THE ANALYSIS OF THE OESTRUS ACTIVITY OF FIVE BREEDS OF SHEEP FOR SEASONALITY IN THE TROPICS

BY

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This dissertation is my original work and has not been presented for a degree in any other University.

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SUMMARY OF CONTENTS

The objective of the study was to examine the oestrus activity of Somali, Nandi, Merino, Romney Marsh and Karakul breeds of sheep in the tropics for seasonality. Chapter I introduces the work of other researchers in this field. Chapter II deals with how the experiment on oestrus activity of the five breeds of sheep was conducted. The experiment was carried out at Kabete, Kenya, in three phases from 23rd June 1966 to 26th December 1969. A flock of ewes comprising all the five breeds were grazed together with two vasectomized rams carrying raddle harnesses. Ewes were observed daily for raddle marks which were interpreted to indicate normal mating or marks that might have arisen from mounting by a ram not associated with mating. Each ram remained with the ewes for two weeks. Disease control consisted of vaccination of sheep against clostridial diseases.

In Chapter III, statistical parameters describing the normal interservice interval were estimated for each breed within years and phases, by tabulating the frequency distributions, and estimating the means and standard deviations. The following sources of variation were tested by analysis of variance: phases, breeds within phases; and years and breeds within years. All these hypotheses except variation between

breeds within phases were non-significant at the five percent level of significance. Interval estimation of the normal oestrus activity was then done. It was found that the population mean for the interservice interval mean for all the five breeds lies between fifteen and twenty days.

In Chapter IV variation in the level of oestrus activity within each breed was examined by obtaining the proportion of the group that showed a normal oestrus activity within consecutive twenty days periods and then testing for departure from random variation of these levels using time series analysis. Power spectrum analysis was used after elimination of trend in the series. The significance of the autocorrelation r_1 at lag one was tested and it was found that r_1 was non-significant for all the five breeds at the five percent level of significance. Thus it was concluded that the series was that of "white noise". Spectrum peaks were tested in order to show whether there existed harmonic oscillations in the series. It was found that for all the breeds except the Karakul, none of the peaks was significant at the five percent level of significance. It was then concluded that the oestrus activity of Merino, Nandi, Somali and Romney Marsh breeds was non-seasonal. The result on the seasonality of oestrus activity of Karakul Breed was not conclusive from analysis since the series was too short for the result to be meaningful.

Chapter V consists of conclusions drawn from the results given in Chapters III and IV.

CHAPTER I

1.1: PRELIMINARIES

The main objective of this study was to look into the seasonality of oestrus activity of sheep in the tropics. No detailed research has been reported on the seasonality of the oestrus activity of sheep in the tropics, although precise research has been done in the temperate regions.

In mature sheep oestrus normally lasts from nineteen to twenty-four hours, but in maiden ewes it may last from nine to twelve hours only. In temperate regions oestrus periods occur regularly every sixteen to twenty days during the breeding season, and for some months of each year the ewes of most breeds do not show any sexual activity at all and they are said to be anoestrus. The oestrus cycle is controlled by hormones which are secreted into the blood system by a number of endocrine glands, the principal one being the anterior pituitary, which is affected by light (day length).

The sexual season of sheep is influenced by many environmental factors such as photoperiod, ambient temperatures, rainfall, nutrition and biotic factors. Most British breeds of sheep have a considerably shorter sexual season than either Corriedale or Merino, which are subtropical breeds. Their sexual activity usually increases from early summer to reach a peak in late autumn or early winter. The explanation of these sexual differences must lie in different rates of hormonal secretions and one of the most important factors which affect these in the temperate regions is the changing length of daylight. As the day length shortens the sexual activity of the ewes increases. In experimental work, housed ewes have been artificially subjected to different days lengths, and by this means have been induced to exhibit sexual activity at different times of the year. The susceptibility of the Merino breed to changes in day length is very much less than that of British breeds or crossbreeds since it is a subtropical breed.

1.2: REVIEW OF LITERATURE:

Knowledge of the sexual variation in the reproductive performance of ewes is deficient in several respects. This is particularly true in the case of the tropical breeds. Breeding season is affected by many environmental factors and in some cases it varies between strains within a breed. In the temperate regions sexual activity is regulated primarily by dark and light ratios (Hart [14], Hafez [12] and Thwaites [37]). In all breeds, rams show less seasonal variation in thier sexual activity than the ewes.

The Indian native sheep are relatively non-seasonal in their sexual activity (Sahni *et al.*[28,29] and Saraswat *et al.*[31]). Rao [25] and Taneja [34,35] showed that sheep breed all the year round but observed a concentration of lambing in certain seasons. Taparia [36] also reported on the non-seasonal nature of oestrus activity in Somali sheep. Sahani *et al.*[27] have confirmed this in Jaiselmeri sheep. Tiwari *et al.*[38] on the other hand observed that all the breeds (exotic, crosses and native) come on heat in large numbers during autumn season and that exotic and higher crosses show some degree of anoestrus during spring under semi-arid conditions. Sahni *et al.*[30] found autumn season to be significantly superior to spring in terms of oestrus activity as well as fertility in Malpura, Chokla and Jaiselmeri. The incidence of oestrus was uniformly high in autumn (80-90%) irrespective of breed. Srivastava *et al.*[32] found that Bikaneri (Magra) sheep were non-seasonal in their sexual activity and could be bred in any season of the year with equal success, although there might not be 100 percent conception in every month.

The existence of seasonal variation in the sexual activity of the Merino ewes in Australia has been demonstrated by Kelly [15, 16]; Kelly and Shaw [17]; Stewart and Moir [33] Underwood *et al.*[40]; and Radford *et al.*[24]. In general, these researchers found that there was a period of anoestrus or relative anoestrus in spring and early summer, and a peak of oestrus activity in the autumn and early winter. There was considerable variation from this general pattern associated with age and strain of the ewes, year, and locality of observations.

The approximate duration of the breeding season of the Merino ewes run continuously with rams has been reported to be January to July in Australia (Underwood et al. [40]). Barret et al. [1] on the other hand found that the approximate duration of the breeding season in the Merino ewes in Australia is from February to August or September. Kelly and Shaw [17] have suggested that the difference between strains of Merinos in the oneset of their breeding season could arise from continued breeding at a particular time of the year over many generations.

Riches and Watson [26] in Australia compared continuous and changing groups of the Merino ewes run in one flock with vasectomized rams and found that the continuous groups showed a greater decline in the proportion served in November-December than did the group changed monthly. The continuous group, however, did not show complete anoestrus in any month, though in previous trial (Kelly and Show [17]) similar sheep on the same station in Australia showed quite long periods of complete anoestrus. This suggests that the presence of freshly introduced ewes being serviced by the vasectomized rams had a stimulatory effect on the continuous ewes. The main reason for the discrepancy in the seasonality and the onset of breeding season of Merino in Australia was due to locality of the experimental stations. Some of the experimental stations were out of the tropics while others were within the tropics. Age and strain of the ewes and year of observations are some of the factors which could have contributed to this considerable variation in the pattern of oestrus activity of Merino ewes in Australia.

Most of these researchers do not seem to have used appropriate statistical procedures to arrive at their conclusions about the incidence of oestrus activity of sheep, in the tropics. Sahni et al.[30] used only percentages to deduce that autumn season is significantly superior to the spring in terms of oestrus activity. This type of method is applicable only if the differences are large, but if there are fluctuations in the observations such that there is no clear trend, then one has to resort to more vigorous statistical prodúres for analysis of the observations.

Barret et al.[1] using percentages concluded that there existed cyclic nature in the oestrus activity throughout the year, and that there was a sudden rise in the proportion of ewes served in February of 1954, 1955 and 1956 in Australia. He thus concluded that the number of ewes served each month remained at high level until September or October.

Dun *et al.*[9] used Chi-squared test to test the significance of incidence of oestrus activity between autumn and spring of the Merino ewes in Australia. For autumn mating they found that there was little difference between years in the overall incidence of oestrus. The incidence of oestrus inspring-mated ewes was very variable. There was a significant difference between years throughout the 21-days of mating and a very highly significant difference in the number of ewes unmated at the end of the period. In contrast to spring, they found a lack of between years differences in autumn, indicating a lack of sensitivity at this season due to the varying nutritional conditions which were operative during the trial. Dun *et al.* could have gone further and used analysis of variance so as to test for between years difference, and between seasons difference, thus comparing autumn and spring directly. Instead they treated autumn and spring separately and tested for between years difference only. In this study time series analysis was used to test for seasonality in five breeds of sheep in the tropics.

A set of observations arranged sequentially with respect to time is known as time series. Time series is therefore discrete or continuous depending on whether the recording of the data is discrete or continuous. Significant work on time series has be done by Bartlett [2], Blackman and Tukey [3], Kolmogorov [19], Hannan [13], Parzen [22], Tukey [30], Wiener [41] and many other authors.

The Wiener-Kolmogorov theory of linear least square prediction (Wiener [41] , Kolmogorov [19]) has been described by Parzen [23] as one of the greatest achievements of modern time series analysis. However, in practice, it is not often used by research workers since it requires the entire (infinite) past of the time series and it involves an anlaysis of the past data in the "frequency domain". The very fact that the theory uses the entire past and involves the "frequency domain" are two of its main advantages.

To study the harmonic oscillation, the concept of the power spectrum or spectrum has been developed by such researchers as Tukey [39], Box and Jenkins [5] . Hannan [13] developed a method called "Hanning" used for smoothing the 'raw estimates' found in the power spectrum. This is a weighting method for 'raw' spectral estimates. Several weighting systems have been suggested, notably by Bartlett [2] , Blackman and Tukey [3] and Parzen [22] .

As information on the oestrus activity of the indigenous breeds of sheep in Kenya was negligible it was decided to carry out a series of observations on this. Also it was considered that as the seasonal variation on oestrus activity is so much smaller in the tropics and sub-tropics than in the temperate regions, then the statistical techniques for the analysis of the data for seasonality need to be more sensitive than techniques reported so far, and this series of observations would provide an opportunity to apply time series analysis to such data.

CHAPTER II

MATERIALS AND METHODS

2.1: Experimental Design:

The experiment was conducted at Nairobi University, Kabete Campus situated at about 36° 44 E longitude, 1°15'S latitude and at an altitude of 1815 metres above sea level. The experiment was conducted from 23rd June 1966 to 26th December 1969. The main objective of the study was to look into the seasonal oestrus activity in five breeds of sheep in the tropical region. The five breeds of sheep were:

(a) Nandi
(b) Somali
(c) Merino
(d) Romney Marsh and
(e) Karakul.

A flock of thirty to fourty ewes comprising all breeds of sheep were grazed together with two vasectomized rams carrying raddle harnesses. Oestrus was recorded for a particular ewe when she received a raddle mark from a ram, typical of a normal mating. Ewes were observed daily for raddle marks which were interpreted to indicate a normal mating or marks that might have arisen from mountings by the ram not associated with mating. Each ram remained with the ewes for two weeks. Every two weeks the colour of the raddle harnesses was changed. A full cycle of the colours of raddle harnesses lasted for four weeks as there were four different colours of the raddle harness. It was considered that this ram/ewe ratio, length of service period, and the sequence of changing rams and raddle colours minimized the risk of variation of marking due to ram factors.

The experiment was conducted in three phases as shown in Table 2.1. A preparatory phase was included to ensure that all ewes had fully adjusted to the experimental conditions.

Table 2.1: Phase and Date when the experiment was conducted for each of the five breeds.

PHASE	DATE	NANDI	SOMALI	MERINO	KARAKUL	ROMNEY MARSH
Preparatory	24/10/65 to 22/6/66	G1	G1	G1	G1	G1
1	23/6/66 to 23/1/68	G1	G1	G1	G1	G1
2	24/1/68 to 18/3/69	G1	G1	G2	-	G2
3	20/7/69 to 26/12/69	G1	G1	G2	-	G2

Note: G1 = Group 1

G2 = Group 2.

Phase 2 was intended to be a replicate of phase 1, and phase 3 was testing the response of ewes to the introduction of the rams after separation for four months. For the Nandi and Somali breeds the same sheep had to be used in all the three phases, because no new sheep were available at that time.

For the Merinos group 1 and group 2 came from the same flock at Timau, for the Romney Marsh group 1 and group 2 came from different flocks both in the Mau area. The Karakul ewes came from one flock at Ulu. The Nandi ewes came from several small holders in the Kapsabet district, and the Somali ewes were selected from flocks around Garissa. All ewes had two or more permanent incisors when recording began.

Disease control consisted of vaccination of the sheep against clostridial diseases, bluetongue, and Rift Valley fever. Routine care of the tick control and helmiths was carried on. Normally the sheep were grazed on natural pasture, except that the whole flock was supplemented with standard mineral mixture. Rams' feed in addition was supplemented as required to maintain body weight with a feed containing ten percent crude protein. Weekly body weights were recorded for each sheep.

2.2. Statistical Analysis

Statistical parameters describing the normal interservice interval were estimated, for each breed within years and phases, by tabulating the frequency distributions, and estimating the means and standard deviation. The following sources of variation were tested by analysis of variance:- phases, breeds within phases, year and breeds within years. Interval estimation of the population mean of the normal interservice interval was considered, thus bringing in the theory of statistical inference.

2.3: Seasonal variation of the oestrus activity

Variation in the levels of the oestrus activity within each breed was examined by obtaining the proportion of the ewes that showed oestrus activity within consecutive 20-days periods and the series for each breed was then subjected to spectrum analysis. Departure from random variation of these levels and spectrum peak (testing for harmonic oscillation) was thus tested as shown in Chapter IV.

2.4: Analysis of variance

Let the observation of the ith treatment in the jth block be y_{ij}. For a 2-way classification without interaction the model of analysis is

$$y_{ij} = \mu + \alpha_i + \gamma_j + \varepsilon_{ij} \qquad (2.1)$$

where

$$i = 1,2,\ldots, b, \quad j = 1,2,\ldots,p.$$

μ is an unknown parameter and is called the general effects,

α_i is the ith treatment effect

γ_j is the jth block effect and

ε_{ij} is the random variable due to chance.

The usual assumptions about ε_{ij}, α_i and γ_j hold true The design is orthogonal. The total sum of squares, sum of squares due to treatments, due to blocks and due to error were computed.

2.5: Estimation of Missing Observations in the Analysis of Variance.

When only a few observations are missing a simple method of estimating the values is available, provided that all treatments and blocks are represented. Algebraic values $x_1, x_2, \ldots, x_k$ are inserted in the cells with missing observations and analysis of variance was performed, supposing that $x_1, x_2, \ldots, x_k$ are numbers. The error sum of squares may be evaluated and it will be a function of $x_1, x_2, \ldots$ and x_k, their squares, and their products. Estimates of $x_1, x_2, \ldots$ and x_k are obtained by minimizing error sum of squares partially with respect to $x_1, x_2, \ldots$ and x_k respectively (Kempthorne [18]). Estimates of $x_1, x_2, \ldots,$ and x_k are now used in the analysis of variance.

An approximate test of significance is obtained from the analysis of the augmented values by treating the augmented table as the actual yields except the degrees of freedom for the remainder are reduced by the number of missing observations. It can be verified that the treatment mean square has an expectation of the form $k\sigma^2 + b\,\sigma_t^2$, where k is greater than unity. It is this latter fact that results in bias in the test. Furthermore the treatment sum of squares so obtained is not distributed as $\chi^2\sigma^2$ under the null hypothesis that t_j's are zero, nor is it distributed independently of the error sum of squares. The approximate test may be obtained quickly and suggests when it is desirable to calculate the exact significance level, since the significance level indicated by the approximate test is, in general, too large (i.e. instead of say, 10 percent, the test may indicate a 5 percent level of significance).

2.6: Confidence Interval Estimation for the Population Mean

Confidence interval estimation for any statistic is an example of statistical inference. In practice, estimates are often given in the form of the estimates plus or minus a certain amount. The method used to find the confidence interval in this study is the Pivotal Quantity Method.

Let $x_1, x_2, \ldots, x_n$ be a random sample from a density function $f(x,\theta)$. Let $Q = q(x_1,\ldots x_n,\theta)$, that is, let Q be a function of $x_1,x_2,\ldots, x_n$ and θ. If Q has a distribution that does not depend on θ, then Q is defined as a Pivotal Quantity (Mood [20]). If the random sample is from a density function which is normal with population mean μ and variance σ^2, both population mean and variance unknown, then the pivotal quantity for evaluating the confidence interval for the population mean is

$$T = \frac{(\bar{X} - \mu)\sqrt{n-1}}{s} \qquad (2.2)$$

where

$\bar{x}$ is the mean and

$$s^2 = \sum_{i=1}^{n} (x_i - \bar{x})^2/n.$$

T has t-distribution with (n-1) degrees of freedom, whatever, the value of $\sigma^2 > 0$.

The number a and b, $a < b$ can be found from t-distribution table such that

$$P(a < \frac{(\bar{x} - \mu)\sqrt{n-1}}{s} < b) = \alpha \qquad (2.3)$$

α is called the confidence coefficient.

It can be shown that when $a = -b$, then this confidence interval is the shortest confidence interval which contain μ.

Equation (2.3) can therefore be written as

$$P(\bar{x} - b\, s/\sqrt{n-1} < \mu < \bar{x} + bs/\sqrt{n-1}) = \alpha \qquad (2.4)$$

The interval $(\bar{x} - bs/\sqrt{n-1}, \bar{x} + bs/\sqrt{n-1})$ is a random interval having probability α of including the unknown fixed parameter μ.

2.7: Time Series

A time series is a collection of observations made sequentially in time. There are several objectives in analysing a time series. Time series analysis is mainly concerned with decomposing a series into trend, seasonal variation and other irregular fluctuations. In the analysis of time series there are three types of models used to transform the data into stationary data. The three models are:

$$\begin{aligned} &(A) \quad X_t = M_t + S_t + \varepsilon_t \\ &(B) \quad X_t = M_t S_t + \varepsilon_t \\ &(C) \quad X_t = M_t S_t \, \varepsilon_t \end{aligned} \qquad (2.5)$$

where

M_t is the smooth component of the series (trend and short term oscillations)

S_t is the seasonal component

ε_t is the error term and

X_t is the observation at time t.

Model A is completely additive, model C is a completely multiplicative and model B has multiplicative seasonality and additive error (Chatfied, [7]).

In this study the pure additive model was used since all the other models (B) and (C) could be reduced to additive model by taking logarithms, for example model (C) will become

$$\log U_t = \log M_t + \log S_t + \log \ _t.$$

To estimate S_t in the additive model the estimate of M_t had to be found. This can be done by various methods. The two methods considered for the removal of M_t in this study are:

(1) Moving average method

(2) Finite difference method.

These methods are called filters, since they filter out some component of time series. One of these filters was used for the removal of trend in the series of each breed.

2.7.1: Autocorrelation:

An important guide to the properties of a time series is provided by a series of quantities called sample autocorrelation coefficients, which measure the correlations at different distances apart. These coefficients often provide insight into the probability model which generate the data.

Given T observations, $x_1, x_2, \ldots, x_T$, made sequentially in time, the sample covariance C_h of lag(h) where $h = 0,1,2,\ldots T-1$ is defined as

$$c_h = \frac{1}{T} \sum_{t=1}^{T-h} (X_t - \bar{X})(X_{t+h} - \bar{X}) \ldots \qquad (2.6)$$

where

$$\bar{X} = \sum_{t=1}^{T} X_t/T$$

by Box and Jenkins [4].

The autocorrelation function of a stationary time series is define as

$$r_h = \frac{c_h}{co} \qquad (2.7)$$

$$h = 0,1,2,\ldots, T-1$$

Thus the autocorrelation function is the autocovariance function normalized at $h = 0$ (Fuller [10]). There is usually little point in calculating r_h for values of h greater than T/4. Note that some authorssuggest

$$c_h = \frac{1}{T-h} \sum_{t=1}^{T-h} (X_t - \bar{X})(X_{t+h} - \bar{X}) \qquad (2.8)$$

instead of equation (2.6) above, but there is little difference for large T (Chatfield [7]).

2.7.2: <u>The Correlogram</u>:

A useful aid in intepreting a set of autocorrelation coefficients is a graph called a correlogram in which r_h is plotted against the lag h. Sample correlogram can be used to find out whether the data:

(1) are stationary with continuous spectrum

(2) contain one or more harmonic oscillations

(3) are a sample from a white noise, that is, a sequence of uncorrelated variables with mean zero and constant variance (Bartlett, M.S. [2]). If a time series is completely random, then for large T, $r_h \simeq 0$ for all non-zero values of h.

2.7.3: General Discription of the Power Spectrum.

Procedures for computing power spectra vary, but for the most part they follow the approach developed by Tukey [39] and Blackman and Tukey [3].

Given a series of T equally spaced values, $X_1, X_2, \ldots, X_T$, one starts by computing all serial correlation coefficients (or serial covariances) for lag 0 to M, where $M < T$. Next, one computes the cosine transform of these $(M+1)$ lag correlation values, in a manner analogous to finding the Fourier transform of a continuous variable. The cosine transform yields $(M+1)$ "raw estimates" of the power spectrum, the ith value $(0 \le i \le m)$ of which is a rough measure of the total variance in the original series that is contributed by wavelengths near the ith harmonic of the fundamental wavelength of the analysis. The "raw estimates" are then smoothed by a 3-term weighted moving average with weights equal to $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$ respectively. This averaging operation is necessary in order to derive a consistent estimate of the final spectrum in terms of $m+1$ discrete estimates (W.M.O, [43]).

The following mathematical definitions will help to clarify the nature of the power spectrum and the usual procedure of its calculation. Let $X_1, X_2, \ldots, X_T$ be T terms of the series X_t, then compute the serial covariance, c_h, as given in equation (2.8), for all lags, $h = 0$ to $h = m$ (where $M < T$)

Raw spectral estimates $\hat{S}_k$ are then obtained directly from these c_h values by equations

$$\hat{S}_o = \frac{1}{2m}(c_o + c_m) + \frac{1}{m}\sum_{h=1}^{m-1} c_h$$

$$\hat{S}_k = \frac{c_o}{m} + \frac{2}{m}\sum_{h=1}^{m-1} c_h \cos\left(\frac{\pi kh}{m}\right) + \frac{1}{m} c_m(-1)^k \tag{2.9}$$

$$\hat{S}_m = \frac{1}{2m}(c_o + (-1)^m c_m) + \frac{1}{m}\sum_{h=1}^{m-1} (-1)^h c_h$$

where $k = 1,2,\ldots, m-1$.

Final spectral estimates S_k are then computed by smoothing the raw estimates with a 3-term weighted average. Using the "Hanning" method (which differs only very slightly from a second method known as "Hamming ") the smoothing formula are:

$$S_o = \frac{1}{2}(\hat{S}_o + \hat{S}_1)$$

$$S_k = \frac{1}{4}(\hat{S}_{k-1} + 2\hat{S}_k + \hat{S}_{k+1}) \tag{2.10}$$

$$S_m = \frac{1}{2}(\hat{S}_{m-1} + \hat{S}_m)$$

where $k = 1,2,\ldots, m-1$, by W.M.O. [43]).

The sample serial autocorrelation, r_h, can be used instead of the serial covariance, c_h, in the computation of the raw estimates $\hat{S}_k$. In this study the autocorrelation r_h was used.

2.7.4: Test of significance for white noise

It has been shown by Dixon [8] that for large T the square of r_1 has the same probability distribution as that of the square of ordinary correlation coefficient in the samples of size (T+2) from an uncorrelated normal population. Therefore

$$t = \sqrt{\frac{r_1^2 T}{1-r_1^2}} \qquad (2.11)$$

has student's t-distribution under the null hypothesis.

2.7.5: Test of significance of power spectrum

r_1 is tested for significance using 't' test given in equation (2.11). If r_1 is found to be non-significant, then the null continuum is that of 'white noise', i.e. the spectrum is a horizonal line whose value is everywhere equal to the average of the values of all m+1 "raw" spectral estimates in the computed spectrum. The significance of the peak at "k" (harmonic number) in the power spectra is then tested using the ratio $S_k/\bar{S}$ where $\bar{S}$ is the average of all (m+1) "raw" spectral estimates. The ratio $S_k/\bar{S}$ is distributed as $\chi^2(v)/v$ under the null continuum where

$$V = \frac{2T - m/2}{m} \qquad (2.12)$$

as shown by Tukey [39].

If r_1 is significant, the appropriate null continuum is that of Markov Chain , that is, a sequence of correlated variables. Having established the significance of r_1, the following equation for the various choices of harmonic number k (corresponding to peaks) between h = 0 and h = m is computed

$$S_k^* = \bar{S} \left(\frac{1 - r_1^2}{1 + r_1^2 - 2r_1 \cos\left(\frac{\pi k}{m}\right)} \right) \qquad (2.13)$$

as shown by Otieno [21].

The ratio S_k/S_k^* is distributed as $\chi^2(v)/V$ under the null continuum, where v is as defined in equation (2.12).

The significance of the peak at "k" in the power spectra implies the presence of the corresponding harmonic oscillation in the given time series.

