

Packed cell volume was determined using the Hematocrit Method (Coles, 1967).

Procedure

Small bore (about 1.0 mm) capillary hematocrit tubes were filled with blood using capillary action. The tubes were sealed at one end using clay. They were then placed in the microhematocrit centrifuge with the sealed end toward the rim and centrifuged at 2,000 revolutions per minutes for 10 minutes.

The values were read off a special chart.

Statistical Methods

All dimensions were analysed using estimation of population mean; confidence interval (Dunn 1964). Seasonal variations in the dimensions of various parts of the genital organs (estimated rectally and grossly), blood chemistry (glucose, total protein, albumin, globulin, calcium, phosphorus, sodium and potassium) and hematological measurements (Hb and PCV) were subjected to variance test and estimation (Dunn 1964; Sokal and Rohlf 1969).

Seasonal occurrence of noncycling cows, atrophic ovaries and their relationship as well as seasonal variation in total number of follicles were analysed using chi-square test (Dunn 1964). Seasonal variation of ratio of oviducal epithelial cell height and diameter of the nuclei were similarly analysed.

RESULTS

Clinical Examination

1. Ovaries

The average monthly dimensions of bovine ovaries at Galambi ranch determined by rectal examination are summarized in Table 1 and Fig. 1 and 2. The detailed monthly findings are presented in the Appendix (Tables 1-15).

The monthly average for all dimensions for both ovaries demonstrate a statistically significant increasing linear trend. The mean (for all samples) for each dimension measured in millimeters are as follows:

Ovary	Length	Width	Height
Left	26.2	9.1	11.7
Right	27.5	9.3	12.4

The right ovaries were on the average longer, wider and taller than the left ovaries but the difference was not statistically significant.

In order to test whether or not seasonal variations are present, the data was grouped according to the following seasons:- Dry, January to March; Pre-rain, April to May; Rain, June to September; and Pre-dry, October to December. The mean of the ovarian dimensions for each season are presented (Table 2).

Table 1. Average monthly dimensions of bovine ovaries at Galambi ranch as estimated by rectal palpation

	Left Ovary			Right Ovary		
Month	Length	Height	Width	Length	Height	Width
January	19.5±7.57	6.9±2.49	7.4±3.4	20.7±7.8	7.4±3.0	8.3±4.28
February	21.2±7.7	7.1±2.5	8.2±3.6	24.1±7.6	8.3±3.3	10.0±4.7
March	23.1±10.8	10.4±4.9	10.0±3.9	23.3±10.6	9.6±4.6	9.8±4.0
April	22.2±6.1	7.6±3.4	9.3±4.2	23.8±6.3	8.0±3.4	10.1±5.5
May	23.7±6.5	7.9±3.4	10.5±4.8	25.4±5.9	8.1±3.7	11.0±5.1
June	27.0±7.2	9.9±5.2	12.8±5.1	27.9±8.5	10.0±3.0	13.4±4.0
July	26.9±7.0	12.0±5.6	30.4±8.3	30.4±8.3	11.7±5.0	15.2±5.3
August	30.3±8.7	8.5±4.9	11.8±7.4	31.8±7.4	9.2±3.8	12.7±5.8
September	28.8±6.3	8.2±4.3	12.2±6.3	29.7±7.1	8.8±6.1	12.0±6.5
October	28.7±7.0	9.9±3.7	14.5±5.2	30.4±8.2	9.7±5.3	15.4±5.9
November	31.5±7.0	10.7±4.7	15.8±5.6	31.9±6.1	11.0±4.5	17.2±5.6
December	29.1±8.2	9.2±5.1	12.3±6.6	29.5±7.7	10.0±4.9	12.3±5.7
January	25.9±6.8	7.3±3.9	7.9±4.1	24.8±6.6	8.1±4.0	9.6±5.1
March	24.8±8.0	6.3±2.2	12.3±4.4	24.8±9.2	6.1±3.2	9.8±3.0
May	20.6±11.9	7.6±3.6	10.3±5.4	18.8±12.2	8.8±5.2	10.6±7.1

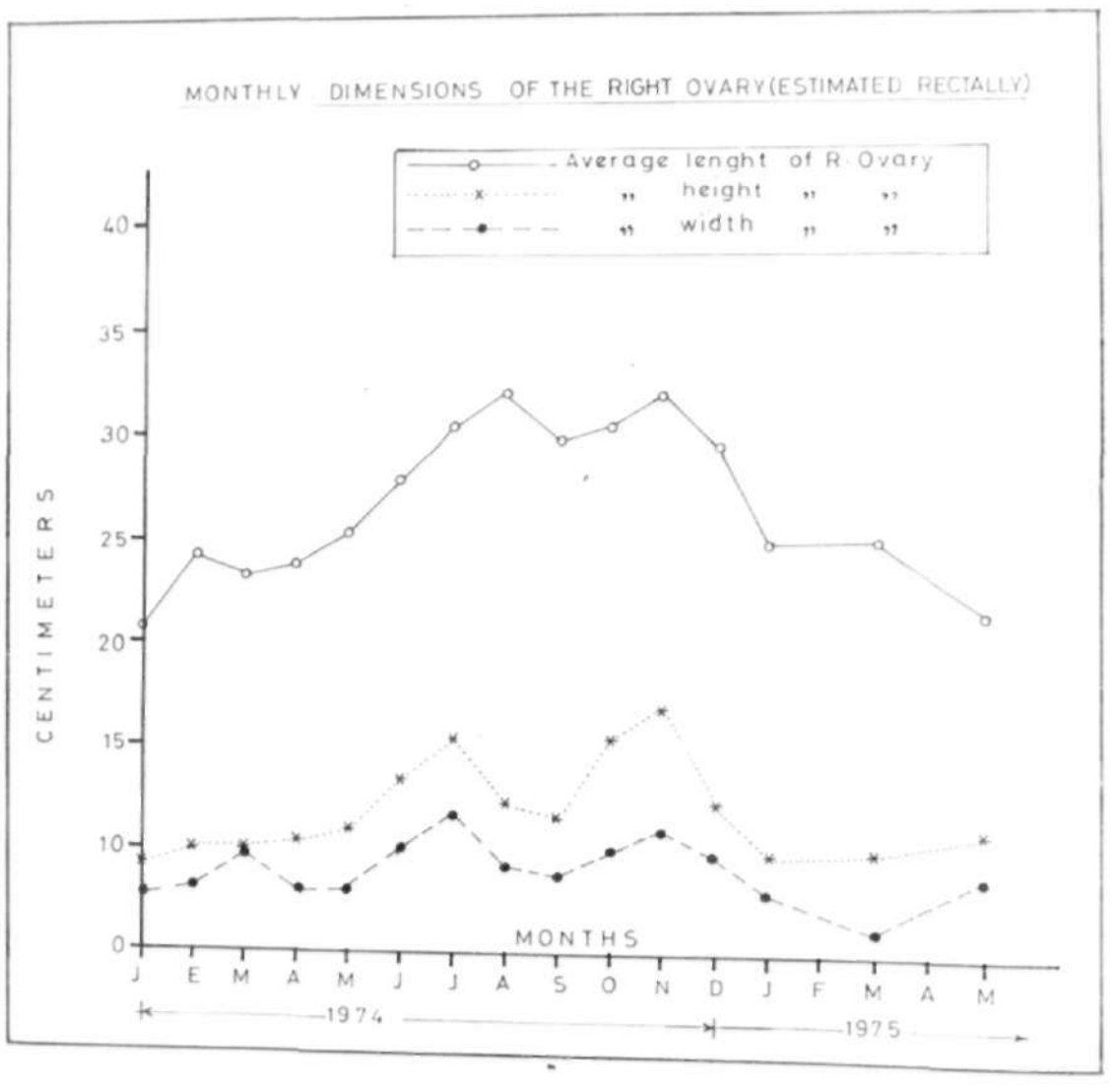

MONTHLY DIMENSIONS OF THE RIGHT OVARY(ESTIMATED RECTALLY)
Average lenght of R Ovary
" height " "
" width " "
CENTIMETERS
40
35
30
25
20
15
10
0
MONTHS
J E M A M J J A S O N D J F M A M
1974
1975

Fig. 2. Monthly dimensions of the left ovary as estimated by rectal palpation.

All three dimensions showed an increasing linear trend. Inter-month variation was significant for all dimensions and for both ovaries. The degree of significance at F(11,228)are as follows:

Ovary	Length	Width	Height
Left	5.93	3.09	4.52
Right	8.81	1.99	5.96

Table 2: Seasonal means of the ovarian dimensions of cattle at Galambi ranch.

Season	Length (mm) Left	Right	Width (mm) Left	Right	Height (mm) Left	Right
Dry	21.5	22.7	10.0	10.1	8.6	9.4
Pre-rain	23.0	24.7	8.3	8.5	10.0	10.5
Rain	28.3	29.9	7,9	8.1	12.9	13.3
Pre-dry	29.8	30.6	9.6	9.9	13.8	15.1

There was no significant variation in ovarian length between the dry and pre-rain period and between the rainy and pre-dry period. The seasonal difference in length between pre-rainy and rain, however, was highly significant (F11,228) was 29.48 for the left ovary and 21.16 for the right). This difference was responsible for the highly significant inter-season variation (F(3,228)was

28.40 for the left ovary and 19.17 for the right). The difference in ovarian length during the rainy season and the remaining seasons combined was significant (F(11, 228) was 14.52 for the left ovary and 13.28 for the right).

Seasonal variation in ovarian width was significant (F(3,228)was 13.09 for left ovaries and 12.63 for the right). It was also observed that pre-rainy and season difference was the major factor in the observed variation. There was no statistically significant difference between ovarian width during the rainy season and the other three seasons combined.

Seasonal variation in ovarian height was highly significant (F(3,228)was 13.29 and 16.44 for left and right ovaries, respectively). The factor responsible for this difference is the same for length and width. The difference in ovarian height during the dry and pre-rainy season was not significant. The rainy versus pre-dry season height was different statistically significant for the left ovary only (F(1,228) was 4.81). The rainy season ovarian height was statistically different from the other three periods at the 0.025 level of significance. At 0.5 level, only the height of the left ovary was significant.

Table 3. Monthly variation in functional structures in the ovaries of cows examined at Galambi Ranch.

Month	No. Cows examined	Functional Structures					Noncycling
		No.	Follicle	CL_1	CL_2	CL_3	
January	21	5	2	-		-	16
February	21	8	2	-	6	-	13
March	24	3	-	2	1	-	21
April	46	14	7	4	3	-	32
May	58	8	4	-	2	2	50
June	34	17	9	2	6	-	17
July	27	8	6	-	-	2	19
August	31	20	11	1	3	5	11
September	30	10	3	3	-	4	20
October	39	33	16	14	13	4	6
November	37	35	23	4	11	6	2
December	32	27	15	4	8	9	5
January	24	14	5	-	4	5	10
March	20	8	4	-	5	-	12
May	17	7	3	1	2	1	10

CL_1 = corpus luteum 2 cm. CL_2 = corpus luteum 2-3 cm. CL_3 = corpus luteum 3 cm.+

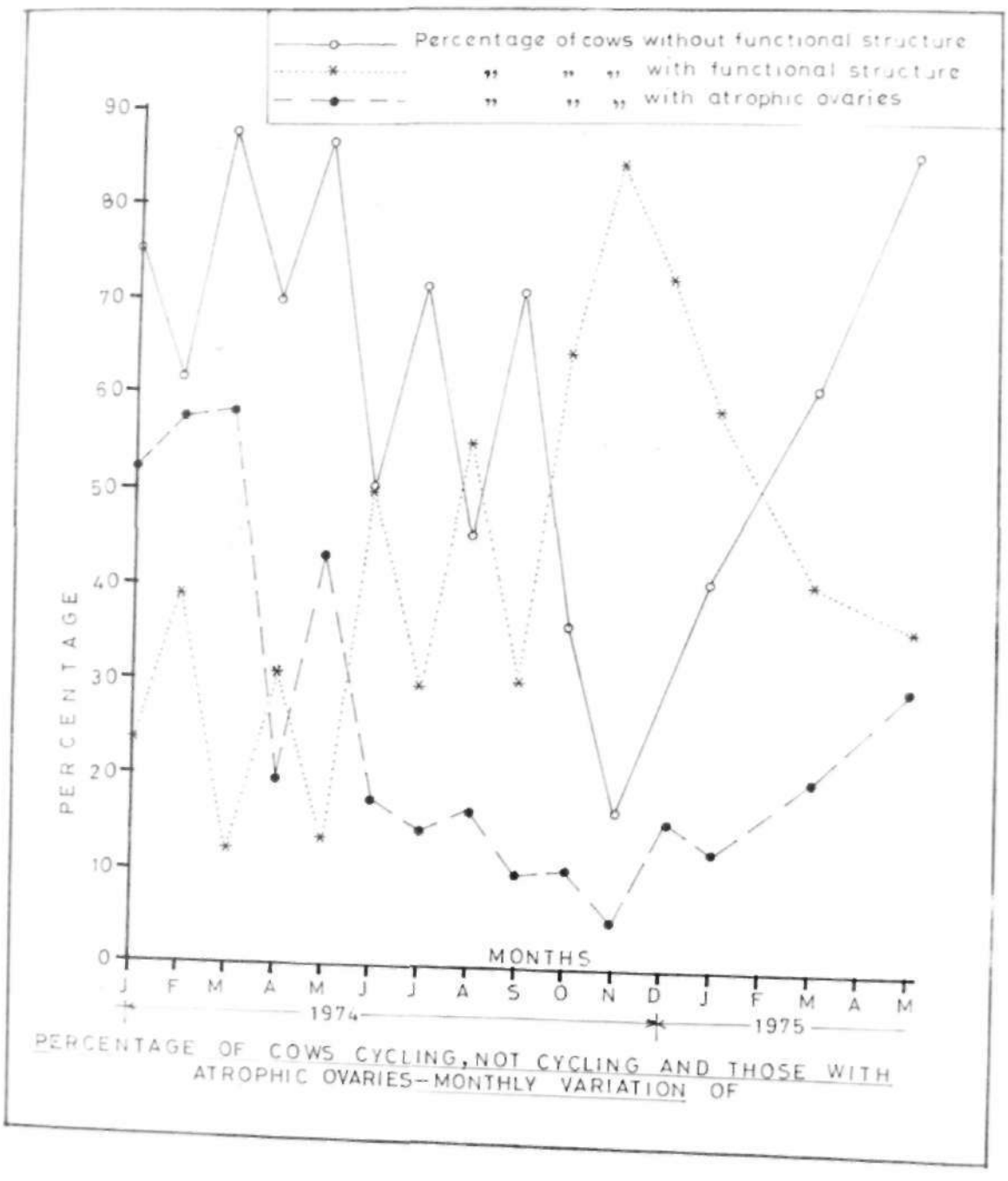
Monthly distribution of functional structures (follicles, ovulation depression, corpus hemorrhagicum, growing corpus luteum, and regressing corpus luteum) are presented in the Appendix (Tables 1-15). Cows without these structures were classified as noncycling. Ovaries in noncycling cows with dimensions of 25 x 5 x 5 mm or less were classified as atrophic (Table 3).

The seasonal frequency of ovarian activity is presented in Table 4 and Fig. 3.

Table 4: Seasonal Distribution of Noncycling cows at Galambi ranch in 1974-75.

Season	Dry	Pre-rain	Rain	Pre-dry	Total
Atrophic (A) Ovaries	27	28	10	4	69
Non-cycling (B)	50	82	71	29	232
Proportion of A to B	0.54	0.34	0.14	0.14	0.3

Chi-square test showed that occurrence of atrophic ovaries in noncycling cows depended upon the season. The seasonality of atrophic ovaries was highly significant (X_2 = 18.77). Comparison between the rainy and remaining seasons was as follows:



PERCENTAGE OF COWS CYCLING, NOT CYCLING AND THOSE WITH ATROPHIC OVARIES—MONTHLY VARIATION OF

Ovary	Rainy Season	Remaining Seasons	Total
Atrophic (A)	10	59	69
Non-cycling (B)	71	161	232
Proportion of A to B	0.14	0.37	0.3

The incidence of atrophic ovaries was significantly lower during the rainy season ($X_2 = 7.69$).

2. Palpable Abnormalities

Four hundred and sixty-one rectal examinations were performed and the pathological conditions found are tabulated (Table 5).

Table 5: Incidence of pathological conditions found in cattle upon rectal examination.

Pathological condition	Number	Incidence (%)
Ovaritis	6	1.3
Follicular cyst	1	0.2
Perisalpingitis	7	1.5
Hydrosalpinx	1	0.2
Pyometra	1	0.2
Cervicitis	23	5.0
Total	39	8.4

Gross and Histological Examination of genital organs

1. Ovaries

(a) Dimensions:

The range, mean, standard deviation and the 95% confidence level was calculated for length, width and height of the ovaries examined from Bauchi slaughter-house (Tables 5-8; Figs 4-6). The data was grouped according to periods of the year. The marked spread of the range of all three dimensions was primarily due to a corpus luteum in the larger ovaries. Although the difference in length and height were not statistically significant, the average width of the right ovary was greater than that of the left ($F=8.71$ and $df=1,65$).

There was variation within and between monthly measurements (Fig. 7 and 8). The greatest values of the three dimensions of both ovaries were found in May and August.

(b) Weight:

Weight could be obtained only for 29 pairs of ovaries, collected in January, July and December. The weight of the left ovary ranged from 1.5 - 10.25g with a mean of 3.4g and a standard deviation of 2.0g. The corresponding measurements for the right ovary were 3.5g and 2.0g respectively. At 95% confidence level the average weight

Table 6. Seasonal Variations in length in bovine ovaries examined from Bauchi slaughterhouse.

Month	Range (mm)		Mean (mm)		Standard Deviation		95% C.L.* (mm)	
	Left	Right	Left	Right	Left	Right	Left	Right
January	18.9-31.5	15.75-31.5	28.85	24.60	±5.10	5.31		
May	20.0-40.0	23.0-43.0	28.10	30.30	±7.53	±6.46		
July	18.0-45.0	18.0-43	25.63	25.88	±8.86	8.03		
August	25.0-38.0	30.0-35.0	30.17	31.67	±4.96	±2.58		
October	15.0-40.0	18.0-40.0	25.27	25.27	±7.31	8.08		
December	20-32	20.1-43.0	27.58	28.71	±3.87	±6.81		
TOTAL	15.0-45.0	15.75-43.00	26.91	27.43	6.38	6.87	26.91 ±161	27.43 ±181

*C.L. = Confidence level

Fig. 4. Frequency Polygon of the length of left and right ovary compiled from slaughter-house specimens.

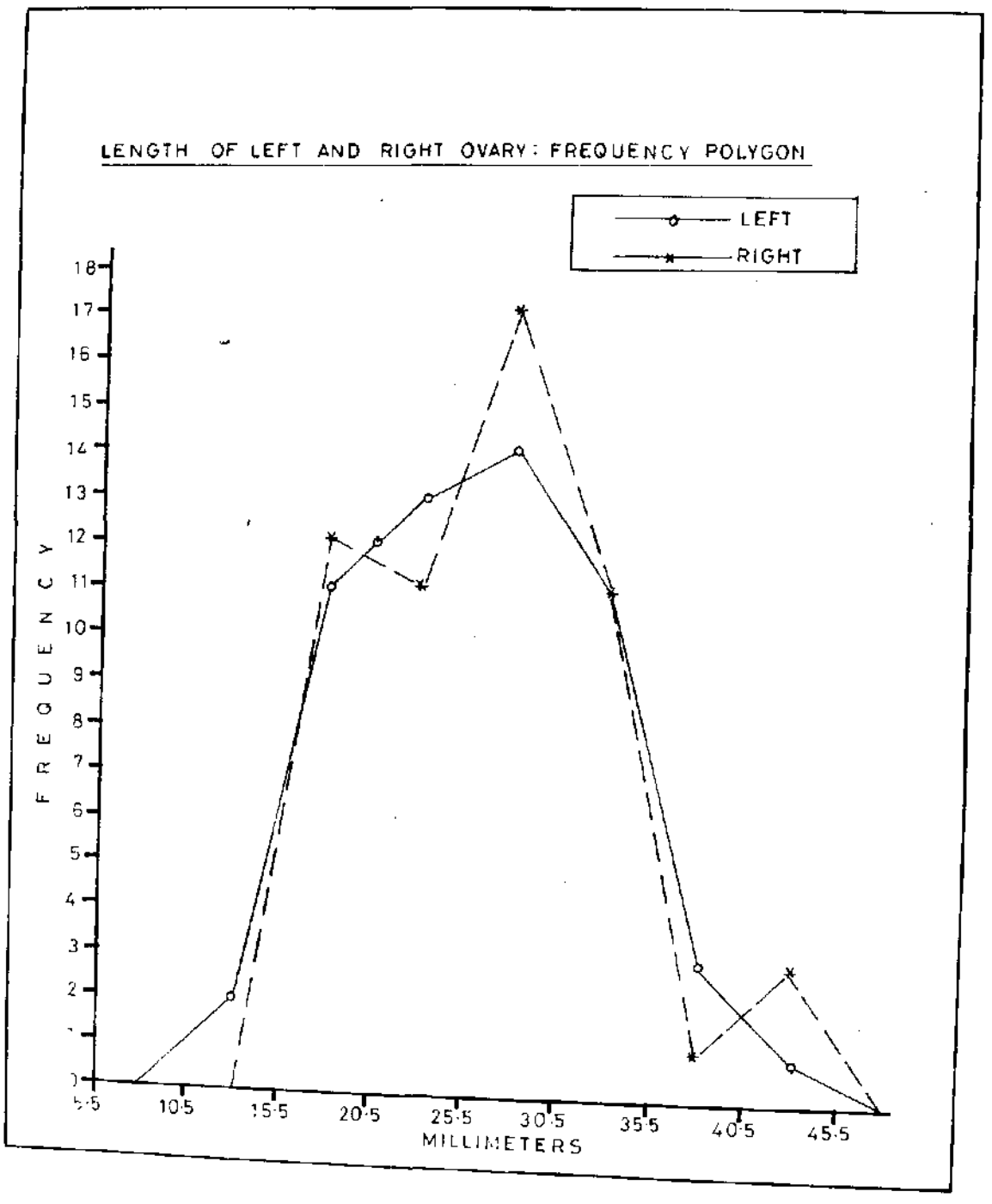

LENGTH OF LEFT AND RIGHT OVARY: FREQUENCY POLYGON
LEFT
RIGHT
FREQUENCY
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
10·5
15·5
20·5
25·5
30·5
35·5
40·5
45·5
MILLIMETERS

Table 7. Seasonal variation in width in bovine ovaries examined from Bauchi slaughterhouse.

	Range (mm)		Mean		Standard deviation		95%C.L.*(mm)	
Month	Left	Right	Left	Right	Left	Right	Left	Right
January	8.4-18.9	9.5-18.9	12.04	13.25	3.26	3.23		
May	11.0-23.0	10.0-25.0	13.06	16.3	4.45	5.77		
July	8.0-13.0	8.0-18.0	9.88	10.88	1.89	3.09		
August	8.0-25	10.0-18.0	12.85	14.17	6.65	2.79		
October	8.0-20.0	8.0-20.0	12.18	12.36	3.31	3.29		
December	9.0-18.0	6.6-20.0	12.04	12.48	3.21	3.41		
TOTAL	8.0-25.0	6.6-25.0	12.12	13.06	3.81	3.92	12.12 ±0.998	13.09 ±1.04

*C.L. = Confidence level

Fig. 5. Frequency Polygon of the width of left and right ovaries compiled from slaughter-house specimens.

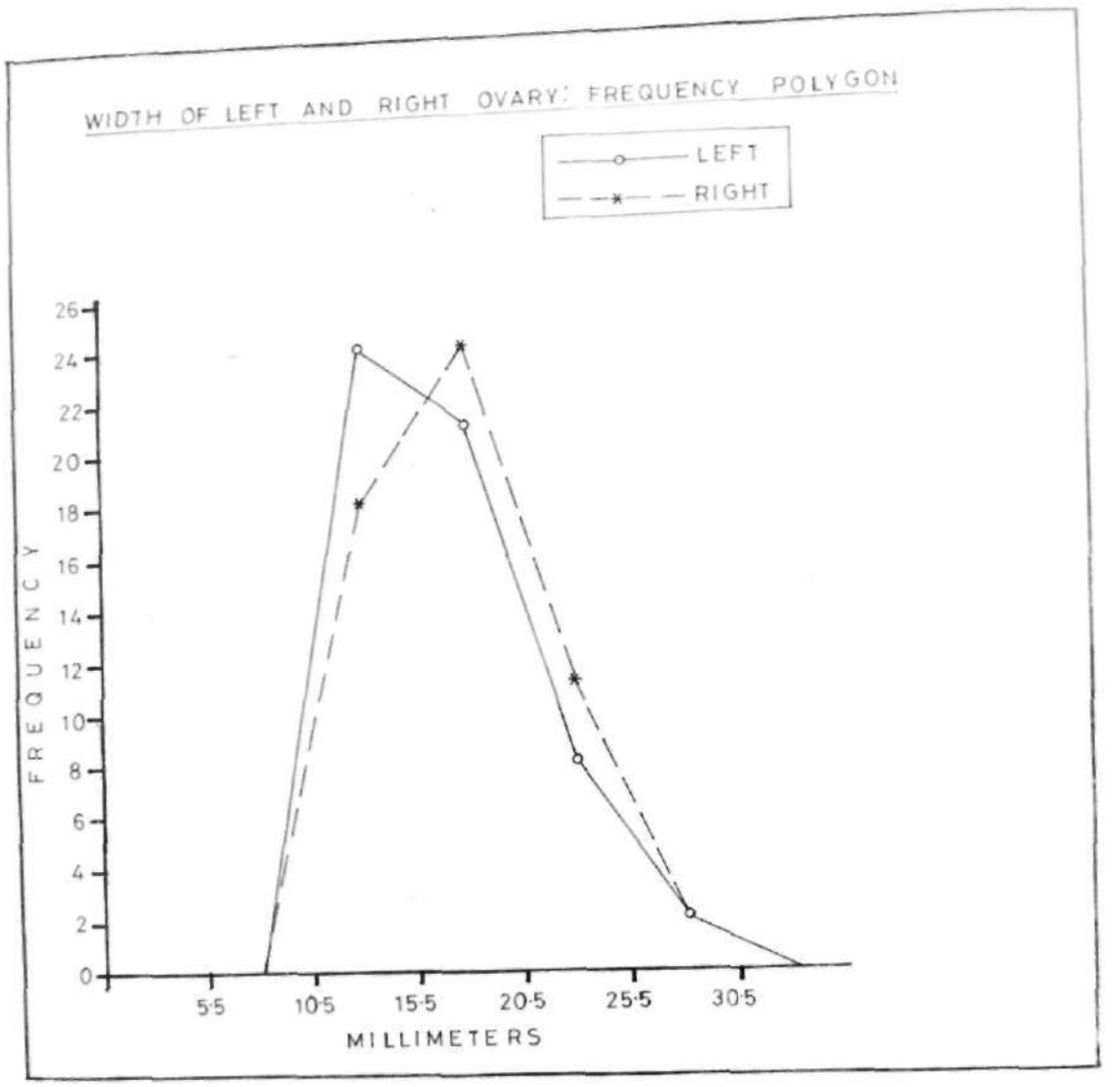

WIDTH OF LEFT AND RIGHT OVARY: FREQUENCY POLYGON
LEFT
RIGHT
FREQUENCY
0
2
4
6
8
10
12
14
16
18
20
22
24
26
5·5
10·5
15·5
20·5
25·5
30·5
MILLIMETERS

Table 8. Seasonal variation in height **in bovine ovaries examined** from Bauchi slaughterhouse

	Range (mm)		Mean (mm)		Standard deviation		95% C.L.* (mm)	
Month	Left	Right	Left	Right	Left	Right	Left	Right
January	6.3-18.9	9.5-18.9	11.67	13.25	3.33	3.23		
May	8.0-22.0	6.0-15.0	9.4	11.10	3.66	3.41		
July	8.0-22.0	8.0-21.0	14.75	14.75	4.34	4.59		
August	12.0-22.0	15.0-30.0	14.83	19.83	3.92	5.53		
October	6.0-15.0	8.0-23.0	10.27	12.00	2.61	5.20		
December	8.0-27.2	7.3-32.0	16.99	17.81	5.04	6.48		
TOTAL	6.3-27.2	6.0-32.0	12.71	14.50	4.62	5.54	12.71 ±1.21	14.50 ±1.46

*C.L. = confidence level

Fig. 6. Frequency Polygon of the height of left and right ovaries as measured from slaughterhouse specimens.

