from these treatments are presented in Table 3. Productivity for gilts subjected to both chambers during mid pregnancy were comparable to those maintained outside full term indicating that gilts were relatively resistant to heat stress in mid pregnancy.

Pronounced adverse effects of high ambient temperatures were noted during late pregnancy. Gilts subjected to the hot chamber at this time farrowed fewer live pigs and more stillborn pigs and there was a tendancy for the pigs to be lighter at birth but the differences in birth weight were not significant. Large differences in litter birth weights and litter 21-day weights were obtained. Using the average ovulation of 14.8 based on all gilts slaughtered in this study as a measure of the potential litter size, the control gilts farrowed 70.9 percent live pigs of potential compared to 69.5 percent for those subjected to heat stress in mid pregnancy and 40.5 percent for those subjected to heat stress in late pregnancy.

Literature Cited

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A Study of Seasonal Changes in Boar Semen

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Story in Brief

Changes in the semen characteristics of eight boars housed in pens containing three types of shelters and collected three times a week were studied over a seven month period, July, 1965 to January, 1966.

There were no consistent differences in motility associated with any season. The quantitative values of volume and total sperm per ejaculate were higher during cool weather, However, semen quality, as measured by the percent abnormal sperm, was lower during this period. The reason

for this was not clear although part of the explanation is probably that it was a delayed response to the previous exposure to high temperatures. Although the air conditioned house provided the coolest summer temperatures, the overall semen quality picture was best in the boars housed in the three sided shelter with access to wet sand for cooling.

Introduction

Significant differences in semen quality associated with season of the year have been reported in cattle and sheep. In general, semen quality is higher in the seasons with cooler weather. However, the deleterious effects of high summer temperatures on semen quality are generally of a temporary nature. No studies have been specifically concerned with the influence of season on semen quality of boars.

This study was designed to determine the extent and pattern of the variation in semen of boars maintained in three types of shelters over a seven month period.

Materials and Methods

This study was conducted during a seven month period from July, 1965 to January, 1966. Nine purebred Yorkshire boars, approximately 18 months of age, from the Oklahoma State University swine herd were used. Three boars were randomly assigned to each of three lots, however, semen collections could be obtained from only two boars in Lot II. Each lot of boars was assigned to one of three adjacent pens that were approximately 30 x 115 feet in size. Three types of shelters were in the lots as follows:

Lot I. A pole shade approximately 14 x 18 feet in size with a galvanized metal roof with a dirt floor and no bedding of any sort provided.

Lot II. A three sided shelter approximately 10 x 12 feet in size open to the east, with wet sand and straw being provided as bedding during warm and cool weather, respectively.

Lot III. A completely enclosed, fully insulated air conditioned house, approximately 8 x 10 feet with a wooden floor and a spring loaded door. A thermostatically controlled one horsepower air conditioner was in operation from July 1 to October 28, and was sufficient to maintain a maximum house temperature of 68° - 75° F.

Air temperatures under the shelters were taken at three and five o'clock each afternoon by means of thermometers placed in similar shaded locations in each of the shelters. The daily maximum and mini-

mum ambient temperatures were obtained from climatological data recorded for the Environmental Science Services Administration on instruments located less than one mile from the boar pens.

The boars were individually fed 5.0 lbs. per day of a 14 percent protein milo and soybean meal ration from July to the latter part of October. At this time, it was increased to 6 lbs. per day in an effort to more nearly maintain constant boar weights. Water was available free choice at all times in automatic waterers.

The boars, which had previously been used for natural service, were trained to mount a breeding dummy and semen collections were made from each boar three times a week in an attempt to simulate production conditions. The boar was stimulated to ejaculate by applying pressure, with the hand, upon the spiral portion of the extended penis. Each ejaculate was strained as collected through four layers of gauze into a graduated 600 ml. beaker. The beakers were wrapped with an insulating material and prewarmed to prevent cold shock during collection. Following collection the semen samples were held at a constant temperature of 99.5° F. until evaluation was completed.