CHAPTER III

ANALYSIS OF VARIANCE AND INTERVAL ESTIMATION FOR OESTRUS ACTIVITY

3.1: Analysis of Interservice Interval

3.1.1: Analysis of Variance For Breed Within Phases:

The following two hypotheses were tested using the analysis of variance method:-

(i) If there exist variation in the interservice interval between breeds within phases in the normal oestrus activity.

(ii) If there exist variation in the interservice interval between phases in the normal oestrus activity.

The frequency distribution of the interservice interval for normal mating for the Nandi, Somali, Merino, Karakul and Romney Marsh breeds for phase 1 to phase 3 is shown in Table 3.1 (see Appendix A).

From the frequency distribution curves (Fig. 3.1. to Fig. 3.5.) of the interservice interval of the five breeds of the sheep during the three phases, it could be observed that the curves were trimodal. The two segments of the curves to the right hand side are not well pronounced in contrast to the segment to the left . This well pronounced segment which corresponds to the normal oestrus activity of the sheep was considered in the analysis of variance.

Judging from the frequency distribution,a partition for this normal segment was at the 28th day for each of the five breeds for each phase,because after the 28th day there was a break until the 31st day or the frequency of occurance after the 28th day was too low in each of the three phases for all the five breeds. Again,from past research it has been found that normal oestrus periods occur regularly every sixteen to twenty days during the breeding season.

This segment which corresponds to the normal oestrus activity was assumed to be a normal curve as could be seen in all the five figures (Fig. 3.1 to Fig. 3.5.). This assumption is again justified as the sample size was large and it is known that all distributions have a limiting distribution which is normal. The values of the interservice interval mean plus or minus the standard deviation for the normal oestrus activity is given in Table 3.2.

Table 3.2.: Interservice interval mean ± standard deviation for the five breeds and the three phases (days)

BREEDS	PHASE 1	PHASE 2	PHASE 3	ALL PHASES
SOMALI	16.8±2.68	17.3±1.78	17.7±2.35	17.2±3.21
NANDI	17.5±2.24	17.6±1.93	17.4±2.93	17.5±2.24
MERINO	17.9±3.26	17.8±2.89	17.9±2.47	17.9±2.99
KARAKUL	17.5±2.57	17.7*	17.8*	17.5±2.57
ROMNEY MARSH	16.5±4.05	16.5±3.54	16.9±2.28	16.5±3.41
ALL BREEDS	17.4±2.90	17.3±2.75	17.5±2.46	-

Note: * Estimated value

Fig. 3.1: Frequency distribition curve of interservice interval for the Somali ewes for Phases 1,2 and 3.

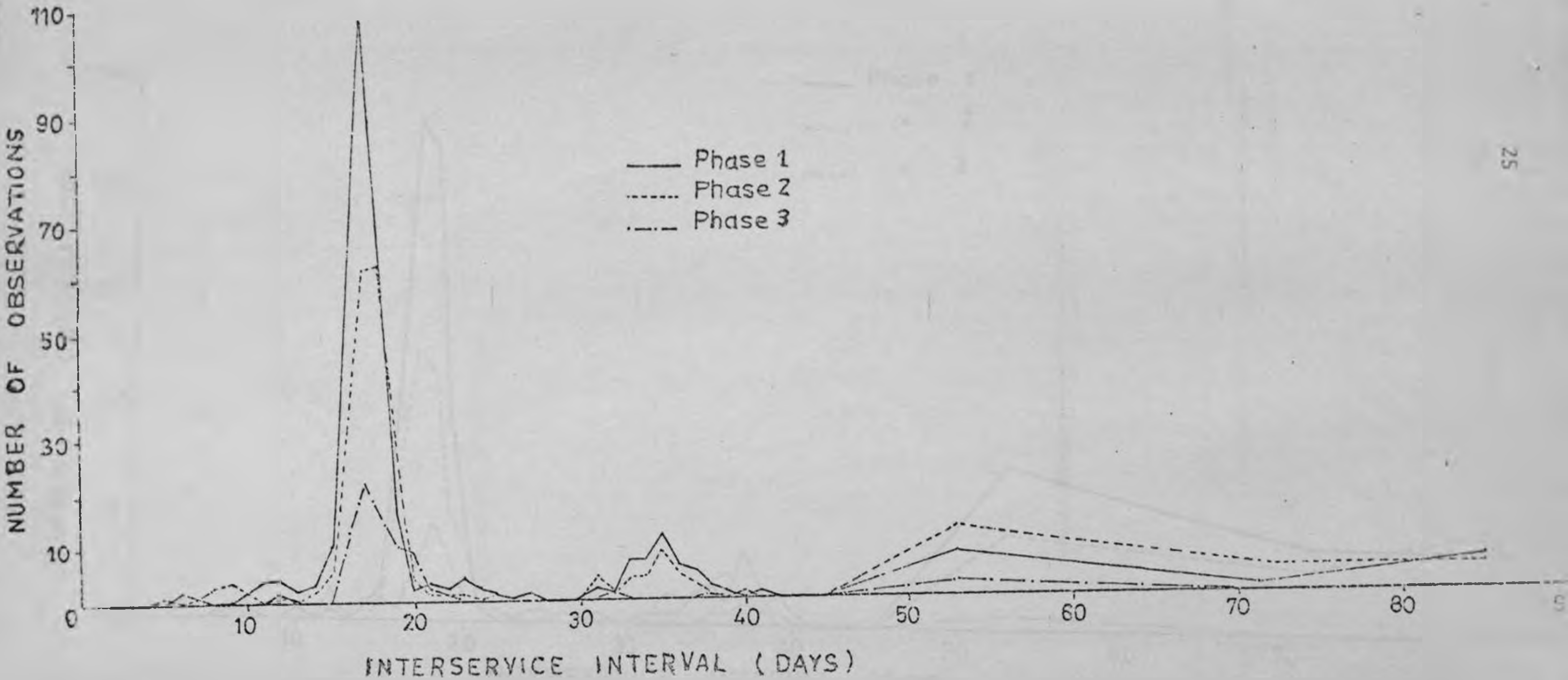


Fig: 3.2: Frequency distribution curve of interservice interval for the Nandi ewes for phase 1,2, and 3.

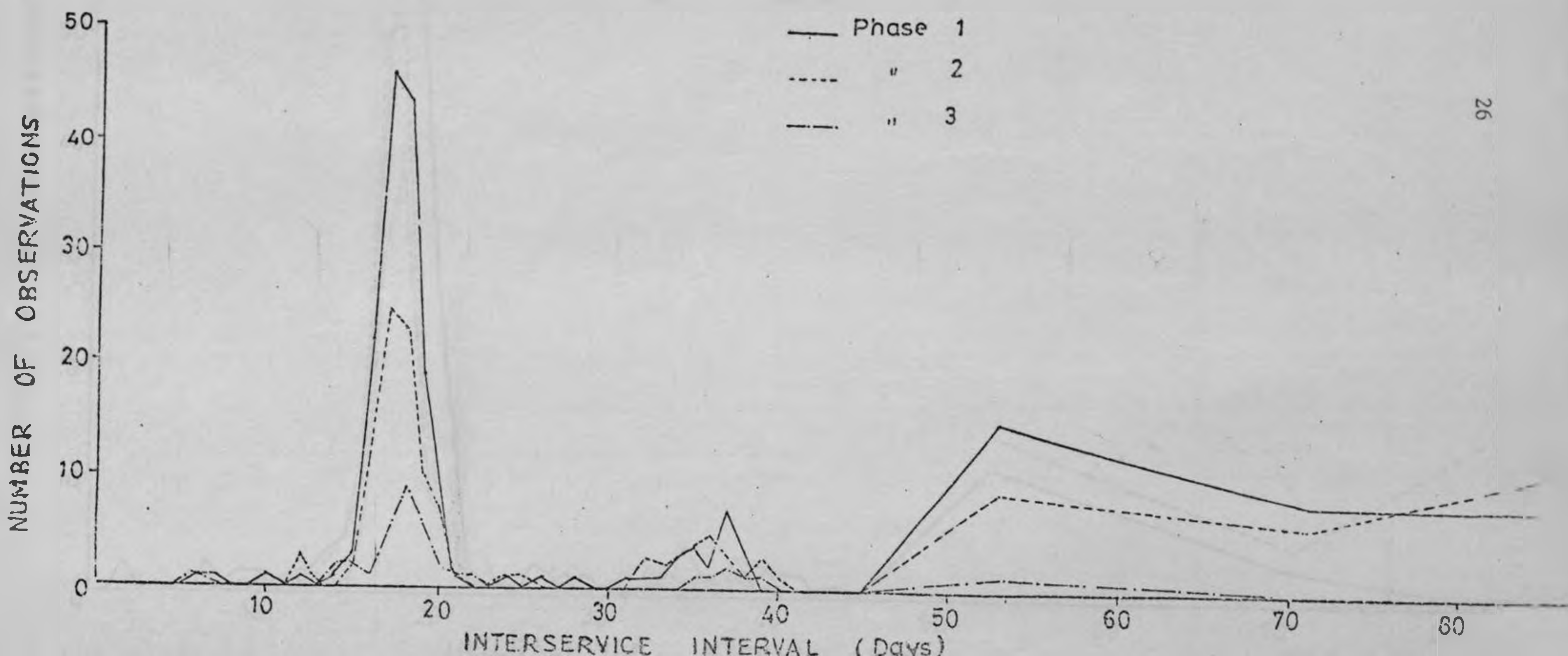


Fig. 3.3: Frequency distribution curve of interservice interval for the Merino ewes for phases 1,2 and 3.

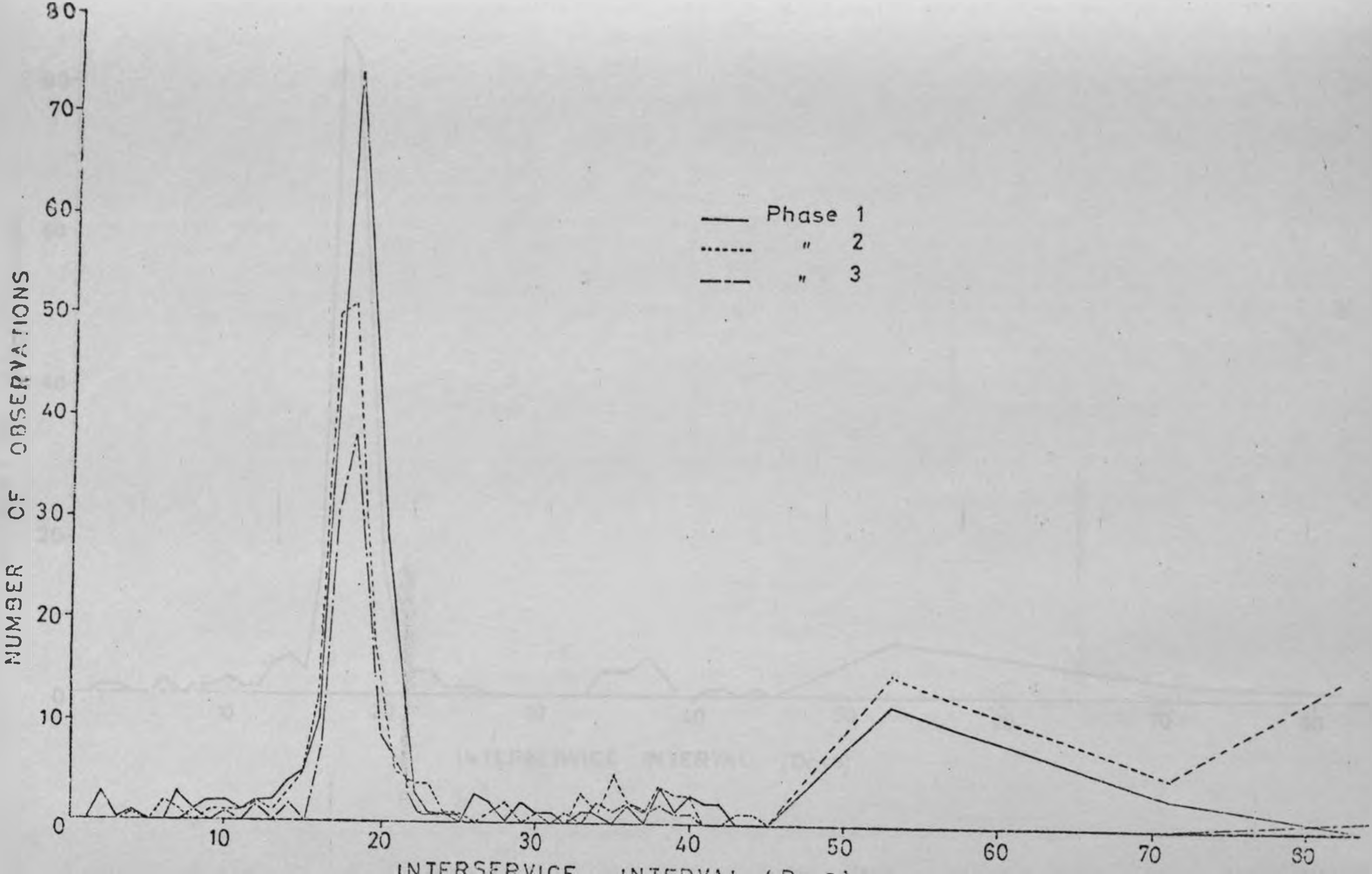


Fig. 3.4: Frequency distribution curve of interservice interval for the Karakul ewes for phase 1

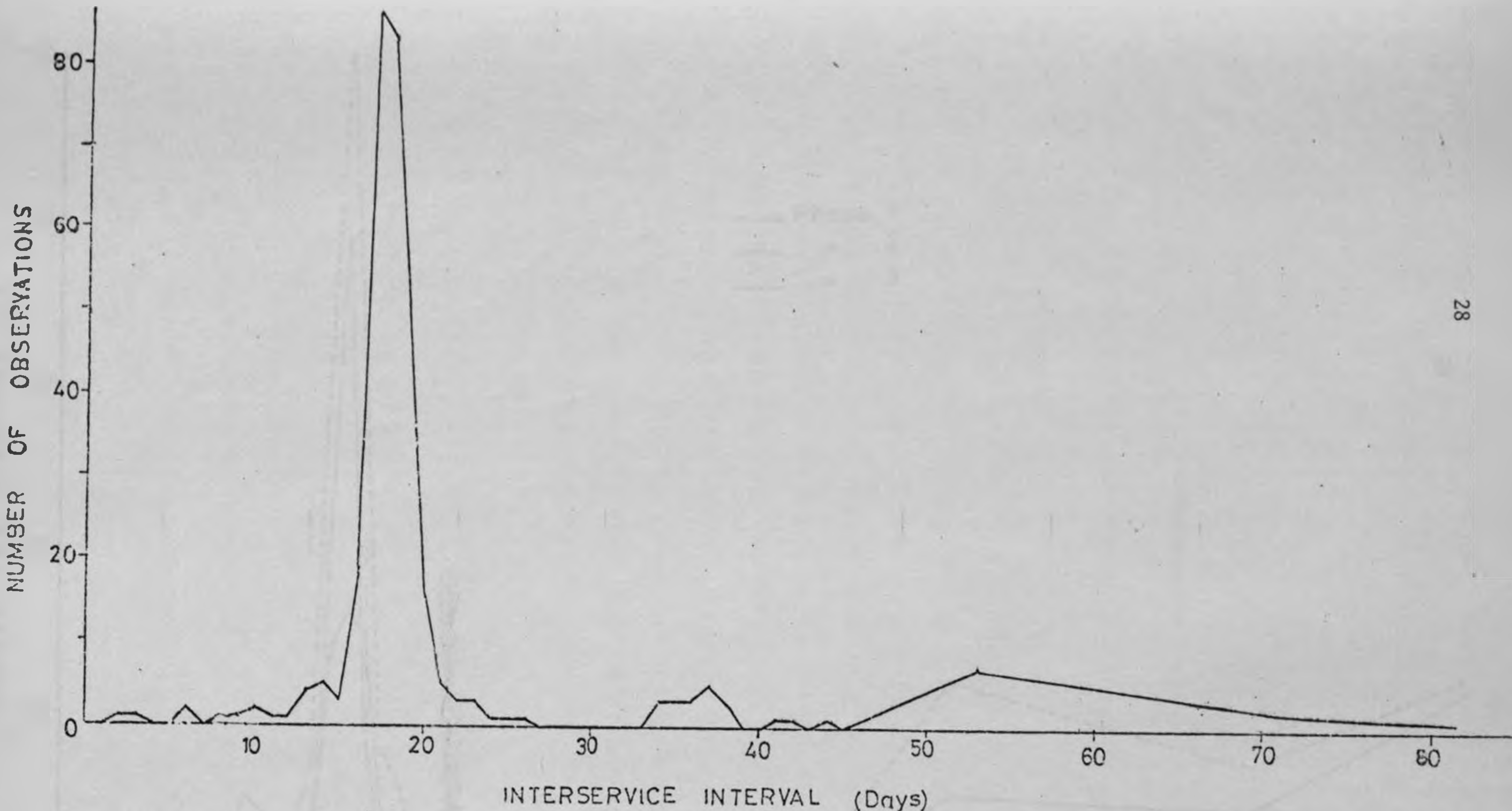


Fig. 3.4: Frequency distribution curve of interservice interval for the Karakul ewes for phase 1

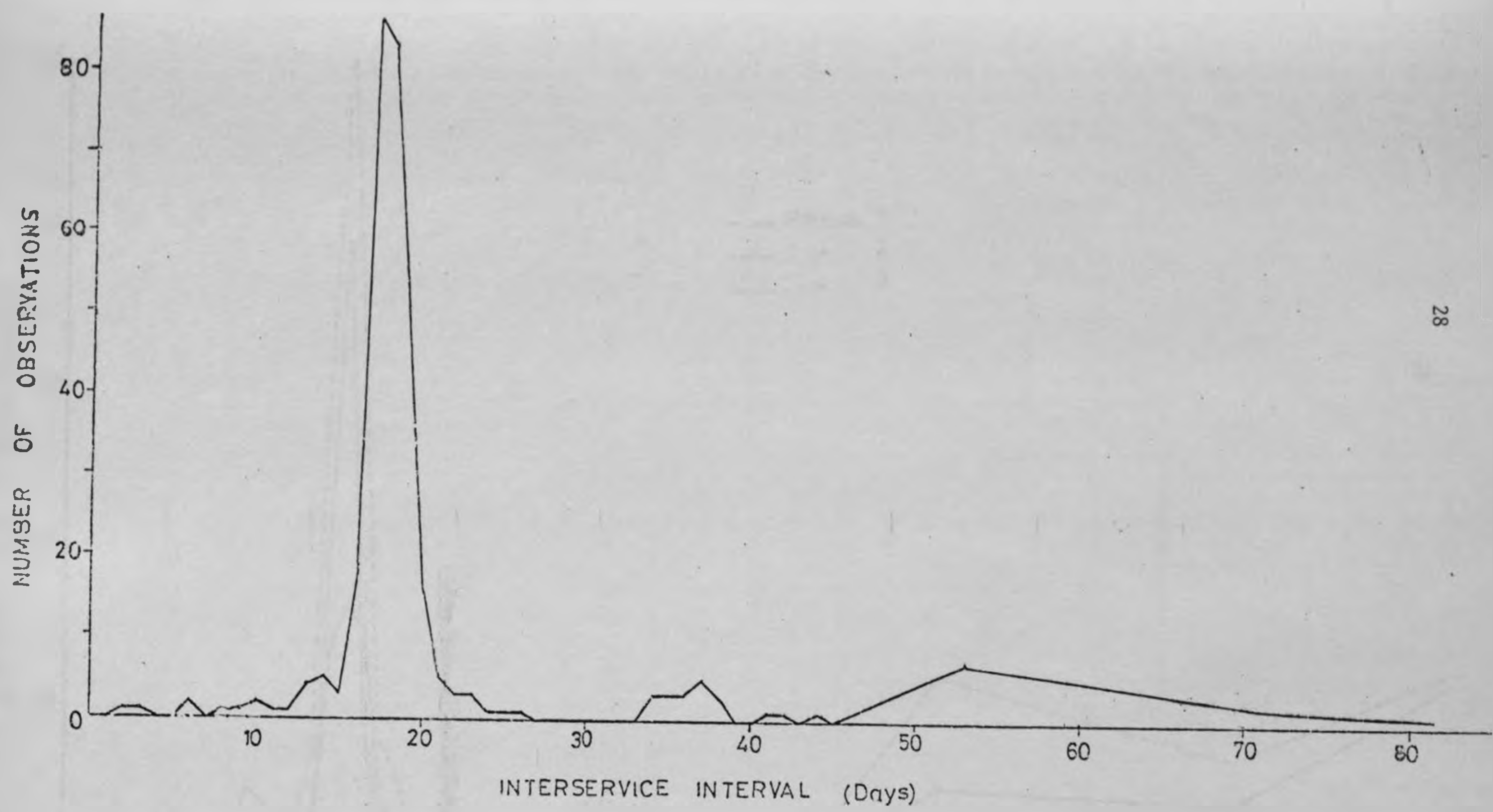
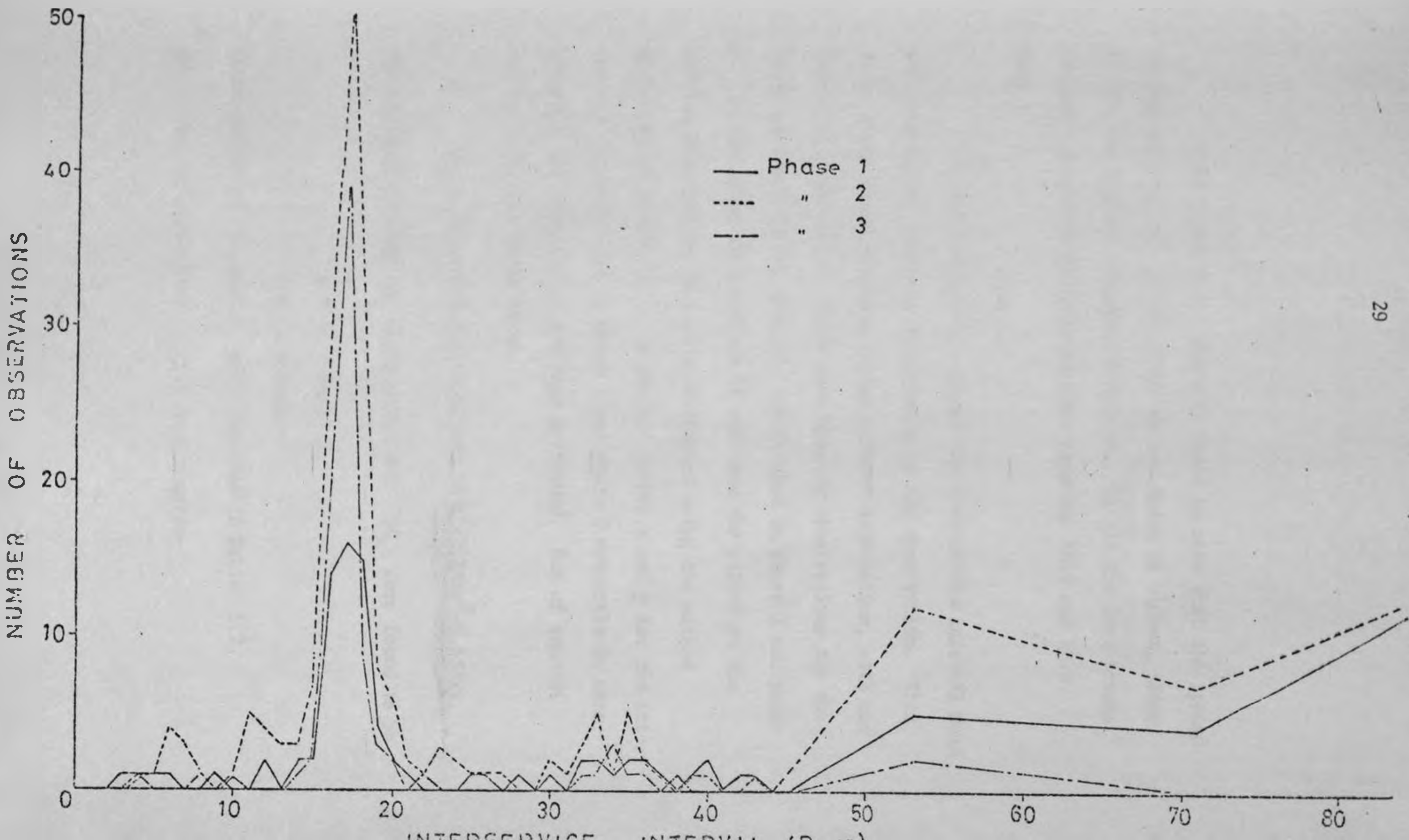


Fig. 3.5: Frequency distribution curve of interserive interval for the Romney Marsh ewes for phase 1,2 and 3



From Table 3.2 above it could be seen that the spread in the interservice interval for Romney Marsh is widest, since it has the highest standard deviation. In all the five breeds the mean interservice interval lies between 16.5 and 17.9 days.