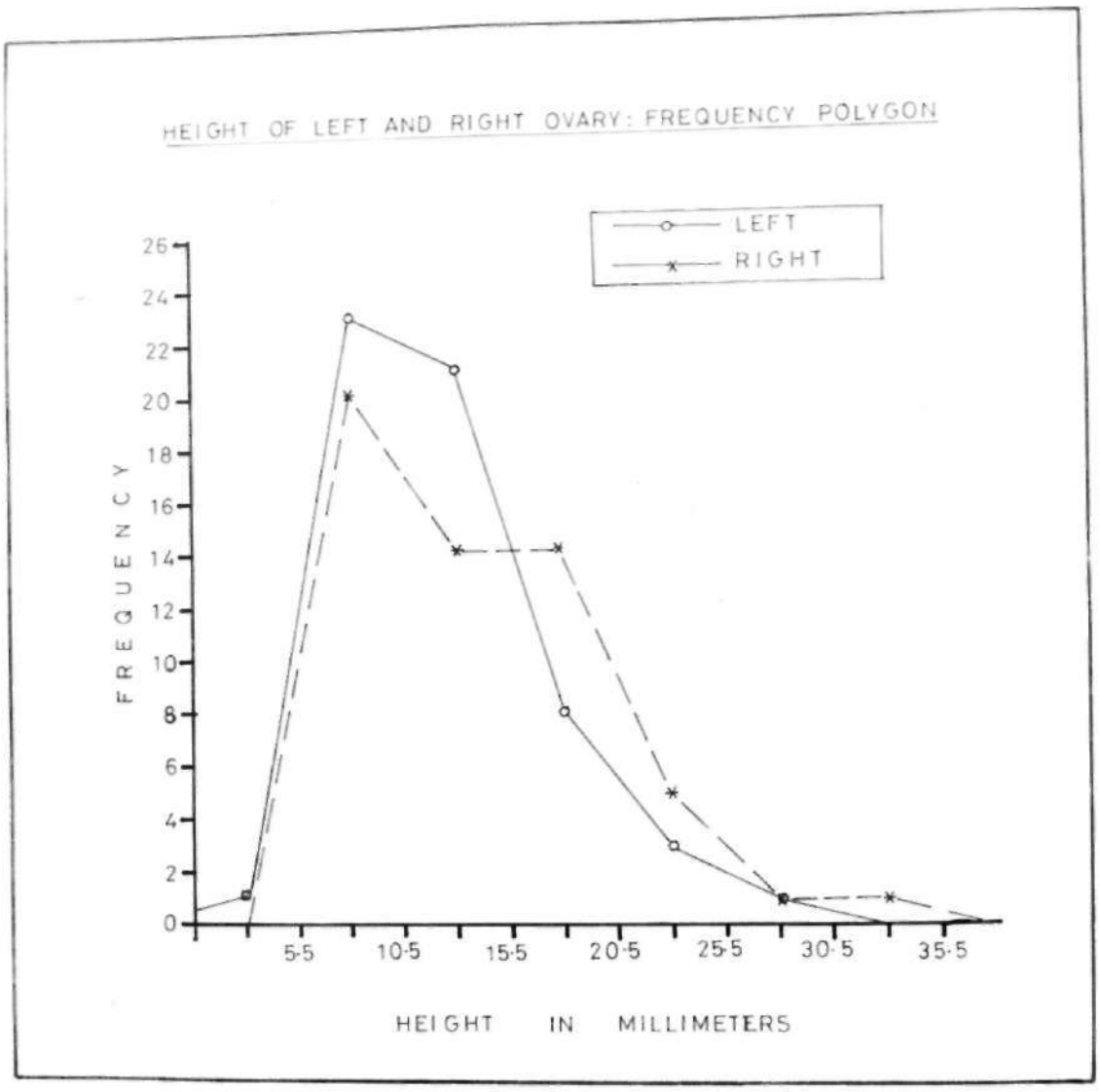

HEIGHT OF LEFT AND RIGHT OVARY: FREQUENCY POLYGON
LEFT
RIGHT
FREQUENCY
0
2
4
6
8
10
12
14
16
18
20
22
24
26
5·5
10·5
15·5
20·5
25·5
30·5
35·5
HEIGHT IN MILLIMETERS

Fig. 7. Seasonal variation of the dimensions of the left ovary measured from slaughter-house specimens.

SEASONAL VARIATION OF THE DIMENSIONS OF THE LEFT OVARY
(DETERMINED FROM GROSS SAMPLES)

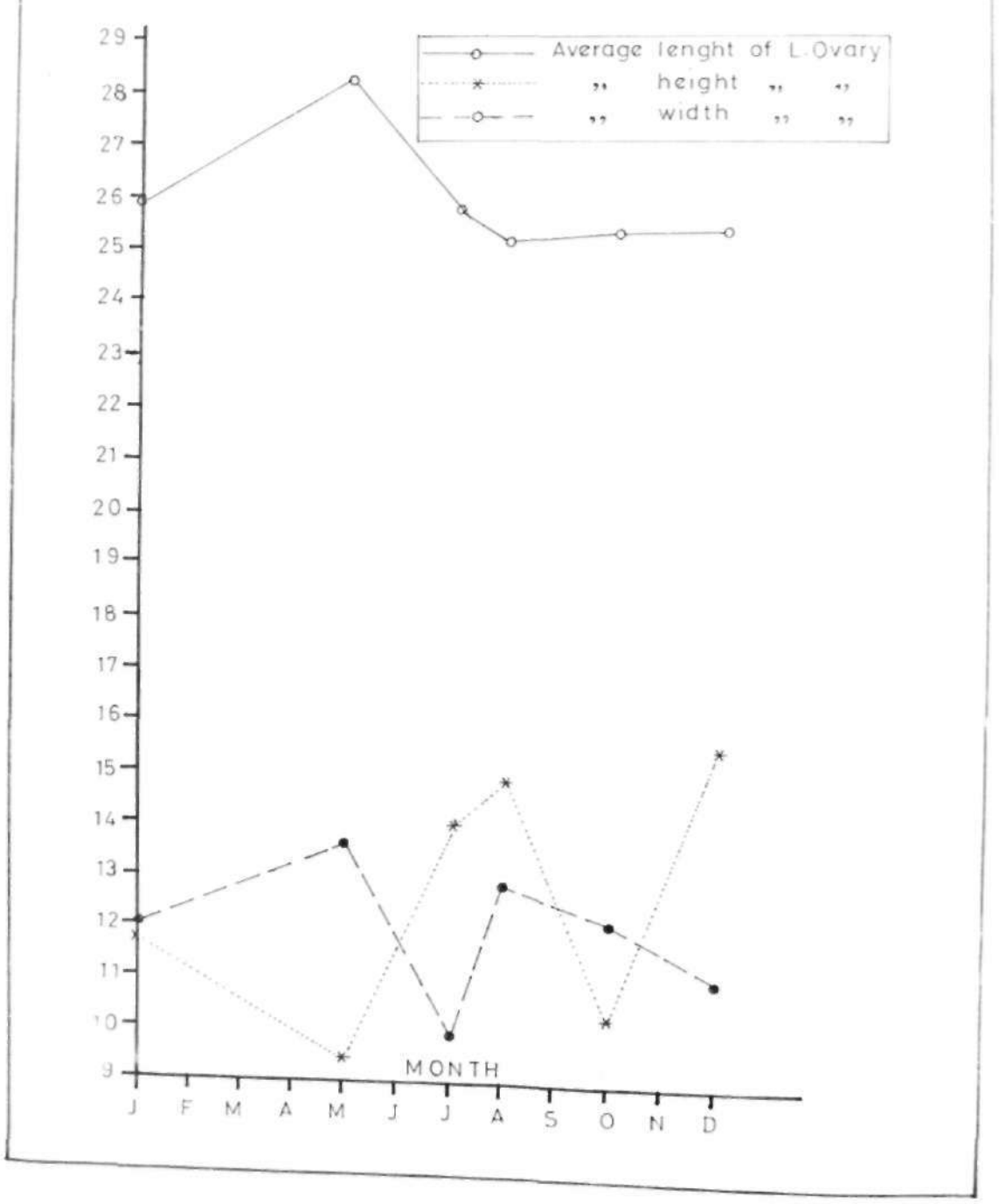
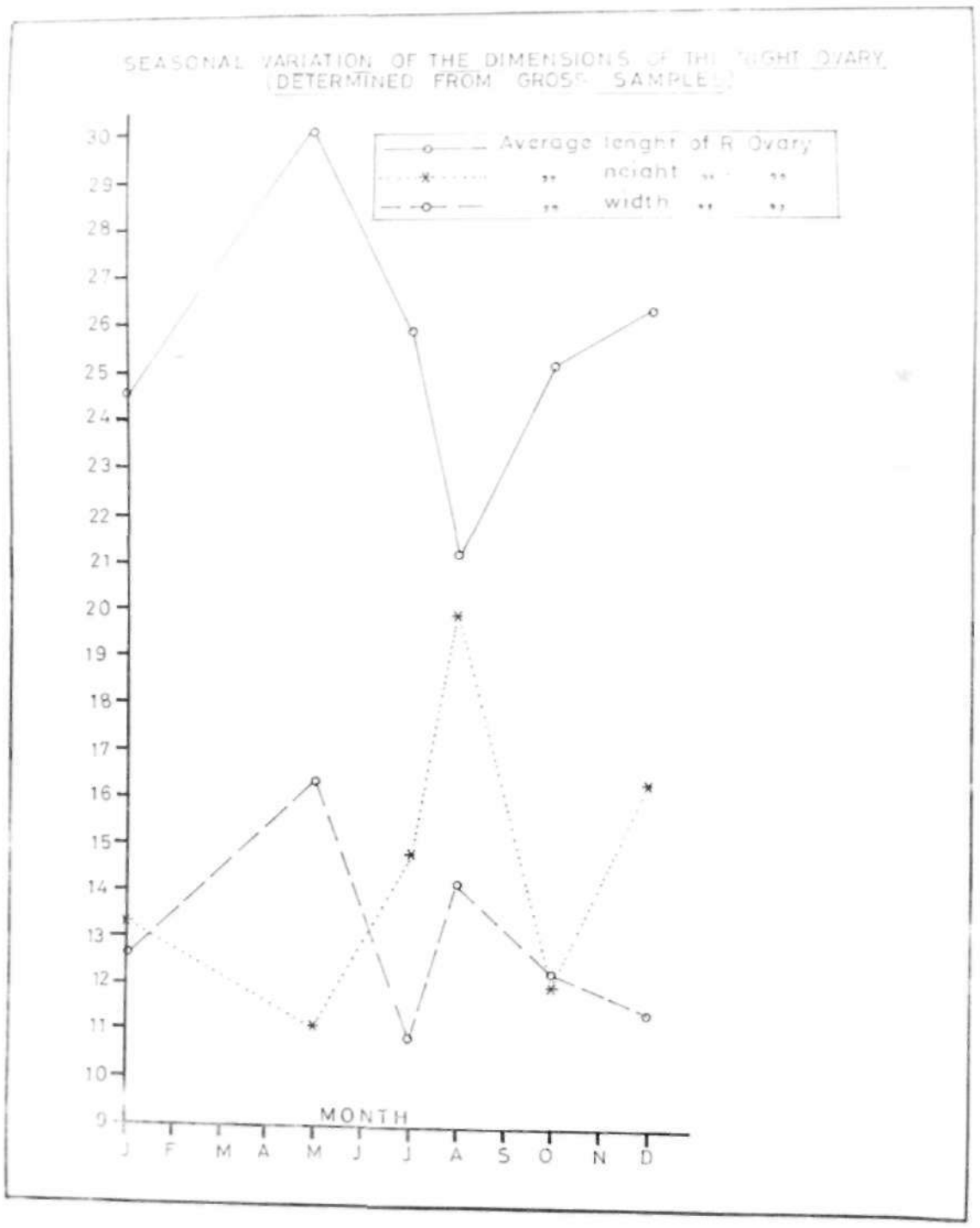


Fig. 8. Seasonal variation of the dimensions of the right ovary measured from slaughterhouse specimens.


SEASONAL VARIATION OF THE DIMENSIONS OF THE RIGHT OVARY
(DETERMINED FROM GROSS SAMPLES)
Average lenght of R Ovary
,, height ,, ,,
,, width ,, ,,
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
MONTH
J F M A M J J A S O N D

of the left and right ovary was 3.4 ± 0.7 and 3.5 ± 0.7g, respectively.

(c) Cyclic Activity:

A pair of ovaries was classified as cyclic or functional if one or both ovaries contained functional structures such as follicles, ovulation depression, and a developing, developed or regressing corpus luteum. With the absence of functional structures the ovaries were classified as non-functional. The monthly incidence of functional ovaries is given in Table 9.

Table 9: Monthly Incidence of cyclic activity in ovaries examined from Bauchi slaughter house.

Month	No. pairs of Ovaries	Functional Ovaries Total	Percent
January	10	3	30.0
May	10	3	30.0
July	8	7	87.5
August	6	6	100.0
October	11	5	45.5
December	11	3	27.3

The highest incidence of functional ovaries was found in specimens collected in July and August. The difference was statistically significant, with respect to the four seasons. When the proportion of atrophy during the rainy season was tested against the other three seasons, the difference was statistically significant.

(d) Gross Abnormalities:

A unilateral case of follicular cystic degeneration was the only gross abnormality observed.

(e) Microscopic Examination:

The total number of large ($>150\mu$), medium ($75-150\mu$), small ($<75\mu$), and atretic follicles is recorded for each ovary (Fig. 9 and 10). Monthly averages were calculated for each of these parameters. Seasonal variation was observed in distribution of size group (Table 10; Fig. 11 and 12). When the values during rainy season were compared with the rest of the seasons combined the differences were not significant - $X_2 = 2.26$ at 2df. This suggested that the seasonal variations noted were due to variation in the size groups within the remaining three seasons.

The incidence of atretic follicles was lowest in ovaries collected in August (Table 11. Fig. 9 and 10).

Table 10. Monthly average follicles and size groups

Months	Left Ovaries Total No.	No. <75μ	No. 75-150μ	No. >150	Right Ovaries Total No.	No. <75	No. 75-150	No. >150
January	10.5	4.8	1.9	3.9	8.8	3	1.5	4.3
May	18.6	4.6	5.2	6.8	23.8	15.25	4.25	4.25
July	17.7	4.7	6.0	7.0	8.6	2.4	1.8	4.4
August	22.7	11	6.3	5.3	17.25	8.5	5.0	3.75
October	10.1	4.8	3.3	2	10.9	6.3	2.6	2.0
December	10.8	5.4	3.8	2	10.9	5.5	2.9	2.5

Table 11. Average monthly incidence of atretic follicles in bovine ovaries examined from Bauchi slaughterhouse.

Months	Left Ovary			Right Ovary		
	Total Follicles	Atretic Follicles		Total Follicles	Atretic Follicles	
		No.	%		No.	%
January	10.5	8.6	82.2	8.8	7.3	83.0
May	18.6	16	86.0	23.8	19.5	81.93
July	17.7	13.2	74.6	8.6	5.4	62.8
August	22.7	14.3	63.0	17.25	8.75	50.7
October	10.1	8.8	87.0	10.9	8.6	78.9
December	10.8	10.2	94	10.9	9.5	87.2

Fig. 9. Seasonal variation in number of ovarian follicles, atresia and percent atresia.

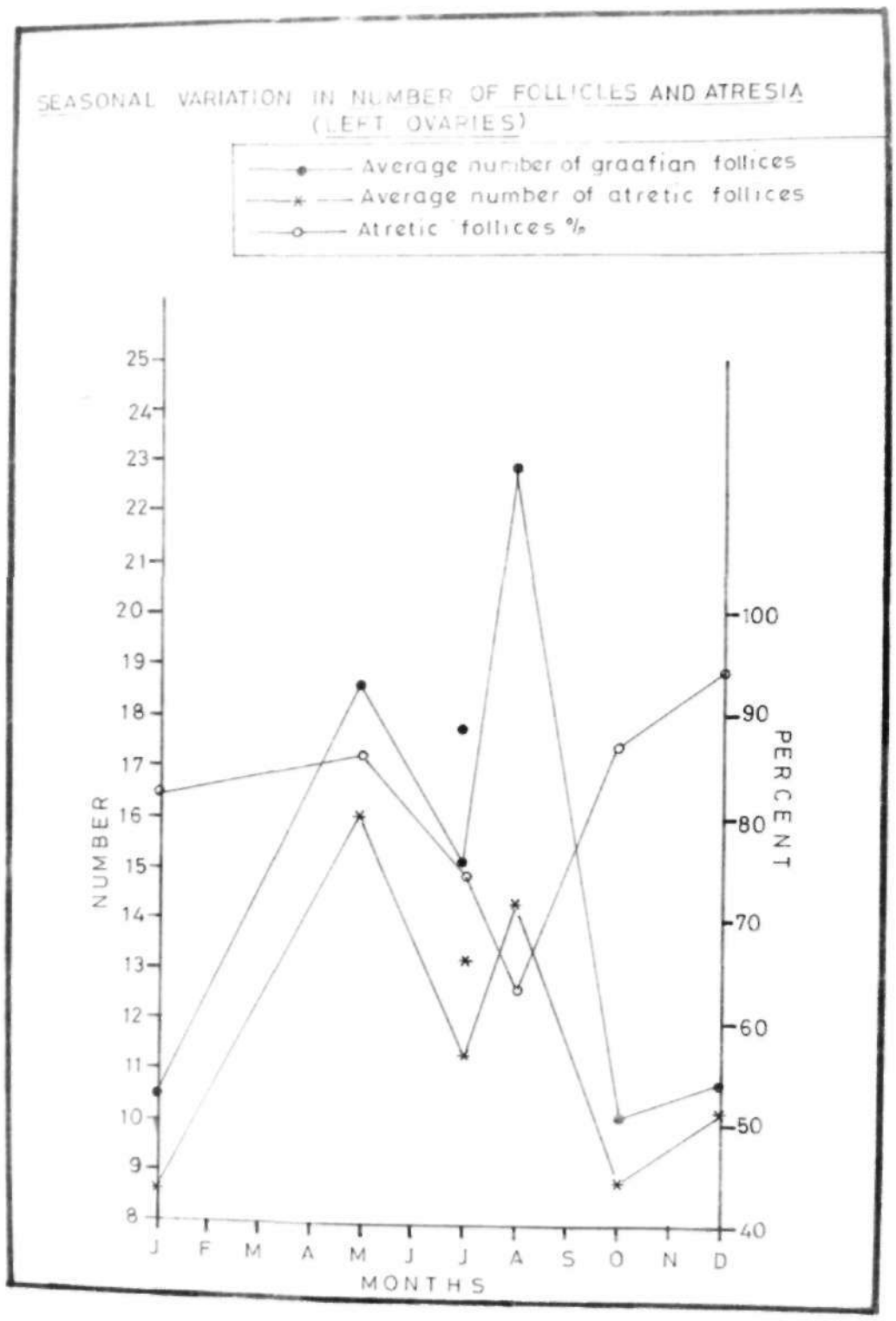

SEASONAL VARIATION IN NUMBER OF FOLLICLES AND ATRESIA
(LEFT OVARIES)
Average number of graafian follices
Average number of atretic follices
Atretic follices %
NUMBER
PERCENT
MONTHS
J F M A M J J A S O N D
25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8
100 90 80 70 60 50 40

Fig. 10. Seasonal variation in number of ovarian follicles, atresia, and percent atresia,

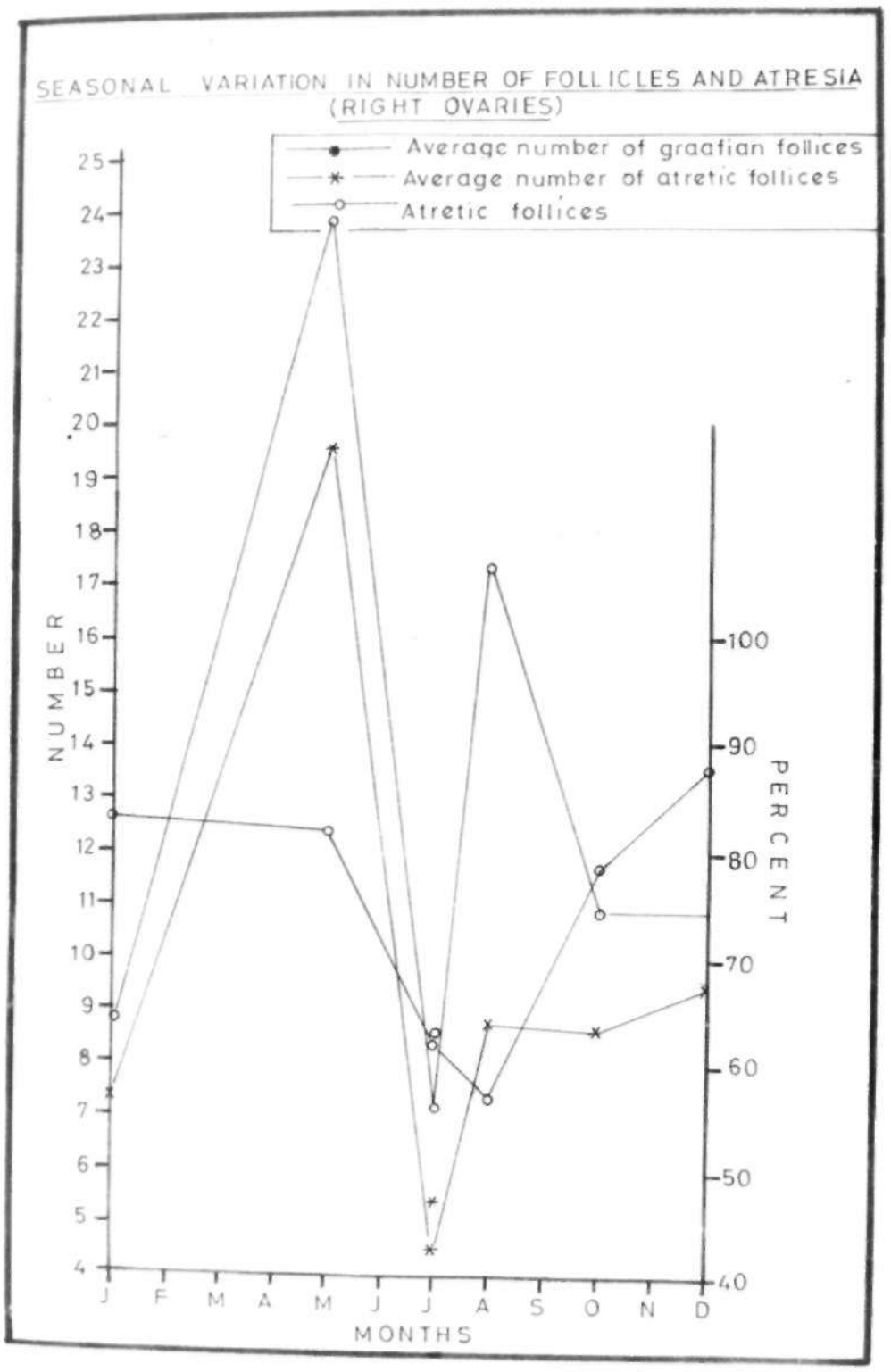

SEASONAL VARIATION IN NUMBER OF FOLLICLES AND ATRESIA
(RIGHT OVARIES)
Average number of graafian follices
Average number of atretic follices
Atretic follices
NUMBER
PERCENT
MONTHS
J F M A M J J A S O N D
25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4
100 90 80 70 60 50 40

Fig. 11. Seasonal variation in number and size of Graafian follicles in the left ovary.

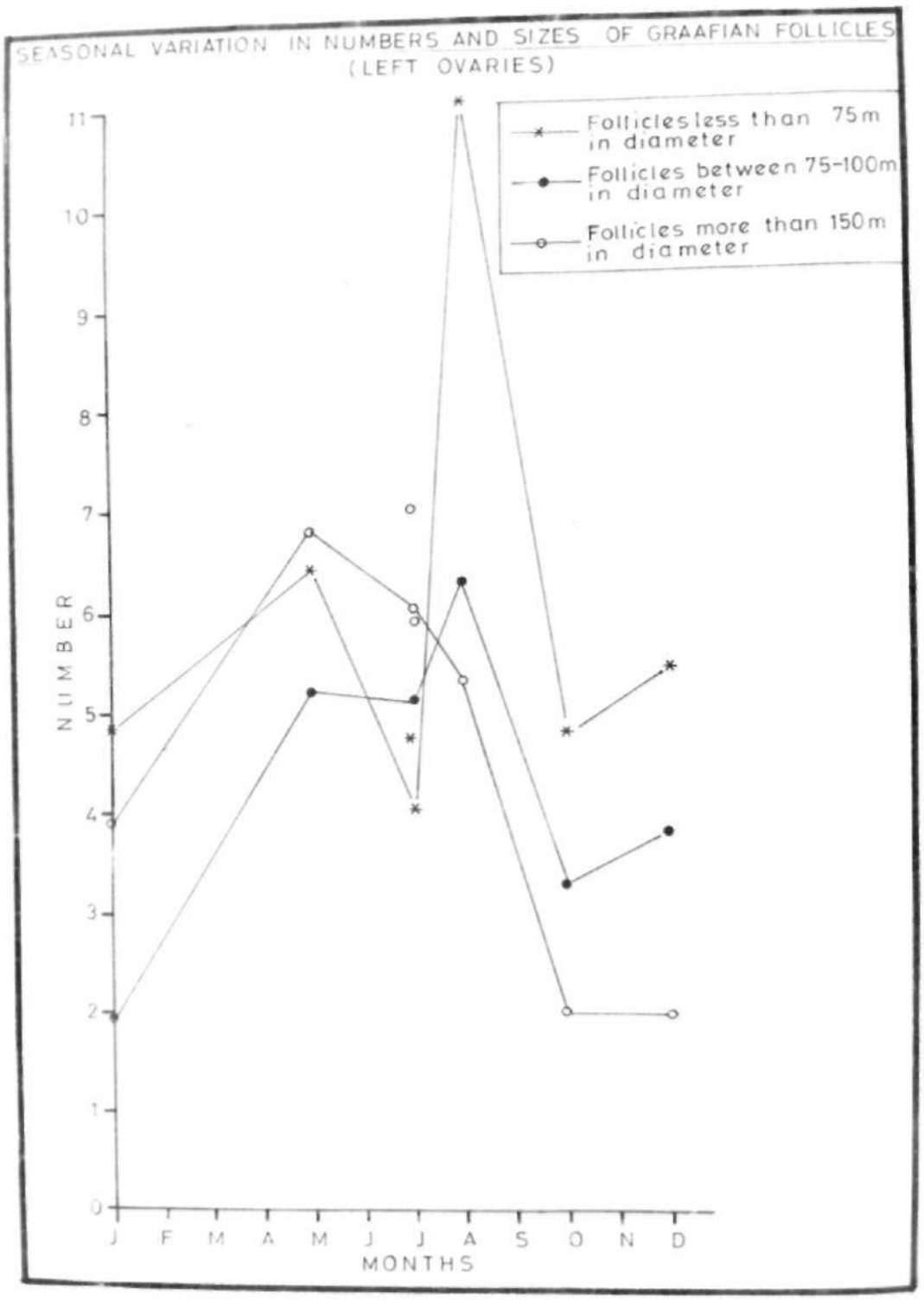
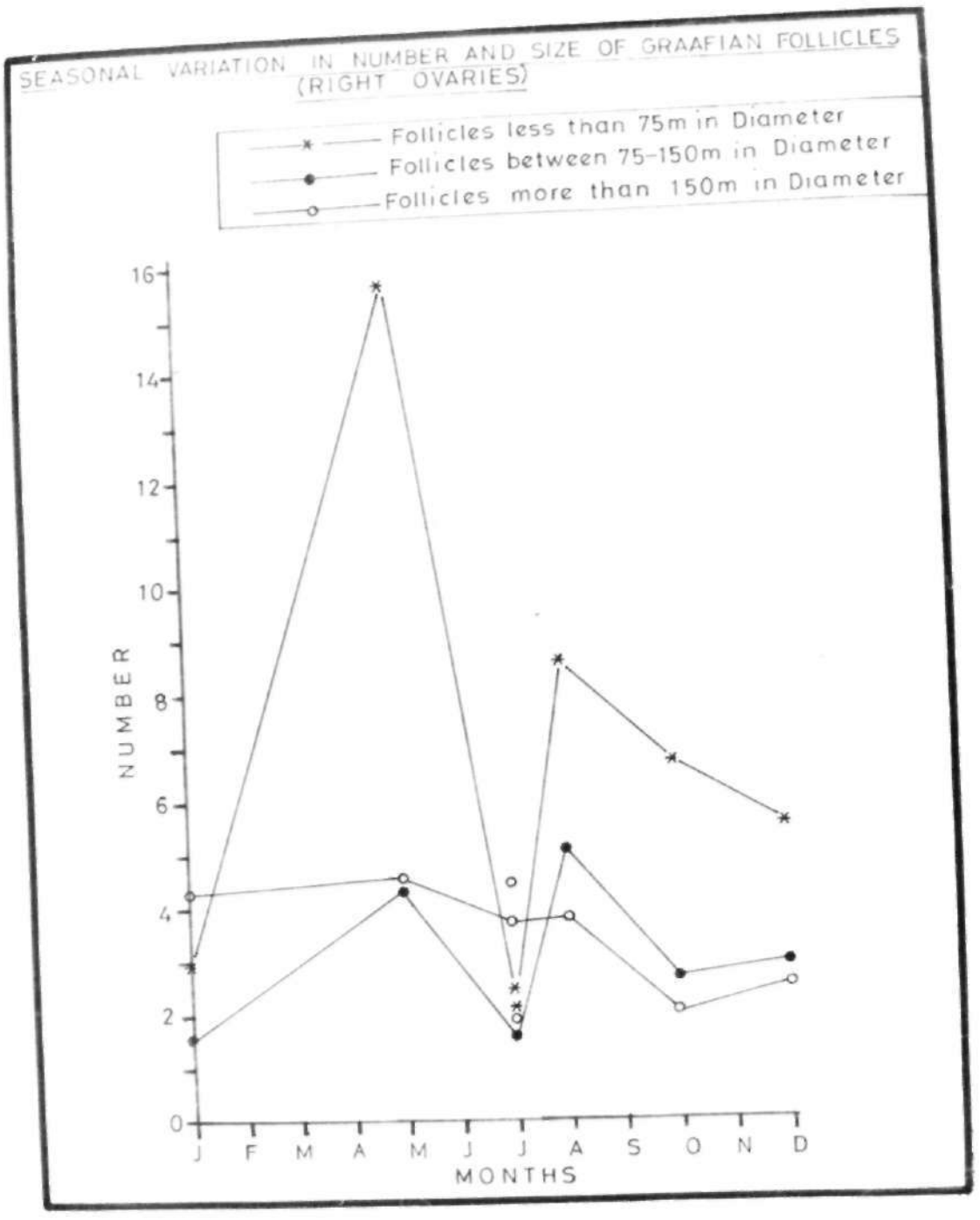

SEASONAL VARIATION IN NUMBERS AND SIZES OF GRAAFIAN FOLLICLES
(LEFT OVARIES)
Follicles less than 75m in diameter
Follicles between 75-100m in diameter
Follicles more than 150m in diameter
NUMBER
0
1
2
3
4
5
6
7
8
9
10
11
J F M A M J J A S O N D
MONTHS

Fig. 12. Seasonal variation in number and size of Graafian follicles in the right ovary.


SEASONAL VARIATION IN NUMBER AND SIZE OF GRAAFIAN FOLLICLES (RIGHT OVARIES)
Follicles less than 75m in Diameter
Follicles between 75-150m in Diameter
Follicles more than 150m in Diameter
NUMBER
0
2
4
6
8
10
12
14
16
J F M A M J J A S O N D
MONTHS

The difference between the incidence of atresia in the rainy months of July and August and the rest of the seasons combined was statistically significant, $X_2 = 7.634$ at 1 df.

One pair of ovaries from July samples had no Graafian follicles but had a few primordial follicles.

2. Oviduct

(a) Dimensions:

The diameter of grossly abnormal oviducts only was measured.

(b) Gross abnormalities:

The incidence of gross abnormalities was 12.3%. The abnormalities observed were:-

(i) Perisalpingitis with subsequent thickening and adhesions involving the mesosalpinx, mesovarium and salpinx, 7%.

(ii) Hydrosalpinx with mucoid or honey-colored fluid, 3.5%.

(iii) Perisalpingeal cyst - One perisalpingeal cyst, 3.78 by 0.95 cm was observed.