The volume of the strained ejaculate was the only data recorded for the ejaculates collected the first two collection days of each week. The ejaculates obtained during the third collection day of each week were subjected to additional evaluations.

Standard laboratory techniques were used to estimate the percent motile spermatozoa, the percent of abnormal spermatozoa and sperm concentration.

Results and Discussion

During the course of this study, 712 individual collections were attempted, with 634 (89.0 percent) being successful. The successful collections per boar ranged from 69.7 percent to 97.8 percent of those attempted. Ejaculates were obtained from 96.6 percent, 83.1 percent and 85.4 percent of the collections attempted from the boars in Lots I, II and III, respectively.

A wide variation in the response of boars to collection efforts was observed, even among littermate boars. For example, of three littermate boars assigned to the experiment, one could not be trained to serve the dummy; 71.9 percent of the collection attempts were successful with a second boar; and an ejaculate was obtained in 97.8 percent of the attempts to collect from the third. The failure to obtain regular collections from trained boars has been reported by others.

The values obtained for all eight boars in each weekly semen evaluation were averaged over three week periods, and the results are present-

ed in Table 1. The average minimum and maximum temperatures for the same periods are also presented.

The quantitative values for both semen volume and total sperm per ejaculate were highest during the latter part of October, November and December. During these periods of time, the average high temperatures were no higher than 76.5° F. However, during this same period, semen quality as measured by percent abnormal sperm was at its lowest point. There was no consistent difference in motility associated with any season.

The increased incidence of abnormal sperm during the cooler months was believed to be partly due to the period of time between formation of sperm in the testicle and their ejaculation. Sperm being formed in the testicle are very sensitive to heat and readily damaged, whereas those that have moved out of the testicle are much more resistant. Therefore, the abnormal forms appearing in October ejaculates were believed to be sperm formed during the hot temperatures of July and August. Sperm ejaculated in July and August were formed during periods of cooler temperatures.

However, this explanation does not explain the continued large numbers of abnormal sperm as were observed in late November and in December and January. The most common abnormal form observed was coiled tail, which increased proportionately throughout the trial. It is known that coiled tails can result from cold shock. It was felt that adequate precautions were taken to prevent cold shock. Also, sperm with coiled tails were not observed in all ejaculates. The data obtained in this study were not adequate to determine the reason for the increased numbers of abnormal sperm during the cooler months of the trial.

The three shelters provided for the boars in this study were designed to be applicable to production conditions rather than to impose rigid climatological control. The daily afternoon air temperatures taken at each of the shelters are valuable only for comparison purposes. They are not necessarily representative of the extreme daily temperatures, and they do not represent the only difference between the shelters. Table 2 compares the average afternoon temperature of each lot for three week periods, and gives the average maximum ambient temperature for the same period. The difference in air temperatures of Lots I and II was generally less than 3° F. Of course, one big difference between Lots I and II was the comfort factor that the boars of Lot II were provided with wet sand during the summer and straw bedding during the winter. In comparison to both Lot I and II, the air temperature in Lot III varied less and was considerably cooler in very hot weather and warmer in cold weather.

Table 1. Averages By Three Week Periods Of Semen Characteristics Of Eight Yorkshire Boars And The Average Maximum And Minimum Ambient Temperatures During Each Three Week Period.

Period Ending	Ambient Temperature Avg. Maximum °F.	Ambient Temperature Avg. Minimum °F.	Motility Percent	Abnormal Spermatozoa Percent	Semen Volume ml.	Sperm Concentration/ml. millions/ml.
July 16	94.1	69.6	58.5	4.2	196.1	165.7
August 6	95.5	68.4	56.8	5.8	188.6	253.7
August 28	99.5	70.7	61.4	4.7	180.5	204.8
September 17	92.7	64.2	56.9	6.7	197.6	163.3
October 8	76.8	42.0	53.4	11.3	222.9	204.5
October 29	76.5	45.1	49.5	13.6	234.7	302.4
November 19	70.0	45.5	50.7	13.2	223.2	215.3
December 10	65.5	36.7	62.5	18.4	252.7	207.9
December 31	55.9	33.7	51.5	16.1	266.2	160.8
January 21	51.4	26.1	56.1	16.0	216.8	163.4
Total number of ejaculates evaluated			216	216	634	216
Overall Average			55.4	11.7	212.5	213.0