To test the two hypotheses the interservice interval mean was used in the analysis of variance as the observation. This is a 2-way classification design without interaction, with one observation per cell. There were missing observations for the interservice interval mean for the Karakul in phase 2 and phase 3. To carry out the analysis of variance the values of the missing observations had to be estimated using the method developed in section 2.5. Algebraic symbol x and y for the interservice interval mean in phase 2 and phase 3 respectively were inserted and analysis of variance performed. Sum of squares due to error was found to be:

$$SS_E = 167.695-9.309x-9.587y+0.533x^2+0.533y^2-0.534xy.$$

The values of x and y which minimized SS_E were found to be

$$x = 17.7 \text{ days}$$
$$y = 17.8 \text{ days.}$$

These values of x and y were inserted in Table 3.2.

The source of variations in this design were:-

(a) the effect of the breeds, α_i (treatments) i=1,2,...5

(b) the effect of the phases γ_j (blocks) j=1,2,3.

(c) the error, ε_{ij} (due to unobservable factors).

It was found that:-

(1) the sum of squares due treatments was

$$SS_t = 2.711$$

(2) Sum of squares due to blocks was

$$SS_b = 0.225.$$

(3) Total sum of squares was

$$SS_T = 3.297.$$

(4) Since the design is orthogonal the error sum of squares was computed from the relationship

$$SS_E = SS_T - SS_t - SS_b.$$

and it was found that

$$SS_E = 0.361$$

In the analysis of variance, two degrees of freedom were lost since two observations (that is x and y) were estimated. Thus the total degrees of freedom were 12 instead of 14.

An approximate test of significance for breed and phase difference when these values had been inserted in is shown in Table 3.3.

Table 3.3: Approximate test of significance for breed and phase difference

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES (SS)	MEAN SUM OF SQUARES (MSS)	F
Due to Breeds	4	2.711	0.678	11.26**
Due to Phases	2	0.225	0.113	1.88
Due to Error	6	0.361	0.60	-
Total	12	3.297	-	-

** P < 0.01

Table 3.4: Exact test of significance for treatment (breed) difference

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES (SS)	MEAN SUM OF SQUARES (MSS)	F
mean and phase	3	3904.7505		
Treatment (breeds)	4	2.4995	0.6249	10.39**
Mean, Phases and Breed	7	3907.25		
Error	6	0.361		
Total	13	3907.61		

For the breed difference the approximate test suggested the use of the exact test and is shown in Table 3.4.

Result:

(i) Breed difference were significant at the one percent level of significance. This implies that there exists variation between breeds within phase.

(ii) There was no significance difference between phases.

3.1.2: Analysis of Variance for Breed Difference Within Years

The following two hypotheses were tested using the analysis of variance method:-

(i) If there exist variation in the interservice interval between year.

(ii) If there exist variation in the interservice interval between breeds within years.

The frequency distribution curves (fig.3.6 to fig. 3.10) for each breed in each year were drawn for only one day to fourty-five days, from fourty-six days onwards was omitted. From these frequency distribution curves it could be seen that the curves were bimodal curves. The segment of the curves to the left, which is well pronounced was considered. This segment corresponds to the normal oestrus activity of the sheep. Judging from the frequency distribution, a partition for this segment will be at the 28th day for all the five breeds for each year. This decision is the same as when considering the frequency distribution of the interservice interval in each of the three phases considered in Section 3.1.1.

The frequency distribution of the interservice interval for the Somali, Nandi, Merino, Karakul and Romney Marsh breeds in the year 1966 to 1969 is given in Table 3.5 (see appendix A) and the frequency distribution curves for the years 1966, 1967, 1968 and 1969 are shown in Fig. 3.6. to Fig. 3.10. The values of the interservice interval mean plus or minus the standard deviation for the normal oestrus activity is shown in table 3.6. below

Table 3.6: Interservice interval mean ± standard deviation during the four years for the five breeds (days)

BREED	1966	1967	1968	1969	ALL YEAR
SOMALI	15.9±3.34	16.8±2.48	17.3±1.92	17.7±2.04	17.2±2.31
NANDI	17.6±2.52	17.5±1.33	17.5±2.32	17.2±2.77	17.5±2.24
MERINO	17.2±3.62	18.1±3.08	17.9±2.70	18.4±2.74	17.9±2.99
KARAKUL	17.2±2.82	18.6±2.36	17.5*	17.7*	17.5±2.57
ROMNEY MARSH	17.6±3.14	16.3±4.21	16.4±3.45	16.4±2.55	16.5±3.41
ALL BREEDS	17.1±3.19	17.4±2.75	17.3±2.77	17.4±2.53	-

Note: * Estimated value

As when considering the spread in the phases, the spread in the interservice interval for Romney Marsh is the widest. In all the five breeds the mean interservice interval lies between 15.9 and 18.1 days.

Fig. 3.6 Frequency distribution curve of interservice interval for the Somali ewes for the year 1966 to 1969.

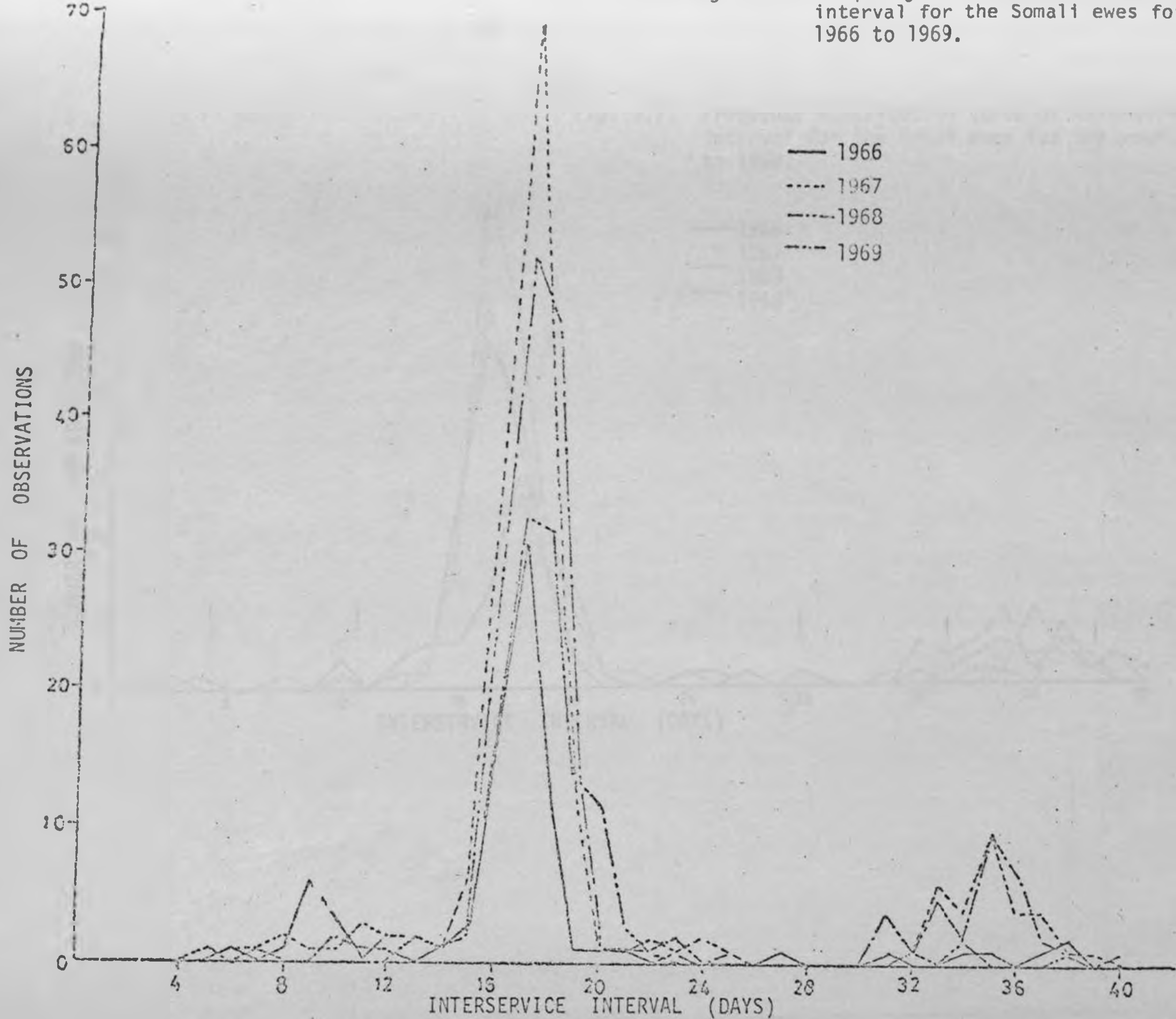


Fig. 3.7: Frequency distribution curve of interservice interval for the Nandi ewes for the year 1966 to 1969.

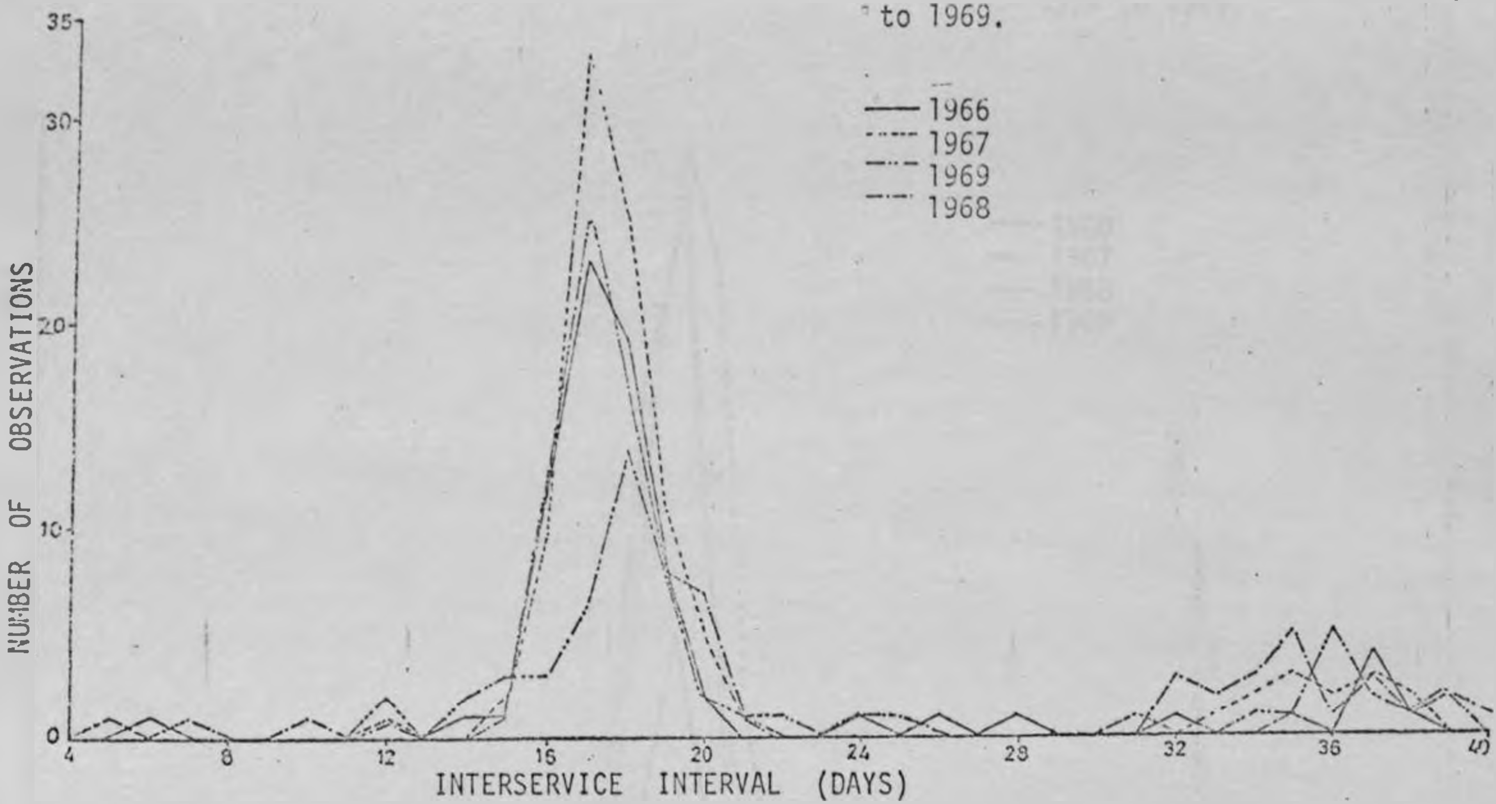


Fig. 3.8: Frequency distribution curve of interservice interval for the Merino ewes for the year 1966 to 1969.

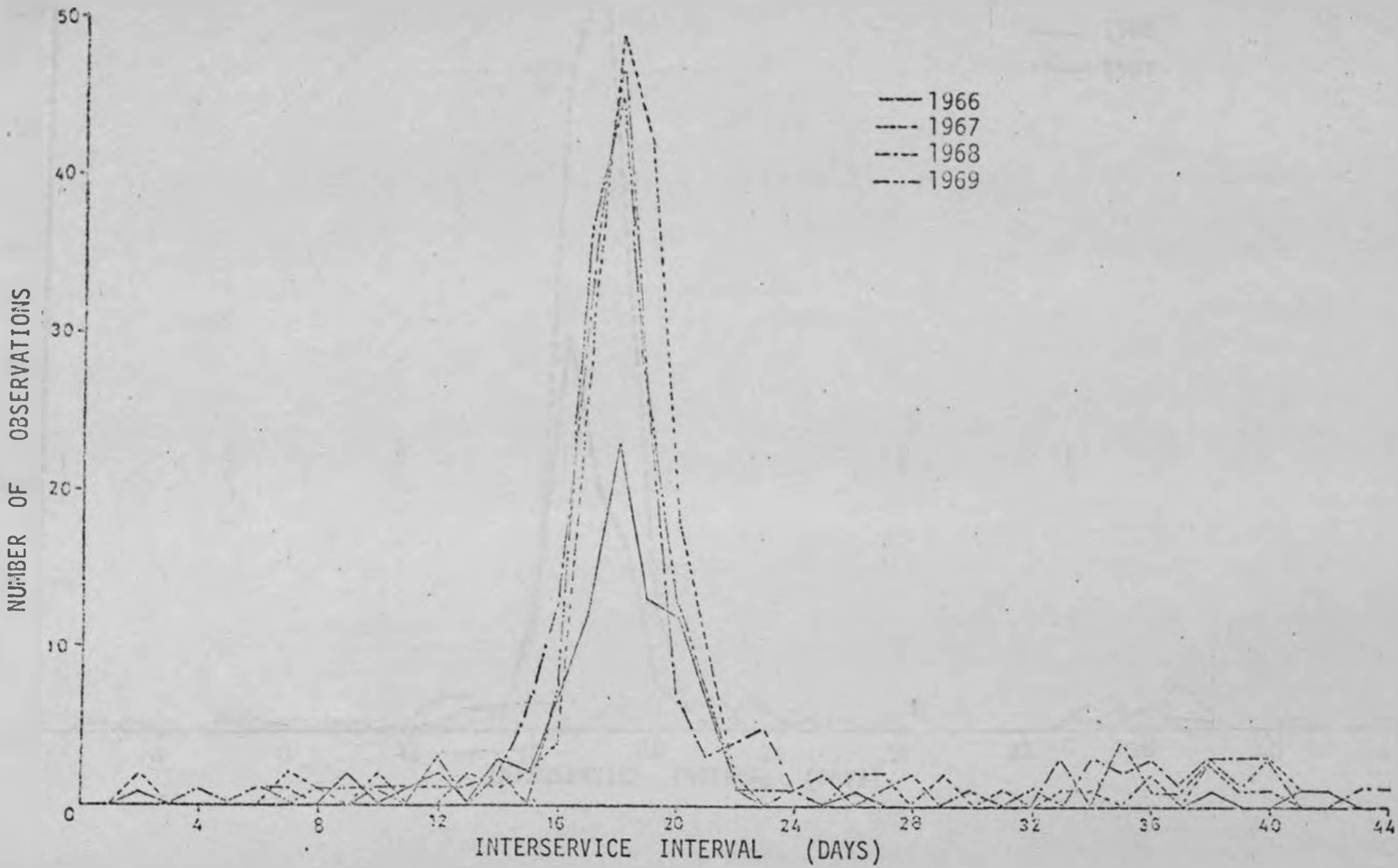


Fig. 3.9: Frequency distribution curve of interservice interval for the Karakul for the year 1966 to 1967.

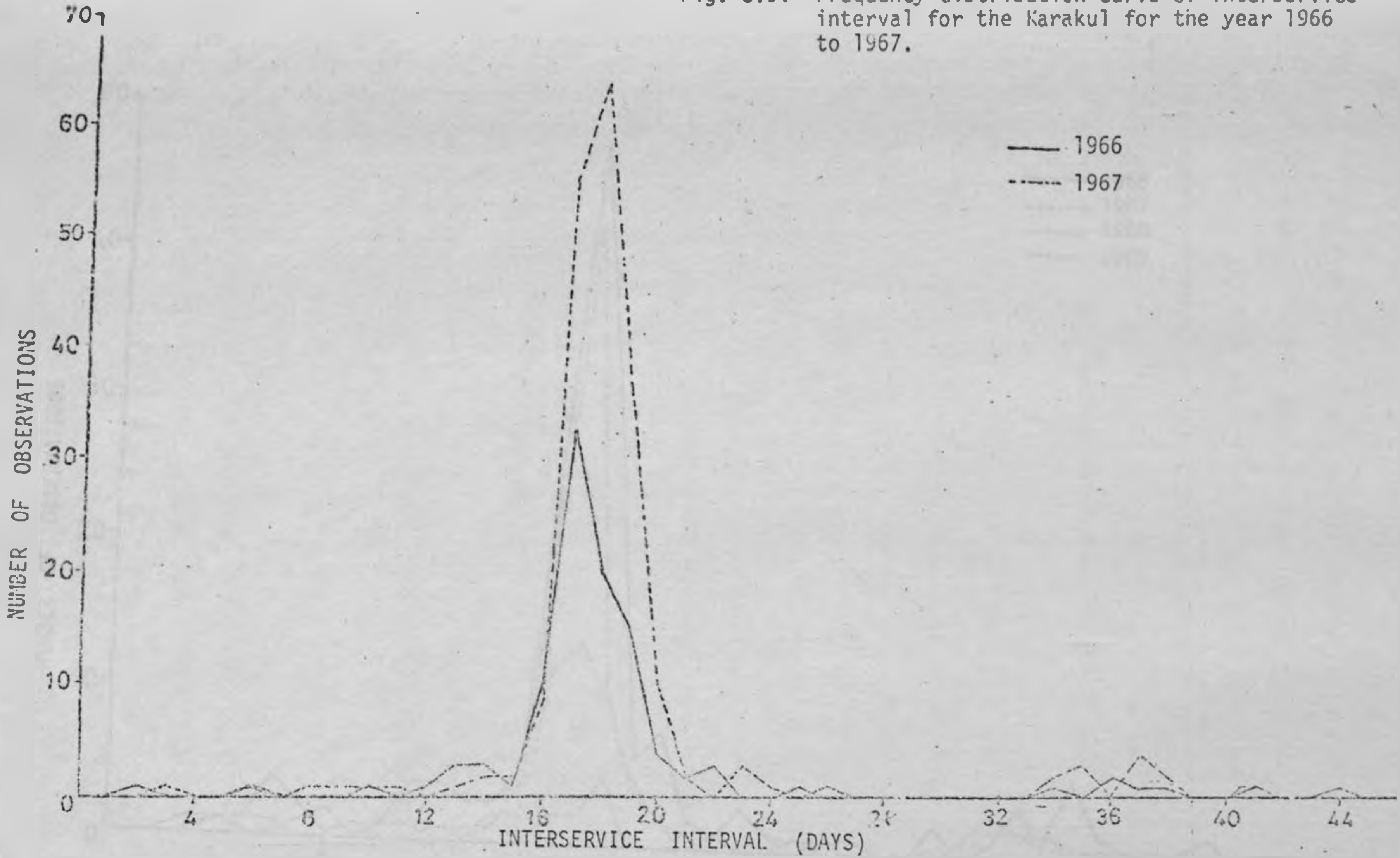
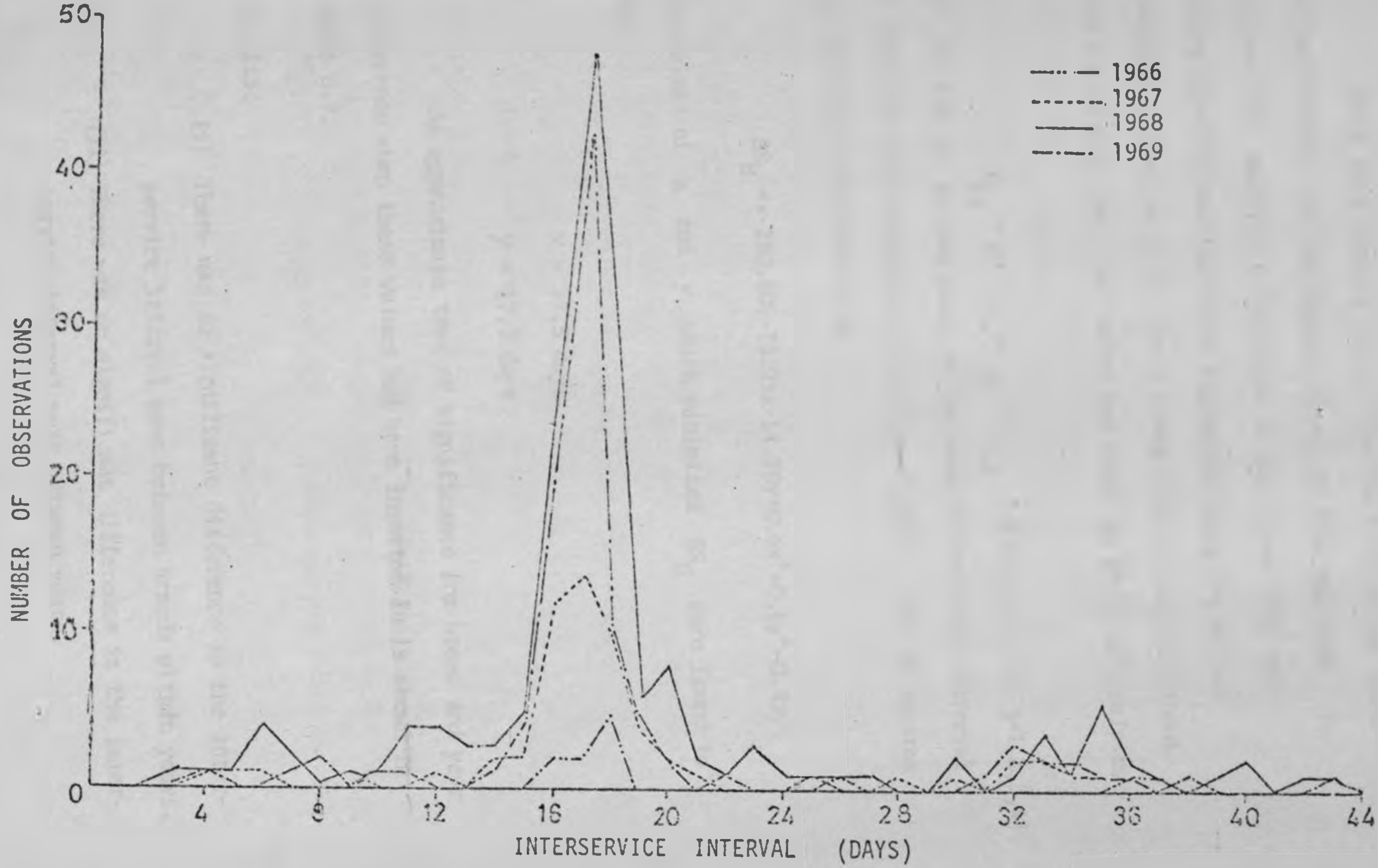


Fig. 3.10: Frequency distribution curve of interservice interval for the Romney Marsh for the year 1966 to 1969.



There were missing values for the mean of the inter-service interval for the Karakul breed in 1968 and 1969. To carry out the analysis of variance on the above data the missing observations had to be estimated using the method developed in Section 2.5. For a 2-way classification without interaction with one observation per cell the model of analysis is

$$y_{ij} = \mu + \alpha_i + \gamma_j + \varepsilon_{ij} \quad (i=1,2,\ldots, 5,\ j=1,2,3,4).$$

Let x and y be the value of the mean interservice interval in 1968 and 1969 respectively for the Karakul. Sum of squares due to error was found to be

$$SS_E = 250.807-13.95x-14.19y+0.6x^2+0.6y^2-0.4xy.$$

The values of x and y which minimized SS_E were found to be:-

$$x = 17.5 \text{ days}$$

$$y = 17.7 \text{ days}.$$

An approximate test of significance for breed and year difference when these values had been inserted in is shown in Table 3.7.