(c) Microscopic examination:

Height of epithelial cells, average cell diameter and cell; nucleus ratio are summarized (Table 12; Fig. 13).

Fig. 13. Height of cells and nuclei of oviduct epithelial cells and the cell: nucleus ratio.

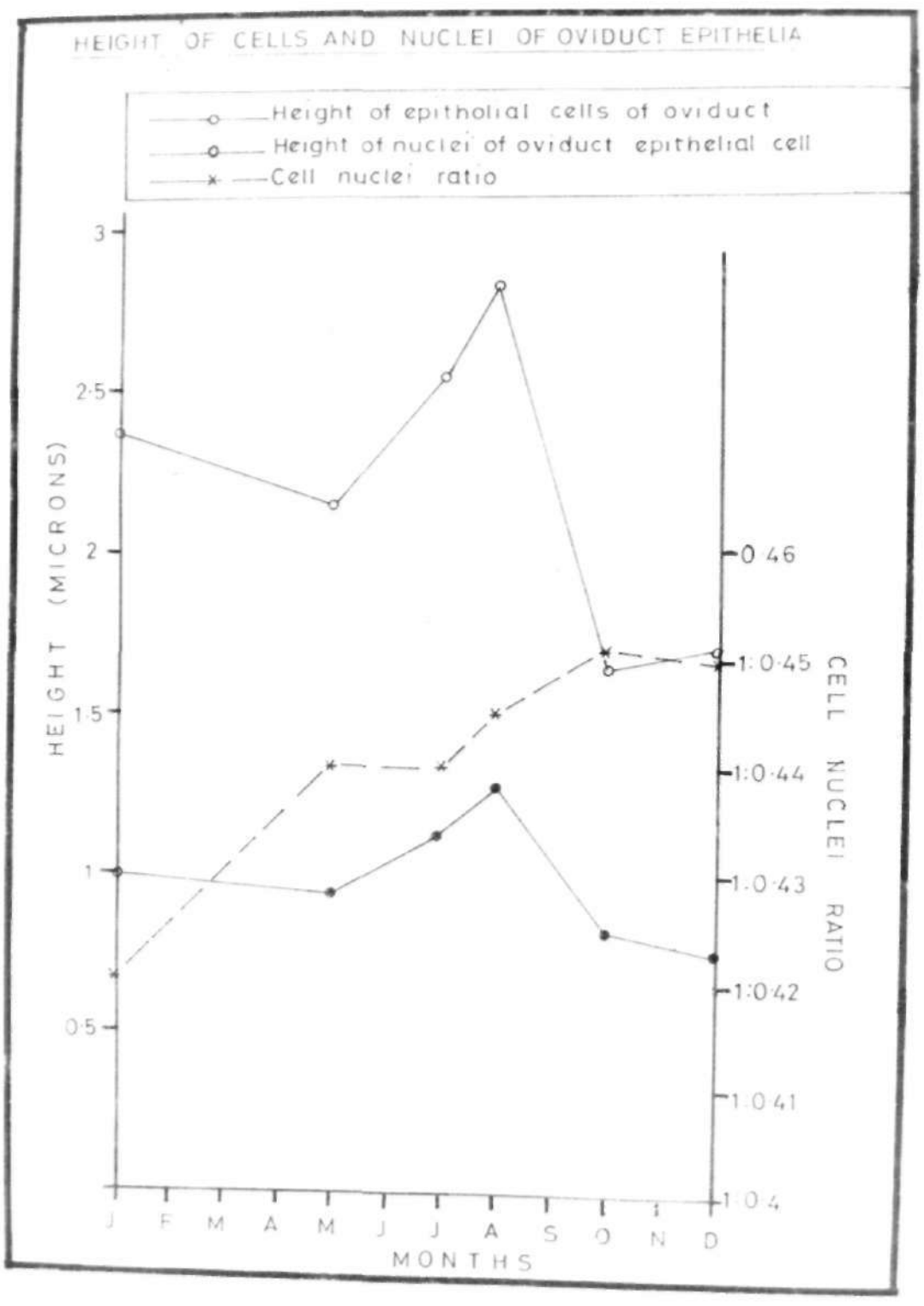

HEIGHT OF CELLS AND NUCLEI OF OVIDUCT EPITHELIA
Height of epitholial cells of oviduct
Height of nuclei of oviduct epithelial cell
Cell nuclei ratio
HEIGHT (MICRONS)
3
2·5
2
1·5
1
0·5
0·46
1:0·45
1:0·44
1:0·43
1:0·42
1:0·41
1:0·4
CELL NUCLEI RATIO
J F M A M J J A S O N D
MONTHS

Table 12. Monthly average of the height of the epithelial cells, the diameter of cells, and the cell to nucleus ratio in bovine oviducts examined from Bauchi slaughterhouse.

Months	Height of epithelial cells (μ)	Diameter of oviduct epithelial cell nucleus (μ)	Cells: Nucleus ratio
January	2.36	1.00	1:0.42
May	2.15	0.95	1:0.44
July	2.54	1.13	1:0.44
August	2.82	1.27	1:0.45
October	1.64	0.83	1:0.51
December	1.69	0.76	1:0.45

The difference between the monthly or seasonal average was not significant.

3. Uterus

(a) Dimensions:

Monthly average of parameters measured are given in Table 13 and Fig. 14-16.

At 95% confidence level the length, width and thickness of the wall of the left uterine horn were 131.00 ± 10.2, 15.5 ± 1.9, and 5.3 ± 0.8 mm, respectively. The same values for the right uterine horn were 127.7 ± 10.3, 15.9 ± 1.7, and 5.0 ± 0.7 mm.

Table 13. Dimensions of the left and right uterine horns (mm)

	Left Uterine Horn						Right Uterine Horn					
	Length		Width		Wall Thickness		Length		Width		Wall Thickness	
Month	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
January	75.6-195.3	132.97 ±34.30	7.86-15.75	11.04 ±2.34	1.0-9.5	4.53 ±2.83	88.2-163.8	127.95 ±23.41	9.5-15.75	11.83 ±2.47	2.0-9.5	4.93 ±2.31
May	128.0-185.0	160.11 ±23.27	12.0-38.0	23.22 ±9.86	0.5-2.5	1.33 ±0.83	105.0-214.0	164.33 ±33.02	14.0-35.0	24.00 ±7.83	0.5-5.0	1.66 ±1.37
July	60.0-120.0	86.25 ±22.64	10.0-25.0	13.75 ±4.89	4.0-13.0	7.38 ±2.88	60.0-110.0	86.88 ±23.14	8.0-25.0	14.75 ±6.45	5.0-10.0	6.38 ±2.33
August	75.0-190.0	139.0 ±46.42	10.0-15.0	13.00 ±2.74	5.0-10.0	8.0 ±1.87	100.0-210.0	158.00 ±43.24	10.0-20.0	15.4 ±4.56	5.0-10.0	8.2 ±2.17
October	75.0-170.0	112.27 ±27.87	8.0-14.00	11.09 ±2.21	3.0-9.0	5.4 ±1.90	75.0 ±130.0	104.09 ±18.26	8.0-16.0	12.36 ±2.50	3.0-8.0	5.2 ±1.69
December	130.0-200.0	153.18 ±29.43	12.0-33.8	20.06 ±5.9	2.0-9.5	6.25 ±2.25	58.0-180.0	136.91 ±37.72	5.7-23.0	17.68 ±5.17	3.0-9.5	5.33 ±2.24
Average	60.0-200.0	131.00 ±10.15	8.0-38.0	15.50 ±7.09	0.5-10.0	5.27 ±2.95	58.0-214.0	126.68 ±38.73	8.0-35.0	15.92 ±6.43	0.5-10.0	5.03 ±2.66

Fig. 14. Frequency Polygon of the length of uterine horns as measured from slaughterhouse specimens.

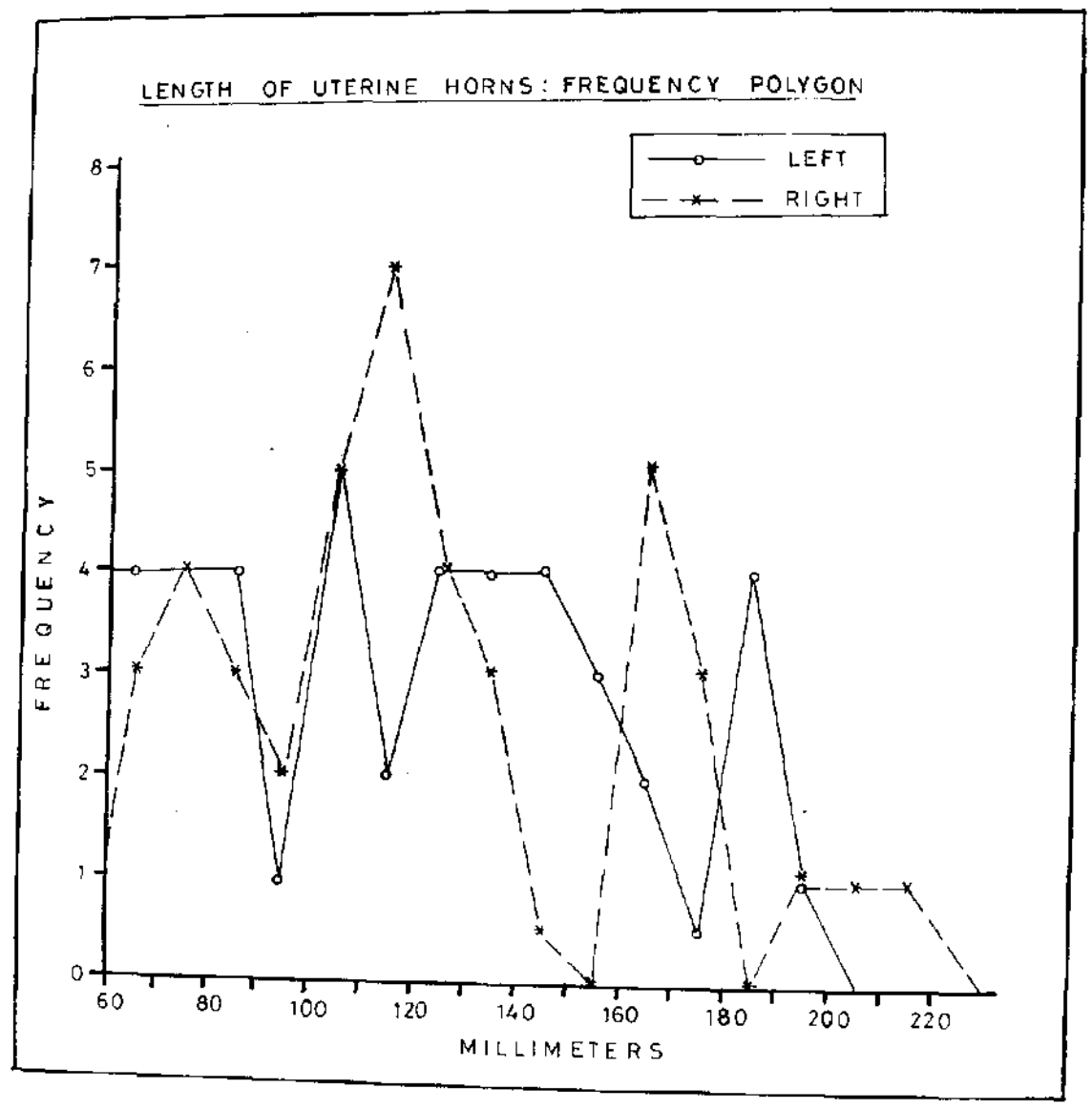

LENGTH OF UTERINE HORNS: FREQUENCY POLYGON
LEFT
RIGHT
FREQUENCY
0
1
2
3
4
5
6
7
8
60
80
100
120
140
160
180
200
220
MILLIMETERS

Fig. 15. Frequency Polygon of the width of uterine horn as measured from slaughterhouse specimens.

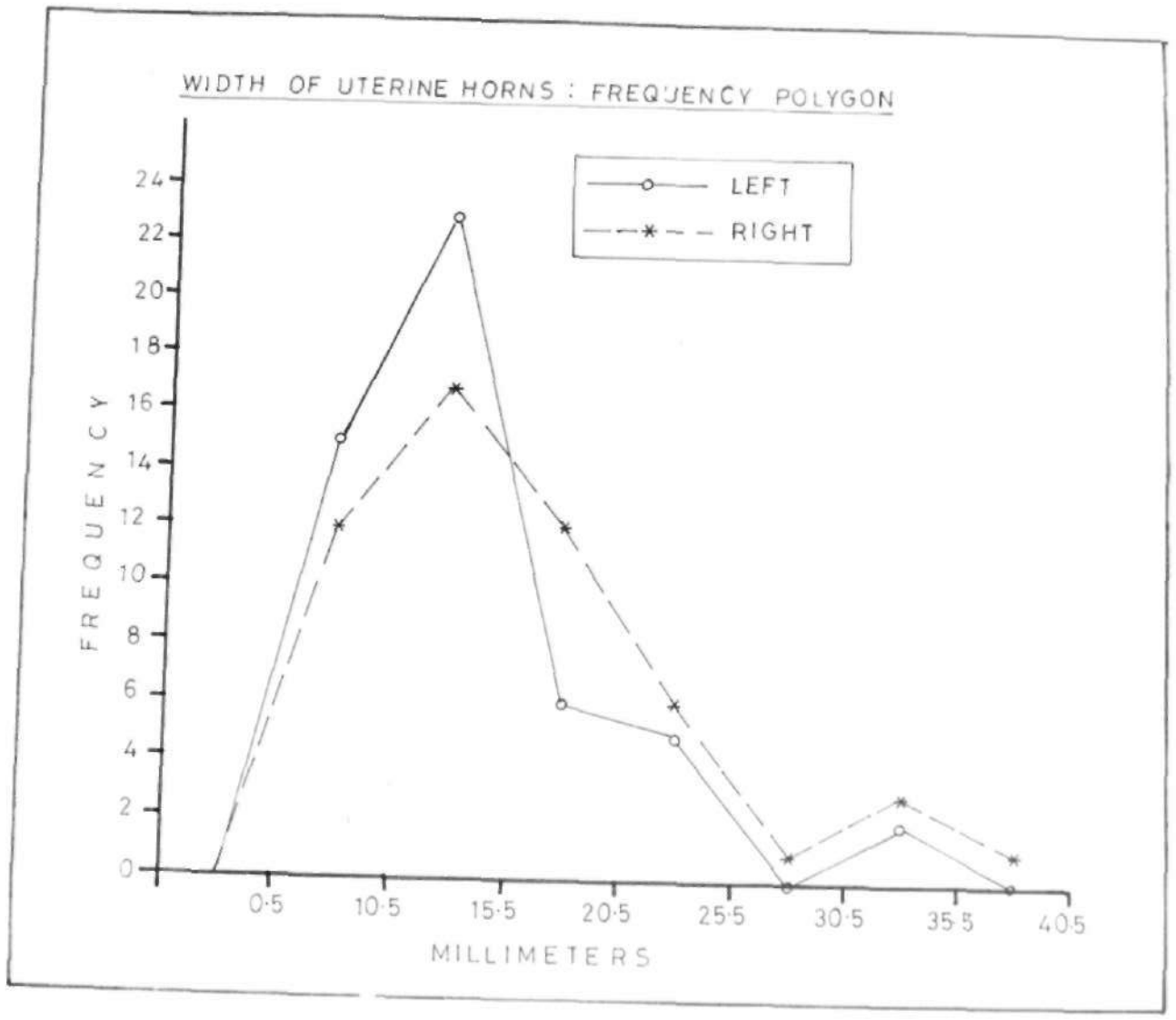
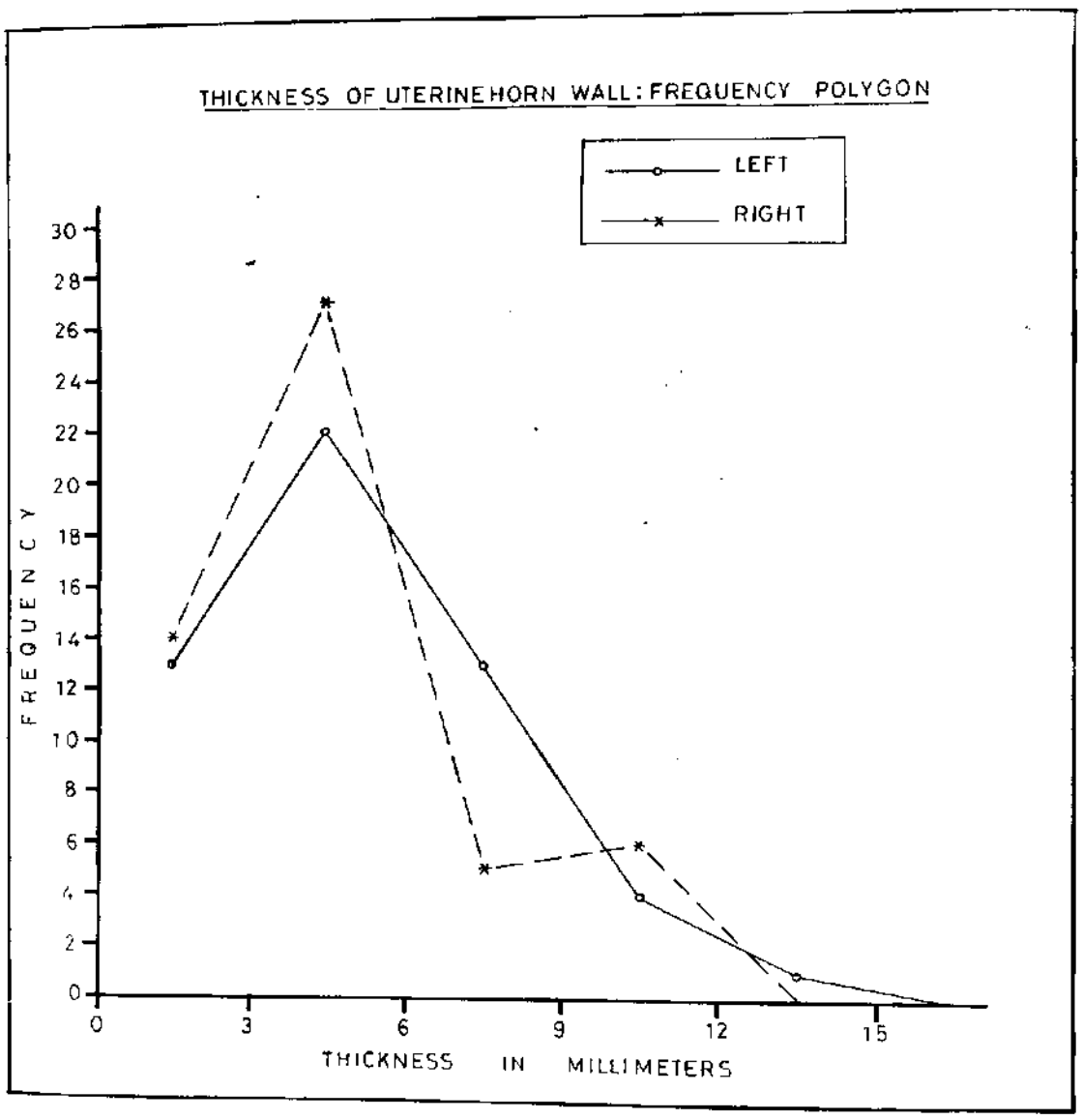

WIDTH OF UTERINE HORNS : FREQUENCY POLYGON
LEFT
RIGHT
FREQUENCY
0
2
4
6
8
10
12
14
16
18
20
22
24
0·5
10·5
15·5
20·5
25·5
30·5
35·5
40·5
MILLIMETERS

Fig.16 Frequency Polygon of the thickness of uterine horn as measured from slaughter-house specimens.


THICKNESS OF UTERINE HORN WALL: FREQUENCY POLYGON
LEFT
RIGHT
FREQUENCY
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
3
6
9
12
15
THICKNESS IN MILLIMETERS

(b) Gross Abnormalities:

Of the 57 uteri examined, eight contained a small volume of clear to semi-viscous fluid that was light yellow to honey-colored. In one case the fluid was brownish-red. In addition to these cases of slight hydrometra, there was one case of generalized hyperemia of the mucosa (Appendix, Tables 16-21).

(c) Microscopic Examination:

Sections from all uteri were examined for enlargement of lumen of endometrial glands, degeneration of glandular epithelium, and modification of stroma accompanied by infiltration of eosinophils or lymphocytes, or both. The seasonal distribution of these findings are presented in the Appendix (Tables 22-27).

4. Cervix

(a) Dimensions:

Monthly averages of parameters measured are given in Table 14 and Fig. 17 and 18. At 95% confidence level the cervical length, diameter of the middle of the cervix and diameter of the external os were 74.6 $\pm$ 4.4, 29.1 $\pm$ 2.3, and 40.1 $\pm$ 2.6, respectively.

(b) Gross Abnormalities:

There were 11 cases of chronic cervicitis characterized by distorted shape and increased firmness (Appendix, Tables 22 - 27).

Table 14. Monthly averages of length and diameter of the cervix

Month	Length		Middle diameter		Distal diameter	
	Range mm	Mean & S.D. mm	Range mm	Mean &S.D. mm	Range mm	Mean & S.D. mm
January	63.0-100.8	77.4±14.1	18.9-38.8	27.7±6.6	18.9-44.1	37.1-9.7
May	50.0-110.0	70.22±19.2	18.0-55.0	31.9±12.6	20.0-40.0	28.3±8.4
July	45.0-80.0	63.75±10.3	15.0-45.0	26.5±9.0	30.0-60.0	41.9±8.8
August	60.0-110.0	92.0±19.24	20.0-25.0	23.6±2.2	35.0-45.0	40.2±4.8
October	60.0-100.0	77.3±12.1	20.0-35.0	27.3±5.6	35.0-50.0	43.6±3.9
December	59.0-100.0	72.7±16.62	25.0-45.5	30.5±10.7	33.0-61.0	47.2±9.3
Total	45.0-110.0	74.6±16.3	15.0-55.0	29.1±61.0	18.9-61.0	40.1±9.8

Fig. 17. Frequency Polygon of the length of the cervix measured from slaughterhouse specimens.

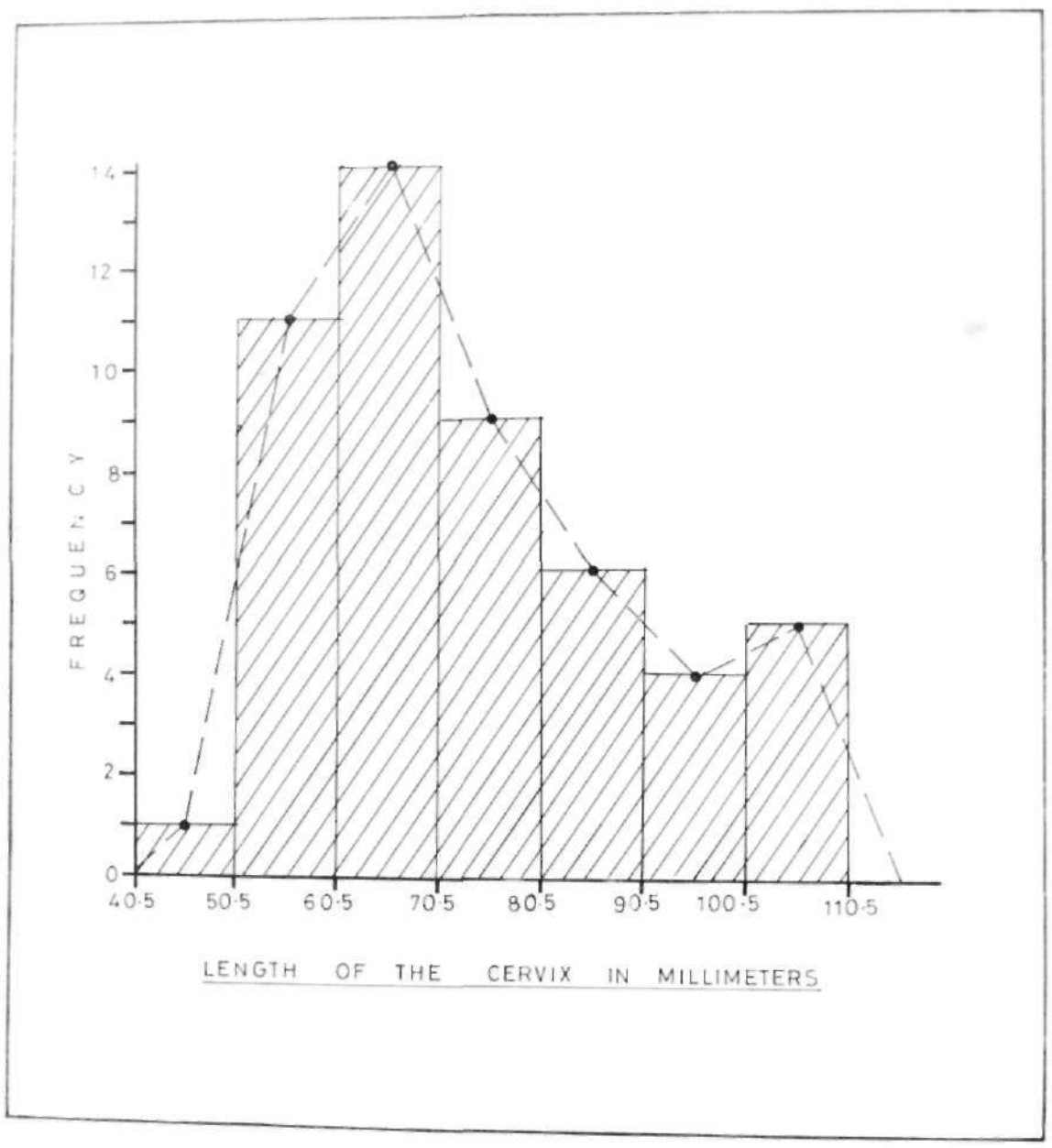
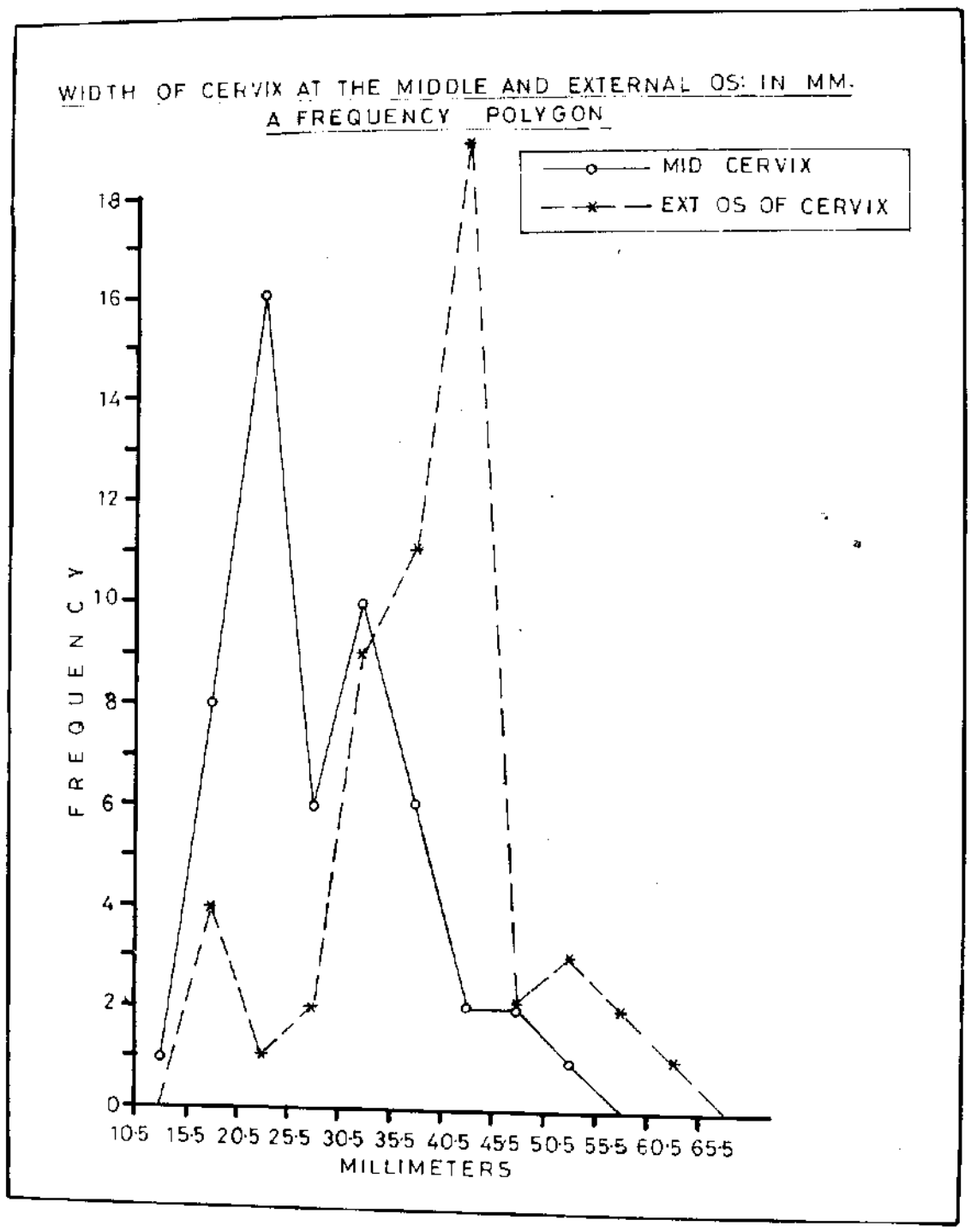

14
12
10
8
6
4
2
0
40·5
50·5
60·5
70·5
80·5
90·5
100·5
110·5
LENGTH OF THE CERVIX IN MILLIMETERS

Fig. 18. Frequency Polygon of the width of cervix at the middle and external as measured from slaughterhouse specimens.


WIDTH OF CERVIX AT THE MIDDLE AND EXTERNAL OS: IN MM.
A FREQUENCY POLYGON
MID CERVIX
EXT OS OF CERVIX
FREQUENCY
0
2
4
6
8
10
12
14
16
18
10·5 15·5 20·5 25·5 30·5 35·5 40·5 45·5 50·5 55·5 60·5 65·5
MILLIMETERS

Blood Chemistry

1. Glucose

Individual monthly glucose levels for the cows samples at Bauchi are given in the Appendix (Table 28). Monthly averages for nomadic cattle are summarized in Table 15 and Fig. 19 and 20.