There were distinct differences between the lots in volume, percent abnormal sperm, sperm concentration and total sperm per ejaculate. The averages per lot are presented in Table 3. It is true that no one lot had the highest values for all of the semen criteria. Values for concentration and total sperm per ejaculate values were similar in Lots II and III, and were definitely higher than in Lot I. Volume was somewhat greater in Lot I than in Lot III, while Lot II was approximately midway between Lot I and Lot II. Lots I and II were both characterized by approximately 12 percent abnormal spermatozoa which was considerably higher than the 5 percent value observed in Lot II.

It has been established that extreme temperatures, both hot and cold, are detrimental to spermatogenic function. Since the air conditioned house in Lot III provided more moderate temperatures throughout the period of time included in this study, it would be expected to be conducive to maximum semen quality. Yet, such an advantage for Lot III was not observed. Rather, in this study, higher semen quality was associated with boars in Lot II housed in the three sided shelter, which

Table 2. Average Maximum Daily Ambient Temperatures For Three Week Periods And The Corresponding Average Afternoon Shelter Temperature

Period Ending	Maximum Ambient Temperature (°F.)	(°F.) Average afternoon shelter temperature Lot I	Lot II	Lot III
August 28	99.5	93.2	91.4	73.5
September 17	92.7	84.6	84.4	71.1
October 8	76.8	73.8	73.2	69.3
October 29[1]	76.5	69.6	70.2	69.6
November 19	70.0	57.8	63.3	72.3
December 10	65.5	54.9	55.0	64.0
December 31	55.9	46.9	48.1	56.8
January 21	51.4	42.8	42.8	55.9

[1]Air conditioner turned off October 28

Table 3. Comparison Of Averages For Semen Measurements Of The Boars In The Three Lots

Item	Lot I	Lot II	Lot III
Number of boars	3	2	3
Percent Motile Sperm	58.0	57.4	51.5
Percent Abnormal Sperm	12.23	4.98	12.01
Volume (ml.)	222.1	215.6	195.9
Concentration/ml. (millions)	151.38	218.61	253.71

had access to wet sand for cooling and straw bedding for warmth. It is doubtful, however, whether any importance can be attached to the comparison of shelters obtained in this study. It does suggest that confining boars to small, air conditioned shelters may not be effetcive in preventing the decline in semen quality associated with high summer temperatures.

The Influence of Pig Birth Weight on Performance*

I. T. Omtvedt

Story in Brief

The production records for the herds in the swine breeding project were analyzed to determine the relative influence of various factors on pig birth weight and to evaluate the importance of size at birth on subsequent performance.

The records revealed that pig birth weight was increased by crossbreeding and that levels of feeding and climatic conditions during gestation also influenced the weights of pigs at farrowing. Temperature stress the week before farrowing reduced pig weight by 19 percent. Heavier pigs were farrowed by second litter sows than by first litter gilts and the records revealed that delaying the time of first breeding for gilts beyond 7 months of age resulted in heavier pigs at birth. As number of pigs in the litter increased, pig birth weight tended to decrease with the heaviest pigs being farrowed in litters of 4-6 pigs. Sex differences tended to have little influence on the weights of the pigs at birth in this study.

The average pig birth weight was 2.93 lbs. with 87.2 percent of the pigs weighing in the 2 and 3 lb. range. No pigs survived that weighed less than 1 lb. at birth while 95 percent of the pigs weighing 4 lbs. and over survived to weaning. Preweaning and postweaning growth rates were closely related to birth weight. Pigs weighing 4 lbs. at birth gained almost 0.3 lb. per day faster after weaning and reached 200 lbs. in 27 days less time than those weighing 2 lbs. at birth.

*In cooperation with USDA Agri. Research Service, Animal Husbandry Research Division.