Results:

(i) There was no significant difference in the inter-service interval mean between breeds within years.

(ii) There was no significant difference in the inter-service interval mean between years.

Table 3.7: Approximate test of significance for breed and year difference

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES (SS)	MEAN SUM OF SQUARES (MSS)	F
Due to Breeds	4	4.1970	1.049	3.138
Due to years	3	.2695	0.0898	0.2687
Due to Error	10	3.343	0.3343	-
Total	17	7.8095	-	-

3.2: Interval Estimation:

3.2.1: Confidence Interval Estimation for the Population mean of the interservice interval for each phase for each breed

From the frequency distribution curves of the interservice interval for each phases, it was found that the normal oestrus activity was normally distributed (approximately). The theory developed in section 2.6, particularly equation (2.4) for confidence interval estimation for the population mean was used.

A 95 percent confidence interval for the population mean, μ, for the interservice interval mean for each phase for each breed is shown in Table 3.8.

Table 3.8: Confidence interval for the population mean of the interservice interval mean for each phase for each breed (days)

BREED	CONFIDENCE LIMITS	PHASE 1	PHASE 2	PHASE 3
SOMALI	Lower	16.5	17.1	17.2
	Upper	17.1	17.5	18.2
NANDI	Lower	17.1	17.2	16.3
	Upper	17.9	18.0	18.5
MERINO	Lower	17.5	17.4	17.5
	Upper	18.3	18.2	18.3
KARAKUL	Lower	17.2	-	-
	Upper	17.8	-	-
ROMNEY	Lower	15.5	16.0	16.4
MARSH	Upper	17.5	17.0	17.4

The lowest of the lower confidence limit of the population mean, μ, and the highest of the upper confidence limit for each breed in all the three phases was taken. This gave a 95 percent confidence interval of the population mean, μ, for the interservice interval mean for each breed for all phases. These are:

(a) Somali Breed - (16.5, 18.2) days

(b) Nandi Breed - (16.3, 18.3) days

(c) Merino Breed - (17.3, 18.3) days

(d) Karakul Breed - (17.2, 17.8) days

(e) Romney Marsh Breed - (15.5, 17.5) days

3.2.2: Confidence Interval Estimation for the Population Mean of the Interservice Interval Mean for Each Breed on Yearly Basis.

A 95 percent confidence interval for the population mean, μ, for each of the five breeds in 1966, 1967, 1968 and 1969 is as shown in Table 3.9.

From Table 3.9 the lowest of the lower confidence limit and the highest of the upper confidence interval in all the four years for each breed was considered. This gave a 95% confidence interval for the population mean, μ, of the inter-service interval mean for each breed during the four years since this confidence interval covered all the other intervals for that particular breed. These are:

(a) for Somali Breed - (15.2, 18.1) days

(b) for Nandi Breed - (17.0, 18.2) days

(c) for Merino Breed - (16.7, 18.8) days

(d) for Karakul Breed - (16.6, 17.9) days

(e) for Romney Marsh Breed - (15.2, 19.8) days.

Table 3.9: Confidence interval for the population mean of the interservice interval mean for each year for each breed (days).

BREED	CONFIDENCE LIMITS	1966	1967	1968	1969
SOMALI	Upper	15.2	16.4	17.0	17.3
	Lower	16.6	17.2	17.6	18.1
NANDI	Upper	17.0	17.2	17.0	16.3
	Lower	18.2	17.8	18.0	18.0
MERINO	Upper	16.7	17.6	17.5	18.0
	Lower	18.3	18.6	18.3	18.8
KARAKUL	Upper	16.6	17.3	-	-
	Lower	17.8	17.9	—	—
ROMNEY MARSH	Upper	15.4	15.2	15.9	15.9
	Lower	19.8	17.4	16.9	16.9

Table 3.9: Confidence interval for the population mean of the interservice interval mean for each year for each breed (days).

BREED	CONFIDENCE LIMITS	1966	1967	1968	1969
SOMALI	Upper	15.2	16.4	17.0	17.3
	Lower	16.6	17.2	17.6	18.1
NANDI	Upper	17.0	17.2	17.0	16.3
	Lower	18.2	17.8	18.0	18.0
MERINO	Upper	16.7	17.6	17.5	18.0
	Lower	18.3	18.6	18.3	18.8
KARAKUL	Upper	16.6	17.3	-	-
	Lower	17.8	17.9	-	-
ROMNEY MARSH	Upper	15.4	15.2	15.9	15.9
	Lower	19.8	17.4	16.9	16.9

CHAPTER IV

SPECTRUM ANALYSIS OF OESTRUS ACTIVITY

4.1: Oestrus activity of the five breeds for the years 1966, 1967, 1968 and 1969.

The incidence of oestrus activity (expressed as a percentage by taking the proportion of the ewes that showed oestrus activity within consecutive 20 days periods) for each of the five breeds for each year is given in Tables 4.1, 4.2., 4.3 and 4.4. (see appendix B).

The aim of the study was to use the data to study the seasonal variation in the oestrus activity of sheep in the tropics. The duration for all the periods was twenty days except for periods 23/6/66 - 9/7/66 and 8/9/66 - 10/9/66 which were shorter due to a change in the recording system. Analysis therefore started from period 11/9/66 - 30/6/66 to period 7/12/69 - 26/12/69. From the 18th of March 1969 to 19th July 1969 rams were separated from ewes. This period was partitioned into twenty days periods and estimates of level of oestrus activity inserted in during the spectrum analysis. Tables 4.5, 4.6, 4.7, 4.8, and 4.9 (see appendix C) show the serial correlations for all the five breeds.

4.2: Spectrum Analysis of Oestrus Activity in the Merino Ewes

Fig. 4.1. shows the original series of Merino's oestrus activity (expressed as percentages) on time domain. This figure

shows its non-stationary behaviour. Fig. 4.2. is the correlogram of the original series. It suggests the Markov process, that is

$$\varepsilon_t = Y_t + \beta_1 Y_{t-1} \qquad (4.1)$$

$$|\beta_1| < 1 \qquad \text{for stationary.}$$

Equation (4.1) defines a first order autoregressive process known as Markov process.

Elimination of trend in Merino's oestrus activity by differencing (first difference)

The first difference of the original series was taken to eliminate trend since correlogram suggests a Markov process, that is, an autoregressive process of order one. The new sequence (ΔY_t) is shown in the Table 4.10 (see appendix D) and is shown graphically in Fig. 4.3.

$$\Delta Y_t = Y_{t+1} - Y_t.$$

The autocorrelations, the smoothed spectrum ordinates and period are given in Table 4.11 (see appendix E). The power spectrum of the sequence (ΔY_t) is shown in fig. 4.4.

The significance of the white noise was tested using equation (2.11) given in section 2.7.4

That is $$t = \sqrt{\frac{r_1^2\, T}{1-r_1^2}}$$

which is student's t-distribution with degrees of freedom equal to T + 2, which in this case is 61.

$$t = \sqrt{\frac{(-0.1670)^2 \times 59}{1-(0.1670)^2}} = 1.301$$

$$1.301 < 2.000 \text{ (Table value).}$$

Thus r_1 is not significant at the 5% level of significance. This implies that the null continuum is that of white noise or in other words the spectrum is a horizontal straight line whose value is everywhere equal to the average of the values of all m+1 'raw" spectral estimates in the computed spectrum.

The significance of the peaks at 'k' in the power spectrum is then tested using the ratio $S_k/\bar{S}$. Table 4.12 gives the values of the ratios of $S_k/\bar{S}$ which are distributed as $\chi^2(v)/v$ under the null hypothesis.

$$v = \frac{59 \times 2 - 15/2}{15} \simeq 7$$

Table 4.12: <u>Significance Test of peaks at 'k' for Merino Breed</u>

K	S_k	$S_k/\bar{S}$
4	0.0801	1.00
6	0.0698	0.87
11	0.1135	1.42
13	0.1112	1.40

where $\bar{S} = 0.0800$

Fig.4.1: Non-stationary character of the original series for Merino breed.

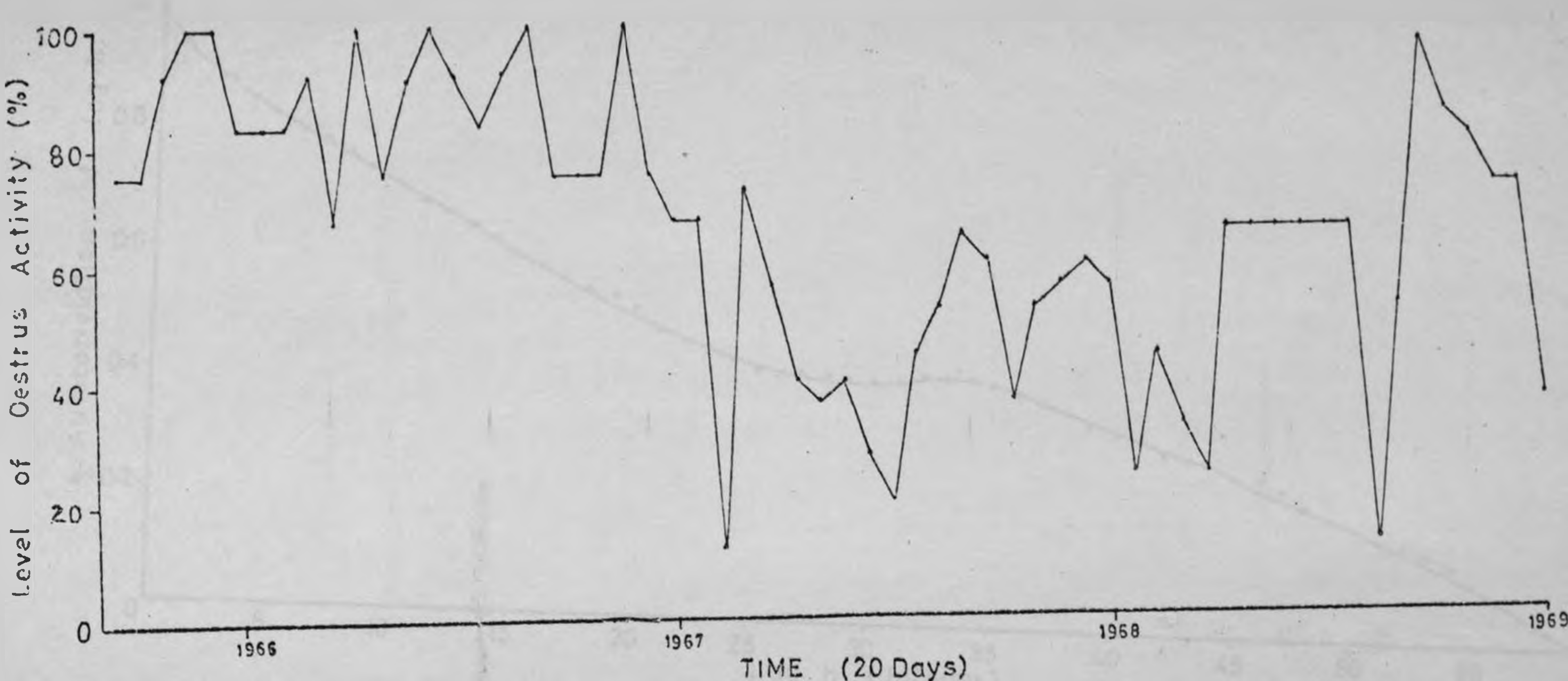


Fig. 4.2: Correlogram of the original series for Merino breed.

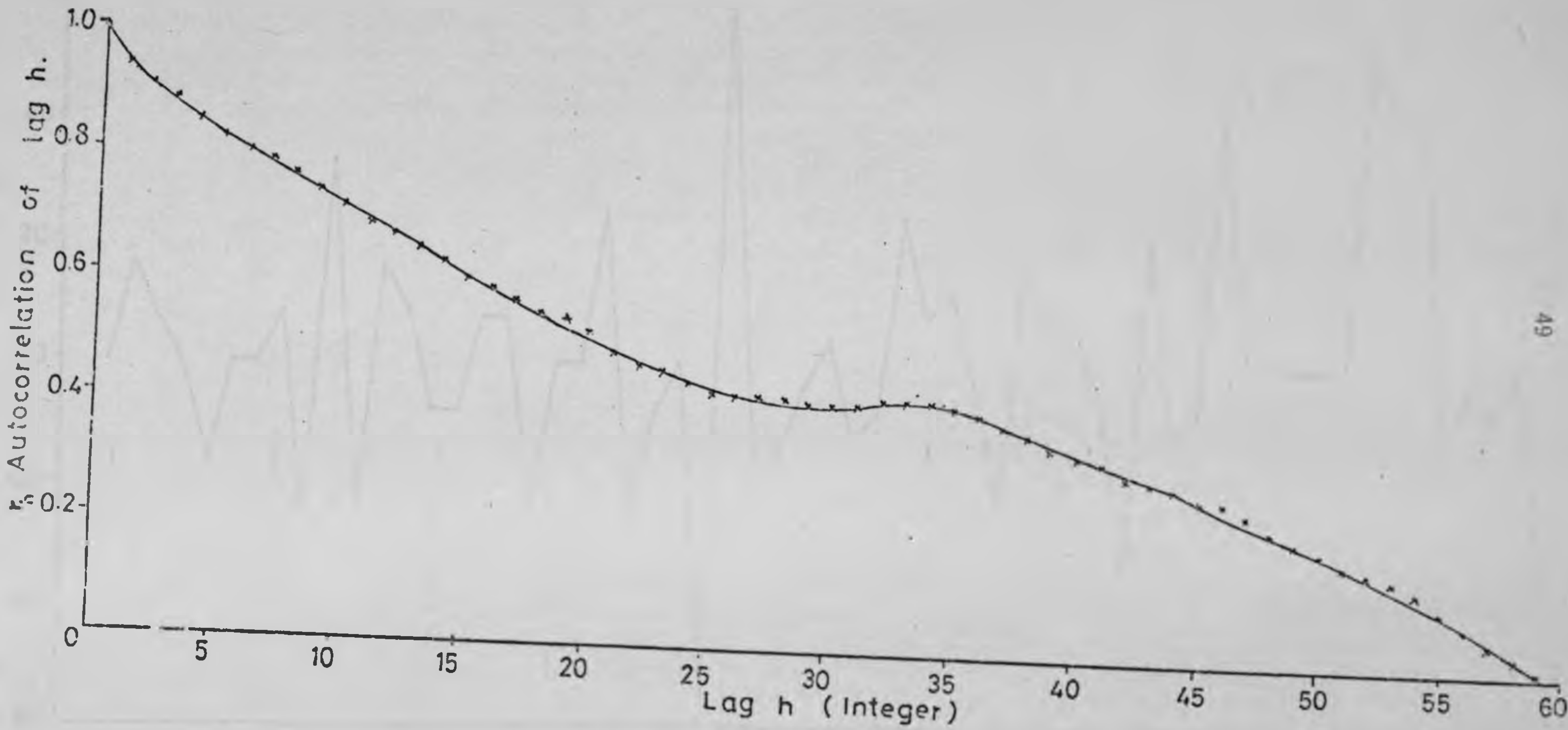


Fig.4.3: Merino's series obtained after eliminating trend by difference method.

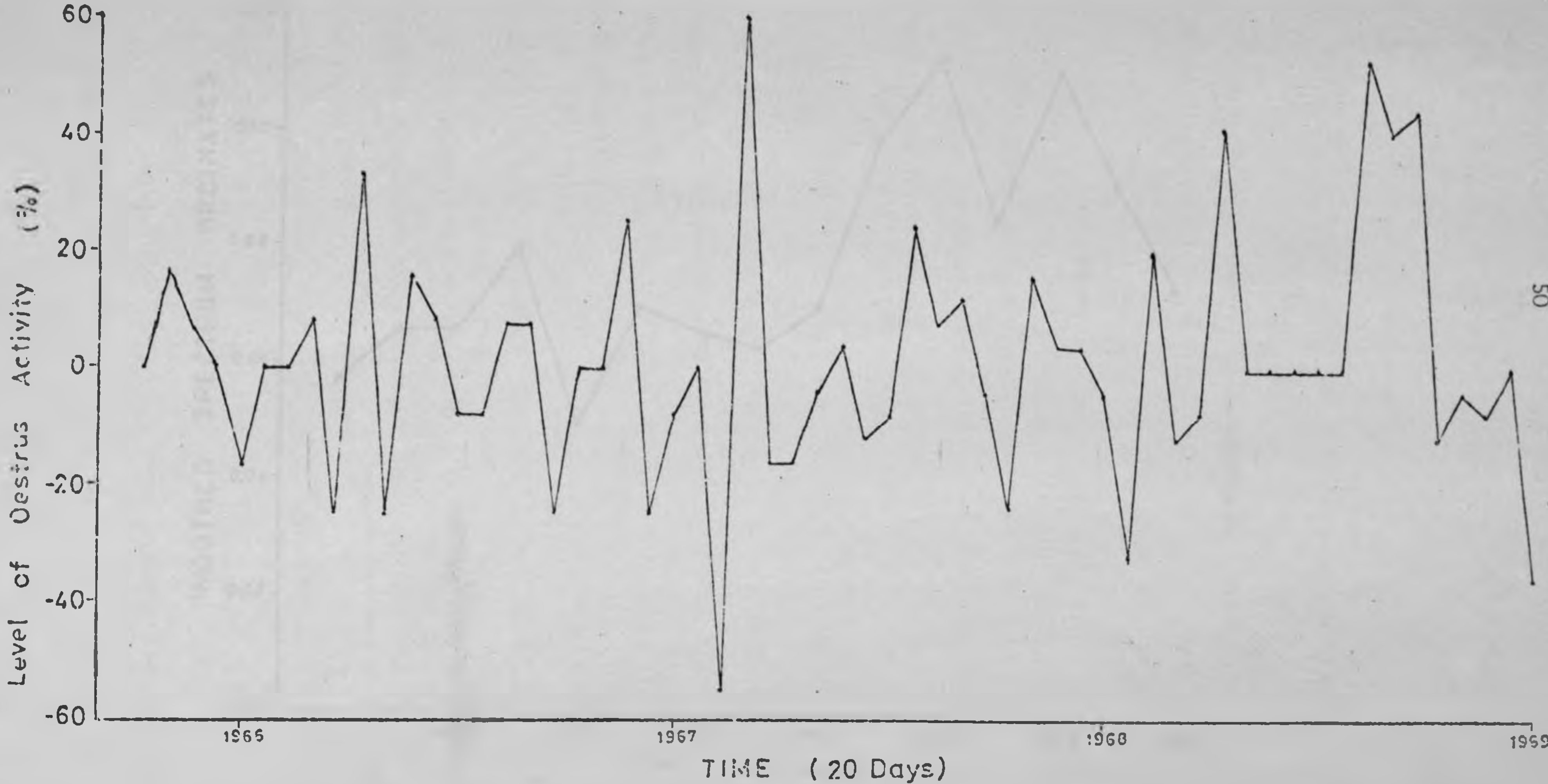
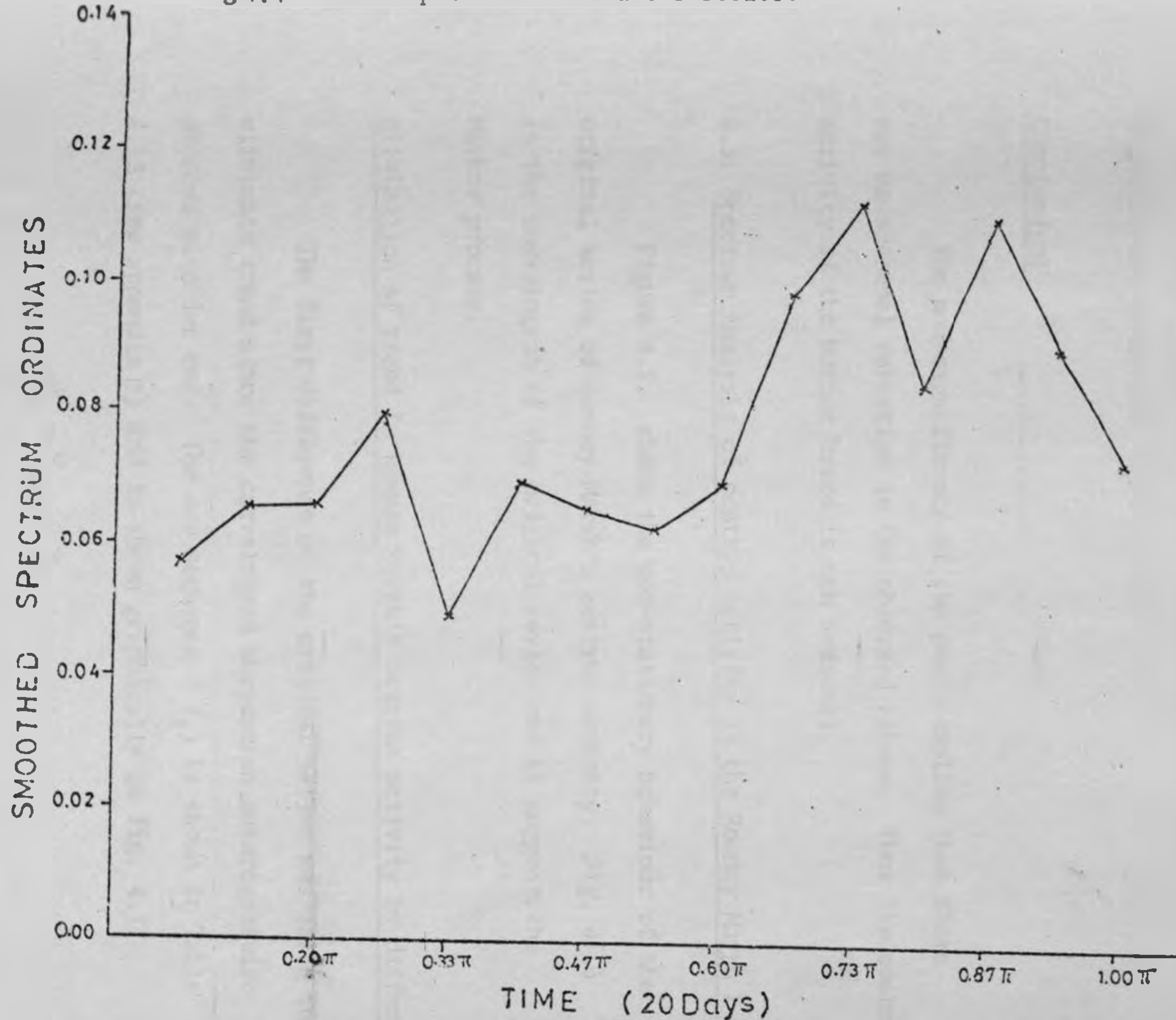


Fig4.4 : Power spectrum of Merino's series.



From χ^2 table $\chi^2(7)/7 = 2.01$ at the 5% level of significance.

All the four peaks were not significant at $\alpha = 5\%$ level of significance since all $S_k/\bar{S} < 2.01$.

Conclusion:

The non-significance of the peaks implies that there was no seasonal variation in the observed values. Thus the oestrus activity of the Merino breed is non seasonal.

4.3: Spectrum Analysis of oestrus activity in the Romney Marsh Ewes

Figure 4.5. shows the non-stationary behaviour of the original series of Romney Marsh's oestrus activity. Fig. 4 .6 is the correlogram of the original series and it suggests the Markov process.

Elimination of trend in Romney Marsh's oestrus activity by difference

The first difference of the original series was taken to eliminate trend since the correlogram suggests an autoregressive process of order one. The new sequence (Y_t) is shown in Table 4.13 (see appendix D) and is shown graphically in fig. 4.7.

$$\Delta Y_t = Y_{t+1} - Y_t.$$

The autocorrelations, the smoothed spectrum ordinates and

period are given in Table 4.14 (see appendix E)
The power spectrum of the new sequence (ΔY_t) is shown in Fig. 4.8.;

The significance of the white noise was tested using equation (2.11).

That is

$$t = \sqrt{\frac{r_1^2 T}{1-r_1^2}} = \sqrt{\frac{(0.1931)^2 \times 59}{1 - (0.1931)^2}}$$

$$= 1.512$$

1.512 < 2.000 (Table value, i.e., student's t tables with 61 degrees of freedom at $\alpha = 5\%$.

Thus r_1 is not significant at the 5% level of significance. This implies that the null continuum is that of white noise.

The significance of the peaks at "K" in the power spectrum was then tested using the ratio $S_k/\bar{S}$. Table 4.15 gives the values of the ratios $S_k/\bar{S}$ which are distributed as $\chi^2(v)/v$ under the null hypothesis.

Fig. 4.5 Non-stationary character of original series for Romney Marsh breed.