The values were analysed for seasonal change; the grand mean was 30.97 and standard deviation was 11.12. The inter-month variation was significant (F(10, 271)was 14.08).

For 1974, the pre-rain and dry seasons had blood glucose values above the grand mean, 35.51 and 33.2, respectively. The rainy and pre-dry seasons were below the grand mean (29.67 and 26.83, respectively).

The inter-season variation was significant (F(3,271) being 6.13). The rainy season value compared to the mean of the remaining three seasons was not significant.

The blood glucose value of the control cattle at Shika are presented in the Appendix (Tables 35-38). Their grand mean was 47.82. Inter-month variations were significant (F = 12.39). This was due principally to the low value obtained in April.

Table 15. Monthly averages of blood glucose levels of cattle at Galambi ranch.

1974	February	19.00 ± 6.99
	March	24.67 ± 0.58
	April	36.8 ± 12.6
	May	34.3 ± 11.6
	June	22.0 ± 11.6
	July	33.4 ± 15.0
	August	22.9 ± 9.3
	September	36.3 ± 14.0
	October	26.4 ± 11.21
	November	- - -
	December	28.1 ± 8.58
	January	27.7 ± 7.68
	February	48.6 ± 4.68
	March	23.9 ± 9.43
	April	49.4 ± 15.72
	May	44.4 ± 8.68
	June	50 ± 15.95

Fig. 19 Blood glucose levels between February 1974 - February 1975.

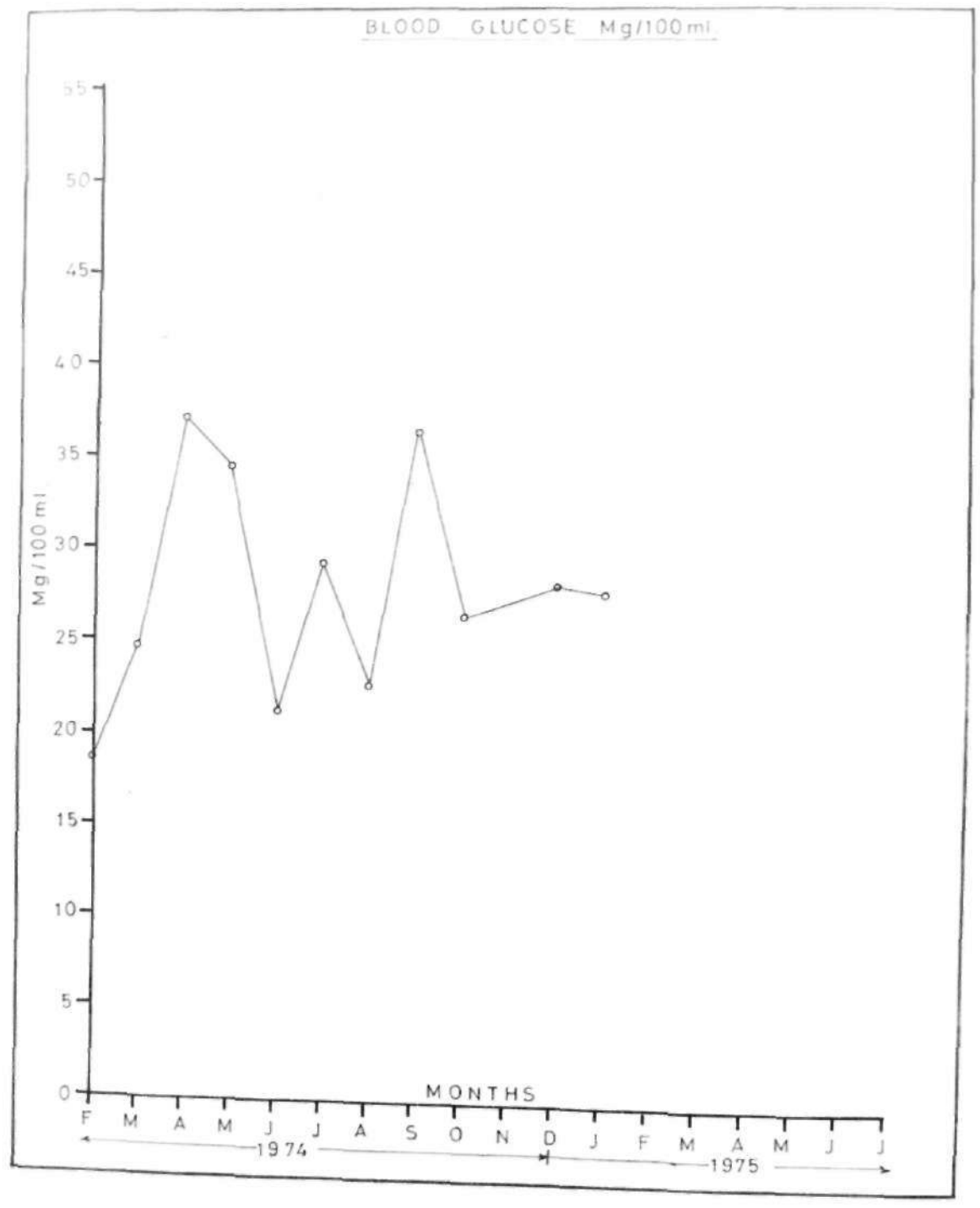
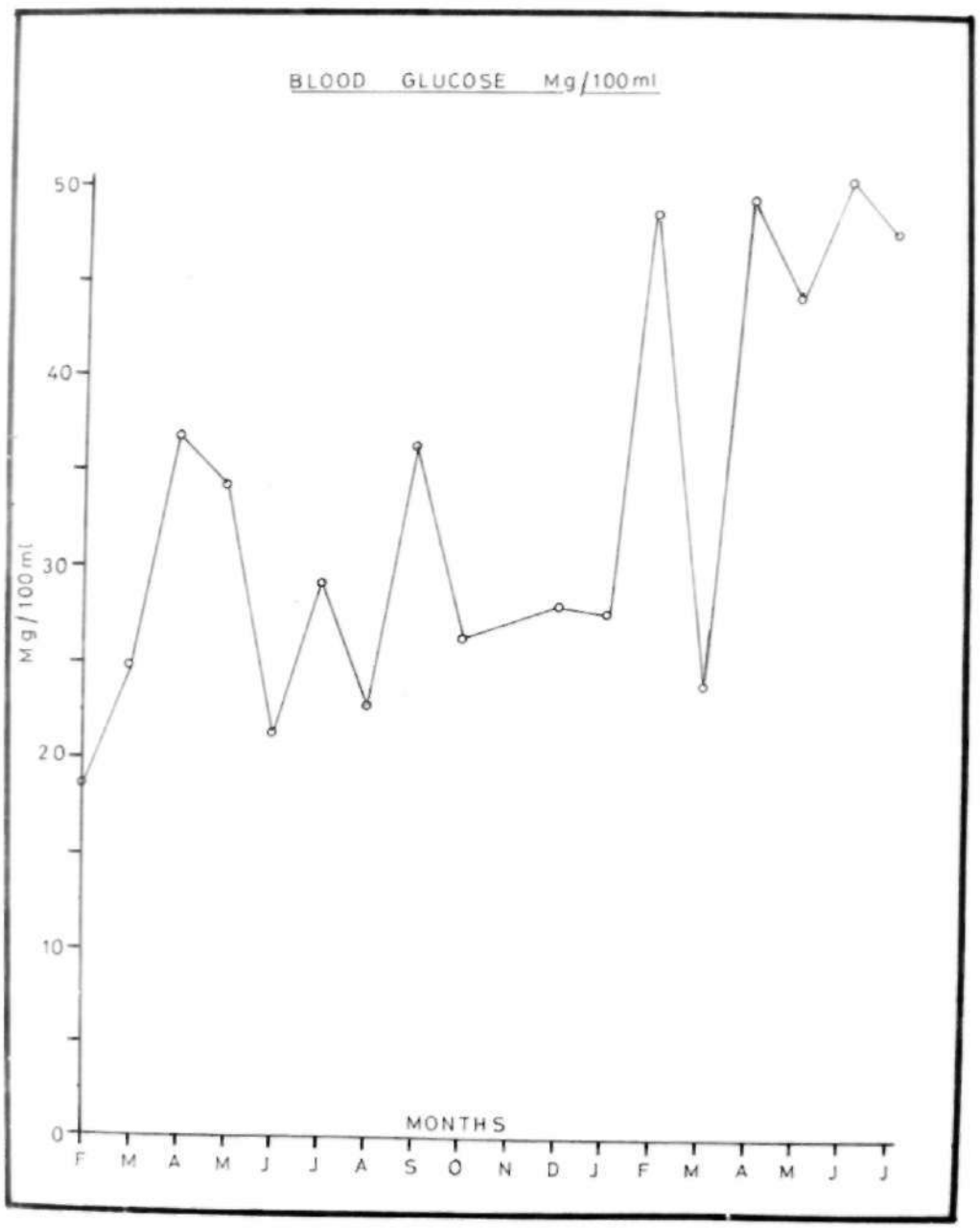

BLOOD GLUCOSE Mg/100 ml
55
50
45
40
35
30
25
20
15
10
5
0
Mg/100 ml
MONTHS
F M A M J J A S O N D J F M A M J J
1974
1975

Fig. 20. Blood glucose levels between February 1974 and July 1975.


BLOOD GLUCOSE Mg/100ml
Mg/100ml
50
40
30
20
10
0
MONTHS
F M A M J J A S O N D J F M A M J J

2. Total Protein, Albumin and Globulin.

Monthly average protein, albumin and globulin values and albumin: globulin ratio for the cows sampled from the Galambi ranch are summarized in Table 16 and Fig. 21. Individual monthly averages for these cows are presented in the Appendix (Table 29).

"Inter-season" variation in total protein was significant ($F(3,271) = 15.22$). The grand mean for total protein was 7.79g%. The mean for pre-rain, rainy pre-dry and seasons was 7.78, 7.30, 8.32, and 7.49g %, respectively. Seasonal variation of albumin was significant ($F(3,271) = 6.96$). So also was the variation of globulin. The grand means and seasonal values were as follows:-

	Grand mean (g)	Pre-rain (g)	Rain (g)	Pre-dry (g)	(Dry) (g)
Albumin	4.23	4.74	4.48	4.03	3.99
Globulin	3.55	3.03	2.83	4.31	3.5

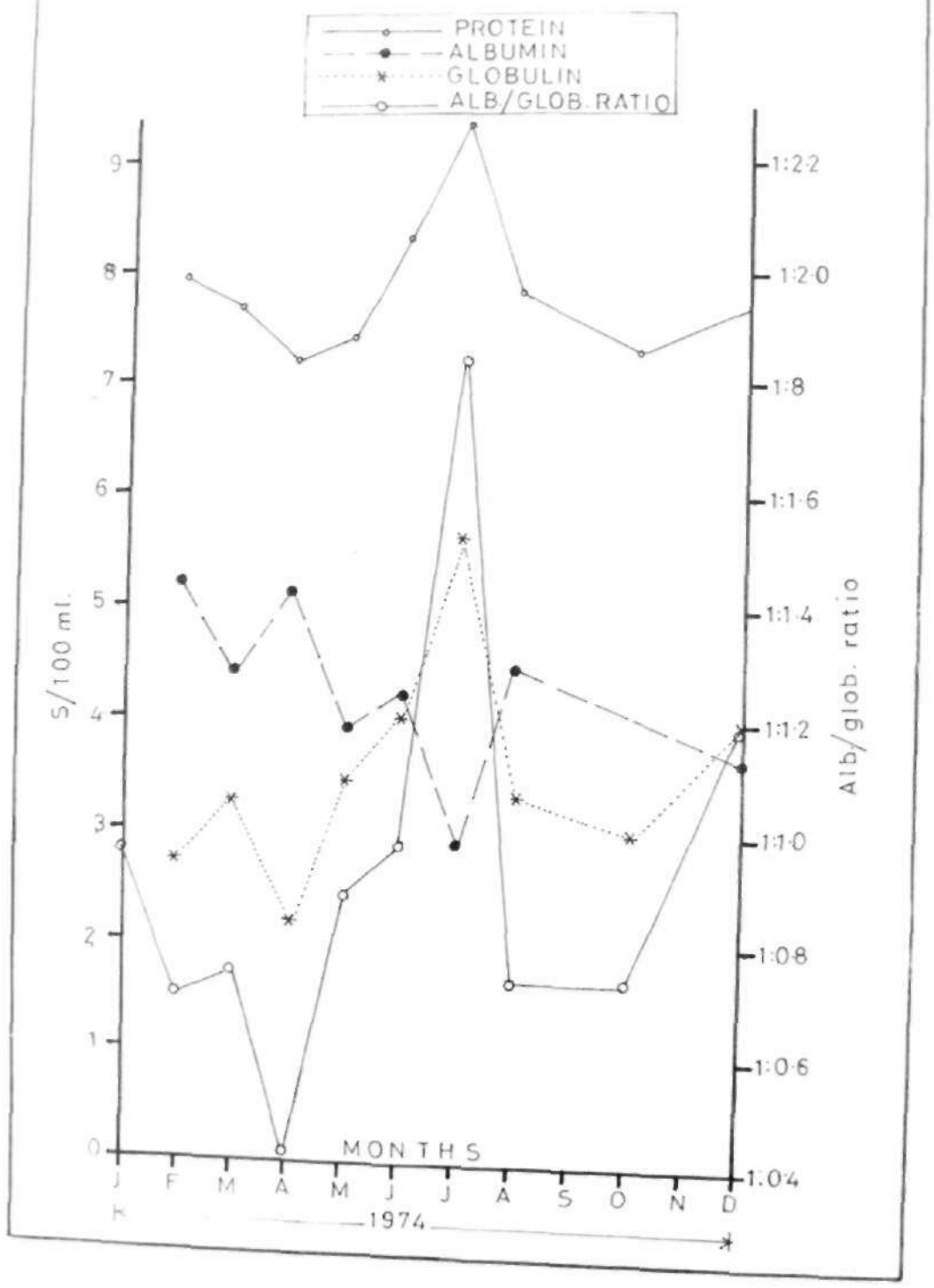
Mean rainy season values for total protein, and globulin were significantly different from the other three seasons ($F=40.48$) and ($F=51.1$) respectively. Albumin variation was only significant at 1% level.

Table 16. Monthly averages of blood total protein: Albumin, Globulin and Albumin: Globulin ratio.

Months	Total Protein	Albumin	Globulin	A/G ratio
February	7.88	5.17	2.71	1:0.7
March	7.69	4.41	3.28	1:0.7
April	7.22	5.1	2.12	1:0.4
May	7.37	3.82	3.45	1:0.9
June	8.28	4.2	4.08	1:1
July	9.30	2.99	5.51	1:1.8
August	7.79	4.49	3.30	1:0.7
September	-	-	-	-
October	7.28	4.13	3.05	1:0.7
November	-	-	-	-
December	7.22	3.64	4.08	1:1.1
January	7.25	3.70	3.55	1:1
February	-	-	-	-
March	7.85	4.99	2.86	1:0.6
April	7.22	4.24	2.98	1:0.7
May	7.58	4.21	3.37	1:0.8
June	7.71	4.21	3.50	1:0.8

Fig. 21. Blood levels of total protein, albumin globulin and albumin: globulin ratio measured between January 1974 to December, 1974.

A LINE GRAPH SHOWING MONTHLY SERUM-ALBUMIN GLOBULIN AND TOTAL PROTEIN



Grand mean, total protein, albumin and globulin values for the control cattle at Shika were as follows:-

	Grand mean	Pre-rain	Rain	Pre-dry	Dry
Total protein g %	7.82	7.9	8.7	7.8	7.0
Albumin g %	5.43	5.9	5.4	5.4	5.0
Globulin g %	2.4	2.0	3.3	2.4	2.0

Inter-season variation for total protein and albumin was significant (F 3,228)was 11.38 and 5.26, respectively).

3. Serum Inorganic Phosphorus and Calcium

Monthly averages of serum inorganic phosphorus and Ca: P ratio for nomadic cattle at Galambi ranch are summarized in Tables 17 and Fig. 22. The individual monthly values are presented in the Appendix (Tables 30 and 31).

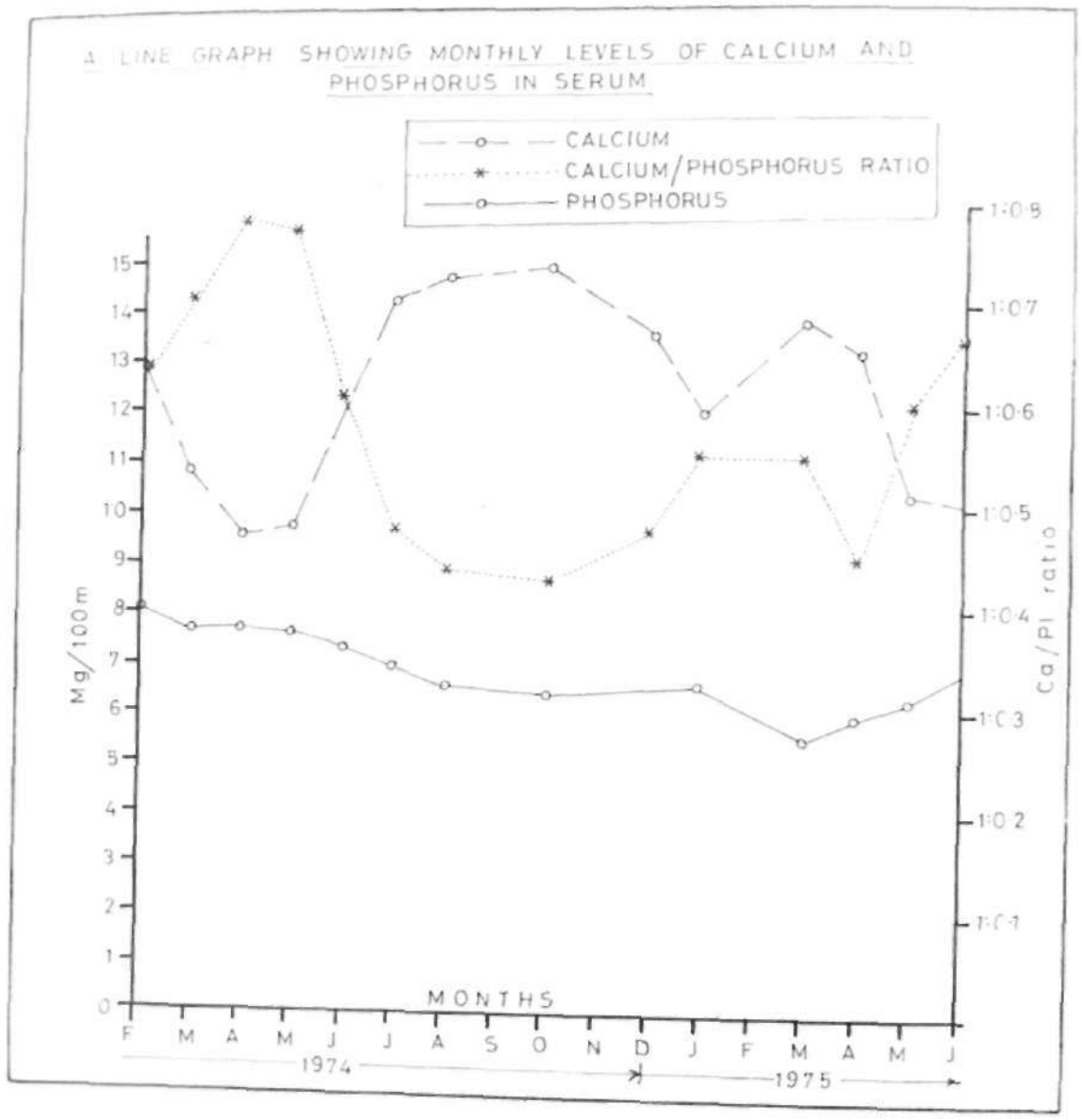
Grand mean for serum inorganic phosphorus was 6.8mg % with standard deviation of 0.94. Inter-month variation was significant (F(8,228)= 10.91).

Grand mean and standard deviation for serum calcium were 12.89 mg% and 4.05, respectively. Inter-month variation was significant (F8,228) was 5.87).

Table 17. Monthly averages of serum inorganic phosphorus, serum calcium and calcium phosphorus ratio.

	Calcium mg/100 ml	Phosph. mg/100 ml	Calcium Phosph.
February	13.0	8.1	1:0.6
March	10.8	7.7	1:0.7
April	9.5	7.7	1:0.8
May	9.7	7.6	1:0.8
June	12.1	7.3	1:0.8
July	14.3	6.9	1:0.5
August	14.6	6.6	1:0.4
September	-	-	-
October	14.8	6.4	1:0.4
November	-	-	-
December	13.5	6.5	1:0.5
January	11.9	6.5	1:0.6
February	-	-	-
March	13.8	5.6	1:0.6
April	13.1	5.9	1:0.5
May	10.4	6.2	1:0.6
June	10.1	6.8	1:0.7
July	12.2	6.6	1:0.5

Fig. 22. Blood levels of calcium, phosphorus, and calcium: phosphorus levels between February 1974 and June 1975.


A LINE GRAPH SHOWING MONTHLY LEVELS OF CALCIUM AND PHOSPHORUS IN SERUM
CALCIUM
CALCIUM/PHOSPHORUS RATIO
PHOSPHORUS
Mg/100m
Ca/Pl ratio
MONTHS
F M A M J J A S O N D J F M A M J
1974
1975

Inter-season variation of serum inorganic phosphorus was significant ($F(3,228)$ was 20.51). The levels for the pre-rain and rainy seasons were higher than the pre-dry and dry seasons. Inter-season variation for serum calcium was significant ($F(3,228)$ was 20.51). The rainy and the pre-dry levels were higher than the other two seasons. The seasonal values are summarized as follows:-

Parameter	Pre-rain	Rain	Pre-dry	Dry	Grand mean
Phosphorus (mg/100 ml)	7.7	6.9	6.4	6.2	6.8
Calcium (mg/100 ml)	9.6	13.6	14.2	12.7	12.9

The variation in the mean values of serum calcium and serum inorganic phosphorus during the rainy season was compared with the corresponding mean for the remaining three seasons combined was not significant.

The calcium: phosphorus ratio gave a negative gradient. The overall ratio was 2.6:1.

Details of the serum calcium and inorganic phosphorus for the controls are presented in Appendix (Tables 29-32) and summarised as follows:

Parameter	Grand mean	Pre-rain	Rain	Pre-dry	Dry
Calcium (mg/100 ml)	9.4	10.0	9.4	9.3	9.1
Inorganic phosphorus (mg/100 ml)	5.6	5.0	7.4	6.0	5.0

Inter-season variation was significant for phosphorus and not for calcium (F=24 and F = 0.2, respectively). Inorganic phosphorus was highest during the rainy season.

4. Sodium and potassium:

Monthly averages for serum sodium and potassium for nomadic cattle sampled at Galambi ranch are summarized in Table 18 and Figs. 23 and 24. The individual monthly values are outlined in the Appendix (Tables 32 and 33).

Grand mean and standard deviation for sodium and potassium were 144.6 and 4.4 meq. per litre and 6.6 and 0.6, respectively. At F(8,[illegible])the inter-month variation in sodium level was 4.46 while at F(8,[illegible])the variation for potassium was 9.89. Inter-season variation for sodium and potassium were slight. The pre-rain and dry season means were higher for both parameters and was significant for sodium (F = 64). The seasonal means were as follows:

Table 18· Monthly averages of blood Sodium and Potassium.

	Sodium Meq/litre	Potassium Meq/litre
March	141.7	5.3
April	148.6	4.9
May	148.5	5.0
June	141.3	4.8
July	143.9	4.5
August	142.7	4.0
September	-	-
October	141.8	4.2
November	-	-
December	145.9	4.2
January	146.9	4.2
February	-	-
March	146.4	4.8
April	141.9	4.0
May	143.9	4.2
June	143.9	4.0
July	143.2	4.2

Fig. 23. Blood levels of sodium measured between March 1974 and July 1975.

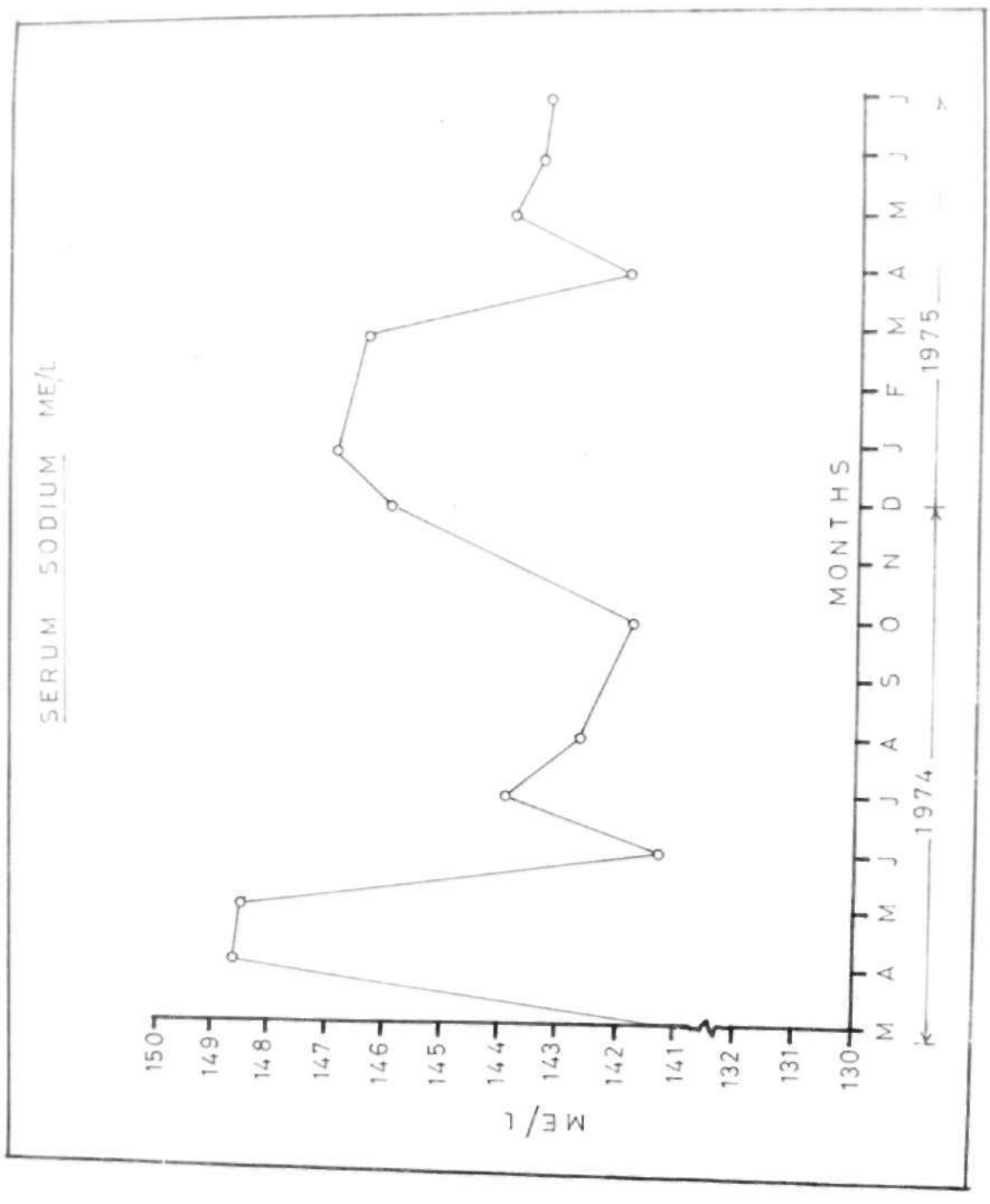
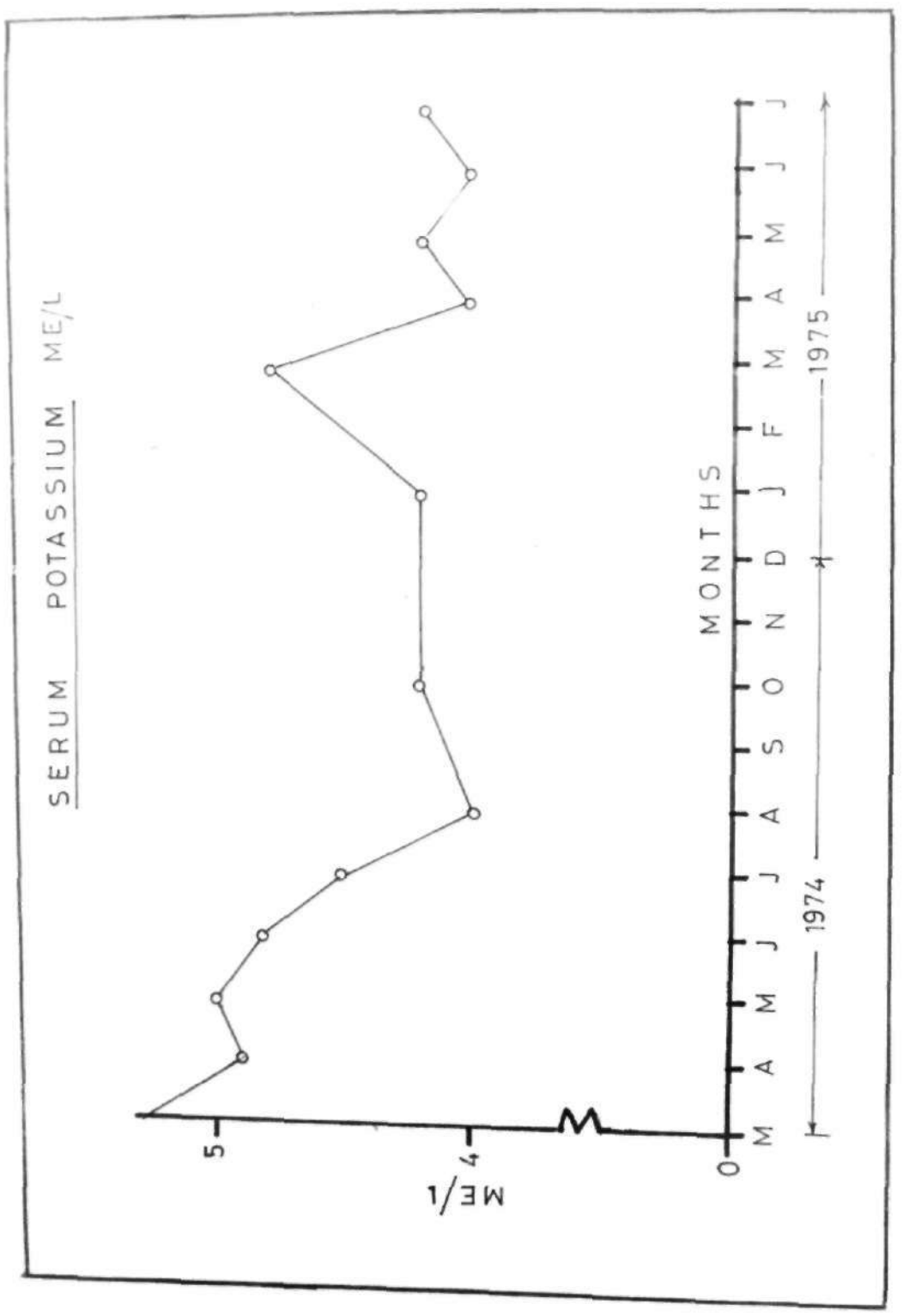

SERUM SODIUM ME/L
MEQ/L
150
149
148
147
146
145
144
143
142
141
132
131
130
MONTHS
M A M J J A S O N D J F M A M J J
1974
1975

Fig. 24. Blood levels of potassium measured between March 1974 and July 1975.


SERUM POTASSIUM ME/L
5
4
0
ME/1
M A M J J A S O N D J F M A M J J
MONTHS
1974
1975

Parameter	Pre-rain	Rain	Pre-dry	Dry	Grand mean	F(3.3)
Sodium meq/liter	148.6	142.6	143.3	146.5	144.6	9.6
Potassium meq/liter	5.0	4.4	4.2	4.4	4.4	12.92

Blood sodium and potassium levels for the controls at Shika are summarised below and set out in detail in the Appendix (Tables 35-38).

Parameter	Grand mean	Pre-rain	Rain	Pre-dry	Dry
Sodium Meq/liter	141.68 ±5.68	147.3	135.4	139.9	143.6
Potassium Meq/liter	4.6	4.7	4.3	4.9	4.5

The inter-season variation for serum sodium was significant (F = 14.9) but not for potassium (F = 2.3).

Hematology

1. Packed Cell Volume

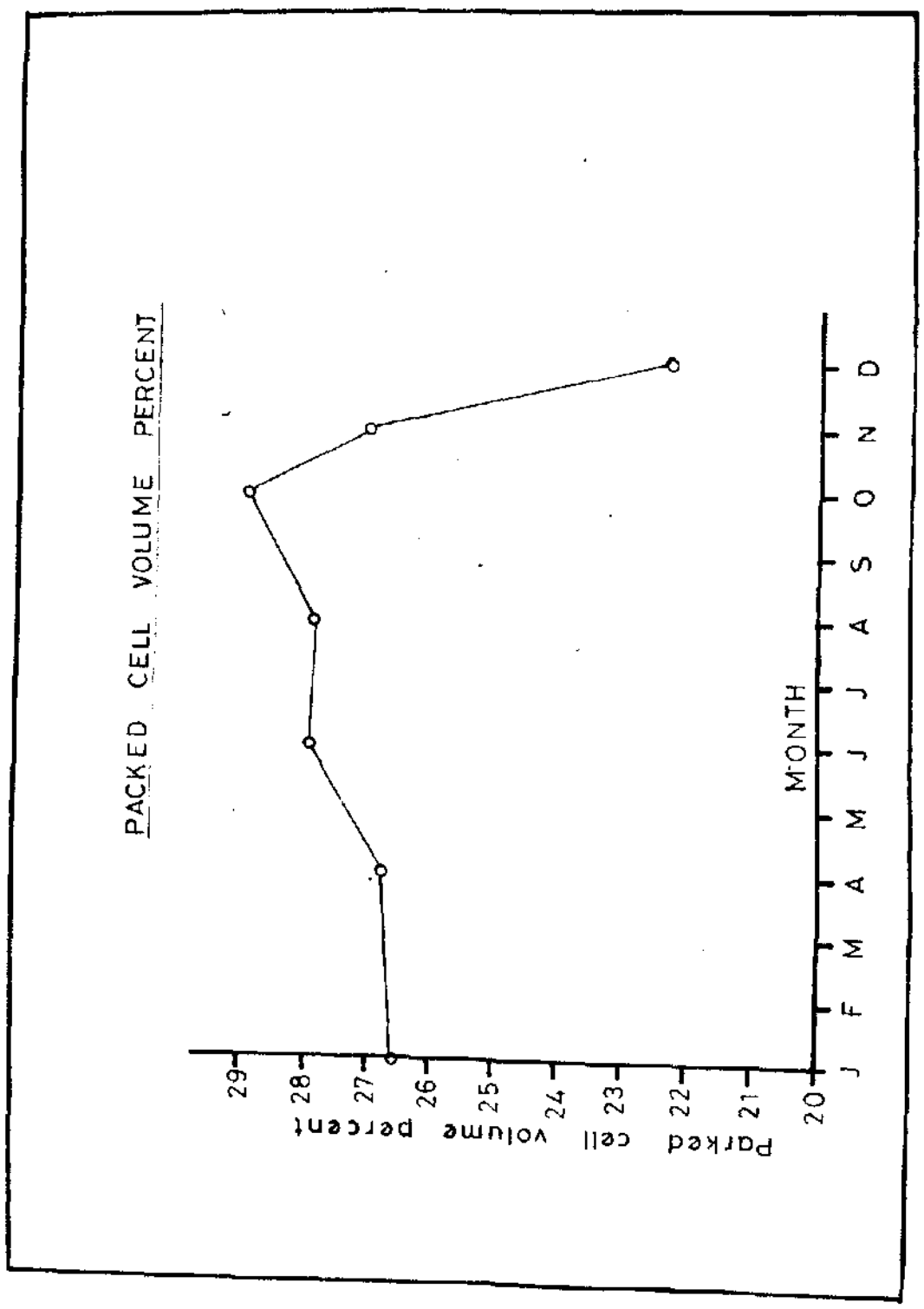
Monthly averages for packed cell volume for the Galambi ranch cows are summarized below and in Fig. 25.

	Jan.	April	June	Aug.	Oct.	Nov.	Dec.
PCV	29.6	26.73	28.5	27.7	28.6	26.9	23.5
S.D.	4.3	5.09	4.23	5.13	4.5	4.7	3.43

Individual PCV values are presented in the Appendix; test cows (Table 34), and control cows (Tables 35-38). Seasonal average PCV values for Galambi and Shika cows were as follows:-

Area	Grand mean	Pre-rain	Rain	Pre-dry	Dry
Galambi	27.3	29.6	26.7	28.1	26.1
Shika	30.2	30.7	29.2	30.0	30.8

Fig. 25. Packed cell volume measured between January and December 1974.


PACKED CELL VOLUME PERCENT
Packed cell volume percent
29
28
27
26
25
24
23
22
21
20
J F M A M J J A S O N D
MONTH

Inter-season variation in PCV value was significant for Galambi ranch (F = 6.3) but not for Shika. The values for the Galambi ranch was lowest during the rainy season. However, when the mean PCV value for the rainy season was compared to the mean of the remaining three seasons the difference was not significant for both Galambi and Shika cattle (F = 3.3 and 0.6, respectively).

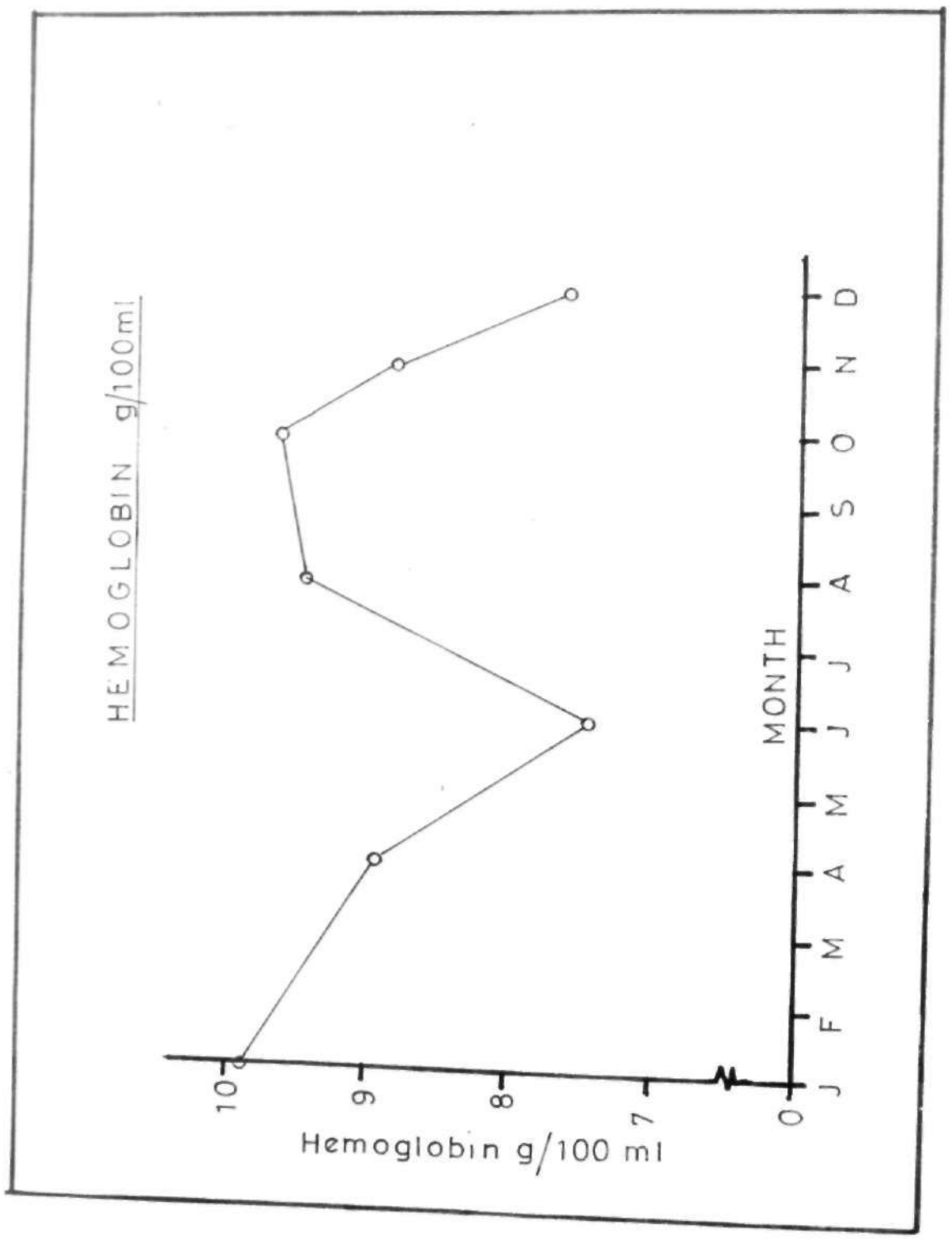
2. Hemoglobin

Monthly hemoglobin averages for the Galambi ranch cows are presented in Fig. 26 and summarized below.

	Jan.	April	June	Aug.	Oct.	Nov.	Dec.
Hb	9.9	9.0	9.9	9.4	9.7	8.8	7.6
S.D.	1.34	1.40	1.4	1.8	1.3	1.7	1.3

Detailed Hb levels for the cows sampled in Galambi and Shika are given in the Appendix (Tables 34 and Tables 35-38, respectively). Average seasonal Hb value for Galambi and Shika Research station are as follows:

Fig. 26. Hemoglobin concentration in bllod between the period of January and December 1974.


HEMOGLOBIN g/100ml
10
9
8
7
0
Hemoglobin g/100 ml
MONTH
J F M A M J J A S O N D

Area	Grand mean g%	Pre-rain g%	Rain g%	Pre-dry g%	Dry g%
Galambi	9.2	9.90	9.0	9.6	8.6
Shika	10.2	10.4	9.9	10.2	10.2

Inter-season variation in the hemoglobin level was significant in Galambi ranch because of relatively lower values during the rainy and dry seasons (F = 10.6).

Similarly when the rainy season Hb level was compared with the mean level of the remaining three seasons combined only the Galambi cows were significantly different (F = 12.64).

DISCUSSION

Annual reproductive pattern of cattle indigenous to Northern Nigeria was studied to determine whether or not they were seasonal breeders. This was accomplished by rectal palpation and gross and histological examination of the female genital tract. Blood profile and hematological examinations were carried out in an endeavour to explain the reproductive variations observed. In addition to the specific parameters measured, there were undoubtedly others which influenced the overall picture. Like all field projects, the ever changing environment was a problem.

Rectal palpation in cattle is well-founded and performed systematically by experienced personnel, as outlined by Zemjanis (1970), is accurate especially for the type of investigation reported here. Limitations of the technique however, were observed (Jordan, 1969; Murray, 1969; Dawson, 1975). Because of the lack of reproductive records, reproductive performance was estimated by comparison of the clinical, gross and histological examinations.

Clinical examination provided current information monthly regarding the reproductive status of the herd investigated. It became clear that the reproductive activity of the cows, all zebu breeds, was seasonal,

Peak activity occurred during and immediately following the rainy season - June to December. This finding confirmed earlier reports of seasonal reproductive variations in Zebu breeds and crosses (McTackett, 1959; Danasoury, 1962; Mahadevan and Seal, 1968; Kiwuwa and Redfern, 1969; Hasherut A.I. Center, 1971; Epstein and Herz, 1973). Presence of gross functional structures in ovaries collected following slaughter together with histological counts of graafian and atretic follicles, confirmed the clinical finding that Zebu cows are seasonal breeders.

Most cows examined during the dry and pre-rain seasons were "noncycling", the majority were cycling during the rainy season. While no comparable reports are available, indirect support is provided by studies on seasonal distribution in sexual activity and calving (Wilson, 1946; Buvanendran et al., 1971; Osman, 1972; Lamorde and Weinman, 1972; Wheat, 1972; Wheat and Broadhurst, 1972; Lamorde and Franti, 1973; Zemjanis, 1974). Rakha and Igboeli (1971) however, found no such effect.

The role of ovarian atrophy in noncycling cows was significant. More than half the cows not cycling had ovarian atrophy. Any factor causing ovarian atrophy is important in seasonal distribution of cycling and noncycling cows.

Average number of follicles in each ovarian sagital section varied widely, partially due to seasonal variations, but mainly were considered to be due to individual variation. The values agreed with those reported by Lamorde and Kumar (1975). The left ovary was found to be slightly more active than the right. This finding was in contrast to that of Kupfer (1920), Asdell et al., (1949), and Rajakoski, (1960). This may have been due to sample variation and the fact that all follicles were not counted in this investigation.

Ovarian dimensions of indigenous cattle estimated rectally were smaller than those of Bos taurus breeds (Sisson and Grossman, 1953; Habel, 1965; Zemjanis, 1970; Roberts, 1971). These findings confirm those of Swett et al., (1961). The right ovary was generally larger than the left. Although this difference was not significant, it was in keeping with earlier reports (Sisson and Grossman, 1953; Rajakoski, 1960). Direct measurement of ovaries obtained following slaughter agreed with length estimated rectally but not for width and height. Average ovarian length and height of ovaries collected post mortem agreed with reports by Herbert (1974) and Lamorde and Kumar (1975). Collectively, these findings establish the dimensions and size variations of the ovaries of Bos indicus. Although variation in ovarian size may reflect

individual variation, it essentially results from presence of functional structures during the period of peak reproductive activity.

Weight of bovine ovaries in Nigeria had not been reported previously. The values were lower than those for Bos taurus (Sisson and Grossman, 1953; Habel, 1965). The finding that the right ovary was heavier than the left agreed with earlier reports for Bos taurus (Kupfer, 1920; Casida et al., 1935; Reece and Turner, 1938).

Incidence of atretic follicles was seasonal as more were present during the pre-dry, dry and pre-rain seasons. This was in contrast with Rajakoski's finding (1960) that the proportion of normal and atretic follicles had no seasonal variation. These conflicting findings may result from a breed difference or some unknown factors that vary with the season and cause follicular atresia, or both. Based on 5% lowered fertility reported during the period in question in well-managed herds in temperate zones (Bane, 1960), the problem may be especially important in Northern Nigeria where zebu cattle have reproductive seasonal variation.

Ovarian pathology observed post mortem was minimal. The only gross lesion was unilateral follicular cystic degeneration. Microscopically, one pair of ovaries with

only a few primordial follicles was classified as mild hypoplasia (Lagerlof and Settergren, 1953; Lagerlof and Boyd, 1953; Lagerlof, 1963; Settergren and Galloway, 1965). The incidence of 1.8% ovarian hypoplasia was similar to the 1.9% reported in the United States of America (Zemjanis, 1961).

The 12.3% gross pathological conditions found in the oviducts of the slaughtered cows was more than that reported in England by Cembrowicz (1950) and agreed with the 15.5% observed in the United States of America (Carpenter et al., 1921) and Swoden (Moberg, 1954). No comparable work has been reported in Nigeria. The fact that the incidence of observed pathological conditions in the oviduct is comparable to that reported elsewhere for Bos taurus suggests that oviductal lesions are not responsible for low annual calf crop, extended calving interval or whatever fertility index in Nigeria is compared to that in the developed agricultural countries.

The height of the epithelial cells of the oviduct, average cell diameter and cell: nucleus ratio had no significant seasonal variation. The technique employed, variation occurring during the various phases of the estrous cycle (Asdell et al., 1949; Lombard et al., (1950), and the fact that the oviducts were sampled randomly and

not in relation to the estrous cycle, may have combined to mask any existing difference. Individual variation and reported variability in epithelial cell height (Dzuik et al., 1958) may also be responsible for the lack of observed variation.

Length, width and thickness of the uterus of the zebu cows examined were less than those of Bos taurus (Sisson and Grossman, 1953; Habel, 1965; Zemjanis, 1970; Roberts, 1971). The incidence of hydrometra is higher than that reported (Roberts, 1971). Small volume of clear fluid in the uterus is considered to be associated with atrophic ovaries (Zemjanis, 1974). Microscopically, 28% of the uteri studied had changes associated with infertility according to the criteria of Cupps (1973). This is relatively higher than the accepted role of infections in bovine infertility in the United States of America (Zemjanis, 1969) and England (Walsby, 1971). Whether this is a realistic figure for Nigeria can only be clarified by expansion of the veterinary profession and more veterinarians taking an active interest in bovine infertility. Cupp's criteria, however, have weaknesses:eosinophils do not invariably indicate infection (Skjerven, 1956), and plasma cells and neutrophils were not considered. Although foci of plasma cells are common

in older cows, they are indicative of previous contract with an infectious agent. The age of the slaughtered cows was not known.

The cervix of Zebu cows, like other parts of the genital tract, is smaller than that of Bos taurus (Roberts, 1971). The incidence of cervicitis (19.2%) was higher than that reported in the United States of America (Zemjanis, 1961). Although this may have been due partially to infection, the majority were considered to have resulted from unskilled interference at parturition.

In contrast to direct examination of the genital tract, rectal palpation revealed a lower incidence (8.5%) of abnormalities than reported elsewhere (Cunkelman, 1948; Herrick, 1957; Dawson, 1958; Zemjanis, 1961; Roberts, 1971).

The value of metabolic profile studies in bovine infertility was shown by Payne et al., (1973). Cause of variation between the parameters and herds are numerous (Payne et al., 1970; Poulsen, 1974). Care was taken to minimize this as much as possible by standardized method and time of sampling. Excitation (Gartner et al., 1965) was minimized by standardized sampling and use of herdsmen familiar with the particular cows. Influence

of age (Hewett, 1974) was reduced by excluding heifers and the effect of pregnancy (Payne et al., 1970) was removed by confining the investigation to open cows. The influence of lactation (Payne et al., 1970) was not eliminated. The main sources of variation between the monthly samples were environmental and husbandry (level of feeding, feed quality, and hygiene).

Glucose levels were consistently low in 1974 due to the drought. In 1975, glucose increased to acceptable levels during the rainy season (Coles, 1967; Benjamin, 1969; Kaneko and Cornelius, 1971). The values for 1974 were generally less than the values for the first six months of 1975. The fact that the rains commenced earlier in 1975 is shown by the higher blood glucose levels in April and May. The control cattle at Shika had higher levels than the test cattle at Bauchi. This indicates that management is an important factor in blood glucose levels, a finding that is supported by Kronfeld (1972), Blowey et al., (1973) and Hewett, (1974).

The role of energy in fertility has been documented (Reid, 1949; Olds, 1953; Joubert, 1954; McClure, 1965, 1968, 1970; Hill et al., 1968; King, 1968; Lamond, 1970). In contrast, Moller and Shannon (1972) and Blowey et al., (1973) found no correlation between glucose levels and fertility. In this study, it was not a question of

comparing an adequate level of glucose to a high level but that of levels bordering on starvation - in such a situation, energy level may be important.

The fact that there was a drought and that dehydration may be responsible for the high levels of total protein, albumin, globulin, calcium, phosphorus, sodium and potassium makes any deduction difficult. If dehydration is responsible then the values are worth considering for seasonal variation. Most values were higher during the rainy season - that is, during the peak period of ovarian activity. As the level of each of the above parameters have been associated with fertility, it is reasonable to assume that they are contributing factors to the peak reproductive activity in zebu cows during the rainy season.

The higher protein values support Ross's finding (1960) that zebu breeds have a higher total protein value than Bos taurus. Total protein is reported to rise in cattle with age (Calstrom, 1961; Dimopoullos, 1970) and increasing lactations (Hewett, 1974). The highest values found in this investigation in the middle of the 1974 drought year suggested that dehydration and hemocentration may be responsible (Coles, 1967).

The values for serum calcium and phosphorus were slightly higher than normal (Crookshank and Sim, 1965; Specter, 1956; Hewett, 1974). These values may be normal for the Zebu. This is supported by the finding by Reed et al., (1974) that calcium levels in areas where bonemeal was not provided were higher than in better managed herds. In addition to poor management, hyperproteinemia (Coles, 1967) or some unknown factor may be responsible for the higher values. The higher values were found during the 1974 drought year while most of the values in 1975 were within accepted limits. This suggests that dehydration may be another reason. The calcium: phosphorus ratio remained within the accepted range.

Changes in Hb and PCV did not follow seasonal variation. The mean values were lowered than those previously reported in Nigeria (Smith, 1959; Oduye and Okunaiye, ,1971; Saror and Coles, 1973a, b; Saror, 1975). The low values in August for both test and control cows may have resulted from ticks and tickborne parasites, drought and malnutrition, or age of the cows (Payne et al., 1970; Hewett, 1974; Poulsen, 1974).

Wagner (1962) associated mild anemia with infertility due to anestrus. Similar lower Hb level was found during most of the year in this investigation and it may

be an important factor in the poor reproductive performance in indigenous zebu breeds.

There is probably no single satisfactory fertility index, especially as one index affects another. They are however, a useful indicator of a herd's reproductive performance. Without well-kept reproductive records, fertility indices cannot be determined, hence any effort to provide an answer for reproductive efficiency has no sound foundation. This present investigation suffered this setback due to the methods of husbandry prevailing.

Considerable work will be required to obtain a clear picture of "what is really happening" in bovine fertility in Northern Nigeria. It is suggested that the following areas be investigated.

1. Endocrinological profile of Zebu breeds, particularly the levels of follicular stimulating hormone, luteinizing hormone, estrogen and progesterone.
2. Biossay estimation of the level of releasing factors and histochemical studies of slaughter house specimens as a basis for understanding the pathogenesis of ovarian atrophy in indigenous breeds.

3. Determination of the role of infections in bovine infertility in Nigeria.
4. Normal blood profile of indigenous cattle be established to provide the physiological range for future studies into the non-infectious causes of bovine infertility.

As a result of this investigation, the following recommendations are made to improve the efficiency of the cattle industry in Nigeria.

1. A standardized, efficient reproductive record system be established for all government-owned herds so that fertility indices can be calculated as a basis for future breeding programs.
2. Research in livestock production be intensified to provide information on reproductive physiology and pathology, nutrition, genetics, economics, and rural sociology.
3. Cattle be bred in July and August. This will permit three to four services before the end of the breeding season. Breeding cows and heifers should be supplementary fed for two months prior to breeding.
4. Replacement heifers and nursing cows should be supplementary fed. All non-producing cattle

should be culled to conserve feed for breeding cattle.

5. Grass should be conserved as hay or silage for supplemental feeding during the dry and pre-rain seasons.

In conclusion, attention should be drawn to the fact that too often, reproductive inefficiency in the national cattle herd is blamed on the Fulani's "refusal to settle". This may be valid but it must not be forgotten, that his cattle are raised not for profit, but for security and investment. He does not own land, he does not buy stocks and shares, he has no use for banks; his cattle provide all his security. Remember changing the way of life of any individual or group is not easy, it is always resisted and suspected. Unfortunately, Nigeria with its growing population needs increased meat production. To obtain it, conditions encouraging cattle raising as a business, and not as a way of life, must be emphasized.

SUMMARY

Seasonal variation in reproductive activity of ndigenous cattle of Northern Nigeria was investigated ver a 15 month period by rectal palpation, examination of genital organs post mortem, blood profile, and hematological examination. The data obtained was analyzed according to the following seasons: Dry, January to March; Pre-rain, April to May; Rain, June to September; and Pre-dry, October to December.

Length, width and height of the ovaries of Zebu cows, determined by rectal palpation, was 26.2 x 9.1 x 11.7 and 27.5 x 9.3 x 12.4 mm for the left and right, respectively. These dimensions are smaller than those of Bos taurus. There was an increasing linear trend in the three dimensions and the inter-month variation was significant. Ovarian activity was greater during the rainy and pre-dry seasons.

Pathological conditions (8.5%) found in 461 rectal examinations were as follows: ovaritis 1.3%; follicular cyst 0.2%; perisalpingitis 1.5%; hydrosalpinx 0.2%; pyometra 0.2%; and cervicitis 5.0%.

Examination of the genital tract of a number of cows examinad clinically following slaughter confirmed the ovarian dimensions. The average weight of the left and right ovaries was 3.4 ± 0.7 and 3.5 ± 0.7g, respectively. Ovarian function peaked during July and August and

...e measured

the incidence of atretic follicles was lowest in August. The only gross abnormality found was unilateral follicular cystic degeneration.

Pathological conditions (12.3%) found in the oviducts were: perisalpingitis and salpingitis 7.0%; hydrosalpinx 3.5%; and perisalpingeal cyst 1.8%. The height of the epithelial cells of the oviduct, average cell diameter and cell: nucleus ratio were measured but seasonal variations were not significant.

The length, width and thickness of 57 uteri were measured. The only gross abnormality observed was slight hydrometra (14%). Microscopically, the endometrium was examined for epithelium degeneration, enlargement of endometrial glands, and for infiltration of eosinophils and lymphocytes.

The length and diameter of the cervix was measured. Chronic cervicitis was found in 11 cows (19.3%).

Blood glucose, total protein, albumin, globulin, albumin: globulin ratio, serum calcium and phosphorus, calcium: phosphorus ratio, sodium, potassium, packed cell value and hemoglobin concentration were determined.

It was concluded that indigenous cows in Northern Nigeria are seasonal breeders with peak activity during the rainy and pre-dry seasons. For maximum reproductive efficiency under prevailing conditions of husbandry, it is recommended that cows be bred during July and August.