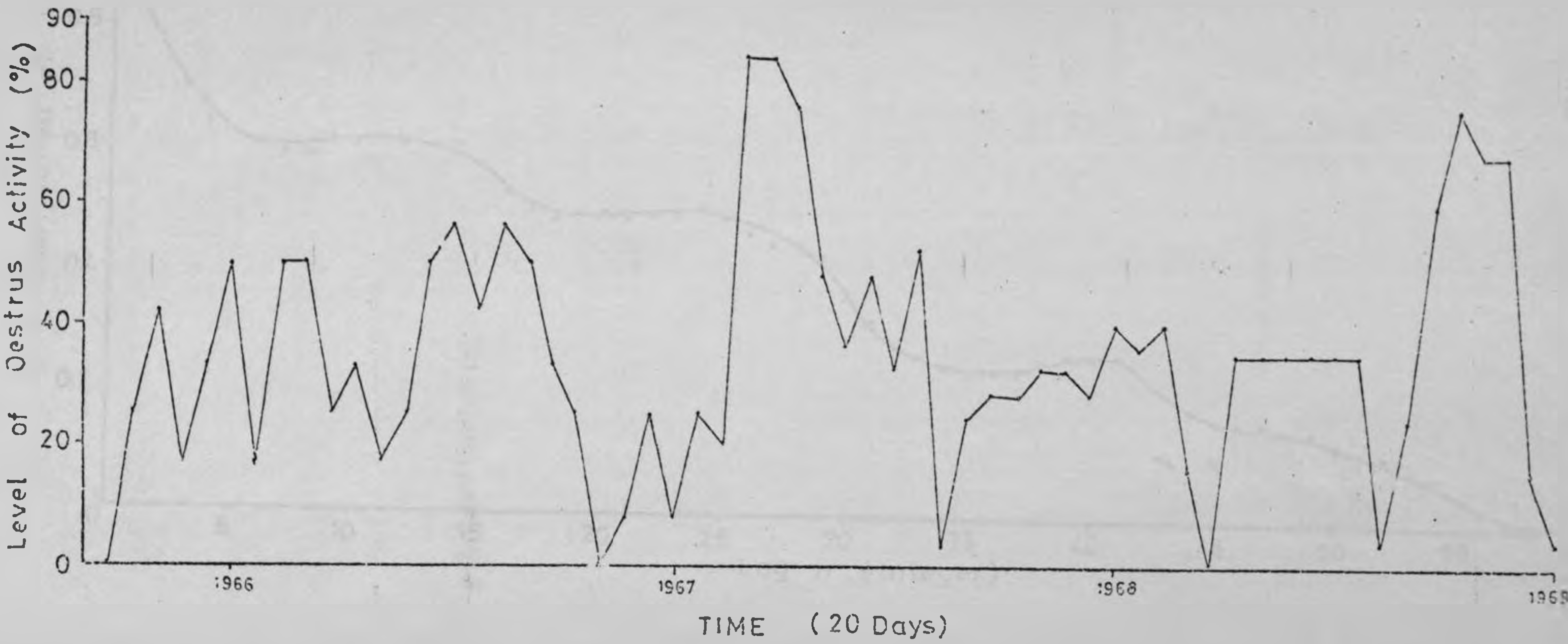


Fig.4.6.: Correlogram of original series for Romney Marsh breed.

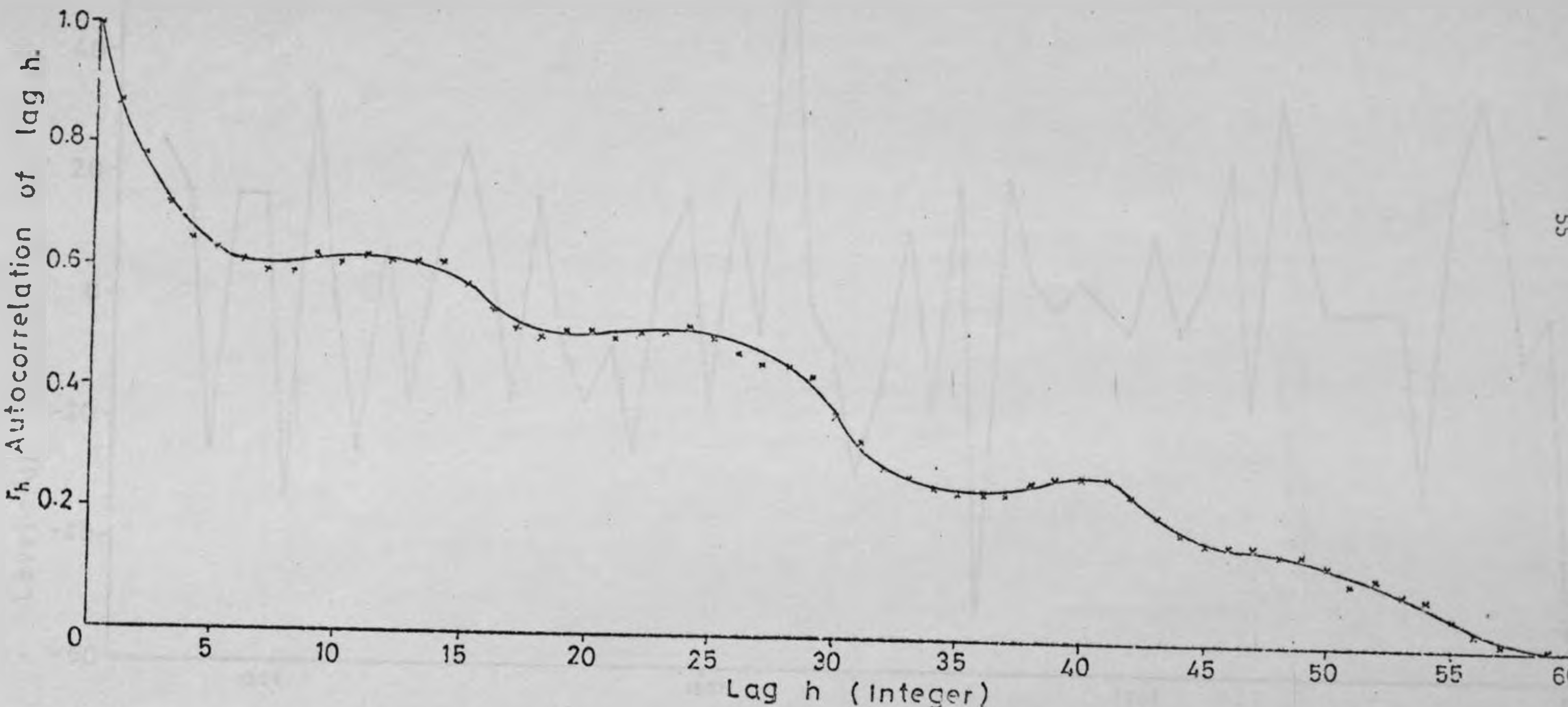


Fig. 4.7: Romney Marsh's series after elimination of trend by finite difference.

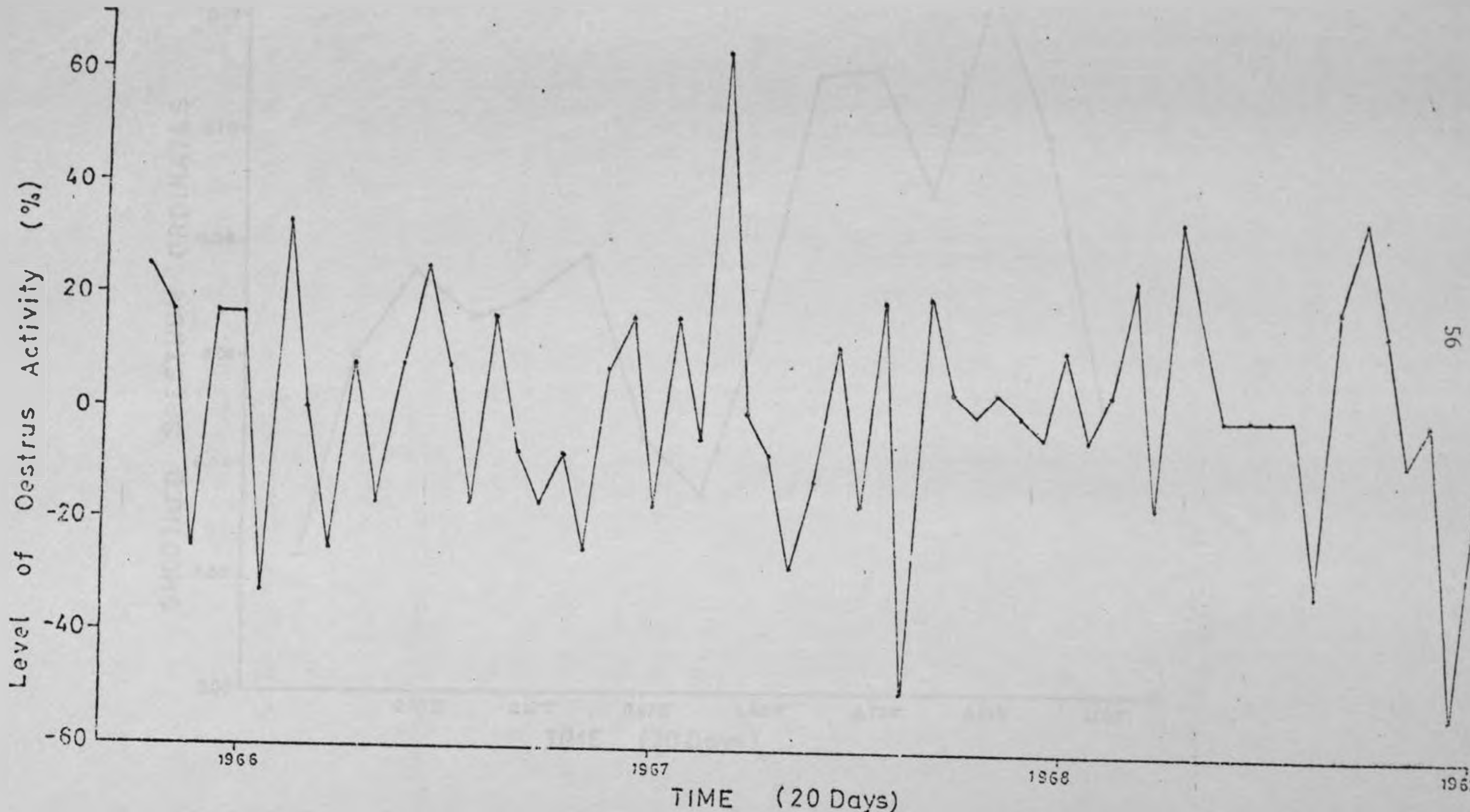


Fig.4.8: Power spectrum of Romney Marsh's series.

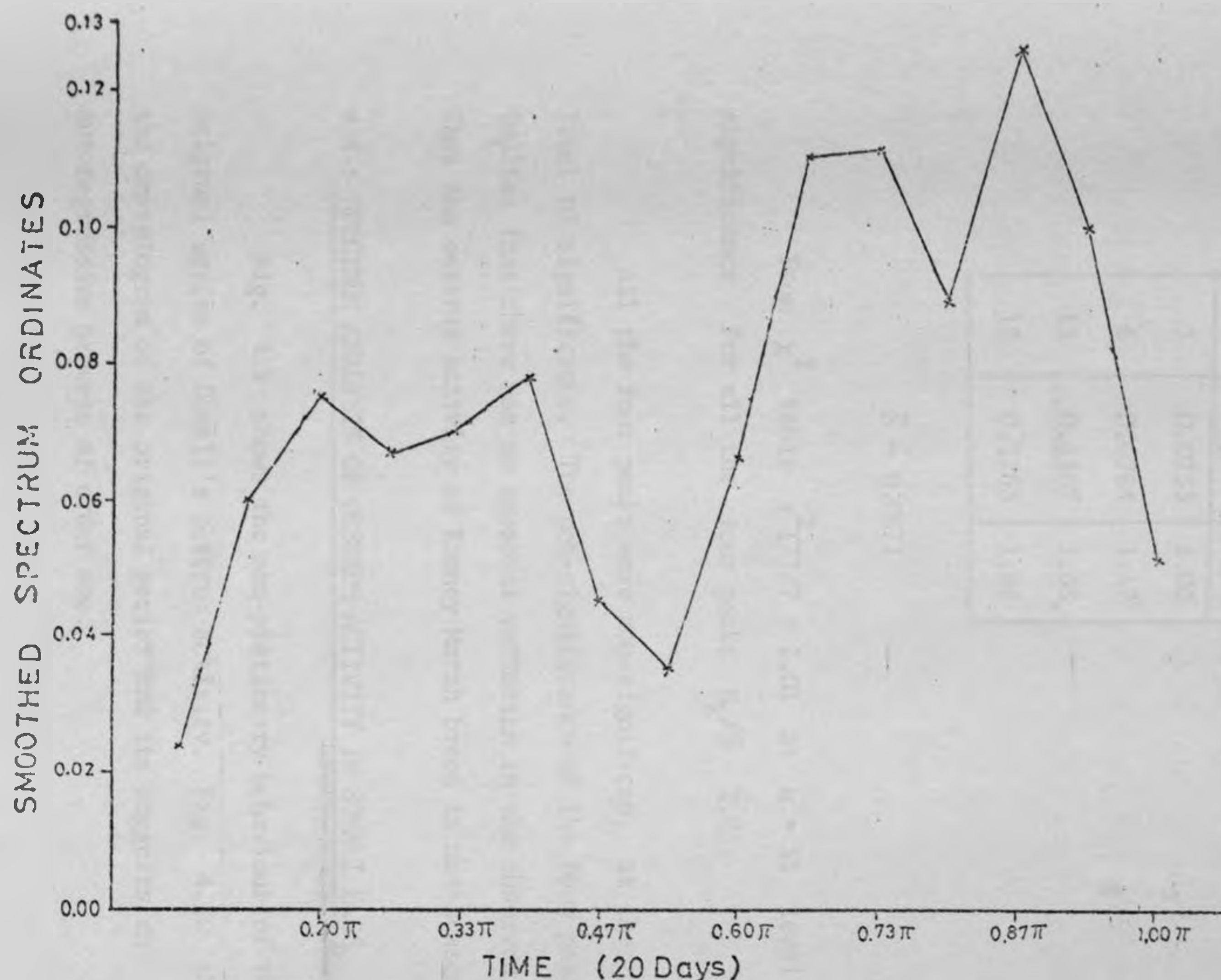


Table 4.15: Significance Test of Peaks at "K" for Romney Marsh breed.

K	S_K	$S_k/\bar{S}$
3	0.0753	1.06
6	0.0784	1.17
11	0.1107	1.65
12	0.1263	1.88

$\bar{S} = 0.0671$

From χ^2 table $\chi^2(7)/7 = 2.01$ at $\alpha = 5\%$ level of significance. For all the four peaks $S_k/\bar{S} < 2.01$.

All the four peaks were non-significant at the 5% level of significance. The non-significance of the four peaks implies that there was no seasonal variation in the observed data. Thus the oestrus activity of Romney Marsh breed is non-seasonal.

4.4 : SPECTRUM ANALYSIS OF OESTRUS ACTIVITY IN SOMALI EWES

Fig. 4.9 shows the non-stationary behaviour of the original series of Somali's oestrus activity. Fig. 4.10 shows the correlogram of the original series and its suggests an autoregressive process of order one.

ELIMINATION OF TREND IN SOMALI'S OESTRUS ACTIVITY BY MOVING AVERAGE METHOD:

The non-stationary behaviour of the original series can be reduced to stationary behaviour if trend is removed. A look at fig. 4.9 of the original series suggests possible harmonic oscillations of periodicities 2,3,4,6 and 12 twenty day periods.

To destroy all harmonic oscillations of these periodicities, a 12-point moving average method was used.

Let the original series be

$$Y_t = T + H + R$$

where T, H and R are trend, seasonal component and random component respectively.

Then

$$O(Y_t) = O(T) + O(H) + O(R).$$

$$= T + O(R).$$

Where the symbol "O" denotes the 12-point simple moving operator.

The new sequence is now defined by

$$X_t = Y_t - O(Y_t)$$
$$= H + (R - O(R)).$$

The trend component has been destroyed. A 12-point simple moving average has centre between the 6th and 7th observation, and hence the value of the trend for the 7th observation is taken to be

$$\frac{1}{2}\{\frac{X_1 + X_2 + \dots X_{12}}{12} + \frac{Y_2 + Y_3 \dots . Y_{13}}{12}\}.$$

The new sequence $\{X_t\}$ after elimination of trend using 12-point moving average is shown in Table 4.16(see appendix D) and is shown graphically in Fig. 4.11.

The autocorrelations, the smoothed spectrum ordinates and periods are given in Table 4.17(see appendix E) and the power spectrum of the sequence (X_t) is shown in Fig. 4.12 .

The significance of white noise was tested using

$$t = \sqrt{\frac{(0.1573)^2 \times 48}{1 - (0.1573)^2}} = 1.104$$

1.104 < 2.001 (table values, i.e t-distribution with 50 degrees of freedom at 5% level).

Thus r_1 is non-significant at $\alpha = 5\%$ level of significance. This implies that the null-continuum is that of white noise.

The significance of the peak at "k" in the power spectrum was then tested using the ratio $S_k/\bar{S}$. Table 4.18 gives the values of the ratios, which are distributed as $\chi^2(v)/v$ under the null hypothesis, where

$$v = \frac{2 \times 48 - 15/2}{15} = 5.90$$

$$\simeq 6$$

Fig 4.9 : Non-stationary character of the original series for Somali breed.

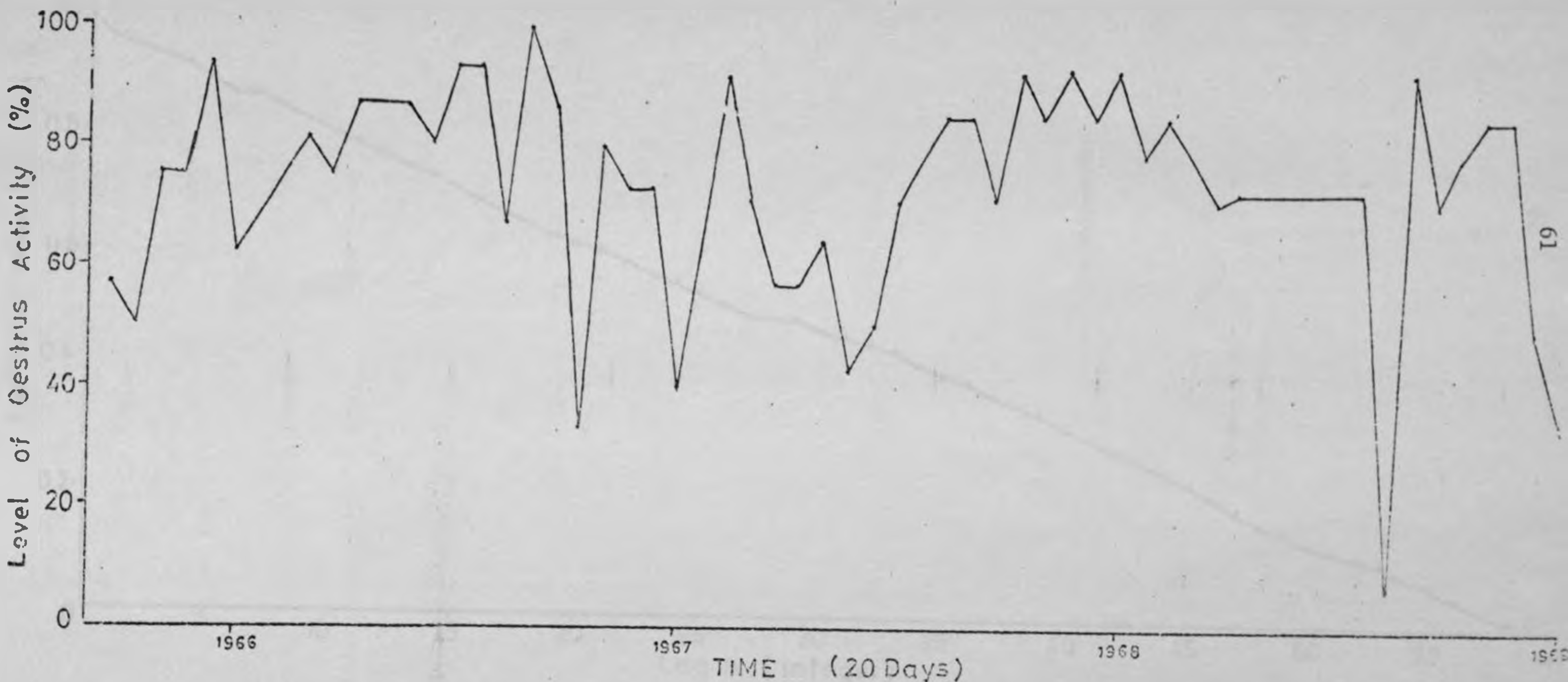


Fig4.10: Correlogram of the original series for Somali breed.

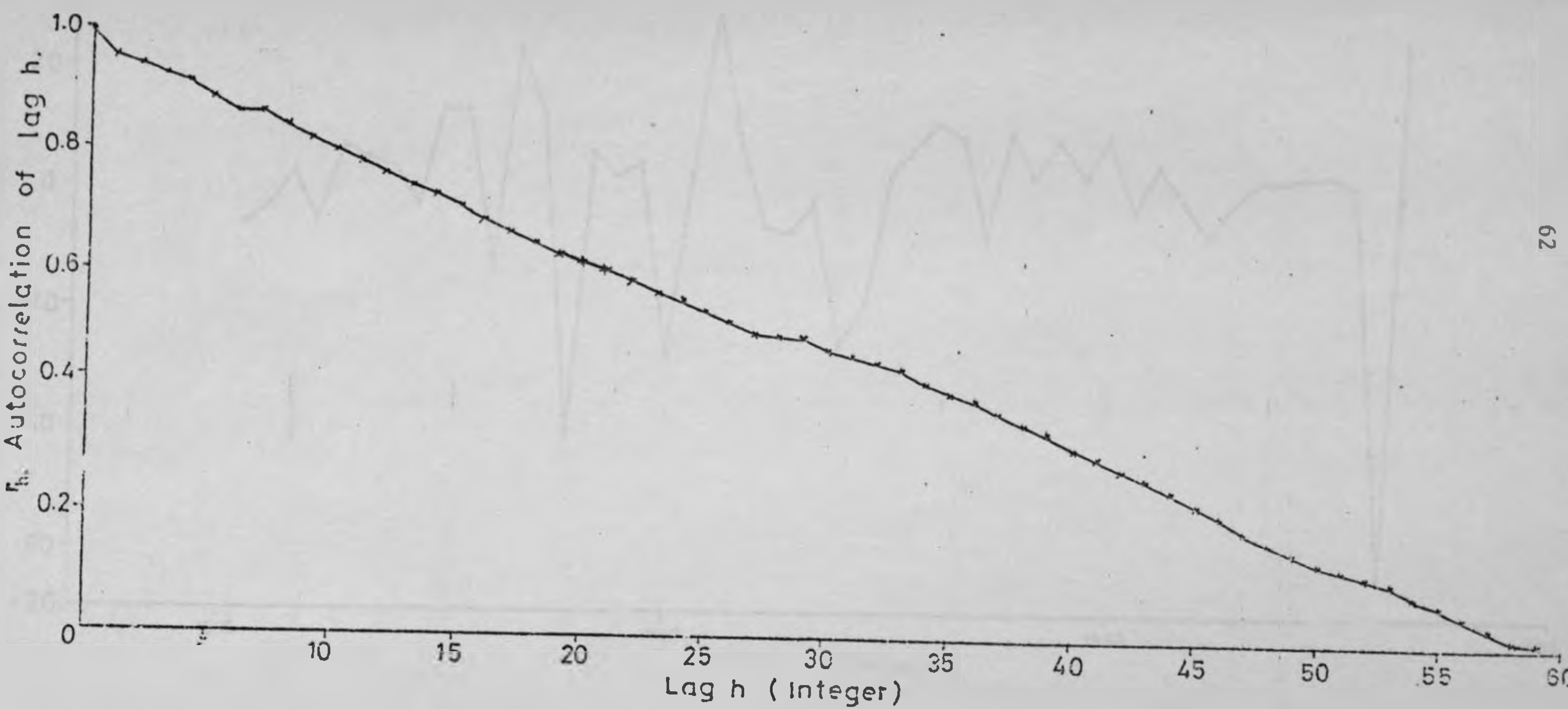


Fig.4.11: Somali's series after elimination of trend by 12-point moving average method.

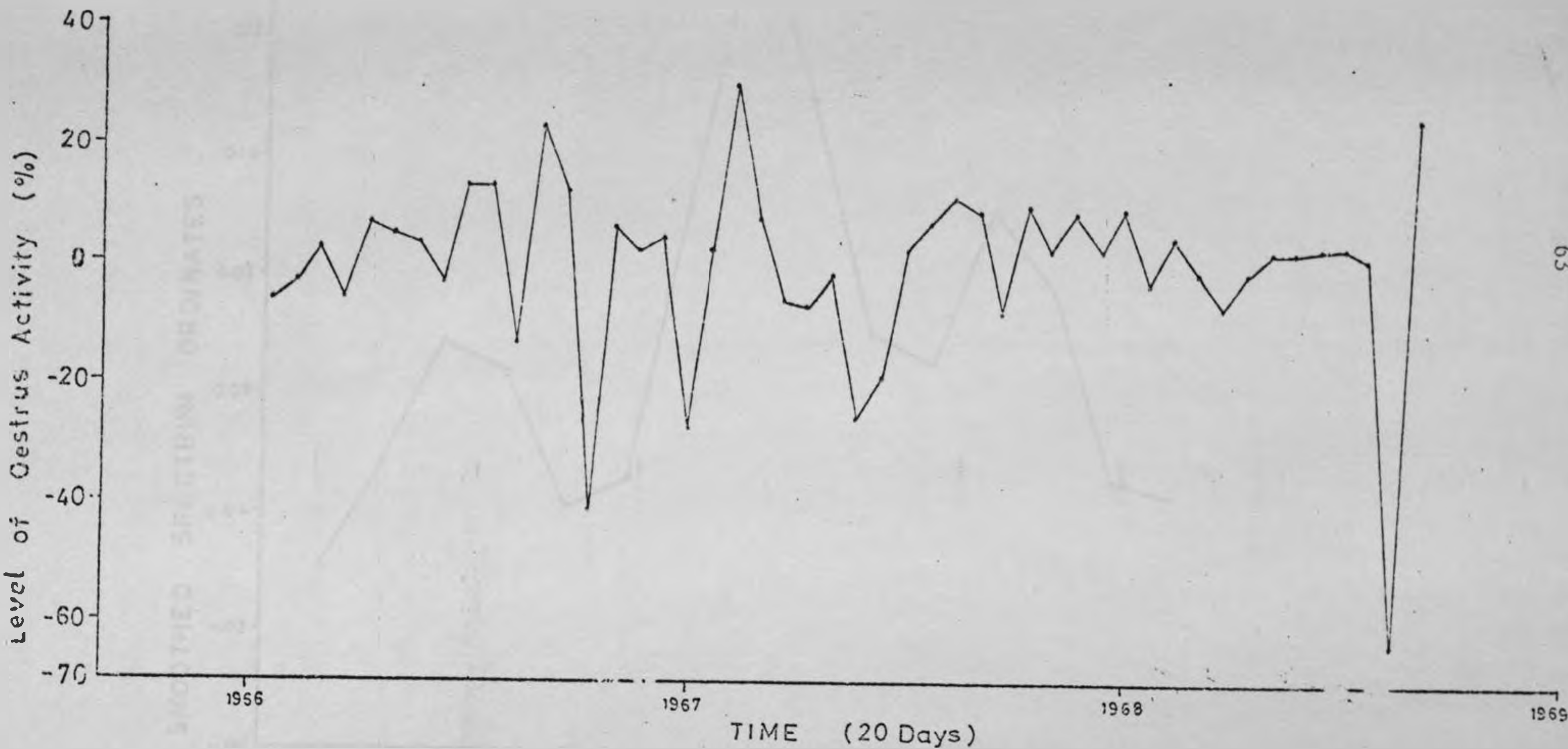
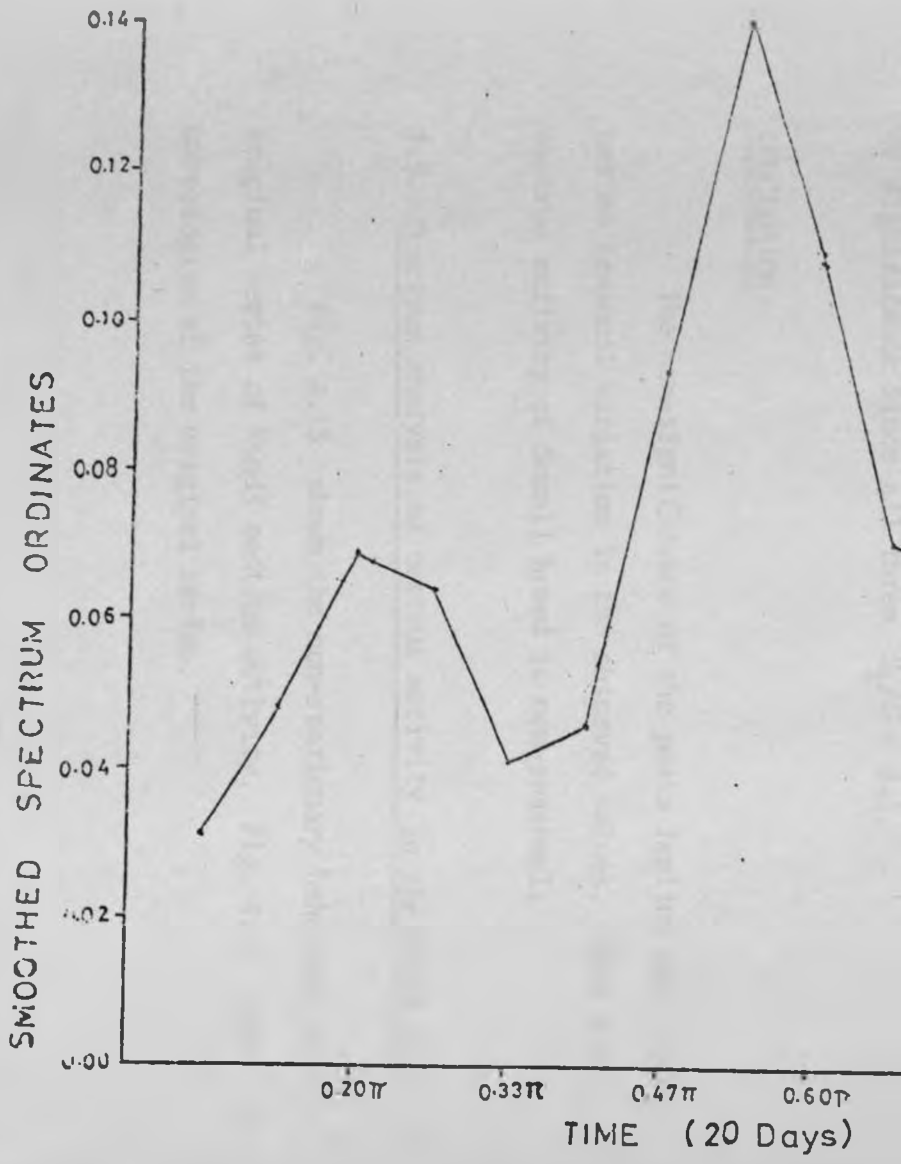


Fig 4.12: Power spectrum of Somali's series



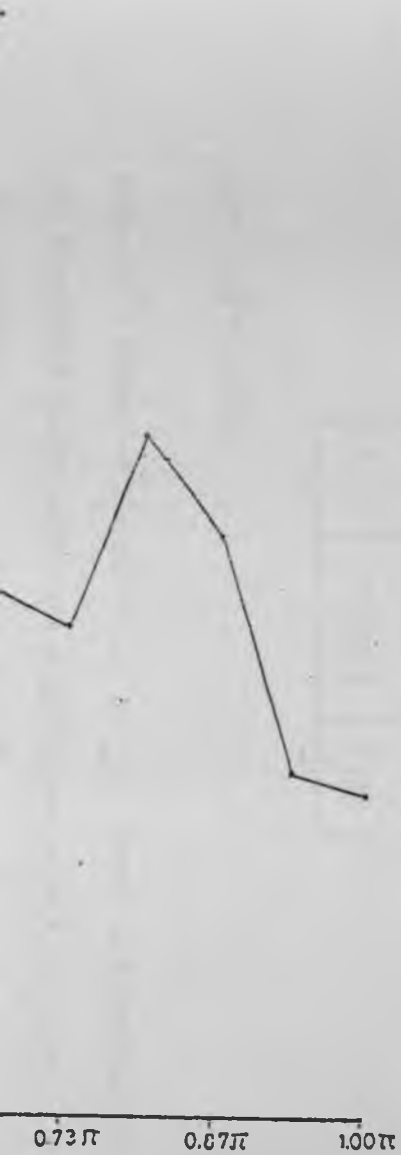

0.73π
0.87π
1.00π

Table 4.18: Significance of Peaks at "K" for the Somali Breed

K	S_k	$S_k/\bar{S}$
3	0.0689	0.93
8	0.1413	1.90
12	0.0923	1.25

where $\bar{S} = 0.0741$.

From X^2 tables $X^2(6)/6 = 2.1$ at 5% level of significance. All the three peaks were not significant at $\alpha = 5\%$ level of significance since all three $S_k/\bar{S} < 2.1$.

CONCLUSION:

The non-significance of the peaks implies that there was no seasonal variation in the observed values. Thus the oestrus activity of Somali breed is non-seasonal.

4.5. Spectrum analysis of oestrus activity in the Nandi Ewes

Fig. 4.13 shows the non-stationary behaviour of the original series of Nandi oestrus activity. Fig. 4.14 shows the correlogram of the original series.

Fig.4.13 Non-stationary character of the original series for Nandi breed.

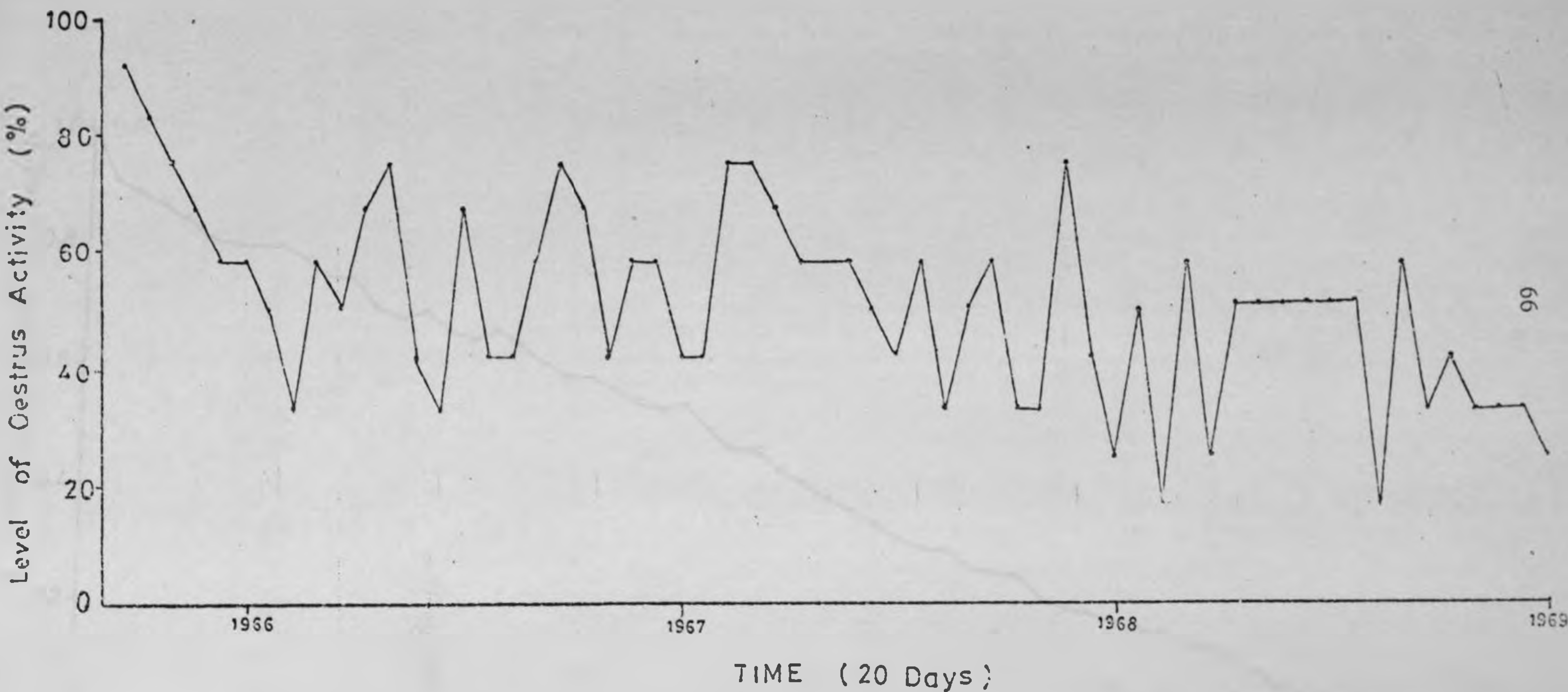
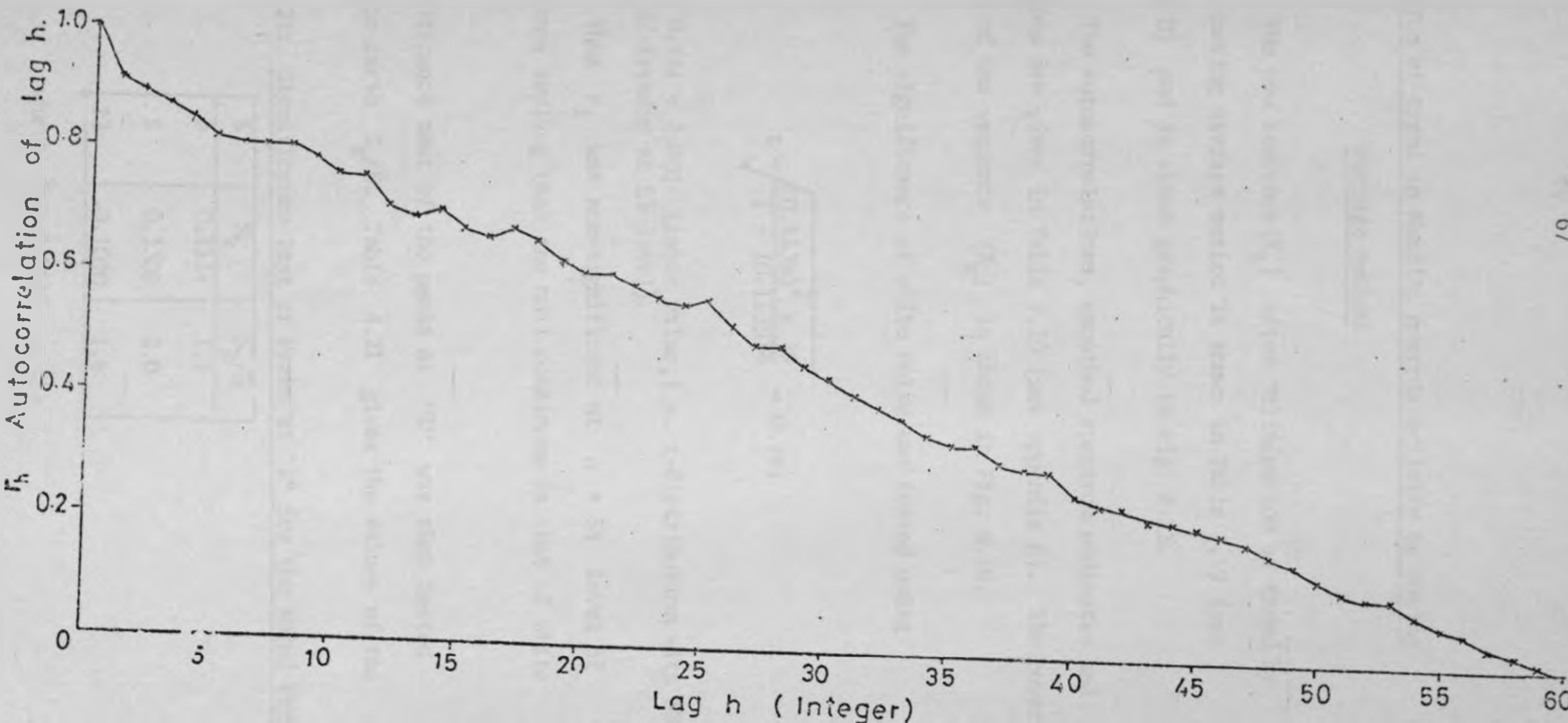


Fig.4.14: Correlogram of the original series for Nandi breed.



Elimination of trend in Nandi's oestrus activity by moving average method

The new sequence (X_t) after elimination of trend by 12-point moving average method is shown in Table 4.19 (see appendix D) and is shown graphically in Fig. 4.15.

The autocorrelations, smoothed spectrum ordinates and the periods are given in Table 4.20 (see appendix E). The power spectrum of the sequence (X_t) is shown in Fig. 4.16.

The significance of white noise was tested using

$$t = \sqrt{\frac{(0.1139)^2 \times 48}{1 - (0.1139)^2}} = 0.794$$

0.794 < 2.001 (table value, i.e. t-distribution with 50 degrees of freedom at 5% level).

Thus r_1 was non-significant at $\alpha = 5\%$ level of significance impling that the null continuum is that of white noise.

The significance test of the peaks at "K" was then tested using the ratio $S_k/\bar{S}$. Table 4.21 gives the values of the ratios.

Table 4.21: Significance Test of Peaks at "k" for the Nandi Breed.

K	S_k	$S_k/\bar{S}$
3	0.1114	1.7
8	0.1309	2.0
13	0.1020	1.6

where $\bar{S} = 0.0647$

Fig. 4.15: Nandi's series after elimination of trend by 12-point moving average method.

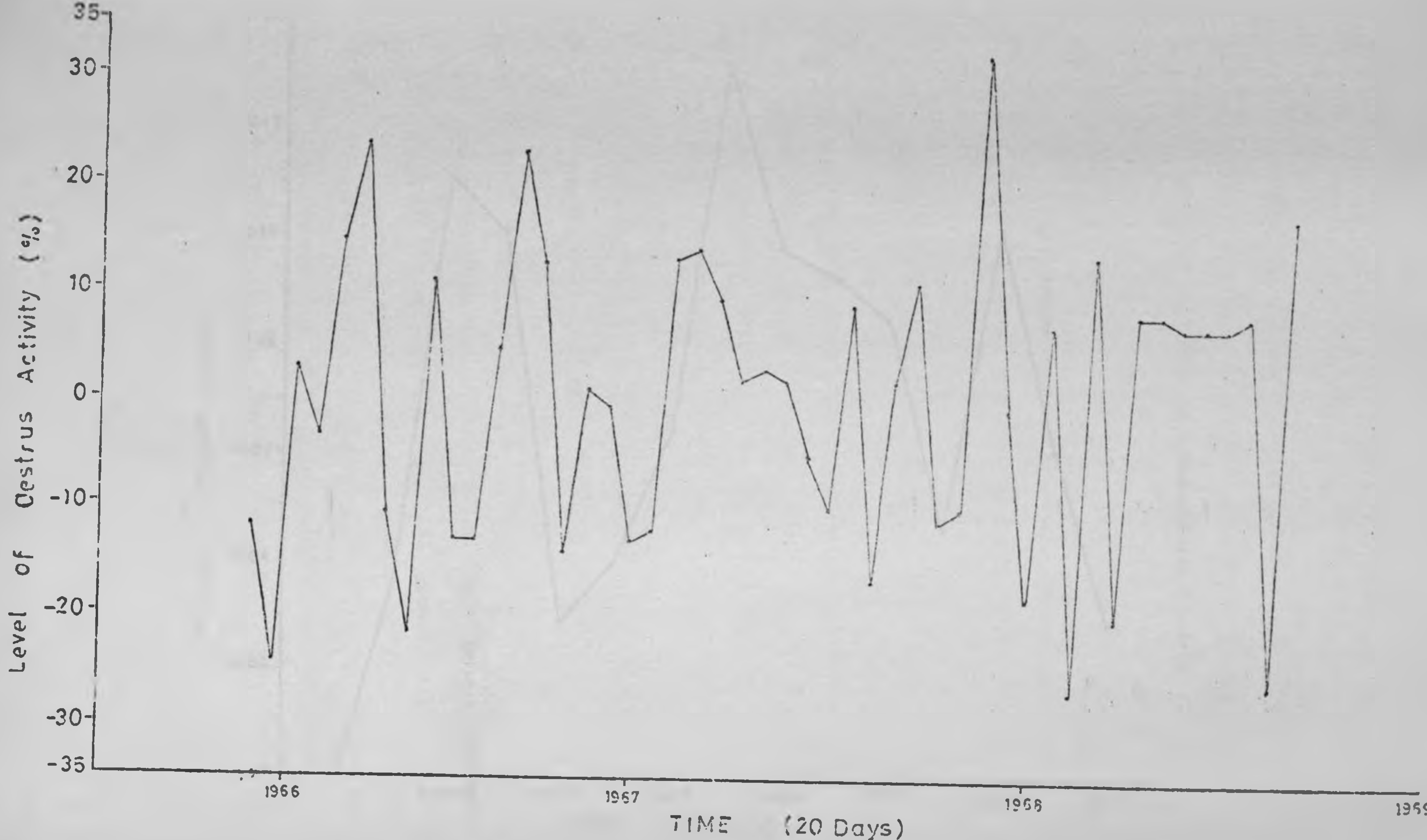
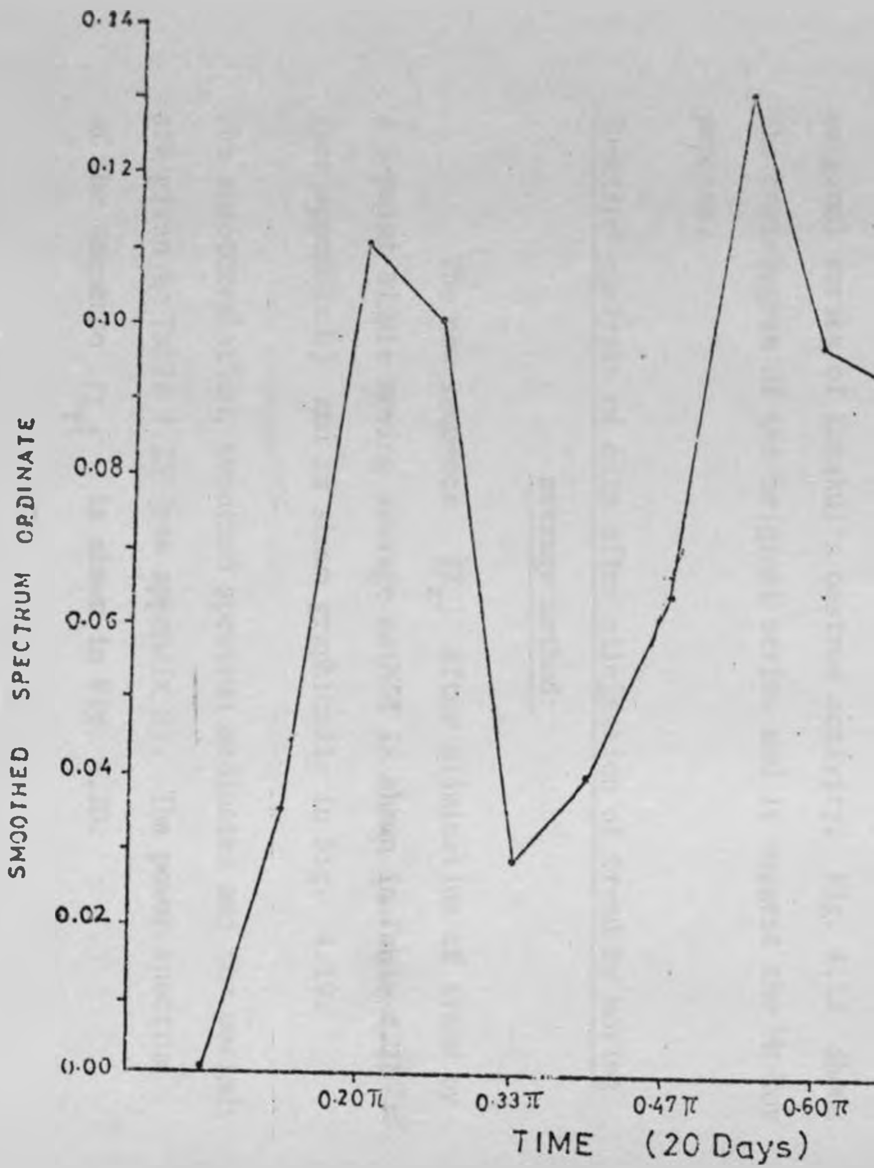


Fig.4.16: Power spectrum for Nandi's series




0·73 π
0·87 π
1·00 π

$$v = \frac{2 \times 48 - 15/2}{15} = 5.90 \simeq 6$$

From χ^2 tables $\chi^2(6)/6 = 2.1$ at 5% level of significance. All the three peaks were non-significant at $\alpha = 5\%$ level of significance since all three $S_k/\bar{S} < 2.1$.

Conclusion:

The non-significance of the peaks implies that there is no seasonal variation in oestrus activity of Nandi breed.

4.6: Spectrum Analysis of oestrus activity in the Karakul ewes

Fig. 4.17 shows the non-stationary behaviour of the original series of Karakul's oestrus activity. Fig. 4.18 shows the correlogram of the original series and it suggest the Markov process.

Spectrum analysis of data after elimination of trend by moving average method:

The new sequence (X_t) after elimination of trend by a 5-point simple moving average method is shown in Table 4.22 (see appendix D) and is shown graphically in Fig. 4.19.

The autocorrelation, smoothed spectrun ordinates and the periods are given in Table 4.23 (see appendix E). The power spectrum of the sequence (X_t) is shown in Fig. 4.20.