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APPENDICES

A. Clinical Examination Results. Tables 1-15

Table 1

Clinical Examination Results
for January 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	C[1]	C[1]2	C[1]3	J	N	A	T	Remark
1.	20	10	10	20	10	10					1				
2.	10	5	5	10	5	5							1		
3.	15	5	5	15	5	5							1		**Cervicitis**
4.	15	5	5	15	5	5							1		
5.	20	5	5	15	5	5							1		
6.	25	5	5	15	5	5							1		
7.	25	10	10	25	10	20	1					1		1	
8.	30	10	10	30	15	10			1			1			Bil Salp
9.	10	5	5	20	10	15	1							1	Cervicitis
10.	10	5	5	30	10	15							1		
11.	15	10	10	30	10	10			1			1			
12.	25	5	5	35	5	10						1		1	Cervicitis
13.	25	5	5	25	5	5							1		
14.	25	5	5	20	5	5							1		
15.	25	5	5	20	5	5							1		Cervicitis
16.	10	5	5	10	5	5							1		Cervicitis
17.	10	5	5	10	5	5							1		
18.	35	10	10	30	10	10						1			Cervicitis
19.	15	10	10	25	10	10			1			1			
20.	30	10	10	25	10	10						1			
21.	20	10	15	10	5	5							1		
Total	420	145	155	435	165	185	2		3		1	7	12	3	7
Ave.	19.5	6.90	7.4	20.7	7.4	9.3									
SD	7.6	2.5	3.4	7.8	3.0	4.3									

Table 2

Clinical Examination Results
for February 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C¹2	C¹3	J	N	A	T	Remark
1.	10	5	5	10	5	5							1		
2.	35	10	10	20	5	5						1			
3.	30	10	10	30	10	10			1			1			
4.	20	10	10	20	10	10					1		1		
5.	35	10	10	35	10	10			1			1			Cervicitis
6.	15	5	5	15	5	5							1		
7.	15	5	5	15	5	5							1		Cervicitis
8.	20	5	5	15	5	5							1		Cervicitis
9.	25	10	10	25	10	20			1			1			Cervicitis
10.	15	10	15	15	10	15			1				1		Cervicitis
11.	30	10	15	35	15	10	1							1	Bil. Perisalpingitis
12.	10	5	5	30	10	15			1			1			
13.	10	5	5	30	10	15							1		
14.	15	10	10	25	10	10	1							1	
15.	25	5	5	35	5	10							1		
16.	25	10	10	30	10	10						1			Cer. bil. peri-salpingitis.
17.	25	5	5	25	5	10							1		
18.	25	5	5	20	5	5							1		
19.	20	5	7	30	15	20			1			1			
20.	15	5	5	15	5	5							1		
21.	25	5	15	30	10	10						1			
Total	445	150	172	506	175	210	2		6		1	8	11	3	7
Ave.	21.19	7.14	8.19	24.10	8.33	10.00									
SD	7.7	2.5	3.6	7.9	3.3	4.7									

Table 5

Clinical Examination Results
for March 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C¹2	C¹3	J	N	ATR	T	Remark
1.	10	5	5	10	5	5							1		
2.	40	10	10	30	20	10						1			
3.	15	10	10	15	10	10							1		
4.	10	5	5	10	5	5							1		
5.	15	10	5	15	10	5							1		
6.	35	15	10	40	15	10			1			1			
7.	40	20	15	40	20	15						1			
8.	20	15	10	20	5	10							1		
9.	15	5	10	20	5	10							1		
10.	15	10	10	15	10	5							1		
11.	25	10	15	30	15	10						1			
12.	30	10	15	40	10	20						1			
13.	20	10	10	25	15	10							1		
14.	10	5	5	10	5	5							1		
15.	20	10	10	20	10	10							1		
16.	25	10	5	20	10	10							1		
17.	20	10	10	20	10	10							1		
18.	40	20	15	30	10	15	1							1	Ovaritis
19.	30	10	15	30	5	10					1				
20.	40	20	15	35	10	15								1	Cervicitis
21.	35	15	15	40	10	15	1							1	
22.	25	5	10	25	5	10							1		
23.	10	5	5	10	5	5							1		
24.	10	5	5	10	5	5							1		
Total	555	250	240	560	230	235	2		1		6		14	3	
Ave.	23.1	10.4	10.0	23.3	9.6	9.8									
SD	10.8	4.9	3.9	10.6	4.6	4.03									

Table 4

Clinical Examination Results
for April 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch1	C¹2	C¹3	J	N	ATR	T	Remark
1.	15	5	5	10	5	5							1		
2.	25	10	15	25	10	10						1			
3.	10	5	5	25	10	15	1					1			
4.	20	5	5	20	5	5							1		
5.	30	10	10	20	5	5						1			
6.	15	5	10	20	5	10							1		
7.	25	10	10	20	10	20	1							1	
8.	20	5	10	20	10	15						1			
9.	20	10	10	20	10	10						1			
10.	25	5	10	20	5	10					1				
11.	20	5	5	20	5	5					1		1		
12.	20	10	10	20	10	10							1		
13.	20	5	10	20	5	5						1			
14.	20	5	10	20	5	10						1			
15.	20	5	5	20	5	5					1		1		
16.	20	5	5	20	5	5					1		1		
17.	15	5	5	20	5	5					1		1		
18.	20	5	5	20	5	5					1		1		
19.	15	5	5	20	5	5					1		1		
20.	25	10	10	25	5	5							1		
21.	20	10	5	25	5	5						1			
22.	25	10	15	30	20	25	1							1	Bil. Hydro? sal.
23.	15	5	5	35	10	15	1							1	
24.	30	5	10	25	5	5						1			
25.	15	5	5	15	5	5							1		

Table 4 (Cont'd)

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch1	C^1_2	C^1_3	J	N	ATR	T	Remark
26.	10	5	5	10	5	5							1		
27.	25	10	5	25	5	5		1						1	
28.	30	10	15	35	10	15		1						1	
29.	20	10	10	25	10	10							1		
30.	30	15	10	30	10	10						1			
31.	20	5	10	20	5	10	1							1	
32.	20	5	10	20	5	10						1			
33.	30	10	20	30	10	15						1			
34.	20	10	10	25	10	10						1			
35.	10	5	5	15	5	5							1		
36.	30	15	15	20	10	10	1							1	
37.	25	10	10	30	10	10						1			
38.	35	20	20	40	15	25	1		1			1			
39.	25	10	15	30	10	20						1			
40.	30	10	15	30	10	15	1							1	
41.	30	10	15	30	10	15			1			1			
42.	30	10	10	30	10	15						1			Bil. ovaritis
43.	25	10	10	30	10	15						1			
44.	20	5	5	25	10	5							1		
45.	20	5	5	25	10	5							1		
46.	30	10	15	35	15	15	1		1			1			
Total	1020	365	430	1095	370	465	7	4	3		7	22	9	7	
Ave.	22.17	7.348	9.348	23.80	8.042	10.11									
SD.	6.11	3.43	4.16	6.34	3.41	5.53									

Table 5

Clinical Examination Results
for May 1974: Determined Rectally

	Left Ovary			Right Ovary											
	L	W	H	L	W	H	F	Ch	$C^1 2$	$C^1 3$	J	N	ATR	T	Remark
1.	20	10	10	25	10	15	1		1				1		
2.	25	10	10	30	5	10						1			
3.	25	10	15	20	10	10						1			
4.	20	5	5	25	5	10						1			
5.	10	5	5	15	5	5							1		
6.	15	5	5	20	5	5							1		
7.	15	5	5	20	5	5							1		
8.	25	5	5	20	5	5							1		
9.	25	5	5	20	10	10						1			
10.	25	10	10	25	15	15						1			
11.	25	10	15	25	10	10						1			
12.	25	5	5	25	5	5							1		
13.	25	10	10	20	5	10							1		
14.	30	15	20	30	15	20							1		
15.	25	10	15	30	10	15						1			
16.	35	10	15	40	15	20						1			
17.	25	10	10	20	10	10						1			
18.	15	5	5	25	5	10							1		
19.	15	15	5	15	5	5							1		
20.	20	10	15	20	10	10						1			
21.	30	10	15	35	10	15						1			
22.	15	10	15	20	5	5							1		
23.	35	10	15	30	15	20							1		
24.	15	5	10	20	5	10							1		
25.	25	5	10	30	10	15	1					1			
26.	25	5	5	30	5	5						1			
27.	15	5	10	25	10	15							1		
28.	25	15	20	20	5	15						1			
29.	30	10	15	30	20	10	1					1			
30.	30	10	15	40	15	25				1		1			

Table 5 (Cont'd).

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C¹2	C¹3	J	N	ATR	T	Remark
31.	20	5	10	25	5	10						1			
32.	25	5	5	25	5	5							1		
33.	25	10	15	25	5	5						1			
34.	25	15	10	25	10	15						1			
35.	25	5	15	25	10	15						1			
36.	30	10	15	25	10	15			1						
37.	15	5	10	20	10	15							1		
38.	25	5	10	30	5	15							1		
39.	40	15	20	40	15	25				1		1			
40.	30	10	15	25	5	10						1			
41.	25	5	10	25	10	15							1		
42.	20	5	10	25	5	5							1		
43.	15	5	5	15	5	5							1		
44.	30	10	15	30	10	10						1			
45.	25	5	5	30	5	5									Pyometra
46.	30	5	5	30	5	5						1			
47.	20	5	5	30	10	10							1		
48.	25	10	10	30	10	10						1			
49.	30	10	15	30	5	15	1					1			
50.	25	5	10	25	10	10						1			
51.	15	5	5	15	5	10							1		
52.	20	5	10	20	5	10							1		
53.	25	5	10	30	5	5						1			
54.	25	5	5	30	5	10						1			
55.	10	5	5	15	5	5							1		
56.	40	15	20	25	10	15						1			
57.	25	5	5	25	5	10							1		
58.	20	10	15	30	10	15						1			
Total	1375	460	610	1475	470	630	4		2	2		31	25		
Ave.	23.71	7.932	10.52	25.43	8.106	11.03									
S.D.	6.5	3.4	4.8	5.9	3.7	5.1									

Table 6

Clinical Examination Results for June 1974: Determined Rectally

	Left Ovary L	Left Ovary W	Left Ovary H	Right Ovary L	Right Ovary W	Right Ovary H	F	Ch	$C^1 2$	$C^1 3$	J	N	ATR	T		Remark
1.	35	10	10	35	10	15		1						1		
2.	25	5	10	35	10	15			1			1				
3.	30	10	10	30	10	10							1			
4.	30	10	15	25	5	10	1					1				
5.	30	10	10	35	10	15						1				
6.	40	25	30	40	15	20	1		1			1				
7.	40	20	25	30	10	10	1							1		
8.	35	10	15	30	10	15						1				
9.	30	5	10	10	5	5							1			
10.	30	15	15	40	10	15	1		1				1			
11.	30	10	15	30	10	10						1				
12.	40	20	25	35	15	15	1		1			1				
13.	20	5	10	15	5	5								1		
14.	25	10	10	20	5	10						1				
15.	35	10	10	40	10	10						1				
16.	20	5	10	30	10	15		1						1		
17.	20	5	15	20	10	10	1					1				Involuting cervicitis
18.	35	10	15	25	10	15	1					1				
19.	20	10	15	35	15	20						1				
20.	20	5	10	25	10	10							1			
21.	30	5	10	35	10	15						1				
22.	15	10	10	10	5	10							1			
23.	25	5	10	30	10	15			1			1				
24.	20	10	10	30	10	15	1							1		
25.	25	5	10	25	10	15	1							1		
26.	25	5	10	25	10	15							1			
27.	15	5	5	25	10	10							1			Cervicitis
28.	30	20	15	10	10	10										Inv. cervicitis
29.	12	5	10	15	5	10							1			
30.	25	10	10	30	10	15							1			
31.	25	10	10	35	15	20	1								1	
32.	25	10	10	35	15	20	1								1	
33.	25	10	15	35	15	20	1		1						1	
34.	30	15	15	25	10	15						1				
Total	917	335	435	950	340	455	12	2	6			15	9	6	3	
Ave.	26.98	9.851	12.79	27.94	10.00	13.39										
S.D.	7.2	5.2	5.1	8.5	3.0	4.0										

Table 7

Clinical Examination Results for July 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C¹2	C¹3	J	N	ATR	T	Remark
1.	35	10	15	25	10	10	1						1		
2.	30	10	15	30	10	15						1			
3.	30	20	25	35	20	15						1			
4.	25	10	5	15	5	10	1					1			
5.	25	5	10	30	10	5						1			Cervicitis
6.	20	15	10	30	15	15						1			
7.	30	20	25	35	15	20						1			
8.	20	5	10	40	5	10	1					1			
9.	15	5	10	40	5	10						1			
10.	25	10	15	40	10	15	1					1			
11.	20	10	10	20	10	10							1		
12.	25	10	15	20	10	15						1			
13.	20	5	10	25	5	10						1			
14.	40	25	25	25	10	15	1					1			
15.	30	10	15	45	15	25				1		1			Perisalpingitis
16.	30	10	15	20	10	15						1			Cervicitis
17.	15	10	10	25	10	15						1			
18.	25	15	10	40	15	25	1					1			Cervicitis
19.	30	15	20	25	10	15						1			
20.	30	15	20	30	15	20						1			Cervicitis
21.	30	15	15	35	15	20						1			Cervicitis
22.	25	5	10	15	5	10							1		
23.	35	20	25	40	25	25						1			
24.	40	10	15	35	10	10				1		1			
25.	25	15	15	40	20	20						1			
26.	35	20	25	30	15	20						1			Cervicitis
27.	15	5	10	30	10	15							1		
Total	725	325	405	820	315	410	6			2		23	4		
Ave.	26.85	12.03	15.00	30.37	11.66	15.18									
S.D.	7.0	5.6	5.9	8.3	5.0	5.3									

Table 8: Clinical Examination Results for August 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C¹2	C¹3	J	N	ATR	T	Remark
1.	40	10	15	35	10	15	1					1			
2.	30	10	10	30	10	10	1							1	
3.	20	5	10	30	10	15		1						1	
4.	15	5	5	15	5	5							1		
5.	25	5	5	30	10	10	1							1	
6.	25	5	10	30	5	5							1		
7.	25	10	15	30	10	10						1			
8.	30	10	10	30	10	15						1			
9.	30	5	5	30	5	5									Fluid both horns
10.	30	5	5	30	5	5							1		
11.	40	10	10	35	10	10						1			
12.	40	10	15	40	5	10						1			Involuting
13.	35	10	15	35	10	15	1							1	
14.	30	10	10	45	15	20				1		1			
15.	35	10	15	30	10	10						1			Involuting
16.	30	10	15	45	20	30				1			1		Pa RH 30 days
17.	30	10	15	25	10	10						1			Perisalpingitis
18.	40	5	5	40	10	15	1							1	
19.	30	5	10	30	10	20				1					
20.	30	10	15	30	10	15						1			
21.	30	10	15	35	10	15	1					1			
22.	40	10	15	45	15	20						1			
23.	35	5	10	25	10	15	F		1					1	Aborted
24.	40	15	25	30	5	10				1		1			Perialpingitis
25.	40	10	15	35	10	10	1					1			
26.	20	10	15	30	5	10	1					1			
27.	45	15	20	45	10	20						1			
28.	25	10	15	25	15	20	1		1	1		1			
29.	20	5	5	20	5	10							1		
30.	5	5	5	20	5	5						1			Involuting
31.	30	10	10	30	5	10	1		1			1			
Total	940	265	365	985	285	495	11	1	3	5		18	5	4	
Ave.	30.32	8.547	11.77	31.77	9.191	12.74									
S.D.	8.7	2.9	4.9	7.4	3.7	5.8									

Table 9

Clinical Examination Results for
September 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C1 2	C1 3	J	N	ATR	T	Remarks
1.	30	10	15	30	10	15						1			Involuting
2.	25	10	15	25	5	10						1			
3.	30	10	15	35	5	10						1			
4.	25	5	15	30	5	5						1			
5.	20	5	5	20	5	5							1		
6.	35	5	10	30	5	10						1			
7.	25	5	10	20	5	10							1		
8.	25	5	10	25	5	5						1			
9.	25	5	5	25	5	10						1			
10.	30	15	25	20	5	5		1						1	
11.	25	10	15	30	25	25				1		1			
12.	25	5	5	25	5	5									
13.	20	5	5	25	5	5						1			Involuting
14.	20	5	5	25	5	10							1		
15.	25	5	10	25	5	10						1			
16.	30	10	15	30	10	15		1						1	
17.	35	10	15	40	20	25	1					1			
18.	25	5	10	20	5	15						1			
19.	20	5	10	25	5	5						1			
20.	40	10	25	45	20	25				1		1			
21.	35	15	20	30	5	10						1			
22.	30	5	5	35	5	5						1			Involuting
23.	40	15	15	40	15	20	1			1		1			
24.	25	5	5	25	5	10						1			Involuting
25.	25	5	5	25	5	20				1		1			
26.	35	20	20	40	20	20		1						1	
27.	40	15	20	40	15	15						1			
28.	30	5	5	35	5	5						1			Involuting
29.	40	10	20	40	15	15	1							1	
30.	30	5	10	30	15	15						1			
Total	865	245	365	890	265	360	3	3		4		22	3	4	
Ave.	28.83	8.168	12.17	29.67	88.33	12.00									
S.D.	6.3	4.3	6.3	7.1	6.1	6.5									

Table 10

Clinical Examination Results for
October 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C¹2	C¹3	J	N	ATR	T	
1.	30	5	10	25	5	10						1			
2.	30	10	15	40	20	25	1							1	
3.	40	10	20	40	10	20			1			1			
4.	30	5	10	30	5	10	1							1	
5.	30	10	20	40	10	15	1		1					1	
6.	30	10	10	30	10	15	1					1			
7.	30	10	15	30	10	15		1						1	
8.	25	10	15	35	20	30	1			1		1			Cervicitis
9.	30	10	15	35	10	15	1					1			
10.	30	10	10	25	5	10		1				1			
11.	25	10	15	30	5	10						1			
12.	20	5	10	20	10	15	1					1			
13.	40	15	20	50	15	25	1					1			
14.	30	5	10	15	5	10						1			
15.	30	10	15	35	15	20			1			1			
16.	45	20	30	30	10	15	1		1					1	
17.	25	5	10	25	5	10							1		
18.	30	5	5	35	5	10							1		
19.	35	10	15	30	5	10						1			
20.	45	15	25	50	15	25	1		1						
21.	35	15	20	40	10	15		1						1	
22.	25	10	10	25	10	15						1			
23.	30	10	15	40	15	25			1			1			
24.	20	10	15	20	5	10		1						1	
25.	10	5	10	15	5	10					1				

Table 10 (Cont'd.)

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C¹2	C¹3	J	N	ATR	T	Remark
26.	20	10	15	25	5	10	1		1						
27.	30	15	20	30	10	15			1	1		1			Ovaritis
28.	30	10	15	35	10	20				1					Pg 70 days
29.	35	20	25	30	10	15			1			1			Pg 35 days
30.	25	10	15	40	20	25	1			1		1			
31.	25	10	5	30	25	25	1					1			
32.	25	10	15	25	5	10			1			1			
33.	25	5	10	30	5	10	1						1		
34.	25	10	15	25	5	15			1				1		
35.	15	10	10	20	5	5					1				
36.	25	5	10	20	10	15	1					1			
37.	30	10	15	30	15	15	1		1			1			
38.	30	10	15	30	5	15						1			
39.	30	10	15	25	10	15			1			1			
Total	1120	385	565	1185	380	600	16	4	13	4	2	23	4	7	
Ave.	28.72	9.872	14.48	30.38	9.74	15.38									
S.D.	7.0	3.7	5.2	8.2	5.2	5.9									

Table 11

Clinical Examination Results for
November 1974: Determined Rectally

	Left Ovary			Right Ovary			F	Ch	C 1 2	C 1 3	J	N	ATR	T	Remark
	L	W	H	L	W	H									
1.	35	10	15	35	15	20	1					1			
2.	20	10	15	25	10	15			1					1	
3.	30	10	15	30	10	15	1					1			
4.	25	5	10	30	10	15		1						1	
5.	35	20	25	40	20	30				1					
6.	20	5	10	25	5	5						1			
7.	35	10	20	25	10	15	1		1			1			
8.	45	15	25	35	20	25	1			1		1			
9.	30	5	10	20	5	10						1			
10.	25	10	15	30	10	25				1		1			
11.	40	10	15	25	10	15	1					1			
12.	25	5	10	35	15	25				1		1			
13.	45	20	30	35	15	20				1		1			
14.	25	5	10	30	10	15	1		1					1	
15.	35	15	20	30	15	20	1		1					1	
16.	35	10	15	45	15	20	1							1	
17.	20	5	10	25	5	10	1							1	
18.	35	10	15	30	10	15	1		1					1	
19.	30	10	15	30	10	20	1		1			1			
20.	25	5	10	25	5	10	1						1		
21.	30	10	15	30	5	10						1			
22.	40	15	20	45	15	25	1							1	
23.	30	10	15	40	15	20	1		1			1			
24.	30	5	10	25	5	10						1			
25.	30	10	15	30	5	15						1			
26.	30	10	15	30	10	15	1					1			
27.	35	15	25	30	10	15	1					1			
28.	30	5	10	30	5	10		1						1	

Table 11 (Cont'd)

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C 1 2	C 1 3	J	N	ATR	T	Remark
29.	40	15	20	35	15	20	1		1					1	
30.	40	20	20	40	20	25	1	1				1			
31.	20	10	15	35	10	15	1		1			1			
32.	30	15	20	30	10	15	1			1		1			
33.	40	20	25	35	10	20	1		1					1	
34.	25	10	10	30	15	25	1							1	
35.	35	10	15	40	10	15	1					1			
36.	40	15	20	40	15	20		1						1	
37.	25	5	5	25	5	15			1				1		
Total	1165	395	535	1180	405	635	23	4	11	6		21		13	
Ave.	31.49	10.68	15.81	31.89	10.95	17.16									
S.D.	7.0	4.7	5.6	6.1	4.5	5.6									

Table 12

Clinical Examination Results for December 1974: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch	C 1 2	C 1 3	J	N	ATR	T	Remark
1.	35	20	15	35	15	10									
2.	25	5	5	25	5	10			1			1			
3.	35	20	25	40	25	25	1			1		1			
4.	25	5	5	30	10	10	1			1		1			
5.	25	15	15	30	10	10	1						1		
6.	30	5	10	30	5	10						1			
7.	25	5	10	25	5	10	1		1			1			
8.	35	10	15	30	10	15			2			1			
9.	40	15	20	40	15	20		1						1	
10.	40	15	20	40	15	20		1						1	
11.	25	10	15	25	10	15	1			1				1	
12.	20	10	10	20	10	10						1			
13.	30	15	15	30	10	15	1							1	
14.	20	5	5	10	5	5	1							1	
15.	40	15	20	35	10	10		1						1	
16.	10	5	5	15	5	5			1				1		
17.	35	10	10	35	10	15				1		1			
18.	30	5	10	35	10	15	1		1					1	
19.	35	10	20	35	20	25			1	1		1			
20.	25	5	10	30	10	15		1							
21.	25	10	15	20	5	10	1					1			
22.	25	5	15	25	5	10							1		
23.	20	5	10	25	5	5						1			
24.	30	5	5	30	5	5						1			
25.	30	5	5	35	10	10	1							1	
26.	15	10	5	25	10	15				1			1		
27.	25	5	10	25	10	5	1			1		1			
28.	25	5	10	25	5	10	1							1	
29.	45	10	20	45	15	20	1		1					1	
30.	35	5	5	30	5	10	1					1			
31.	45	20	30	40	15	20	1			1		1			
32.	25	5	5	25	5	5				1			1		
Total	930	295	395	945	310	395	15	4	8	9		12	5	10	
Ave.	29.07	9.219	12.34	29.53	9.690	12.34									
S.D.	8.2	5.1	6.0	7.7	4.9	5.7									

Table 13

Clinical Examination Results for January 1975: Determined Rectally

	Left Ovary			Right Ovary											
	L	W	H	L	W	H	F	Cl_1	C^12	C^13	J	N	ATR	T	Remark
1.	30	20	15	30	15	10						1			
2.	30	5	5	25	5	5	1					1			
3.	35	10	15	30	15	10			1			1			
4.	20	10	10	30	10	10			1			1			
5.	30	5	10	25	5	10				1					
6.	25	10	15	30	10	15	1							1	
7.	25	10	15	20	10	10			1			1			
8.	20	10	10	20	10	10						1			
9.	10	5	5	10	5	5							1		
10.	35	10	10	35	10	15				1		1			
11.	30	5	10	35	10	15				1		1			
12.	35	10	15	35	20	25	1							1	
13.	25	5	10	30	10	15	1							1	
14.	25	5	15	25	5	10						1			
15.	20	5	10	25	5	5						1			
16.	30	5	5	30	5	5						1			
17.	30	5	5	35	5	5				1		1			
18.	15	10	5	15	5	5							1		
19.	20	5	5	15	5	5							1		
20.	15	10	5	25	10	15	1							1	
21.	25	10	5	25	10	5				1		1			
22.	25	5	10	25	10	5			1			1			
23.	35	15	5	30	5	10					1	1			
24.	25	5	5	25	5	5						1			
Total	615	175	190	595	195	230	5		4	5	1	16	3	4	
Ave.	25.9	7.29	7.9	24.8	8.1	9.6									
S.D.	6.8	3.9	4.1	6.6	4.0	5.1									

Table 14

Clinical Examination Results for March 1975: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Ch1	C¹2	C¹3	J	N	A	T	Remark
1.	10	5	5	10	5	5							1		
2.	30	10	15	25	5	10	1					1			
3.	35	5	15	35	5	10	1							1	
4.	10	5	5	10	5	5					1		1		
5.	25	10	15	25	15	10			1						
6.	25	5	15	10	5	5							1		
7.	10	5	5	10	5	5							1		
8.	35	10	15	35	5	10			1			1			
9.	25	5	20	25	5	10						1			
10.	15	5	15	15	5	15						1			
11.	25	5	5	35	5	10			1						
12.	35	5	15	35	5	10						1			
13.	25	5	15	25	5	15						1			
14.	25	5	15	25	5	10						1			
15.	30	10	15	35	5	10	1					1			
16.	25	5	10	25	5	10						1			
17.	25	5	10	25	5	10					1				
18.	35	5	15	35	15	10	1		1						
19.	25	5	10	30	5	15			1			1			
20.	25	10	10	25	10	10						1			
Total	495	125	245	495	125	195	4		5		2	10	4	1	
Ave.	24.8	6.3	12.3	24.8	6.1	9.8									
S.D.	8.0	2.2	4.4	9.2	3.2	3.0									

Table 15

Clinical Examination Results for May 1975: Determined Rectally

	Left Ovary L	W	H	Right Ovary L	W	H	F	Cl[1]	C[1]2	C[1]3	J	N	A	T	Remark
1.	15	10	10	5	5	5					1		1		
2.	20	10	15	10	10	5		1				1			
3.	25	15	10	15	10	10	1							1	
4.	15	10	10	25	10	10							1		
5.	5	5	5	5	5	5							1		
6.	5	5	5	5	5	5							1		
7.	5	5	5	5	5	5							1		
8.	25	5	5	10	5	5									
9.	25	5	10	25	5	10	1							1	
10.	10	5	5	10	5	5							1		
11.	25	10	15	25	10	10	1							1	
12.	25	5	15	25	5	15						1			
13.	10	5	5	30	25	20			1						
14.	30	15	25	50	15	25									Cystic
15.	20	5	10	25	10	25						1			
16.	35	5	10	25	10	5			1			1			
17.	30	10	15	25	10	15				1					
Total	350	130	175	320	150	180	3	1	2	1	1	4	6	3	
Ave.	20.6	7.6	10.3	18.8	8.8	10.6									
S.D.	11.9	3.6	5.4	12.2	5.2	7.0									

B. Bauchi Slaughter House Sample Examination Results.

Tables 16-21.

Table 16

Bauchi Slaughter House Samples (January)

	Left Ovary (mm)			Right Ovary (mm)			Weight of Ovary		Oviduct	
	L	W	H	L	W	H	L	R	L	R
1 - Jan.	22.1	9.5	9.5	22.1	9.5	9.5	20	20	N	N
2.- Jan.	28.4	8.4	12.6	28.4	12.6	15.75	32	45	N	N
3 - Jan.	31.5	12.6	12.6	28.4	12.6	12.6	35	37.5	Abn	Abn
4 - Jan	18.9	11.0	12.6	15.75	6.3	9.5	22.5	17.5	N	N
5 - Jan	18.9	12.6	9.5	22.1	12.6	15.75	17.5	22.5	N	N
6 - Jan	31.5	18.9	18.9	31.5	15.75	18.9	65	52.5	N	N
7 - Jan	25.2	15.75	12.6	25.2	15.75	12.6	37.5	40.0		
8.- Jan	31.5	12.6	12.6	31.5	12.6	12.6	45	50	N	N
9 - Jan	22.1	9.5	9.5	18.9	15.75	9.5	17.5	22.5	N	N
10 - Jan	28.4	9.5	6.3	22.1	12.6	12.6	28	17.5	N	N
Total	6916.15	1543.86	1461.45	6303.16	1667.93	1848.43	12208.00	12312.50		
Average	25.89	12.04	11.67	24.60	12.61	13.25	32	32.5		

Table 16 (Cont'd)

	Left Uterine Horn (mm)			Right Uterine Horn (mm)			Cervix (mm)		
	Length	Width	Thickness	Length	Width	Thickness	Length	Width at mid.	Width at Ext. OS
1 - Jan	151	11.0	6.3	138.6	11.0	6.3	100.8	37.8	44.1
2 - Jan	132.7	12.6	9.5	132.9	12.6	9.5	88.2	31.5	31.5
3 - Jan	126.0	15.75	6.3	113.4	15.75	6.3	75.6	18.9	31.5
4 - Jan	138.6	12.6	4.75	113.4	12.6	4.75	75.6	31.5	44.1
5 - Jan	75.6	9.58	1.58	113.4	9.5	4.75	63	25.2	50.4
6 - Jan	195.3	12.6	6.3	163.8	15.75	4.75	75.6	31.5	44.1
7 - Jan	100.8	7.86	1.0	126.0	9.5	2.0	63	18.9	31.5
8 - Jan	157.5	9.5	-	163.8	12.6	-	-	-	-
9 - Jan	100.8	9.5	2.0	88.2	9.5	2.0	63	22.5	18.9
10 - Jan	151.2	9.5	3.0	126.0	9.5	4.0	94.5	31.5	37.8
Total	1382.90	1268.12	248.38	168643.17	1454.41	261.32	55923.21	7253.55	13137.39
Average	165.47	11.04	4.53	127.95	11.83	4.93	77.7	27.7	37.1

Table 17

Bauchi Slaughterhouse Samples (May)

Lab. No. Histology	Pregnant L or R	Left Ovary Length (mm)	Left Ovary Width (mm)	Left Ovary Height (mm)	Right Ovary Length (mm)	Right Ovary Width (mm)	Right Ovary Height (mm)	L/Oviduct	R/Oviduct	Left U. Horn Length (mm)	Left U. Horn Width (mm)	Left U. Horn Thick-ness(mm)	Right U. Horn Length (mm)	Right U. Horn Width (mm)	Right U. Horn Thick-ness(mm)	Cervix Length (mm)	Cervix Width (mm)	Cervix Thick-ness(mm)
1	-	35	17	10	35	25	15	N	N	185	35	2.0	214	32	1.5	110	55	32
2	3mths	32	12	9	32	24	12	N	N	225	65	5.0	250	2.5	2.5	25	62	41
3	-	20	14	10	25	16	7	N	N	185	25	1.0	190	25	1.0	55	25	30
4	-	32	17	11	33	19	15	N	Abn	128	38	1.5	130	35	2.5	54	40	40
5	-	20	11	8	25	10	10	N	N	185	20	0.5	180	20	5.0	65	20	20
6	-	20	7	4	25	10	10	N	N	145	20	0.5	165	17	1.0	50	20	20
7	-	35	13	8	32	15	10	N	N	138	32	2.5	105	27	1.25	83	40	32
8	-	22	11	9	Cut	off	-	N		180	12	0.5	170	14	0.5	65	18	21
9	-	25	11	7	23	10	6	N	N	145	12	1.0	145	15	1.0	65	29	20
10	-	40	23	18	43	18	15	N	N	150	15	2.5	180	31	1.2	85	40	40
Total		281	136	94	273	147	100			1666	274	17	1729	228.5	17.45	657	349	296
Ave.		28.1	13.6	9.4	30.3	16.1	11.1			166.6	27.4	1.7	172.9	34.1	1.75	65.7	34.9	29.6
R_6		8407.00	2028.00	1000.00	8615.00	2667.00	1204.00			285678.00	9856.00	46.50	314271.00	21299.00		47955.00	14259.00	9470.00

Table 18

Bauchi Slaughterhouse Samples (July)