Fig.4.17: Non-stationary character of the original series for Karakul breed.

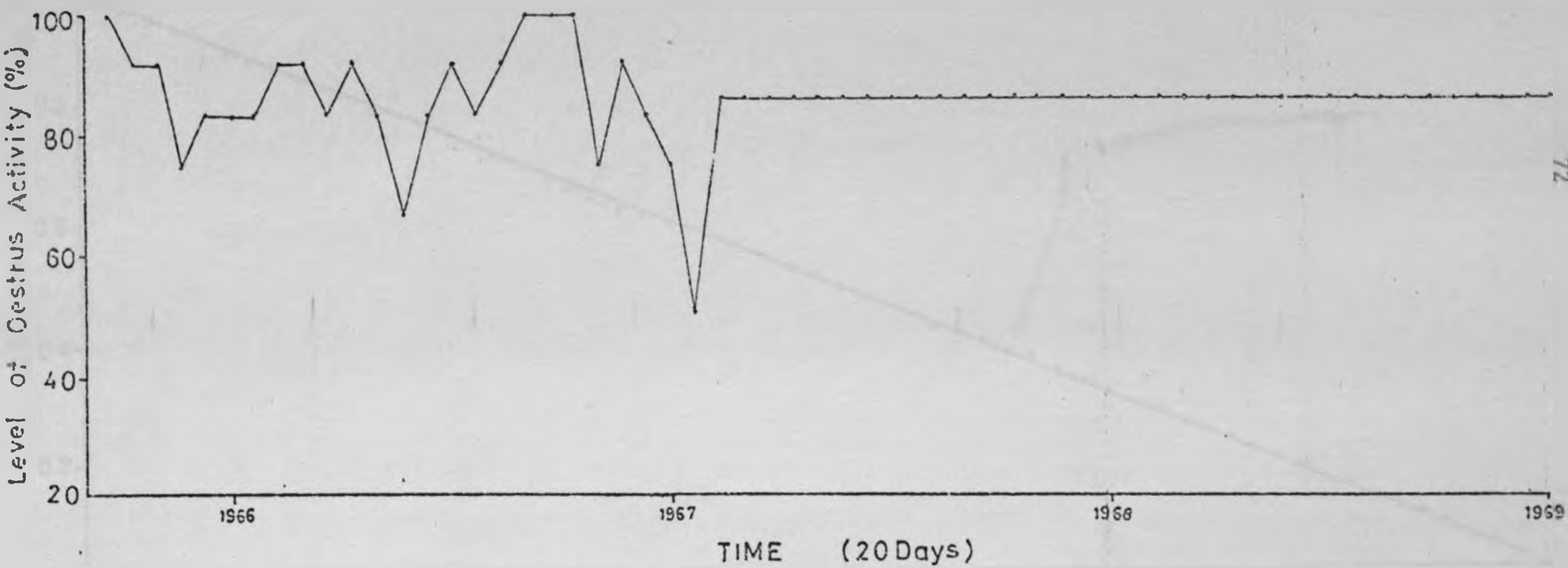


Fig.4.18: Correlogram of the original series for Karakul breed.

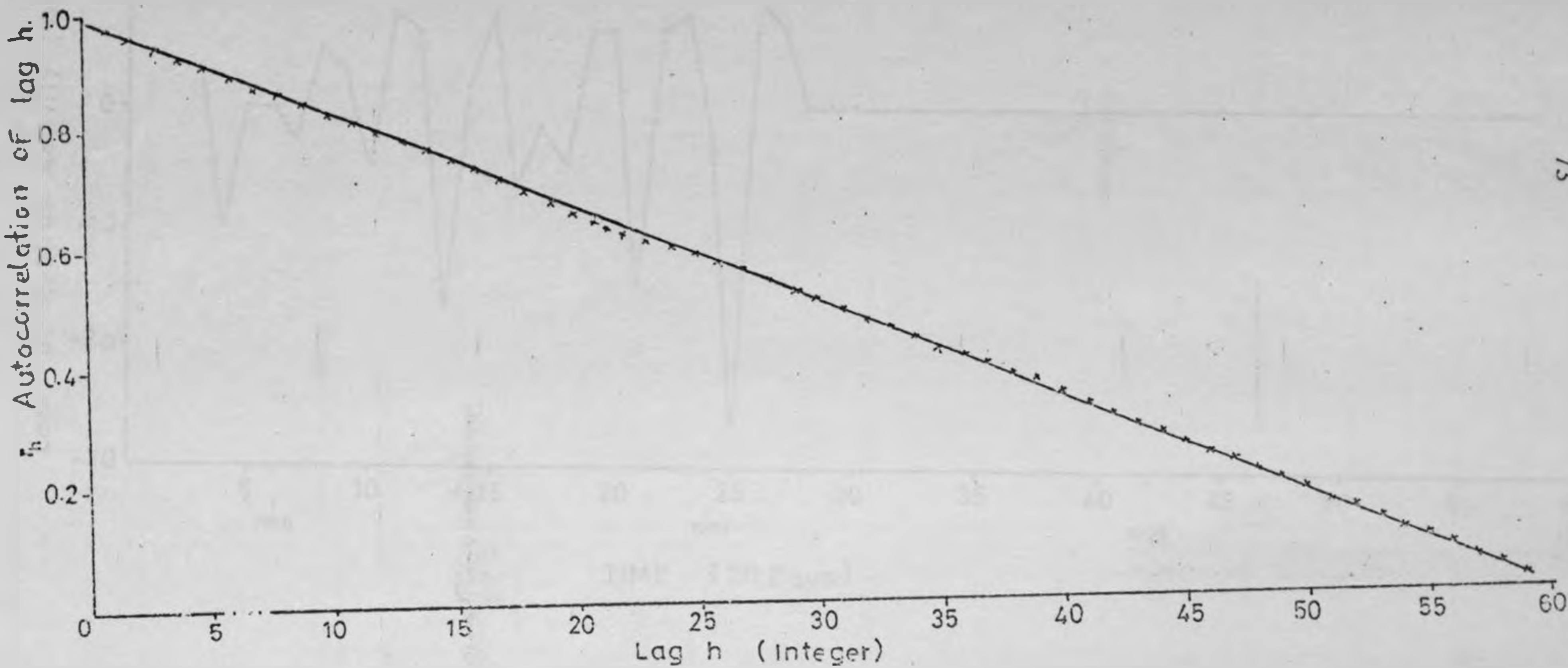


Fig. 4.19:Karakul series after elimination of trend by 5-point moving average method.

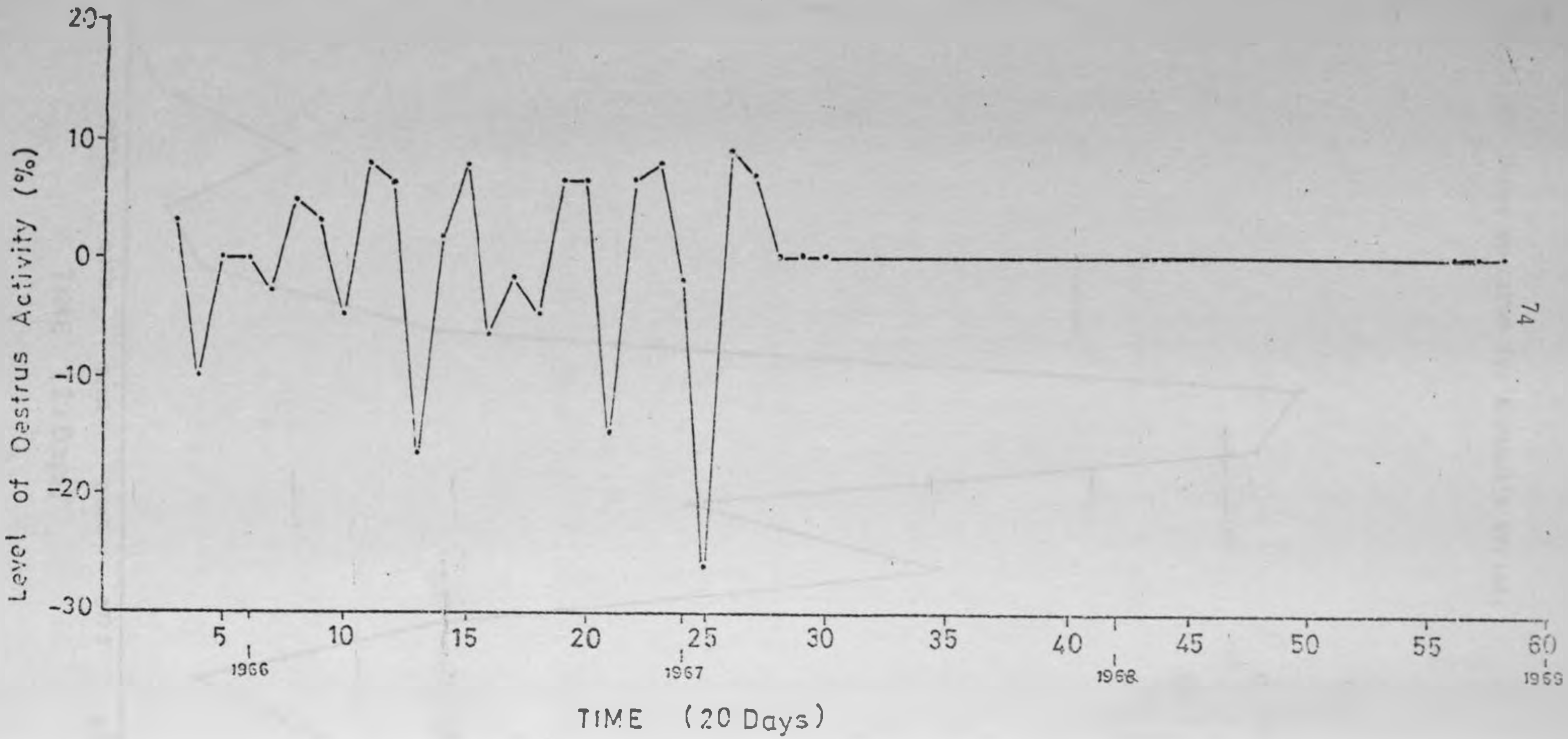
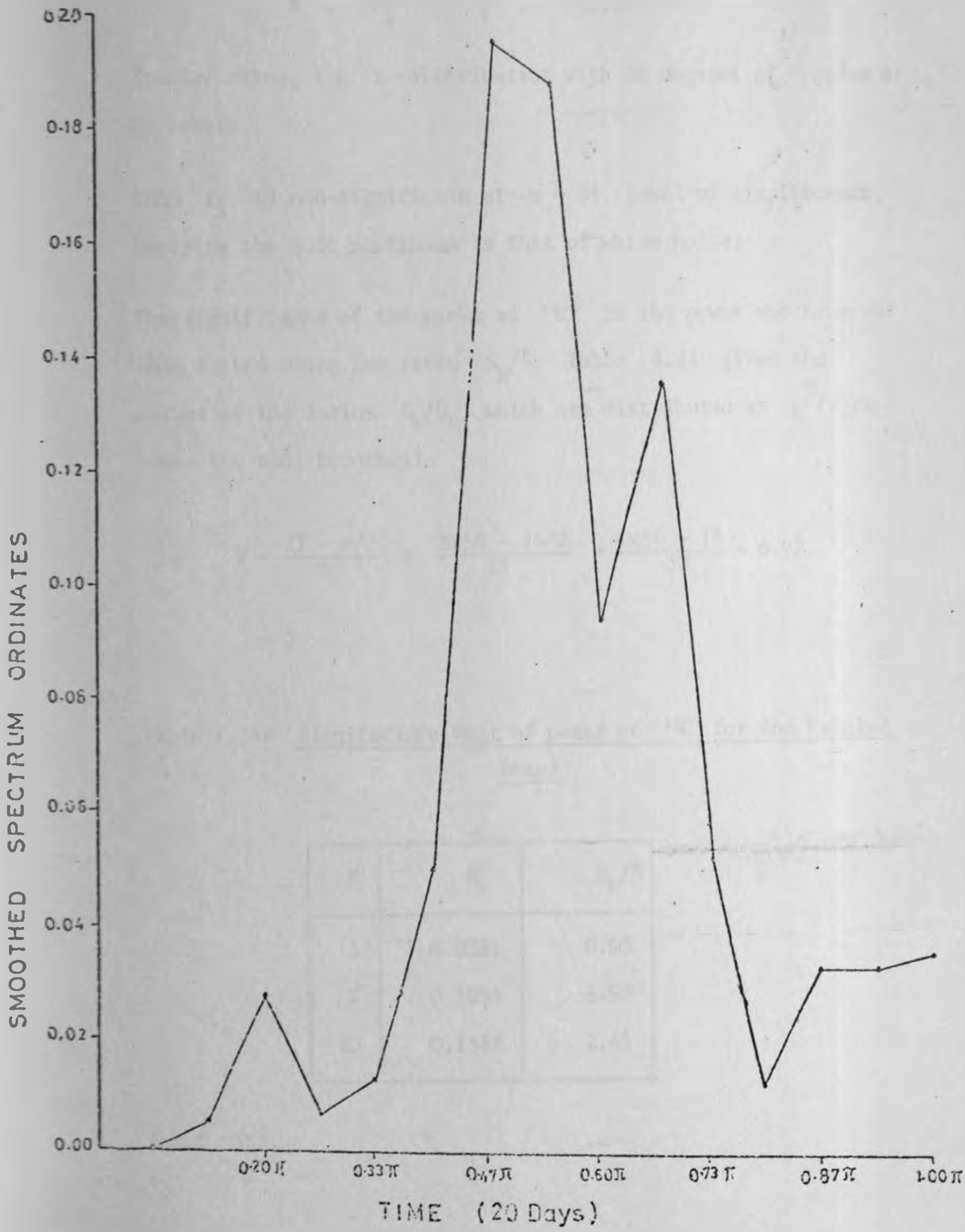


Fig. 4.20: Power spectrum for Karakul's series.



The significance of white noise was tested using

$$t = \sqrt{\frac{r_1^2 \times T}{1 - r_1^2}} = \sqrt{\frac{(0.1998)^2 \times 56}{1 - (0.1998)^2}} = 1.526 < 2.001$$

(tables value, i.e. t -distribution with 58 degrees of freedom at 5% level).

Thus r_1 is non-significant at $\alpha = 5\%$ level of significance, implying the null continuum is that of white noise.

The significance of the peaks at "K" in the power spectrum was then tested using the ratio $S_k/\bar{S}$. Table 4.24 gives the values of the ratios $S_k/\bar{S}_k$ which are distributed as $\chi^2(v)/v$ under the null hypothesis

$$V = \frac{2T - m/2}{m} = \frac{2x56 - 15/2}{15} = \frac{4x56 - 15}{30} = 6.97.$$

$$\simeq 7$$

Table 4.24: Significance test of peaks at "K" for the Karakul breed

K	S_k	$S_k/\bar{S}$
3	0.0281	0.50
7	0.1956	3.50
10	0.1358	2.43

$\bar{S} = 0.0559.$

From $\chi^2(7)/7 = 2.01$ at $\alpha = 5\%$ level of significance. The last two of the three peaks are significant at the 5% level of significance since $S_7/\bar{S} > 2.01$ and $S_{10}/\bar{S} > 2.01$.

Conclusion:

The significance of these peaks implies the presence of periodicities. This means there is seasonal variation in the oestrus activity of Karakul breed. It can be concluded that oestrus activity of the Karakul breed has cycles of period 4 and 3 twenty day periods.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Using the analysis of variance method to test whether there existed variation in the interservice interval it was found that:-

(i) there existed variation between breeds within phases at the one percent level of significance.

(ii) there was no significant difference between phases at the five percent level of significance.

(iii) there was no significant difference between breeds within years at the five percent level of significance.

(iv) there was no significant difference between years at the five percent level of significance.

The contrast in the results from the two analyses for the differences in the interservice interval between breeds within phases and breeds within years can be explained by considering the length of the phases and years.

The length of the phases is longer than one year and thus the factors affecting the oestrus activity of the sheep will vary to a greater extent for the phases than for the years. For example dry conditions could have prevailed and therefore, the availability of green pasture could have been a problem. Hafez [12] found that a sub-maintenance diet tends to inhibit the manifestation of oestrus. The conflicting results in the variation of breeds within phases and breeds within years could be due to the blocking system (block size). In large blocks the variation will be high while in smaller blocks it tends to be lower.

From the results of section 3.2. (interval estimation) it can be concluded that the oestrus periods for the five breeds of sheep occur regularly every 15 to 20 days. In temperate regions oestrus periods occur regularly every 16 to 20 days during the breeding season. Thus it could be said that there is no apparent difference in the length of the oestrus period in the tropical and temperate breeds of sheep.

The problem of time series is evaluating the non-randomness present in the series in a manner that does not make any presuppositions as to the nature of non-randomness.

In the past a great deal of attention has been given to the stationary time series models which have the property of remaining in equilibrium about a constant mean. However, forecasting has been of particular importance in business and economics where many series are non-stationary and have no natural mean (Box and Jenkins [51]). It is not suprising, therefore, that the economics forecasting methods which have been proposed by such workers as Winter [42] and Brown [6], all using the exponentially weighted moving averages, are appropriate for a particular type of non-stationary process.

Time series are not composed of a finite number of harmonic oscillations of the type $\cos t\lambda$ or $\sin t\lambda$ with wave-length equal to $2\pi/\lambda$ but consist virtually of infinite number of small oscillations spanning a continous distribution of wavelength (Wiener [41]). Generally a study of any time series is:

(i) to estimate the various components of time series.

(ii) to use the estimate in (i) to estimate the future of the time series.

This falls under the theory of time modelling.

The estimated autocorrelation coefficients r_k, lie in the interval - 1 and 1. Box and Jenkins [5] wrote that "in practice, to obtain a useful estimate of the autocorrelation function, one needs at least 50 observations and the autocorrelations and the estimated autocorrelations r_k would be calculated for $k=0,1,2,..,k$ where k is not large than $T/4$

and T is the total number of observations in the time series." However, Granger and Hatanaka [11] suggested that the amount of data necessary before it becomes sensible to attempt to estimate the spectrum would seem to be about 100 observations, although spectra have occasionally been estimated for fewer observations. In this study the number of observations for the Nandi, Somali, Romney Marsh and Merino breeds lie between 60 and 80 observations and thus it was felt that the power spectrum results were going to be sensible.. For the Karakul breed the number of observations were less than 50 and thus the result on the Karakul breed was not very conclusive.

Using time series analysis in Chapter IV to find whether there exists seasonality in the oestrus activity of the five breeds, it was found that all the autocorrelation coefficients (r_1) at lag one were negative when the series were subjected to the power spectrum analysis after the removal of trend by one of the two filter methods.

Trend free series for the five breeds of sheep was subjected to time series analysis and it was found that autocorrelation coefficient (r_1) at lag one for all the breeds was non-significant at the five percent level of significance. The peak significance was tested for all the five breeds to find out whether there were harmonic oscillations in the series of each breed. Since it was found that the autocorrelation coefficient at lag one for the trend free value for the five breeds were non-significant, to test for peak significance at "k" the ratio $S_k/\bar{S}$ was used, where S_k is the smoothed spectral ordinate and $\bar{S}$ is the average of the raw spectral estimates. $S_k/\bar{S}$ is distributed as $\chi^2(v)/v$ under the null continuum. It was found that for the Somali, Nandi, Merino and Romney Marsh breeds, all the spectrum peaks were non-significant at the five percent level. The non-significance of the spectrum peaks implies that the series were non-seasonal. Thus the oestrus activity of Somali, Nandi, Merino and Romney Marsh breeds is non-seasonal; This confirms the results of other researchers such as Sahni and Roy [28] , Rao [25] , Sahni and Roy [29] and Sarvaswat et al.[31] whose observations led to the conclusion that the Indian breeds (tropical breeds) are non-seasonal in their sexual activity.

For the Karakul breed, two spectrum peaks were found to be significant at the five percent level of significance. Thus Karakul sexual activity has harmonic oscillations of period equal to three-and four-twenty days. Although there were harmonic oscillations in the sexual activity of the Karakul, it cannot be concluded that the oestrus activity of this breed is seasonal. This is so because the series was rather too short for the result of power spectrum to be sensible. To achieve meaningful results using time series analysis, the number of observations must be large. It could be concluded that the series of Karakul breed was non-seasonal as those of the other four breeds of sheep.

The conclusion drawn on the seasonality of the Merino breed confirms the suspicion that the conflicting results on Merino in Australia was due to locality of experimental stations. The problem encountered in the analysis (time series analysis) of the data was that the series of Karakul was too short for the results to be meaningful. One has to be careful when using the filter methods (used to filter out the trend component) to make sure that the method used filter out the trend component completely.

Flexible though the power spectrum may be in distinguishing so clearly between different forms of non-randomness, certain limitations of the spectrum appraoch should be noted. First, if the exact periodicities are present in a time series, the spectrum does not necessarily represent them as clearly as classical harmonic analysis can. Second, the spectrum throws away all information about phase of the fluctuations, periodic or otherwise, contained in the original series, so that other techniques of analysis have to be used if one wishes to recover phase information.

Third, if the series is dominated by a very strong periodic variation the spectrum can be significatly influenced at other wavelengths by "leakage" through the lobes of the "spectrum window". This problem can be circumvented, however, by "pre-whitening" the original data series before the spectrum is made. As an example of "pre-whitening", consider a series of monthly mean temperature several years in length, which contains a strong annual march. This annual march can be removed completely by transforming the original temperature series T_i into a new series T_i' by means of the equation

$$T_i' = T_i - \bar{T} .$$

Here $\bar{T}$ is the record- mean temperature for all values of the series pertaining to the same calendar month as this particular T_i. In this example, information about the annual march would be omitted altogether from the spectrum of the T_i' series, but this information can be easily be recovered by other means, as by classical harmonic analysis of the $\bar{T}$ values.

APPENDIX A

Table 3.1: The frequency distribution table for all breeds during each phase

INTERSERVICE INTERVALS (DAYS)	SOMALI PHASE 1	SOMALI PHASE 2	SOMALI PHASE 3	NANDI PHASE 1	NANDI PHASE 2	NANDI PHASE 3	MERINO PHASE 1	MERINO PHASE 2	MERINO PHASE 3	KARAKUL PHASE 1	ROMNEY MARSH PHASE 1	ROMNEY MARSH PHASE 2	ROMNEY MARSH PHASE 3
2	-	-	-	-	-	-	3	-	-	1	-	-	-
3	-	-	-	-	-	-	-	-	-	1	1	-	-
4	-	-	-	-	-	-	1	-	1	-	1	1	1
5	-	-	1	-	-	1	-	-	-	-	1	1	-
6	2	-	-	1	-	-	-	2	-	2	-	4	-
7	1	1	-	1	-	-	3	1	-	-	-	3	-
8	3	-	-	-	-	-	1	-	1	1	-	1	1
9	4	-	-	-	-	-	2	1	-	1	1	-	-
10	2	2	-	1	-	-	2	1	1	2	-	1	1
11	4	-	-	-	-	-	1	1	-	1	-	5	-
12	4	1	2	1	3	-	2	2	2	1	2	4	1
13	2	-	-	-	-	-	2	1	-	4	-	3	-
14	3	2	1	1	-	2	4	3	2	5	2	3	1
15	10	5	-	3	2	2	5	5	-	3	2	7	2
16	48	30	12	22	14	1	10	13	8	19	14	35	16
17	108	61	21	46	25	5	43	50	30	86	16	50	39
18	49	62	15	44	23	9	74	51	38	83	15	34	9
19	17	21	10	19	10	6	58	23	23	49	4	8	3
20	2	4	9	7	7	2	31	11	9	16	2	6	2
21	3	1	2	1	1	1	17	5	6	5	1	2	-
22	2	1	1	-	-	1	3	4	1	3	-	1	1
23	4	1	-	-	-	-	1	4	1	3	-	3	-
24	2	-	-	1	1	-	1	1	1	1	-	2	-

Table 3.1 continued

Interservice Interval	Somali			Nandi	
25	1	1	1	-	1
26	-	-	-	1	-
27	1	-	-	-	-
28	-	-	-	1	-
29	-	-	-	-	-
30	-	-	-	-	-
31	2	4	-	1	-
32	1	1	1	1	3
34	7	4	-	3	3
35	12	9	-	4	4
36	6	5	-	2	5
37	5	2	-	7	3
38	2	1	1	3	1
39	1	-	-	-	3
40	-	1	-	-	1
41	1	-	-	-	-
42	-	-	-	-	-
43	-	-	-	-	-
44	-	-	-	-	-
45	-	-	-	-	-
46-60	8	13	2	15	9
61-80	1	5	-	8	6
Over	6	5	-	8	11
TOTAL	331	247	78	208	138

	Merino			Karakul	Romney March		
–	–	1	1	1	1	1	–
3	3	–	–	1	1	1	–
–	2	1	–	–	–	1	–
–	–	2	–	–	1	–	–
–	2	–	–	–	–	–	–
–	1	1	–	–	1	2	–
–	1	–	–	–	–	1	–
–	–	–	1	–	2	3	–
–	1	1	2	3	1	1	3
1	–	5	1	3	2	5	1
–	2	2	2	3	2	2	1
2	–	1	1	5	1	1	–
1	4	4	2	3	–	–	1
1	1	3	1	–	1	1	–
–	3	3	1	–	2	1	–
–	2	–	–	1	–	–	–
–	2	–	–	1	1	–	–
–	–	1	–	–	1	1	–
–	–	1	–	1	–	–	–
–	–	–	–	–	–	1	–
1	12	15	–	7	5	12	2
–	3	5	–	2	4	7	–
–	–	18	1	1	12	13	–
37	304	246	137	319	103	233	86

Table 3.5: The frequency distribution table for all breeds in 1966, 1967, 1968 and 1969

INTERSERVICE	SOMALI				NANDI				MERINO				KARAKUL		RAMNEY MARSH			
INTERVAL (DAYS)	1966	'67	'68	'69	1966	'67	'68	'69	1966	'67	'68	'69	1966	'67	1966	'67	'68	'69
2	-	-	-	-	-	-	-	-	1	2	-	-	1	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
4	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1	1	1
5	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	1	-
6	1	1	-	-	1	-	-	-	-	-	1	1	1	1	-	1	4	-
7	-	1	1	-	-	1	-	2	-	-	-	-	-	-	-	-	2	1
8	1	2	-	-	-	-	-	-	-	1	-	1	-	1	-	-	-	2
9	6	1	-	-	-	-	-	-	2	-	-	1	-	1	-	1	-	-
10	3	1	2	-	-	-	1	-	-	2	1	1	1	1	-	-	1	1
11	1	3	1	-	-	-	-	-	1	-	1	-	-	1	-	-	4	1
12	2	2	1	-	-	1	1	2	2	-	1	3	1	-	1	1	4	-
13	2	2	-	2	-	-	-	-	-	2	1	-	3	1	-	-	3	-
14	1	1	1	1	1	-	-	2	3	11	2	2	3	2	-	2	3	1
15	3	6	3	2	1	2	1	3	2	2	6	-	1	2	-	2	5	4
16	14	33	26	16	12	10	12	3	7	4	13	8	10 10	9 9	2	12	31	20
17	31	69	52	33	23	33	25	6	12	31	44	36	33	55	2	14	48	43
18	14	37	47	32	19	25	18	14	23	49	47	45	20	64	5	10	32	11
19	1	14	17	14	8	11	8	8	13	42	24	24	15	32	-	4	6	5
20	1	1	1	12	2	5	7	2	12	19	7	13	4	10	-	2	8	2
21	1	1	1	3	-	1	1	1		10	3	8	2	2	1	1	2	-
22	-	2	1	1	-	-	-	1	1	2	4	1	3	-	-	-	1	1

APPENDIX A

Table 3.5.continued

INTERVAL	SOMALI				NANDI				MERINO				KARAKUL		ROMNEY MARSH			
22	-	2	1	1	-	-	-	1	1	2	4	1	3	-	-	-	11	1
23	1	1	2	1	-	-	-	-	-	-	5	1	-	3	-	-	3	-
24	-	2	-	-	1	-	1	-	1.	-	1	1	-	1	-	-	1	-
25	-	1	1	1	-	1	-	1	-	-	-	2	1	-	-	1	1	-
26	-	-	-	-	1	-	-	-	1	2	-	-	-	1	1	-	1	-
27	1	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	1	-
28	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	1	-	-
29	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	2	-
31	1	1	4	-	-	-	1	-	-	1	-	-	-	-	-	-	-	1
32	-	1	1	1	-	1	-	-	-	-	-	1	-	-	-	2	1	3
33	-	6	5	-	1	-	3	-	-	1	3	-	-	-	-	2	4	2
34	1	4	2	2	-	1	2	1	-	1	-	3	1	2	-	1	1	2
35	1	10	10	-	-	2	3	1	-	-	4	2	-	3	-	1	6	1
36	-	4	7	-	1	3	4	1	-	2	1	3	2	-	1	1	2	1
37	1	4	2	-	-	2	1	5	-	-	1	1	1	4	1	-	1	-
38	2	1	1	1	4	3	3	2	1	3	3	3	1	2	-	-	-	1
39	-	1	-	-	1	2	1	1	-	1	3	1	-	-	-	1	1	-
40	-	-	1	-	-	-	2	2	-	3	3	1	-	-	-	1	2	-
41	-	-	-	-	-	-	1	-	1	1	-	-	1	-	-	-	-	-
42	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	-
43	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	-
44	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
46-60	2	5	13	3	5	9	1o	1	4	6	15	2	-	8	3	2	10	4
61-80	1	-	3	2	1	7	5	1	-	3	4	1	-	2	2	2	7	-
Over 80	4	2	5	-	-	7	10	2	-	-	16	3	1	-	4	9	12	2

APPENDIX B

Table 4.1: Level of oestrus activity for each breed during 1966 within consecutive 20 days periods.

PERIOD	BREEDS				
	SOMALI %	NANDI %	MERINO%	KARAKUL%	ROMNEY MARSH %
23/6/66-9/7/66	12.50	8.33	25.00	25.00	0.00
10/7-29/7	43.75	41.67	41.67	58.33	0.00
30/7-18/8	43.75	66.67	50.00	75.00	0.00
19/8-7/9	31.25	66.67	75.00	58.33	8.33
8/9-10/9	6.25	8.33	16.67	16.67	0.00
11/9-30/9	56.25	91.67	75.00	100.00	0.00
1/10-20/10	50.00	83.33	75.00	91.67	25.00
21/10-9/11	75.00	75.00	91.67	91.67	41.67
10/11-29/11	75.00	66.67	100.00	75.00	16.67
30/11-19/12	93.75	58.33	100.00	83.33	33.33
20/12-8/1/6	62.25	58.33	83.33	83.33	50.00

APPENDIX B

Table 4.2: Level of oestrus activity for all breeds during 1967 within consecutive 20 days periods

TIME	BREEDS				
	SOMALI%	NANDI%	MERINO%	KARAKUL%	ROMENY MARSH%
9/1/67-28/1/67	68.75	50.00	83.33	83.33	16.67
29/1/67-17/2	75.00	33.33	83.33	91.67	50.00
18/2-9/3	81.25	58.33	91.67	91.67	50.00
10/3-29/3	75.00	50.00	66.67	83.33	25.00
30/3-29/3	87.00	66.67	100.00	91.67	83.33
19/4-8/5	86.67	75.00	75.II	83.33	16.67
9/5-28/5	86.67	41.67	91.00	66.67	25.00
29/5-17/6	80.00	33.33	100.00	83.33	50.00
18/6-7/7	93.33	66.67	91.67	91.67	58.33
8/7-27/7	93.33	41.67	88.33	83.33	41.67
28/7-16/8	66.67	41.67	91.67	91.67	58.33
17/8-5/9	100.00	58.33	100.00	100.00	50.00
6/9/25/9	89.67	75.00	75.00	100.00	33.33
26/9-15/10	33.33	66.67	75.00	100.00	25.00
16/10-4/11	80.00	41.67	75.00	75.00	0.00
5/11-24/11	73.33	58.33	100.00	91.67	8.33
25/11-14/12	74.33	58.33	75.00	83.33	25.00
15/12-3/1/68	40.00	41.67	66.67	75.00	8.33

APPENDIX B

Table 4.3: Level of oestrus activity for all breeds during 1968 within consecutive 20 days periods

TIME	BREEDS				
	SOMALI %	NANDI%	MERINO%	KARAKUL%	ROMNEY MARSH%
4/1/68-23/1/68	66.67	41.67	66.67	50.00	25.00
24/1-12/2	92.86	75.00	12.00	-	12.00
13/2-3/3	71.43	75.00	72.00	-	84.00
4/3-23/3	57.14	66.67	56.00	-	84.00
24/3-12/4	57.14	58.33	40.00	-	76.00
13/4-2/5	64.29	58.33	36.00	-	48.00
3/5-22/5	42.86	58.33	40.00	-	36.00
23/5-11/6	50.00	50.00	28.00	-	48.00
12/6-1/7	71.43	41.67	20.00	-	32.00
2/7-21/7	78.57	58.33	44.00	-	52.00
22/7-10/8	85.71	33.33	52.00	-	36.00
11/8-30/8	85.71	50.00	64.00	-	24.00
31/8-19/9	91.43	58.33	60.00	-	28.00
20/9-9/10	92.86	33.33	36.00	-	28.00
10/10-29/10	85.71	33.33	52.00	-	32.00
30/10-18/10	92.86	75.00	56.00	-	32.00
19/11-8/12	85.71	41.67	60.00	-	28.00
9/12-28/12	92.86	25.00	56.00	-	40.00

APPENDIX B

Table 4.4.: Level of oestrus activity for all breeds during 1969 within consecutive 20 days periods

TIME	BREEDS				
	SOMALI %	NANDI %	MERINO %	KARAKUL %	ROMNEY MARSH %
29/12-/68-17/-/69	78.57	50.00	24.00	-	36.00
18/1-6/2	85.71	16.67	44.00	-	40.00
7/2-26/2	78.57	58.33	32.00	-	16.00
27/2-18/3	71.43	25.00	24.00	-	0.00
20/7-8/8	7.14	16.67	12.00	-	4.00
9/8-28/8	92.86	58.33	52.00	-	24.00
29/8-17/9	71.43	33.33	96.00	-	60.00
18/9-7/10	78.57	41.67	84.00	-	76.00
8/10-27/10	85.71	33.33	80.00	-	68.00
28/10-16/11	85.71	33.33	72.00	-	68.00
17/11-6/12	50.00	33.33	72.00	-	16.00
7/12-26/12	35.71	25.00	36.00	-	4.00

APPENDIX C

Table 4.5.: Serial correlation for Somali's oestrus activity

k	r_k	k	r_k
0	1.0000	31	0.4738
1	0.9510	32	0.4598
2	0.9393	32	0.4532
3	0.9238	34	0.4217
4	0.9056	35	0.4072
5	0.8757	36	0.3960
6	0.8641	37	0.3764
7	0.8557	38	0.3570
8	0.8433	39	0.3462
9	0.8181	40	0.3235
10	0.8042	41	0.3072
11	0.7227	42	0.2860
12	0.7649	43	0.2674
13	0.7437	44	0.2461
14	0.7337	45	0.2280
15	0.7051	46	0.2099
16	0.6889	47	0.1925
17	0.6712	48	0.1670
18	0.6515	49	0.1545
19	0.6282	50	0.1348
20	0.6182	51	0.1234
21	0.6054	52	0.1050
22	0.5914	53	0.1019
23	0.5693	54	0.0813
24	0.5580	55	0.0652
25	0.5411	56	0.0456
26	0.5182	57	0.0293
27	0.5005	58	0.0135
28	0.4975	59	0.0059
29	0.4953		
30	0.4702		

APPENDIX C

Table 4.6 : Serial Correlation for Nandi's oestrus activity

k	r_k	K	r_k
0	1.0000	31	0.4233
1	0.9103	32	0.4032
2	0.8869	33	0.3872
3	0.8733	34	0.3644
4	0.8469	35	0.3515
5	0.8237	36	0.3464
6	0.8094	37	0.3206
7	0.8085	38	0.3100
8	0.8074	39	0.3088
9	0.7939	40	0.2720
10	0.7622	41	0.2525
11	0.7503	42	0.2472
12	0.7102	43	0.2303
13	0.7002	44	0.2320
14	0.7130	45	0.2173
15	0.6836	46	0.2086
16	0.6727	47	0.1978
17	0.6808	48	0.1821
18	0.6619	49	0.1611
19	0.6337	50	0.1421
20	0.6148	51	0.1239
21	0.6085	52	0.1052
22	0.5934	53	0.1084
23	0.5687	54	0.0853
24	0.5594	55	0.0744
25	0.5674	56	0.0582
26	0.5288	57	0.0449
27	0.5008	58	0.0299
28	0.4970	59	0.0133
29	0.4667		
30	0.4472		

APPENDIX C

Table 4.7: Serial correlation for Merino's oestrus activity

k	r_k	k	r_k
0	1.0000	31	0.4105
1	0.9434	32	0.4152
2	0.9116	33	0.4214
3	0.8856	34	0.4155
4	0.8509	35	0.4061
5	0.8239	36	0.3956
6	0.7974	37	0.3835
7	0.7920	38	0.3702
8	0.7695	39	0.3509
9	0.7393	40	0.3380
10	0.7215	41	0.3278
11	0.6893	42	0.3087
12	0.6683	43	0.3039
13	6511	44	0.2905
14	0.6298	45	0.2771
15	0.6043	46	0.2679
16	0.5878	47	0.2455
17	0.5878	48	0.2240
18	0.5505	49	0.2032
19	0.5471	50	0.1877
20	0.5240	51	0.1745
21	0.4933	52	0.1554
22	0.4705	53	0.1485
23	0.4559	54	0.1320
24	0.4390	55	0.1025
25	0.4224	56	0.0746
26	0.4222	57	0.0487
27	0.4235	58	0.0280
28	0.4152	59	0.0093
29	0.4078		
30	0.4129		

APPENDIX C

Table 4.8: Serial correlation for Karakul's oestrus activity

k	r_k	k	r_k
0	1.0000	31	0.4799
1	0.9754	32	0.4634
2	0.9561	33	0.4468
3	0.9378	34	0.4303
4	0.9235	35	0.4137
5	0.9051	36	0.4041
6	0.8894	37	0.3896
7	0.8740	38	0.3735
8	0.8582	39	0.3558
9	0.8407	40	0.3413
10	0.8236	41	0.3220
11	0.8068	42	0.3026
12	0.7910	43	0.2833
13	0.7768	44	0.2656
14	0.7606	45	0.2495
15	0.7432	46	0.2318
16	0.7270	47	0.2157
17	0.7103	48	0.2028
18	0.6909	49	0.1867
19	0.6717	50	0.1690
20	0.6518	51	0.1529
21	0.6380	52	0.1352
22	0.6188	53	0.1175
23	0.6025	54	0.1014
24	0.5877	55	0.0853
25	0.5792	56	0.0692
26	0.5627	57	0.0547
27	0.5461	58	0.0370
28	0.5296	59	0.0193
29	0.5130		
30	0.4965		

APPENDIX C

Table 4.9: Serial correlation of Romney Marsh's oestrus activity

k	r_k	k	r_k
0	1.0000	31	0.3323
1	0.8695	32	0.2807
2	0.7816	33	0.2680
3	0.7048	34	0.2535
4	0.6394	35	0.2408
5	0.6281	36	0.2370
6	0.6083	37	0.2414
7	0.5932	38	0.2631
8	0.5949	39	0.2741
9	0.6179	40	0.2707
10	0.6117	41	0.2724
11	0.6200	42	0.2391
12	0.6105	43	0.2056
13	0.6102	44	0.1800
14	0.6138	45	0.1611
15	0.5748	46	0.1614
16	0.5297	47	0.1624
17	0.5025	48	0.1515
18	0.4860	49	0.1521
19	0.4965	50	0.1303
20	0.4952	51	0.1046
21	0.4921	52	0.1080
22	0.5005	53	0.0919
23	0.4996	54	0.0672
24	0.5096	55	0.0508
25	0.4917	56	0.0250
26	0.4659	57	0.0058
27	0.4522	58	0.0010
28	0.4546	59	0.0000
29	0.4277		
30	0.3768		

APPENDIX D

Table 4.10: Trend free oestrus figures of Merino after using first difference in (%)

ORDER OF OBSERVATION	ΔY_t(%)	ORDER OF OBSERVATION	ΔY(%)
1	—		
2	0.00	31	4.00
3	16.67	32	-12.00
4	8.33	33	-8.00
5	0.00	34	24.00
6	-16.67	35	8.00
7	0.00	36	12.00
8	0.00	37	4.00
9	8.34	38	24.00
10	-25.00	39	16.00
11	33.33	40	4.00
12	-25.00	41	4.00
13	16.00	42	-4.00
14	9.00	43	-32.00
15	-8.33	44	20.00
16	- 8.34	45	-12.00
17	8.34	46	-8.00
18	8.33	47	41.33
19	-25.00	48	0.00
20	0.00	49	0.00
21	0.00	50	0.00
22	25.00	51	0.00
23	-25.00	52	0.00
24	- 8.33	53	53.33
25	0.00	54	40.00
26	-54.66	55	44.00
27	60.00	56	12.00
28	16.00	57	-4.00
29	-16.00	58	-8.00
30	- 4.00	59	0.00
		60	-36.00

APPENDIX E

Table 4.11: Spectral analysis for trend free values for Merino breed after elimination of trend by finite difference method

K	AUTOCORRELATION r_k	SMOOTHED SPECTRUM s_k	PERIOD
0	1.0000	0.0424	-
1	-0.1670	0.0569	30.00
2	0.0712	0.0660	15.00
3	0.0119	0.0656	10.00
4	-0.0617	0.0801	7.50
5	-0.0080	0.0488	6.00
6	0.0199	0.0698	5.00
7	-0.0614	0.0660	4.29
8	0.0573	0.0627	3.75
9	0.0889	0.o700	3.33
10	-0.1063	0.0986	3.00
11	0.0004	0.1135	2.73
12	-0.1296	0.0847	2.50
13	0.0499	0.1112	2.31
14	0.2562	0.0908	2.14
15	-0.1858	0.0740	2.00

APPENDIX D

Table 4.13: Trend free oestrus figures of Romney Marsh after using first difference in (%)

ORDER OF OBSERVATION	ΔY_t (%)	ORDER OF OBSERVATION	ΔY_t (%)
1	—		
2	25.00	31	-12.00
3	16.67	32	12.00
4	-25.00	33	-16.00
5.	16.67	34	20.00
6	16.67	35	-49.00
7	-33.33	36	21.00
8	33.33	37	4.00
9	0.00	38	0.00
10	-25.00	39	4.00
11	8.33	40	0.00
12	-16.67	41	-4.00
13	8.33	42	12.00
14	25.00	43	-4.00
15	8.33	44	4.00
16	-16.66	45	24.00
17	16.66	46	-16.00
18	-8.33	47	34.70
19	-16.67	48	0.00
20	-8.33	49	0.00
21	-25.00	50	0.00
22	8.33	51	0.00
23	16.67	52	0.00
24	-6.67	53	-30.70
25	16.67	54	20.00
26	-5.00	55	36.00
27	64.00	56	16.00
28	0.00	57	-8. 00
29	-8.00	58	0.00
30	-28.00	59	-52.00
		60	-12.00

APPENDIX E

Table 4.14: Spectral analysis for trend free values for Romney Marsh breed after using first finite difference method.

K	AUTOCORRELATION r_k	SMOOTHED SPECTRUM s_k	PERIOD
0	1.0000	0.0104	30.00
1	-0.1931	0.0243	30.00
2	0.0047	0.0597	15.00
3	-0.0256	0.0753	10.00
4	-0.2356	0.0667	7.50
5	0.0357	0.0698	6.00
6	-0.0078	0.0784	5.00
7	-0.0697	0.0500	4.00
8	-0.1604	0.0350	3.75
9	0.2215	0.0664	3.33
10	-0.0994	0.1104	3.00
11	0.1648	0.1107	2.73
12	-0.1047	0.0895	2.50
13	0.0081	0.1263	2.31
14	0.0620	0.0997	2.14
15	-0.0745	0.0506	2.00

APPENDIX D

Table 4.16: Trend free valuesfor Somali breed after using 12-point moving average method (%)

ORDER OF OBSERVATION	X_t	ORDER OF OBSERVATION	X_t
1	-	30	-2.38
2	-	31	-26.48
3	-	32	-18.97
4	-	33	1.86
5	-	34	6.91
6	-	35	11.24
7	-6.39	36	8.88
8	-2.65	37	-7.94
9	1.58	38	10.49
10	-6.20	39	1.55
11	6.67	40	8.70
12	5.39	41	2.37
13	3.07	42	9.96
14	-2.61	43	-3.33
15	12.51	44	4.55
16	12.63	45	-1.26
17	-13.37	46	-7.07
18	22.50	47	-1.09
19	11.94	48	2.18
20	-41.10	49	2.48
21	5.94	50	3.07
22	1.71	51	3.07
23	3.61	52	2.18
24	-27.83	53	-63.62
25	7.65	54	24.64
26	29.52	55	-
27	7.65	56	-
28	-6.40	57	-
29	-7.12	58	-
		59	-
		60	-

APPENDIX E

Table 4.17: Spectral analysis for trend free value for Somali breed after using 12-point moving average method

K	AUTOCORRELATION r_k	SMOOTHED s_k	PERIOD
0	1.000	0.0165	-
1	-0.1573	0.0319	30.00
2	-0.1684	0.0477	15.00
3	0.0427	0.0689	10.00
4	0.0502	0.0635	7.50
5	-0.1677	0.0407	6.00
6	-0.2019	0.0465	4.29
7	0.1569	0.0935	4.29
8	0.0738	0.1413	3.75
9	-0.0997	0.1103	3.33
10	0.0520	0.0708	3.00
11	-0.0532	0.0658	2.73
12	0.0538	0.0923	2.50
13	-0.1347	0.0786	2.14
14	0.0289	0.0472	2.14
15	-0.0599	0.0442	2.00

APPENDIX D

Table 4.19: Trend free value for Nandi breed after elimination of trend by 12-point moving average method (%)

ORDER OF OBSERVATION	X_t	ORDER OF OBSERVATION	X_t	ORDER OF OBSERVATION	X_t
1	-	21	-14.25	41	-0.74
2	-	22	1.04	42	-18.17
3	-	23	-0.70	43	7.10
4	-	24	-18.05	44	-26.66
5	-	25	-17.36	45	13.53
6	-	26	-17.36	46	-19.54
7	-11.81	27	18.06	47	8.45
8	-24.31	28	9.73	48	8.10
9	3.12	29	2.43	49	7.40
10	-3.82	30	3.12	50	7.06
11	14.59	31	2.08	51	7.06
12	23.61	32	-5.21	52	7.76
13	-10.76	33	-10.07	53	-26.12
14	-21.53	34	7.99	54	17.36
15	11.12	35	-16.67	55	-
16	-13.04	36	2.09	56	-
17	-13.04	37	11.46	57	-
18	4.86	38	-11.12	58	-
19	22.92	39	-10.42	59	-
20	12.85	40	31.95	60	-

APPENDIX E

Table 4.20: Spectral analysis for trend free values for Nandi breed after using 12-point moving average method

K	AUTOCORRELATION r_k	SMOOTHED SPECTRUM s_k	PERIOD
0	1.000	0.0068	-
1	-0.1139	0.0084	30.00
2	-0.1696	0.0351	15.00
3	0.0177	0.1114	10.00
4	-0.1344	0.1071	7.50
5	-0.2818	0.0293	6.00
6	-0.1469	0.0405	5.00
7	0.1412	0.0643	4.29
8	0.1412	0.1309	3.75
9	0.2070	0.0977	3.33
10	-0.1355	0.0929	3.00
11	0.2274	0.0846	2.73
12	-0.2473	0.0460	2.50
13	-0.2704	0.1020	2.31
14	0.2204	0.0614	2.14
15	-0.0302	0.0297	2.00

APPENDIX D

Table 4.22: Trend free values for Karakul breed after using 5-point moving average method (%)

ORDER OF OBSERVATION	ΔY_t	ORDER OF OBSERVATION	ΔY_t
1	-	31	0.00
2	-	32	0.00
3	3.34	33	0.00
4	-10.00	34	0.00
5	0.00	35	0.00
6	0.00	36	0.00
7	-3.34	37	0.00
8	5.00	38	0.00
9	3.34	38	0.00
10	-5.00	39	0.00
11	8.34	40	0.00
12	1.66	41	0.00
13	-16.66	43	0.00
14	1.66	44	0.00
15	8.34	45	0.00
16	-6.67	46	0.00
17	-1.66	47	0.00
18	5.00	48	0.00
19	6.67	49	0.00
20	6.67	50	0.00
21	-15.00	51	0.00
22	6.67	52	0.00
23	8.33	53	0.00
24	-2.13	54	0.00
25	-25.93	55	0.00
26	9.27	56	0.00
27	7.13	57	0.00
28	0.00	58	0.00
29	0.00	59	-
30	0.00	60	-

APPENDIX E

Table 4.23: Spectral analysis for trend free value for the Karakul breed after using 5-point moving average method

K	AUTOCORRELATION r_k	SMOOTHED SPECTRUM S_k	PERIOD
0	1.0000	-0.0035	-
1	-0.1998	-0.0031	30.00
2	-0.5096	-0.0054	15.00
3	0.1371	0.0281	10.00
4	0.3203	0.0071	7.50
5	-0.2085	0.0129	6.00
6	-0.1935	0.0502	5.00
7	-0.1061	0.1956	4.29
8	0.2845	0.1886	3.75
9	0.1724	0.0938	3.33
10	-0.3805	0.1358	3.00
11	0.0833	0.0516	2.73
12	0.3949	0.0133	2.5
13	-0.2212	0.0328	2.31
14	-0.1757	0.0332	2.143
15	0.1292	0.0339	2.00

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