	Lab. No. Histology	Pregnant L or R	Left Ovary Length (mm)	Left Ovary Width (mm)	Left Ovary Height (mm)	Right Ovary Length (mm)	Right Ovary Width (mm)	Right Ovary Height (mm)	L/Oviduct R/Oviduct	U. Horn Length (mm)	Left U. Horn Width (mm)	Left U. Horn Thickness (mm)	Right U. Horn Length (mm)	Right U. Horn Width (mm)	Right U. Horn Thickness (mm)	Cervix Length (mm)	Cervix Width (mm)	Cervix Width at Ext. OS (mm)
B	1	-	20	12.0	15.0	18	10	8.0		60.0	12	7.0	60.0	25	4.0	60.0	25	40
	2	-	20	8.0	17.0	20	9.0	17.0		80.0	13	6.0	80.0	10	5.0	65.0	30	45
	3	-	27	10.0	13.0	27	12	20.0	N N	120	15	7.0	110.0	17	10.0	80.0	45	60
	4	-	45	13.0	22.0	43	10	21.0		80.0	14	10.0	80.0	15	6.0	70.0	30	45
	5	-	30	10.0	15.0	30	18	15.0	N N	120	25	13.0	120.0	23	10.0	70.0	25	40
	6	-	25	10.0	8.0	26	8.0	10.0	N N	70.0	11	7.0	65.0	8.0	6.0	60.0	20	40
	7	-	20	8.0	12.0	23	10	12.0	N N	90.0	10	5.0	110.0	10	5.0	60.0	22	35
	8	-	18	8.0	10.0	20	10	15.0	N N	70	10	4.0	70.0	10	5.0	45.0	15	30
Total			205	79	112	207	87	118	N N	690	110	59	695	118	51	510	212	335
Ave.			25.63	9.88	14	25.88	10.88	14.75		86.25	13.75	7.38	86.88	14.75	6.38	63.75	26.5	41.88
R_6			5803.00	805.00	1700.00	5807.00	1013.00	1888.00		63100.00	1680.00	493	64125.00	2032.00	363.00	33250.00	6184.00	14575.00

Table 19

Bauchi Slaughterhouse Samples (August)

Lab. No. Histology	Pregnant L or R	Left Ovary Length (mm)	Left Ovary Width (mm)	Left Ovary Height (mm)	Right Ovary Length (mm)	Right Ovary Width (mm)	Right Ovary Height (mm)	L/Oviduct	R/Oviduct	Left U. Horn Length (mm)	Left U. Horn Width (mm)	Left U. Horn Thickness (mm)	Right U. Horn Length (mm)	Right U. Horn Width (mm)	Right U. Horn Thickness (mm)	Cervix Length (mm)	Cervix Width (mm)	Cervix Width at Ext. OS.
A1	-	38	25	22	30	12	16	N	N	75	10	8	210	12	9	100	25	45
A2	-	25	10	15	30	15	30	N	N	190	15	8	170	20	10	90	20	35
A3	-	30	8	12	35	18	22	N	N	150	15	10	130	20	10	100	25	45
A4	-	30	10	12	30	15	15	N	N	110	10	5	100	10	5	60	23	36
A5	32 days	33	16	16	35	15	18	N	N	-	-	-	-	-	-	-	-	-
A6	-	25	8	12	30	10	18	N	N	170	15	9.0	180	15	7.0	110	25	40
Total		181.0	77.0	89.0	190.00	85.0	119.0			295.5	695.0	65.0	40.0	790.0	77.0	41.0	460.0	118.0	201.
Ave.		30.17	12.85	14.83	31.67	14.17	19.83			59.1	139.0	13.0	8.0	158.0	15.4	8.2	92.0	23.6	40.
		6	6	6	6	6	6			5	5	5	5	5	5	5	5	5	5
R_6		5583.00	1209.00	1397.00	6050.00	1243.00	2513.00				105225.00	875.00	334.00	132300.00	1269.00	355.00	43800.00	2804.00	8171.00

Table 20

Bauchi Slaughterhouse Samples (October)

Lab. No. Histology	Pregnant L or R	Left Ovary Length (mm)	Width (mm)	Height (mm)	Right Ovary Length (mm)	Width (mm)	Height (mm)	L/Oviduct R/Oviduct	Left U. Horn Length (mm)	Width (mm)	Thickness (mm)	Right U. Horn Length (mm)	Width (mm)	Thick-ness(mm)	Cervix Length (mm)	Width (mid)	Width at Ext.Os(mm)
0-10	-	22	10	10	20	12	8	N N	75.0	8	-	75.0	10	-	60	20	40
0- 9	-	35	13	10	30	12	10	N N	100	13	7	90	12	7	80	25	45
0- 8	-	20	10	8	18	10	8	N N	110	10	5	120	12	5	80	25	50
0- 7	-	28	15	14	35	15	20	N N	90	14	5	80	10	4	60	20	35
0- 6	-	22	14	12	18	10	12	N N	90	10	3	90	12	3	75	25	45
0- 5	-	15	8	6	16	8	8	N N	170	12	9	110	16	8	100	35	45
0- 4	-	28	12	10	30	15	15	N N	130	8	3	120	8	3	90	25	45
0- 3	-	25	10	10	20	10	10	N N	140	14	7	120	14	6	70	25	45
0- 2	-	25	12	10	30	12	10	N N	110	10	5	130	12	6	80	30	40
0- 1	-	18	10	8	20	12	8	N N	90	10	4	100	14	4	70	35	45
0-11	-	40	20	15	40	20	23	N N	130	13	6	110	16	6	85	35	45
Total	-	278.0	134	113	277.0	136.0	132.0		1235	122.0	54.0	1145.0	136.0	52	850	300.0	480.0
Ave.		25.27	12.18	10.27	25.18	12.36	12.0		112.3	11.1	5.4	104.1	12.4	5.2	77.3	27.3	43.6
		7.31	3.31	2.61	8.1	3.3	5.2		27.9	2.2	1.9	18.26	2.5	1.91	12.1	3.0	3.9
		7560.00	1742.00	1229.00	7629.00	1790.00	1854.00		146425,0	1402.0	324.0	122525.0			296.00		211.00

Table 21

Bauchi Slaughter house Samples (December)

Histol.No.	Left Ovary Length (mm)	Left Ovary Width (mm)	Left Ovary Height (mm)	Right Ovary Length (mm)	Right Ovary Width (mm)	Right Ovary Height (mm)	Weight of Ovary (gm) Lf.	Weight of Ovary (gm) Rt.	Oviduct normal or Abnormal		Left U. Horn Length (mm)	Left U. Horn Width (mm)	Left U. Horn Thick-ness(mm)	Right U. Horn Length (mm)	Right U. Horn Width (mm)	Right U. Horn Thick-ness(mm)	Cervix Length (mm)	Cervix Width at Mid	Cervix Width at Ext. OS.
12	29.8	9.8	17.0	35.8	6.6	18.0	3.0	3.0	N	N	130.0	15.0	6.0	130	15.0	6.0	70	41	51
11 90D	32.0	13.0	21.1	43.0	13.0	32.0	4.1	9.0	N	N	200.0	23.4	6.0	58.0	5.7	3.0	100	35	45
10	29.9	9.5	19.0	26.1	12.9	21.1	3.7	4.1	N	N	150.0	20	8.3	150	20.0	8.3	60	26	42
08	25.9	10.0	15.2	26.1	11.1	19.2	2.1	2.1	N	N	100.0	21.3	5.7	100	21.3	5.7	90	45.5	60.2
07	25.8	10.7	16.9	21.5	12.7	16.5	2.6	2.8	N	N	130.0	16.0	5.0	130	16.0	5.0	60	28	50.7
06	21.7	9.0	15.0	22.8	11.0	15.8	1.8	2.2	N	N	135.0	14.2	5.0	106	19.5	5.0	59	25	33
05	31.4	17.4	27.2	34.4	14.7	21.0	7.4	5.6	N	N	175.0	21.0	9.0	165	21.0	-	55	46.0	61
04 42-52	29.9	13.0	20.5	20.1	14.3	7.3	4.7	1.7	N	N	180.0	33.8	8.0	180	23.0	4.5	75	35	55
03	20.0	9.0	12.0	28.0	9.0	19.0	1.5	3.5	N	N	165.0	20.0	2.0	167	19.0	2.0	69	30.5	41
02	29.0	13.0	15.0	30.0	12.0	17	5.2	5.0	N	N	180.0	24.0	9.5	180	22.0	9.5	100	36	45
01	28.0	18.0	8.0	28.0	20.0	9	4.1	4.4	N	N	140.0	12.0	4.3	140	12.0	4.3	61.7	29	35
Total	303.4	132.4	186.9	315.8	137.3	195.9	402	434			1685	220.7	68.8	1506	194.5	53.3	799.7	377.0	518.9
Ave.	27.58	12.04	16.99	28.71	12.48	17.81	36.55	34.45			153.18	20.06	6.25	136.91	17.68	5.33	72.7	34.27	47.17
R_6	8518.36	1696.54	3429.95	9530.5	1830	3909.0	17686	21476			266775	4787.3	481.1	220414	3706.4	329.4 329.4	60898.9	13469	25350.3

C. Estimation of Cycling/Non-cycling and Pathology. Tables 22-27.

Table 22

Estimation of Cycling/Noncycling and Pathology of Genitalia from Slaughter house Samples (January)

Sample No	OVARY		OVIDUCT			UTERUS			CERVIX	
	Static	Cycling	Normal	Abnormal	Description	Normal	Abnormal	Description	Abnormal	Description
Jan 1	+		+			+			+	Nodular
Jan 2	+		+				+	Left and Right contained clear fluid	+	Cervicitis; hard and S-shaped
Jan 3		+		+	Enlarged (3mm) perisalpingitis		+	Left and Right contained clear fluid	+	Hard
Jan 4		+	+				+	Clear yellow fluid	+	S-shaped
Jan 5	+		+			+			+	S-shaped
Jan 6	+			+			+	Clear fluid in both horns	+	S-shaped
Jan 7		+		+	Left and right enlarged (3mm) Right had peri-salpingeal cyst 1½x3/8	+	+		+	S-shaped
Jan 8		+	+				+	Contained brown-ish thick fluid	N O T T A KEN	
Jan 9	+		+			+			+	S-shaped
Jan 10	+		+			+				
%	60	40	70	30		50	50		11.11	88.89

Table 23

Estimation of Cycling, Non-cycling and Pathology of Genitalia from Slaughter House Samples (July)

Sample No.	OVARY Static	OVARY Cycling	OVARY Normal	OVARY Abnormal	OVIDUCT Description	UTERUS Normal	UTERUS Abnormal	UTERUS Description	CERVIX Normal	CERVIX Abnormal	CERVIX Description
Jul 1		+		+	Perisalpingitis	+			+		
Jul 2		+	+			+			+		
Jul 3		+	+			+			+		
Jul 4		+	+			+			+		
Jul 5		+	+				+	Bilateral hyperemia	+		
Jul 6	+		+			+			+		
Jul 7		+	+			+			+		
Jul 8		+	+			+			+		
%	12.5	87.5	89.5	12.87		87.5	12.5		100		

Table 24

Estimation of Cycling, Non-cycling, and Pathology of Genitalia from Slaughter house Samples (May)

Sample No.	OVARY		OVIDUCT			UTERUS			CERVIX		
	Static	Cycling	Normal	Abnormal	Description	Normal	Abnormal	Description	Normal	Abnormal	Description
May 1		+	+			+			+		
May 2		+	+			+			+		
May 3	+		+			+			+		
May 4		+	+			+			+		
May 5	+		+			+		Flaccid	+		
May 6	+		+			+			+		
May 7	+		+			+			+		
May 8	+		+				+	Slight hydrometra	+		
May 9	+		+			+			+		
May 10	+		+			+			+		
%	70	30	100			90	10		100		

Table 25

Estimation of Cycling, Non-cycling and Pathology of Genitalia from Slaughter house Samples (December)

Sample No.	OVARY Static	OVARY Cycling	OVIDUCT Normal	OVIDUCT Abnormal	OVIDUCT Description	UTERUS Normal	UTERUS Abnormal	UTERUS Description	CERVIX Normal	CERVIX Abnormal	CERVIX Description
Dec 12	+		+			+			+		
Dec 11		+	+			+			+		
Dec 10	+		+			+			+		
Dec 08	+		+			+			+		
Dec 07	+		+			+			+		
Dec 06	+		+			+			+		
Dec 05		+	+			+			+		
Dec 04		+	+			+			+		
Dec 03	+		+			+			+		
Dec 02	+			+	Enlarged, contain honey colored mucous discharge		+	Honey colored mucous discharge pethcia of caruncular area	+		
Dec 01	+		+			+			+		
%	72.73	27.27	90.09	9.09		90.91	9.09		100%		

Table 26

Estimation of Cycling, Non-cycling and Pathology of Genitalia from Slaughter house Samples (August)

Sample No.	OVARY Static	OVARY Cycling	O V I D U C T Normal	O V I D U C T Abnormal	O V I D U C T Description	U T E R U S Normal	U T E R U S Abnormal	U T E R U S Description	C E R V I X Normal	C E R V I X Abnormal	C E R V I X Description
Aug 1		+	+			+			+		
Aug 2		+	+			+			+		
Aug 3		+	+			+			+		
Aug 4		+	+			+			+		
Aug 5		+	+			+			+		
Aug 6		+	+			+			+		
Aug 7		+	+			+			+		
%		100	100			100			100		

Table 27

Estimation of Cycling, Non-Cycling and Pathology of Genitalia from Slaughter house Samples (March)

Sample No.	OVARY			OVIDUCT			UTERUS			CERVIX	
	Static	Cycling	Normal	Abnormal	Description	Normal	Abnormal	Description	Normal	Abnormal	Description
Mar 1		+	+			+			+		
Mar 2	+		+			+			+		
Mar 3		+	+			+			+		
Mar 4		+	+				+	Clear Mucous	+		
Mar 5		+	+			+		Post Parturient involution	+		
Mar 6		+	+			+	+	Appeared cooked	+		
Mar 7		+	+				+	Clear mucuus appeared cooked	+		
Mar 8		+		+	Salpingitis	+				+	Cervicitis
Mar 9		+		+	Perisalpigitis	+		Uterus edematous		+	Cervicitis
Mar 10	+		+			+			+		
Mar 11		+	+			+				+	Cervicitis
%	18.18	81.82	81.82	18.18		72.73	27.27		72.73	27.27	

D. Blood Chemistry and Hematology Results.

Tables 28-34.

Table 28

Monthly Estimation of Blood
Glucose in Milligram Percent (Bauchi Samples)

	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June
1.	20		60	25	*-	13	27	47	20		20	30	57	14	28	40	40
2.	15	*-	38	20	*-	33	14	54	13		15	30	51	14	22	35	67
3.	*-	*-	30	15	*-	40	37	27	17		35	46	46	16	72	32	67
4.	*-	*-	25	25	14	23	17	44	30		30	35	49	25	31	57	75
5.	*-	*-	46	15	25	27	40	20	33		35	26	51	41	56	40	50
6.	*-	*-	25	50	*-	27	27	41	23		24	15	49	32	64	35	55
7.	*-	*-	25	30	*-	50	17	47	27		26	30	46	16	49	57	25
8.	*-	*-	25	20	14	33	23	38	30		26	36	49	29	64	49	50
9.	15	*-	30	70	*-	30	20	41	30		24	35	51	22	72	57	50
10.	12	24	50	25	16	27	23	20	43		26	40	46	29	16	57	25
11.	24	*-	60	28	16	47	20	51	37		50	30	49	14	49	49	45
12.	24	*-	50	25	*-	47	20	67	20		24	30	40	10	42	49	55
13.	15	*-	25	40	26	*-	17	29	20		30	26	51	35	42	44	75
14.	*-	*-	30	28	14	63	27	35	30			40	51	25	42	57	30
15.	36	*-	38	45	14	*-	17	51	33			36	46	44	72	35	35
16.	18	*-	50	45	*-	70	20	27	23			26	43	32	49	49	45
17.	12	*-	30	48	20		16	41	30			31	46	16	72	40	45
18.	*-	*-	25	50	*-		24	41	33			26	51	35	56	49	75
19.	18	*-		48	*-		28	54	14			17	49	25	49	40	45
20.		25			25		10	38	40			22	51	10	49	40	
21.		25			70		23	29	23			17	54	35	42	44	
22.		*-			26		17	29	40			17	60	20	49	35	

* Samples haemolysed

Table 28 (Cont'd)

	February	March	April	May	June	July	August	Sept.	October	November	December	January	February	March	April	May	June
23.					16		20	47	27			26	49	16	49	32	
24.					14		14	22	14			26	51	25			
25.					14		14	10	23			22	38	20			
26.					25		23	35	57			17	43	22			
27.					25		57	35	37			22	46				
28.					26		30	32	7			31					
29.					20		17	47	27			22					
30.					16		27	73	27			22					
31.					25			38	17			36					
32.					26			20	20			22					
33.					20			29	14								
34.								29	14								
35.								32	17								
36.								14	20								
37.								32	7								
38.								32	53								
39.								7	37								
40.								47	30								
Ave.	18.63	24.67	36.78	34.32	21.13	29.19	22.53	36.30	26.43			28.08	27.72	48.63	23.92	49.38	44.43	50.45
Total	209	74	662	652	507	530	686	1452	1057			365	887	1313	622	1192		

Table 29(A)

Monthly Estimation of Blood Total Protein, Albumin, and Globulin (gm) (Bauchi Samples)

	FEBRUARY			MARCH			APRIL			MAY		
	T.P.	ALB	GLOB	T.P.	ALB	GLOB	T.P.	ALB	GLOB	T.P.	ALB	GLOB
1.	8.8	2.9	5.9	5.6	3.2	2.4	5.6	2.0	3.6	7.5	2.3	5.2
2.	7.2	3.2	4.0	6.7	4.7	2.0	6.7	2.8	3.9	9.4	2.5	6.9
3.	7.5	3.5	4.0	6.7	2.7	4.0	7.2	3.1	4.1	9.1	2.8	6.3
4.	6.2	3.8	2.4	8.5	4.4	4.1	6.7	2.8	3.9	7.5	3.1	4.4
5.	10.6	4.1	6.5	7.7	4.4	3.3	7.2	3.4	3.8	7.7	4.5	3.2
6.	7.2	5.9	1.3	8.7	5.0	3.7	4.9	2.0	2.9	6.3	3.9	2.4
7.	6.2	5.9	0.3	8.5	4.1	4.4	7.0	3.6	3.4	7.2	3.1	4.1
8.	8.0	6.6	1.4	8.5	4.2	3.8	7.0	4.0	3.0	7.5	3.9	3.6
9.	8.0	6.9	1.1	7.5	4.1	3.4	8.0	4.3	3.7	6.5	2.8	3.7
10.	8.3	7.5	0.8	7.0	5.0	2.0	7.0	5.9	1,1	6.7	3.4	3.3
11.	8.0	6.9	1.1	8.7	4.4	4.3	8.2	6.5	1.7	6.0	2.0	4.0
12.	8.5	6.3	2.2	8.0	5.3	2.7	8.2	6.2	2.0	7.5	5.6	1.9
13.	8.5	5.9	2.6	7.5	4.4	3.1	7.7	6.5	1.2	7.2	4.7	2.5
14.	7.0	4.5	2.5	9.9	5.3	4.6	6.2	5.6	0.6	7.9	5.3	2.6
15.	7.5	4.8	2.7	7.0	3.8	3.2	7.4	6.5	0.9	6.7	3.4	3.3
16.	7.7	5.1	2.6	6.0	2.9	3.1	8.5	5.6	2.9	6.7	3.4	3.3
17.	7.5	4.5	3.0	8.0	5.9	2.1	7.9	6.5	1.4	6.0	4.5	1.5
18.	9.2	4.8	4.4	9.2	4.3	4.9	7.4	6.5	0.9	6.9	4.7	2.2
19.				7.0	4.5	2.5	7.4	6.5	0.9	7.9	5.5	2.4
20.				6.7	3.5	3.2	7.9	5.9	2.0	7.7	5.3	2.4
21.				8.0	4.7	3.3	7.4	6.5	0.9	7.7	5.3	2.4
22.				7.7	5.6	2.1	7.2	5.9	1.3	7.2	4.5	2.7
23.							8.0	6.9	1.1	6.7	4.7	2.0
24.							7.4	6.5	0.9	8.0	6.2	1.8
25.							7.5	5.6	1.9	8.5	5.3	3.2
26.							7.2	4.7	2.5	6.5	4.0	2.5
27.							7.9	5.6	2.3	7.5	3.7	3.8
28.							6.2	3.4	2.8	6.3	3.9	2.4
29.							6.0	5.6	0.4	6.5	3.7	2.8
30.							7.9	6.2	1.7	9.1	2.8	6.3
31.										6.7	4.7	2.0
32.										8.5	2.0	6.5
33.										8.0	2.5	5.5
34.										7.5	3.4	4.1
35.												
36.												
37.												
38.												
39.												
40.												
Ave.	7.88	5.17	2.71	7.69	4.38	3.28	7.22	5.10	2.12	7.37	3.92	3.45
S.D.	1.05	1.38	1.71	1.05	.82	.88	.£3	1.54	1.14	.84	1.16	1.47

Table 29(A) (Cont'd.)

	APRIL			MAY			JUNE		
	T.P.	ALB	GLOB	T.P.	ALB	GLOB	T.P.	ALB	GLOB
1.	6.7	2.8	3.9	7.2	3.5	3.7	8.3	4.8	3.5
2.	5.6	2.0	3.6	6.0	4.1	2.8	7.1	3.5	3.9
3.	7.2	3.1	4.1	7.2	3.7	3.5	9.7	4.8	4.9
4.	8.2	1.2	7.0	7.2	3.5	3.7	8.8	4.5	4.3
5.	6.7	2.8	3.9	7.7	3.7	4.0	8.0	4.1	3.9
6.	7.2	3.4	3.8	7.2	3.2	4.0	6.9	4.5	2.4
7.	4.9	2.0	2.9	8.0	3.8	4.2	6.9	5.2	1.7
8.	7.0	3.6	3.4	7.7	3.7	4.0	8.0	4.5	3.5
9.	8.0	2.3	5.7	7.2	5.3	1.9	6.7	5.4	1.3
10.	7.0	4.0	3.0	8.2	5.3	2.9	8.8	4.8	4.0
11.	8.0	4.3	3.7	8.2	4.4	3.8	7.7	3.5	4.2
12.	7.0	5.1	1.9	8.2	4.4	3.8	7.7	3.8	3.9
13.	7.0	5.4	1.6	7.7	4.4	3.3	6.3	4.3	2.0
14.	7.5	6.9	0.6	6.5	3.2	3.3	7.4	4.1	3.3
15.	8.0	6.3	1.7	7.7	4.4	3.3	7.4	2.9	4.5
16.	8.2	6.3	1.9	8.4	4.4	4.0	8.0	3.5	4.5
17.	6.5	5.1	1.4	8.0	4.1	3.9	7.2	4.1	3.1
18.	7.5	6.0	1.5	7.0	4.4	2.6	6.9	4.8	2.1
19.	7.7	5.1	2.6	9.3	5.0	4.3	8.0	3.2	4.8
20.	8.0	6.0	2.0	6.5	4.4	2.1	8.0	3.8	4.2
21.	7.7	5.4	2.3	7.2	5.6	1.6			
22.									
23.									
24.									
25.									
26.									
27.									
28.									
29.									
30.									
31.									
32.									
33.									
34.									
35.									
36.									
37.									
38.									
39.									
40.									
Ave.	7.22	4.24	2.98	7.58	4.21	3.37	7.71	4.21	3.50

Table 29(B)

Monthly Estimation of Blood Total Protein, Albumin, and Globulin (gm) (Bauchi Samples)

	OCTOBER			DECEMBER			JANUARY			MARCH		
	T.P.	ALB	GLOB	T.P.	ALB	GLOB	T.P.	ALB	GLOB	T.P.	ALB	GLOB
1.	7.2	4.7	2.5	6.2	3.9	2.3	6.7	2.9	3.8	7.5	5.9	1.6
2.	9.6	3.6	6.0	9.0	3.6	5.4	7.0	3.5	3.5	8.8	5.6	3.2
3.	6.7	3.4	3.3	8.2	4.2	4.0	6.7	1.7	5.0	9.1	5.6	3.5
4.	6.2	3.6	2.6	4.9	3.4	1.5	7.0	2.7	4.3	7.2	5.2	2.0
5.	7.2	4.6	2.6	8.0	4.4	3.6	4.6	2.7	1.9	7.2	4.3	2.9
6.	7.4	4.7	2.7	6.7	3.1	3.6	6.7	2.4	4.3	6.7	4.6	2.1
7.	6.4	5.3	1.1	8.2	4.7	3.5	7.2	2.7	4.5	7.2	5.2	2.0
8.	6.4	4.3	2.1	8.5	3.9	4.6	8.6	2.7	5.9	6.7	6.2	0.5
9.	6.2	3.4	2.8	8.2	4.4	3.8	7.5	2.7	4.8	7.2	6.2	1.0
10.	7.2	4.6	2.6	6.7	2.5	4.2	7.5	3.7	3.8	7,5	5.9	1.6
11.	5.0	4.1	0.9	8.2	5.1	3.1	7.5	3.2	4.3	8.0	4.0	4.0
12.	6.0	5.9	0.1	10.7	3.9	6.8	8.2	4.7	3.5	8.8	5.2	3.6
13.	5.6	3.1	2.5	8.0	3.1	4.9	6.7	4.7	2.0	9.7	6.2	3.5
14.	5.9	4.6	1.3	8.2	2.5	5.7	8.0	4.2	3.8	9.7	4.6	5.1
15.	6.7	5.3	1.4	7.7	3.1	4.6	8.0	3.8	4.2	7.2	4.8	2.4
16.	5.6	4.2	1.4	7.2	4.7	2.5	7.4	5.9	1.5	8.1	4.6	3.5
17.	6.7	4.3	2.4	8.5	3.6	4.9	7.0	5.9	1.1	6.2	3.4	2.8
18.	8.2	5.9	2.3	7.7	3.1	4.6	7.0	5.6	1.4	7.2	4.0	3.2
19.	6.4	4.2	2.2	8.0	3.6	4.4	8.2	4.3	3.9	8.1	4.6	3.5
20.	8.5	4.0	4.5	6.7	3.5	3.2	8.2	4.2	4.0	8.1	4.6	3.5
21.	9.6	3.4	6.2	6.5	2.8	3.7	6.9	2.6	4.3	8.6	4.0	4.6
22.	8.0	3.5	4.5	6.7	3.1	3.6	6.0	3.5	2.5			
23.	9.4	3.4	6.0	8.2	3.1	5.1	8.0	4.5	3.5			
24.	8.7	4.0	4.7	7.2	2.5	4.7	7.5	4.1	3.4			
25.	8.0	5.1	2.9	10.7	4.3	6.4	6.2	3.5	2.7			
26.	9.4	3.6	5.8	8.0	4.3	3.7	6.9	2.6	4.3			
27.	7.5	4.7	2.8	6.0	4.7	1.3	6.0	3,8	2.2			
28.	7.5	4.3	3.2	7.7	2.8	4.9	8.0	3.5	4.5			
29.	7.2	3.6	3.6	8.0	3.9	4.1	7.5	2.9	4.6			
30.	7.5	5.1	2.4				8.5	4.8	3.7			
31.	8.6	5.1	3.5				7.5	4.8	2.7			
32.	6.4	4.7	1.7									
33.	7.7	4.7	3.0									
34.	9.2	5.7	3.5									
35.	5.7	2.7	3.0									
36.	6.7	2.7	3.6									
37.	6.4	3.1	3.3									
38.	8.6	3.7	4.9									
39.												
40.												
Ave.	7.28	4.13	3.05	7.22	3.64	4.08	7.25	3.70	3.55	7.85	4.99	2.86

Table 29B (Cont'd).

	JUNE			JULY			AUGUST		
	T.P.	ALB	GLOB	T.P.	ALB	GLOB	T.P,	ALB	GLOB
1.	8.8	2.5	6.3	8.5	3.5	5.0	6.5	3.8	2.7
2.	8.5	3.1	5.4	9.4	2.9	6.5	6.9	4.7	2.2
3.	7.2	2.3	4.9	10.4	3.5	6.9	7.2	3.8	3.4
4.	5.6	2.5	3.1	7.8	2.4	5.4	6.2	3.8	2.4
5.	8.2	2.8	5.4	8.6	4.1	4.5	7.5	4.1	3.4
6.	9.1	3.6	5.5	8.0	3.2	4.8	6.0	3.5	2.5
7.	9.1	3.4	5.7	10.1	3.2	6.9	7.5	4.7	2.8
8.	9.1	3.9	5.2	10.1	2.7	7.4	6.9	4.1	2.8
9.	8.5	4.5	4.0	10.1	2.4	7.7	7.7	4.4	3.3
10.	8.5	3.9	4.6	9.2	2.4	6.8	6.7	2.9	3.8
11.	8.0	3.6	4.4	8.0	2.7	5.3	8.0	3.9	4.1
12.	8.2	2.0	6.2	9.8	3.2	6.6	8.2	4.5	3.7
13.	8.2	3.1	5.1	8.6	2.9	5.7	8.5	3.9	4.6
14.	9.1	3.3	5.8	8.6	2.9	5.7	8.0	4.5	3.5
15.	9.3	3.7	5.6	10.1	2.9	7.2	9.6	3.6	6.0
16.	9.9	4.0	5.9	9.4	2.9	6.5	8.7	4.5	4.2
17.	8.5	5.3	3.2	9.4	2.7	6.7	7.7	4.4	3.3
18.	7.1	4.2	2.9	9.6	2.0	7.6	7.7	4.4	3.3
19.	8.5	5.3	3.2	10.9	2.8	8.1	9.2	3.9	5.3
20.	7.2	4.5	2.7	7.7	2.8	4.9	10.2	5.6	4.6
21.	7.2	4.7	2.5	9.2	2.8	6.4	5.1	3.4	1.7
22.	9.1	5.6	3.5	10.7	4.4	6.3	8.5	5.3	3.2
23.	9.3	4.2	5.1	9.6	3.4	6.2	8.5	6.2	2.3
24.	9.1	4.2	4.9				9.9	3.6	6.3
25.	8.5	6.9	1.6				8.2	5.1	3.1
26.	8.5	6.2	2.3				7.4	5.3	2.1
27.	8.0	4.7	3.3				6.9	5.1	1.8
28.	7.1	4.5	2.6				8.2	5.3	3.9
29.	6.4	3.9	2.5				8.5	4.5	4.0
30.	8.2	5.3	2.9				6.7	4.2	2.5
31.	8.0	5.9	2.1				7.4	4.4	3.0
32,	9.3	6.9	2.4				8.2	5.1	3.1
33.							7.2	5.9	1.3
34.							8.5	4.5	4.0
35.							7.4	4.4	3.0
36.							8.2	5.1	3.1
37.							7.2	5.9	1.3
38.							8.5	4.4	4.1
39.							8.7	4.5	4.2
40.							7.7	4.5	3.2
Ave.	8.28	4.20	4.09	9.30	2.99	6.31	7.79	4.49	3.30
S.D.	.94	1.26	1.42	.93	.54	1.00			

Table 30

Monthly Estimation of Blood Calcium in Milligrams per 100 Milliliters (Bauchi Samples)

No.	February	March	April	May	June	July	August	Sept.
1.	10.7	9.0	9.1	9.2	6.6	6.0	8.7	
2.	10.2	15.0	9.6	7.2	9.5	1.2	15.6	
3.	12.7	10.6	8.9	12.3	12.3	15.7	13.8	
4.	10.7	10.7	7.2	9.9	15.5	18.4	21.4	
5.	21.8	12.0	9.0	10.3	12.8	13.4	7.8	
6.	17.8	9.2	8.5	9.7	8.7	11.3	9.3	
7.	10.8	13.0	2.1	9.4	8.3	15.5	8.4	
8.	11.8	18.0	8.2	9.9	12.3	17.2	11.0	
9.	17.8	6.0	9.5	11.4	15.2	13.6	14.5	
10.	11.3	18.4	11.1	10.2	6.1	13.2	20.0	
11.	12.6	7.4	8.8	10.1	9.7	14.6	16.7	
12.	5.2	7.4	0.5	9.2	13.8	13.8	12.9	
13.	14.4	22.6	8.5	9.2	11.0	18.1	9.9	
14.	13.6	21.3	8.2	9.2	11.0	13.2	18.2	
15.		7.2	17.8	9.2	16.4	11.1	16.6	
16.		7.0	9.1	10.3	11.5	10.5	18.5	
17.		8.3	10.2	8.0	16.3	16.5	15.3	
18.		6.4	20.8	10.4	7.5	21.1	18.1	
19.		5.3	16.1		7.2	13.8	14.1	
20.			8.5		8.8	20.7	15.8	
21.			11.2		16.1	14.2	18.0	
22.			7.3		12.7	15.9	19.1	
23.					15.2	19.4	15.2	
24.					11.0		15.2	
25.					15.5		20.3	
26.					19.3		15.5	
27.							10.0	
28.							17.4	
29.							9.3	
30.							11.7	
31.							9.5	
32.							20.2	
33.								
34.								
Ave.	12.96	11.31	9.54	9.73	11.93	14.27	14.83	
S.D.	4.06	5.34	4.36	1.13	3.55	4.49	4.03	

No.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	Jun	Jul
1.	19.8		11.4	7.8		10.4	17.6	1.2	7.3	10.8
2.	13.0		11.5	10.6		14.6	22.4	8.9	8.5	15.2
3.	18.7		10.2	2.4		13.1	15.0	7.5	13.6	0.3
4.	16.1		10.3	10.3		11.0	17.2	11.6	11.0	13.2
5.	13.4		11.4	14.0		9.7	10.7	12.1	13.3	11.3
6.	17.4		10.9	8.5		19.8	5.7	15.9	11.6	4.5
7.	9.1		12.8	10.5		13.4	25.8	6.9	16.7	4.5
8.	19.0		15.4	8.0		17.9	10.5	9.9	8.4	4.5
9.	18.5		20.4	10.3		16.0	9.5	17.8	8.5	10.2
10.	13.0		19.0	10.9		17.9	10.0	11.4	10.3	20.1
11.	17.2		14.7	9.3		16.2	14.4	6.1	10.4	20.1
12.	23.9		12.1	15.9		1.9	8.1	8.2	9.2	17.2
13.	12.3		19.5	16.5		13.1	11.1	8.3	10.8	2.3
14.	16.4		20.8	10.2		11.5	0.6	8.6	9.4	17.3
15.	17.2		10.9	11.8		19.3	13.5	17.6	7.2	15.8
16.	13.3		17.4	15.9		27.4	10.9	9.2	8.6	16.5
17.	19.9		9.3	16.4		9.0	22.9	8.6	7.4	15.2
18.	12.2		12.0	9.4		14.4	12.6	6.6	9.6	2.7
19.	17.0		9.6	11.3		23.3	9.5	13.6		15.7
20.	4.7		21.1	15.0		13.2	16.1	11.0		2.9
21.	14.9		20.6	13.9		10.7	13.6	16.5		11.3
22.	15.0		10.8	9.1		9.6	10.5	15.5		30.5
23.	21.1		10.0	9.0		8.9		8.3		17.5
24.	8.6		9.5	16.9		8.7		7.4		
25.	15.8		11.5	14.0						
26.	8.3		15.2	7.4						
27.	14.9		9.9	18.9						
28.	14.7		10.6	8.4						
29.	0.5			8.7						
30.	20.0			13.5						
31.	15.6			18.5						
32.	14.3			16.2						
33.	13.5			8.4						
34.				17.9						
Ave.	14.83		13.53	11.94		13.79	13.10	10.36	10.10	12.17
S.D.	4.75		4.06	3.9		5.4	5.75	4.1	2.49	7.4

Table 31

Monthly Estimation of Blood Phosphorus in Milligrams per 100 Milliliters (Bauchi Samples)

	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
1.	8.0	5.8	7.7	8.7	6.4	7.2	6.1		7.		6.1	5.4	6.4	5.7	6.7	5.8	5.8	
2.	8.4	7.9	6.9	8.8	7.6	8.0	6.1		8.0		5.7	7.7	5.6	6.9	4.8	7.7	4.8	
3.	9.2	7.9	9.2	7.5	6.0	6.0	8.0		7.1		7.5	6.9	4.0	4.7	6.5	5.8	7.3	
4.	8.8	7.9	6.5	4.2	6.8	6.8	6.5		4.6		6.1	7.3	6.4	5.6	6.3	8.5	7.1	
5.	8.8	6.7	7.3	7.5	7.6	7.6	5.8		6.4		6.4	6.9	5.6	6.3	6.1	6.9	5.5	
6.	8.8	7.9	8.3	8.7	8.4	4.4	7.0		6.9		6.4	6.2	8.4	5.7	6.7	6.7	7.9	
7.	8.8	7.9	7.3	6.7	7.2	6.8	5.8		5.4		6.4	5.4	5.2	7.1	5.6	6.7	7.2	
8.	8.4	7.5	7.3	7.5	6.8	6.0	8.1		5.7		5.3	6.2	5.2	7.3	7.4	6.7	7.1	
9.	6.0	8.8	7.3	8.0	8.4	6.0	5.4		5.7		5.6	6.5	5.6	5.7	6.1	7.3	5.8	
10.	6.4	7.7	7.3	8.7	8.4	8.4	6.1		7.5		6.7	6.2	6.8	5.7	7.1	6.9	6.6	
11.	9.2	8.3	8.9	8.0	6.0	6.0	7.0		5.4		7.8	5.8	5.2	6.5	5.8	6.2	5.8	
12.	5.6	8.3	8.0	7.5	6.0	6.4	7.6		5.4		5.9	5.8	5.6	4.7	6.5	6.9	5.8	
13.	8.8	5.4	8.0	7.5	7.2	8.0	7.0		5.0		5.6	7.3	5.6	5.9	5.8	8.8	7.1	
14.	8.8	7.5	7.7	7.1	8.8	7,6	6.5		6.0		7.8	8.1	6.0	6.3	6.3	6.3	6.8	
15.	6.4	8.1	9.2	8.0	7.6	8.0	8.0		6.4		5.9	6.2	5.2	7.3	6.9	4.8	7.9	
16.	8.0	8.8	7.0	6.3	8.0	6.8	6.1		5.4		6.7	6.7	5.2	6.3	6.7	6.2	7.2	
17.	8.4	8.3	5.8	7.5	7.2	8.0	6.1		7.1		6.7	6.2	6.0	6.7	5.3		6.6	
18.	9.6	9.1	8.4	8.7	7.6	7.2	5.8		7.1		7.8	6.5	8.0	9.9	6.1		5.5	
19.		7.9	6.2			6.0	7.3		6.4		5.6	7.7	5.2	6.3	6.1		9.6	
20.		7.0	7.7			8.0	5.8		7.1		7.8	6.9	5.6	6.1	6.5		5.1	
21.		7.9	8.9			6.0	6.1		7.5		6.7	4.6	6.8	5.6	5.1		7.2	
22.		7.0	9.6			8.4	6.5		5.6		5.9	7.3	5.6	7.3	6.1		6.0	
23.			5.8			5.6	6.1		6.9		5.9	6.2	6.0	5.4	6.1			
24.			7.9			6.8			7.1		5.6		6.4	6.3	6.7			
25.			7.9								7.8		7.6	6.3				
26.			6.7										4.8	6.5				
27.			8.8										4.8	6.5				
28.			7.7											6.3				
29.			8.3											6.9				
30.			8.3															
31.			5.4															
32.			8.1															
33.			9.1															
34.			7.0															
35.			7.9															
36.			7.0															
Ave.	8.1	7.7	7.68	7.61	7.33	6.92	6.56		6.38		6.47	6.53	5.58	5.92	6.22	6.76	6.62	

Table 32

Monthly Estimation of Blood Sodium in Milli-equivalent per Liter (Bauchi Samples)

	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
1.	162	154	152	140	136	142		148	146	156		148	138	150	140	142	
2.	140	160	152	152	124	144		146	150	150		150	140	144	136	148	
3.	158	144	146	140	140	144		141	150	150		150	150	132	138	146	
4.	144	140	150	142	140	130		142	136	152		144	148	144	146	144	
5.	142	150	152	140	142	140		144	152	161		150	148	144	142	144	
6.	148	148	148	148	132	140		144	144	144		152	148	146	136	142	
7.	130	144	140	140	146	140		147	149	140		144	140	144	142	140	
8.	158	138	150	144	118	138		145	150	142		148	146	144	138	144	
9.	144	152	148	142	144	144		148	146	120		144	146	144	136	144	
10.	145	150	148	135	148	136		144	148	148		148	144	142	142	140	
11.	142	146	152	144	148	150		140	136	150		146	140	142	136	146	
12.	148	146	150	144	150	143		143	145	152		142	144	138	138	142	
13.	112	140	152	146	162	142		133	146	150		146	140	150	144	146	
14.	144	152	150	138	148	138		140	152	148		146	140	146	140	140	
15.	134	150	150	142	144	140		142	154	150		146	142	148	150	144	
16.	144	156	138	142	148	138		134	150	145		144	140	142	160	138	
17.	140	150	150	144	152	140		140	150	152		144	138	148	148	140	
18.	149	150	152	140	154	130		140	146	142		150	136	146	152	144	
19.	131	154	142	138	132	146		138	122	124		138	138	148	160	140	
20.	148	148		144	156	148		144		158		148	138	140		138	
21.	112			144	154	146		144		144			136	144		156	
22.				140	144	140		141		146				142		140	
23.				138	148	144		142		150				146		142	
24.				134		142		145		148				140			
25.				138		150		138		150							
26.				136		156		142		154							
27.				140		148		144		146							
28.				140		154		142		142							
29.						136		140		150							
30.						148		146		160							
31.						150		144		142							
32.						144		134		150							
33.						142		142		120							
34.						156		134		140							
35.						142				152							
36.						144											
37.						142											
38.						130											
39.						152											
Ave.	141.67	148.6	148.5	141.3	143.9	142.7		141.8	145.9	146.9		146.4	141.9	143.9	143.4	143.2	

Table 33

Monthly Estimation of Blood Potassium in Milliequivalent per Liter (Bauchi Samples)

	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
1.	5.6	5.3	4.4	4.0	5.0	4.7		5.4	4.2	5.2	5.5	3.6	3.9	4.0	3.9		
2.	4.1	5.4	4.8	5.5	3.8	4.1		4.4	5.0	5.0	5.4	3.3	4.0	3.7	4.5		
3.	5.6	5.7	4.7	4.5	4.3	3.7		4.8	3.8	4.1	3.8	3.7	3.5	4.1	3.9		
4.	5.6	4.5	5.2	5.8	4.6	3.2		4.8	3.1	4.1	3.7	3.4	3.2	4.0	3.3		
5.	5.9	4.6	5.3	5.8	5.9	4.2		4.3	4.7	5.0	5.0	4.1	5.0	3.2	4.3		
6.	5.9	5.0	4.5	4.7	4.6	3.3		4.3	3.7	3.2	4.3	3.7	4.0	3.6	3.2		
7.	5.3	2.5	4.7	4.5	4.2	3.8		4.6	3.9	5.2	5.0	3.7	5.0	3.9	4.2		
8.	7.0	4.7	4.8	6.0	3.6	3.8		5.1	4.2	3.6	4.4	3.7	5.0	3.3	3.6		
9.	4.6	5.0	6.3	3.7	6.0	4.1		3.2	4.7	3.8	5.1	4.5	3.2	2.7	3.1		
10.	6.0	5.2	5.7	4.4	4.0	3.8		3.9	4.3	4.0	4.5	4.4	3.8	3.8	3.2		
11.	5.9	5.1	5.5	6.3	4.5	4.1		5.1	3.6	4.9	5.3	3.4	4.2	3.4	3.6		
12.	5.7	4.4	5.0	3.9	4.5	3.9		4.1	5.3	4.0	4.5	4.4	3.7	3.6	3.7		
13.	4.0	4.3	4.8	4.4	5.0	4.7		3.6	3.9	4.3	5.2	5.0	4.6	3.0	4.0		
14.	4.2	4.8	4.9	5.4	5.3	3.5		4.2	4.3	4.4	4.7	6.0	3.9	3.2	3.7		
15.	4.5	5.9	4.8	4.4	5.2	3.8		4.9	4.5	4.5	4.9	3.6	4.2	5.5	4.0		
16.	5.7	5.7	4.9	4.5	4.0	4.0		4.1	4.6	3.6	4.5	4.2	4.2	4.7	3.9		
17.	4.5	5.0	4.5	4.7	4.3	3.3		4.7	4.9	4.0	5.0	4.4	4.9	4.7	4.0		
18.	6.5	6.0	5.3	4.0	3.8	4.2		4.4	3.8	4.3	5.5	3.6	4.7	5.8	4.7		
19.	5.0	4.8	4.7	5.0	2.7	4.2		3.8	3.4	3.1	3.8	3.4	4.1	6.2	4.5		
20.	6.0	5.0		5.7	5.0	3.7		4.2		5.4	5.1	4.4	4.6		3.7		
21.	4.6			5.7	4.7	3.7		3.5		4.6		3.8	4.0		4.6		
22.				4.7	4.0	3.9		3.8		4.3			5.0		3.3		
23.				4.0	4.3	3.6		4.0		4.7			3.1		4.2		
24.				4.5		3.8		4.2		3.8			4.3				
25.				4.9		4.0		3.5		4.5							
26.				4.7		4.3		4.4		4.2							
27.				4.6		4.8		4.2		4.1							
28.				4.5		4.8		3.9		3.6							
29.				.		2.9		5.0		3.7							
30.						4.3		4.0		6.2							
31.						4.3		3.6		3.3							
32.						4.3		3.4		3.9							
33.						3.8		4.8		3.0							
34.						4.7		3.2		4.3							
35.						4.2				4.4							
36.						4.4											
37.						3.9											
38.						3.3											
39.						3.9											
40.						5.0											
Ave.	5.3	4.9	5.0	4.82	4.5	4.0		4.2	4.2	4.2	4.8	4.0	4.2	4.0	4.2		

Table 34

Seasonal Variation of Blood Hemoglobin (Grams/100M) and Packed Cell Volume (Per cent) - Bauchi Sample

No.	January		February		Mar.Apr.		April		June		July		August		Sept.		October		November		Dec.	
	PCV	Hb	PCV	Hb	PCV	Hb	PCV	Hb	PCV	Hb	PCV	Hb	PCV	Hb	PCV	Hb	PCV	Hb	PCV	Hb	PCV	Hb
1.	37	11.8					32	10.9	27	8.9			25	8.5			22	9.7	17	5.5	22	7.2
2.	31	10.5					35	11.9	37	11.9			30	10.2			32	10.3	20	6.6	30	9.0
3.	28	9.2					23	7.6	30	10.6			26	8.2			24	7.8	28	9.3	14	3.5
4.	31	10.3					24	8.5	29	10.2			29	10.2			37	12.5	28	9.3	24	8.8
5.	24	8.2					23	8.0	31	10.6			29	9.5			28	9.2	32	11.0	24	7.8
6.	26	8.6					21	8.0	26	9.8			30	10.2			32	10.3	33	11.3	24	7.8
7.	25	8.2					26	8.2	27	9.0			30	10.2			29	10.1	30	10.1	29	9.8
8.	28	9.3					32	11.0	31	11.7			19	6.2			29	9.2	30	10.0	23	7.8
9.	26	9.0					28	9.6	29	10.0			26	8.8			28	9.2	23	7.0	18	5.3
10.	33	10.8					26	8.9	26	8.8			31	10.2			25	8.0	29	9.0	24	8.0
11.	19	6.0					20	6.8	26	8.8			29	9.5			32	10.3	30	9.7	25	8.4
12.	40	12.3					24	8.2	25	8.9			30	10.2			28	9.2	20	5.9	27	9.3
13.	30	9.9					33	11.2	38	13.5			28	9.1			22	7.8	18	5.8	27	9.3
14.	31	9.8					20	6.8	24	8.9			22	7.6			30	10.3	27	8.9	22	7.4
15.	37	12.0					21	8.0	23	7.7			24	8.2			30	10.3	26	8.7	22	7.4
16.	25	9.5					33	11.2	32	11.0			18	6.2			30	9.8	24	7.8	23	7.8
17.	31	10.6					24	8.2	29	10.2			37	11.6			20	7.2	26	8.7	24	7.8
18.	30	10.2					25	8.5	24	8.2			33	11.2			35	11.5	29	9.7	28	5.8
19.	31	11.0					26	8.0	33	11.4			22	6.8			22	7.9	34	11.3	27	9.0
20.	25	8.0					29	9.2	29	10.1			32	10.5			34	11.2	26	8.4	25	8.4
21.	26	8.8					23	8.2	30	10.3			27	9.1			26	8.5	24	8.0	19	6.0
22.	28	9.5					31	10.5	31	11.0			20	6.5			32	11.0	30	10.1	20	6.3
23.	29	9.5					28	9.9	29	10.0			27	9.5			31	10.6	25	8.4	22	6.5

Table 34 (Cont'd)

No.	Jan. PCV	Jan. Hb	Feb. PCV	Feb. Hb	Mar. PCV	Mar. Hb	Apr. PCV	Apr. Hb	Apr. PCV	Apr. Hb	Jun. PCV	Jun. Hb	Jul. PCV	Jul. Hb	Aug. PCV	Aug. Hb	Sept. PCV	Sept. Hb	Oct. PCV	Oct. Hb	Nov. PCV	Nov. Hb	Dec. PCV	Dec. Hb
24.	33	10.8							23	8.4	30	10.0			25	8.5					24	8.0	30	9.7
25.	35	11.5							40	8.4	29	10.5			31	11.6					23	6.9	20	6.8
26.	28	9.5							25	8.6	23	8.6			17	6.6					26	7.8	25	8.1
27.	24	8.3									27	9.2			28	9.9					18	5.4	22	7.0
28.	32	11.5									30	10.6			32	12.7					23	7.4	22	7.2
29.	32	10.8									28	9.3			23	7.6					34	11.3	22	7.2
30.	33	10.9									19	6.8			24	7.9					28	9.3	27	8.2
31.	32	10.7									32	11.4			18	5.4					31	10.1	27	8.2
32.	30	10.1									26	9.0			25	7.8					26	8.4	22	7.4
33.	28	9.5									23	8.4			31	10.5					33	11.3	20	6.3
34.											39	13.2			30	10.5					32	10.6	22	7.4
35.											29	10.1			33	11.6					28	9.0	26	9.0
36.											25	8.0			37	12.5					25	8.4	20	6.6
37.															37	12.7					37	11.8	25	8.5
38.															24	7.9					26	8.4		
39.															30	10.2								
40.															27	9.2								
41.															33	11.6								
42.															34	11.7								
43.															20	8.5								
44.															34	11.6								
45.															29	10.2								
46.															28	9.2								
Ave.	26.63	9.9	26.73	8.95	28.5	9.91			27.70	9.44	28.61	9.65	26.92	8.81	23.59	7.62								
S.D.	4.33	1.34	5.09	1.4	4.23	1.44			5.13	1.84	4.5	1.34	4.74	1.71	3.43	1.30								

E. Blood Chemistry and Hematology Results (Control). Tables 35-38.

Table 35

Shika Samples April

	Glucose	Protein Analysis T.P.	Alb	Glob	A/G	Ca	Ph	Ca:Ph	Na	K	PCV	Hb
1.	48	7.7	5.3			11.9	4.3		152	4.4	32	10.9
2.	42	8.8	6.2			9.4	5.4		146	4.7	35	11.9
3.	48	7.7	6.2			11.1	4.7		148	4.5	32	11.6
4.	42	8.5	6.8			9.3	5.4		150	4.8	33	11.2
5.	33	7.7	6.2			14.9	6.4		152	4.8	33	11.2
6.	39	7.9	6.2			8.1	3.6		150	4.9	29	9.2
7.	48	8.2	6.6			9.6	5.0		138	4.9	28	9.6
8.	27	7.4	6.2			9.0	5.4		142	4.7	31	10.5
9.	27	6.7	4.9			9.3	4.7		150	5.2	29	9.2
10.	21	6.9	5.8			8.0	4.7		154	5.3	31	10.5
11.	39	8.8	6.8			2.0	4.7		148	5.0	34	11.8
12.	42	8.8	5.8			10.2	5.0		150	5.0	30	9.0
13.	43	7.4	5.8			9.0	5.0		146	4.4	29	9.8
14.	33	7.7	5.7			8.7	4.9		138	4.7	30	9.7
15.	39	8.2	6.6			10.0	5.1		150	4.6	30	9.7
16.	48	7.4	4.6			10.3	4.8		146	5.1	33	11.3
17.	39	8.0	4.9			10.3	4.7		148	4.9	34	11.3
18.	33	8.0	6.6			7.3	5.3		160	5.4	37	11.8
19.	42	8.8	5.8			12.9	5.4		138	2.5	26	7.8
20.	33	7.7	4.9			14.3	5.0		140	5.0	28	9.3
Ave.	38.3	7.92	5.90	1.89	1:0.3	9.78	4.98	1:0.5	147.3	4.74	31.2	10.4
S.D.	7.69	.61	.68			2.71	.54		5.78	.59	2.73	1.16

Table 36

Shika Samples August

No.	Glucose	Protein Analysis T. P	Alb	Glob	A/B	Ca	Ph	Ca/Ph	Na	K	PCV	Hb
1.	39	7.9	5.1			10.9	7.04		141	4.3	25	8.5
2.	39	7.4	5.1			8.3	7.04		135	4.8	30	10.2
3.	54	9.6	4.3			13,9	5.23		137	4.2	29	10.2
4.	59	10.1	5.9			6.8	6.22		135	4.3	30	10.2
5.	50	8.3	4.3			9.8	10.00		139	4.1	30	10.2
6.	59	8.3	5.5			9.9	9.27		138	4.5	26	8.8
7.	43	8.3	5.5			10.1	5.00		135	4.7	31	10.2
8.	59	10.4	5.3			10.2	5.96		135	4.4	29	9.5
9.	43	7.9	4.7			7.5	6.77		133	4.5	31	10.5
10.	59	8.5	5.1			8.5	10.00		137	4.6	37	12.7
11.	59	7.6	5.5			14.3	7.95		135	4.8	31	11.6
12.	43	8.3	5.1			7.3	8.58		133	3.6	38	9.1
13.	43	7.4	6.3			7.8	7.64		133	4.3	33	11.2
14.	50	8.7	5.9			7.9	6.77		135	2.6	31	10.6
15.	59	8.1	5.1			8.2	8.26		133	4.8	35	11.5
16.	50	13.1	7.6			7.2	6.77		135	4.1	28	9.9
17.	65	9.6	5.1			11.9	5.71		133	4.8	23	7.6
18.	65	7.5	5.6			8.7	9.27		136	4.2	19	6.2
Total	938.00	157.00	97.00			169.20	133.48		2438.00	77.60	526.00	178.70
Ave.	52.1	8.7	5.4	3.3	1:0.6	9.4	7.4	1:0.79	135.4	4.3	29.2	9.93
S.D.	8.78	1.42	.75			2.21	1.56		2.25	.53	4.28	1.52

Table 37

Shika Samples October

No.	Glucose	Protein Analysis T.P.	Alb	Glob	A/G	Ca	Ph	Ca/Ph	Na	K	PCV	Hb
1.	50.0	7.2	5.9			10.3	6.1		136	6.5	32	12.5
2.	52.6	7.9	6.2			8.9	5.0		148	6.0	37	12.5
3.	47.4	6.5	4.2			8.4	6.1		140	5.3	32	10.3
4.	50.5	6.9	5.1			8.9	6.4		136	4.8	31	10.6
5.	33.7	9.2	5.1			9.5	5.7		139	5.7	32	11.0
6.	52.6	8.1	4.7			10.8	6.4		138	5.8	34	11.2
7.	47.4	7.9	5.5			10.6	5.0		138	4.0	30	9.8
8.	32.0	9.0	7.2			9.5	6.8		138	3.1	28	9.2
9.	54.7	9.2	5.5			10.6	7.0		140	4.5	29	9.2
10.	52.6	7.7	5.1			10.4	4.7		142	4.7	30	9.8
11.	33.7	7.0	5.5			10.7	6.1		150	4.7	29	10.1
12.	52.6	7.7	5.5			2.3	5.8		136	5.0	22	7.8
13.	48.4	7.2	5.1			9.3	4.2		138.	3.7	24	7.8
14.	68.4	7.0	5.0			9.9	5.2		140	4.2	30	10.3
Ave.	48.3	7.8	5.4	2.4	1:0.44	9.29	5.8	1:0.62	139.93	4.87	30	10.15
S.D.	9.69	.88	.71			2.15	.82		4.23	.94	3.76	1.42
Total	171013.4	4495.2	2161.8			6904.4	2519.7		145206	1549.3	2176	7506.6

Table 38

Shika Samples December

No.	Glucose	Protein Analysis T.P.	Alb	Glob	A/B	Ca	Ph	Ca/Ph	Na	T	PCV	Hb
1.	50	7.5	5.1			10.2	5.1		156	5.2	37	11.8
2.	60	6.9	4.9			9.8	4.7		150	5.0	28	9.2
3.	47	7.5	4.9			8.6	5.4		144	5.0	31	10.3
4.	47	7.5	5.4			7.4	3.6		148	4.4	24	8.2
5.	63	6.7	3.9			12.0	4.8		144	5.1	25	8.2
6.	53	7.2	4.5			1.2	5.2		148	5.1	26	9.3
7.	47	5.5	5.4			16.9	4.7		148	4.5	33	10.6
8.	37	7.2	5.4			7.8	4.9		146	5.3	30	9.9
9.	50	5.5	5.4			12.3	5.3		142	4.5	31	9.8
10.	60	7.2	6.4			7.8	5.1		142	3.6	37	12.1
11.	47	6.9	5.1			12.3	5.0		120	3.8	33	10.8
12.	53	7.5	6.1			8.1	3.2		136	3.6	35	11.5
13.	60	7.2	5.1			7.9	5.6		145	5.3	28	9.5
14.	63	7.1	5.4			1.5	4.9		152	4.3	32	11.5
15.	60	6.8	5.4			10.2	4.2		154	4.5	36	12.8
16.	60	6.9	3.9			14.1	4.5		140	5.0	29	9.9
17.	47	7.6	5.2			8.1	5.7		146	4.0	19	6.0
18.	60	7.0	4.5			9.6	6.4		134	3.4	40	12.3
19.	43	6.7	4.2			7.8	7.1		142	4.8	26	8.8
20.	45	7.2	4.0			8.6	4.9		134	3.2	36	12.2
Ave.	52.60	6.98	5.01	1:97	1:0.3	9.11	5.02	1:0.55	143.55	4.48	30.80	10.24
S.D.	7.64	.58	.68			3.63	.85		8.72	.73	5.28	1.71

SEASONAL VARIATION IN REPRODUCTIVE ACTIVITY OF INDIGENOUS CATTLE OF NORTHERN NIGERIA

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AN ABSTRACT OF A THESIS

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Seasonal variation in reproductive activity of indigenous cattle of Northern Nigeria was investigated over a 15-month period by rectal palpation, examination of genital organs postmortem, blood profile, and hematological examination. The data obtained was analyzed according to the following seasons: Dry, January to March; Pre-rain, April to May; Rain, June to September; and Pre-dry, October to December.

The test animals were 45 clinically normal cows, 2 to 10 years of age, randomly selected from the herd of mixed indigenous breeds at Galambi Ranch in North-East State; 10 Bunaji, 10 Wadara, 21 Abore and 4 Kuri. Twenty-five Bunaji cows, 2 to 10 years of age, were randomly selected from the University herd at Shika Research Station, North-Central State and served as the controls. The test cattle at Galambi Ranch were run under typical traditional husbandry methods and were not supplementally fed. The control cattle were kept under improved conditions and were supplementally fed throughout the year.

Length, width and height of the ovaries of Zebu cows, determined by rectal palpation, was 26.2 x 9.1 x 11.7 and 27.5 x 9.3 x 12.4 mm for the left and right, respectively. These dimensions are smaller than those

of Bos taurus. There was an increasing linear trend in the three dimensions and the inter-month variation was significant. Ovarian activity was greater during the rainy and pre-dry seasons.

Pathological conditions (8.5%) found in 461 rectal examinations were as follows: ovaritis 1.3%; follicular cyst 0.2%; perisalpingitis 1.5%; hydrosalpinx 0.2%; pyometra 0.2%; and cervicitis 5.0%.

Examination of the genital tract of a number of cows examined clinically following slaughter confirmed the ovarian dimensions. The average weight of the left and right ovary was 3.4 ± 0.7 and 3.5 ± 0.7g, respectively. Ovarian function peaked during July and August and the incidence of atretic follicles was lowest in August. The only gross abnormality found was unilateral follicular cystic degeneration.

Pathological conditions (12.3%) found in the oviducts were: perisalpingitis and salpingitis 7.0%; hydrosalpinx 3.5%; and perisalpingeal cyst 1.8%. The height of the epithelial cells of the oviduct, average cell diameter and cell: nucleus ratio were measured but seasonal variations were not significant.

The length, width and thickness of 57 uteri were measured. The only gross abnormality observed was slight

hydrometra (14%). Microscopically, the endometrium was examined for epithelium degeneration, enlargement of endometrial glands, and for infiltration of eosinophils and lymphocytes.

The length and diameter of the cervix was measured. Chronic cervicitis was found in 11 cows (19.3%).

Blood glucose, total protein, albumin, glubulin, albumin: globulin ratio, serum calcium and phosphorus, calcium: phosphorus ratio, sodium, potassium, packed cell value and hemoglobin concentration were determined.

It was concluded that indigenous cows in Northern Nigeria are seasonal breeders with peak activity during the rainy and pre-dry seasons. For maximum reproductive efficiency under prevailing conditions of husbandry, it is recommended that cows be bred during July and August.