HEAT STRESS INDICES IN HOLSTEIN AND JERSEY CATTLE

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Previously, it has been shown that shade is beneficial to dairy cattle during warm summer months. Since Jersey cattle tend to be more "heat tolerant" than Holstein cattle we examined their responses to a shade. Ten Jerseys and fifteen Holstein cattle were assigned to a lot with no shade and an equal number to an adjacent lot containing a shade structure from June 6 to September 20, 1977. Details concerning construction of the shade have been published previously and are available upon request.

Table 1 illustrates the average Black Globe temperature between the shade and no shade areas from 12:00 noon to 5:00 p.m. Black Globe temperature is an integrated measurement of air temperature, solar radiation and wind speed. It is more accurate than dry bulb or air temperature alone in assessing the amount of heat the animals are exposed to. Black Globe temperatures were an average 8.73 degrees Centigrade higher in the no shade area during these time periods. Jersey cattle were cooler than Holstein cattle in both the shade and no shade areas. However, respiration rates were similar between breeds under shade or without shade. Respiration rates were different between animals under shade or without shade. We also measured rumen contractions in animals under shade or without shade during this same period of intense heat. Rumen contraction rate was greater in Jerseys than Holsteins and was greater in animals under shade. It is known that rumen contraction rate is influenced by body temperature and could be involved in reduced milk production during thermal stress.

Table 1. Milk Yield and Heat Stress Indices in Holstein and Jersey Cattle.

	Shade			No Shade		
	Jersey	Holstein	$\bar{X}$	Jersey	Holstein	$\bar{X}$
Rectal Temp.	38.53	38.75	38.65	39.20	39.74	39.65
Respiration Rate	78.62	77.48	79.58	115.12	114.21	115.31
Rumen Contractions	2.63	2.19	2.34	1.96	1.44	1.64
Black Globe Temp.			30.05			38.78
Milk Yield A.M. (kg)	16.6	18.9	18.07	15.7	15.1	15.3

In addition to examining the above parameters an a.m. and p.m. milk sample was taken once weekly and analyzed for fat %, freezing point depression, % acidity, total protein and somatic cells by the State milk testing laboratory at White Springs, Florida. Differences between shade and no shade areas in milk constituents were not apparent.

However, there were significant differences between a.m. and p.m. milk samples in freezing point depression, milk fat % and % acidity. These differences could be due to a reduction in water content of milk in the p.m. sample.

Table 2. Effect of Shade and Time of Day on Selected Milk Parameters.

	Shade		No Shade	
	AM	PM	AM	PM
Freezing Point Depression**	- .5490	- .5504	- .5451	- .5519
% Acidity**	.1580	.1720	.1650	.1800
Total Protein	3.33	3.34	3.26	3.35
Fat %*	3.41	3.83	3.60	3.62
Somatic Cells	655,826	594,260	569,619	591,395

**AM different than PM P<.0001
*AM different than PM P<.025

Another method of looking at differences between Holsteins and Jerseys is to examine them around a 24 hr period. This provides a more complete picture of the cows' response to heat during the day and cooling at night.

The average milk production of the animals used in this study is presented in Table 3. Both Holsteins and Jerseys in the no shade area had slightly lower average milk yields than animals under the shade. Physiological patterns in Holsteins were examined on August 5-6 and those of Jerseys, August 15-16. Figure 1 illustrates Black Globe temperatures under the shade structure and in an adjacent no shade area on these days. Black Globe temperature is an integrated measurement of dry bulb temperature, solar radiation and wind speed. As shown in Figure 1 the daily Black Goobe temperature patterns were almost identical for the two 24 hour periods. It also is interesting to note that in both studies the afternoon thundershower common to this area occurred between 3 and 4 p.m., lowering temperatures most dramatically in the no shade area. It is quite evident that Black Globe temperatures are much lower under shade during the late morning and afternoon hours. This is due primarily to reduction in solar radiation by the shade.

Table 3. Ave Milk Production of Cows on Shade Experiment.

Shade				No Shade			
Breed	# Animals	Lbs Milk	Date	Breed	# Animals	Lbs Milk	Date
Holstein	5	41.1	8-5-77	Holstein	5	37.8	8-5-77
Jersey	5	29.6	8-15-77	Jersey	5	27.6	8-15-77

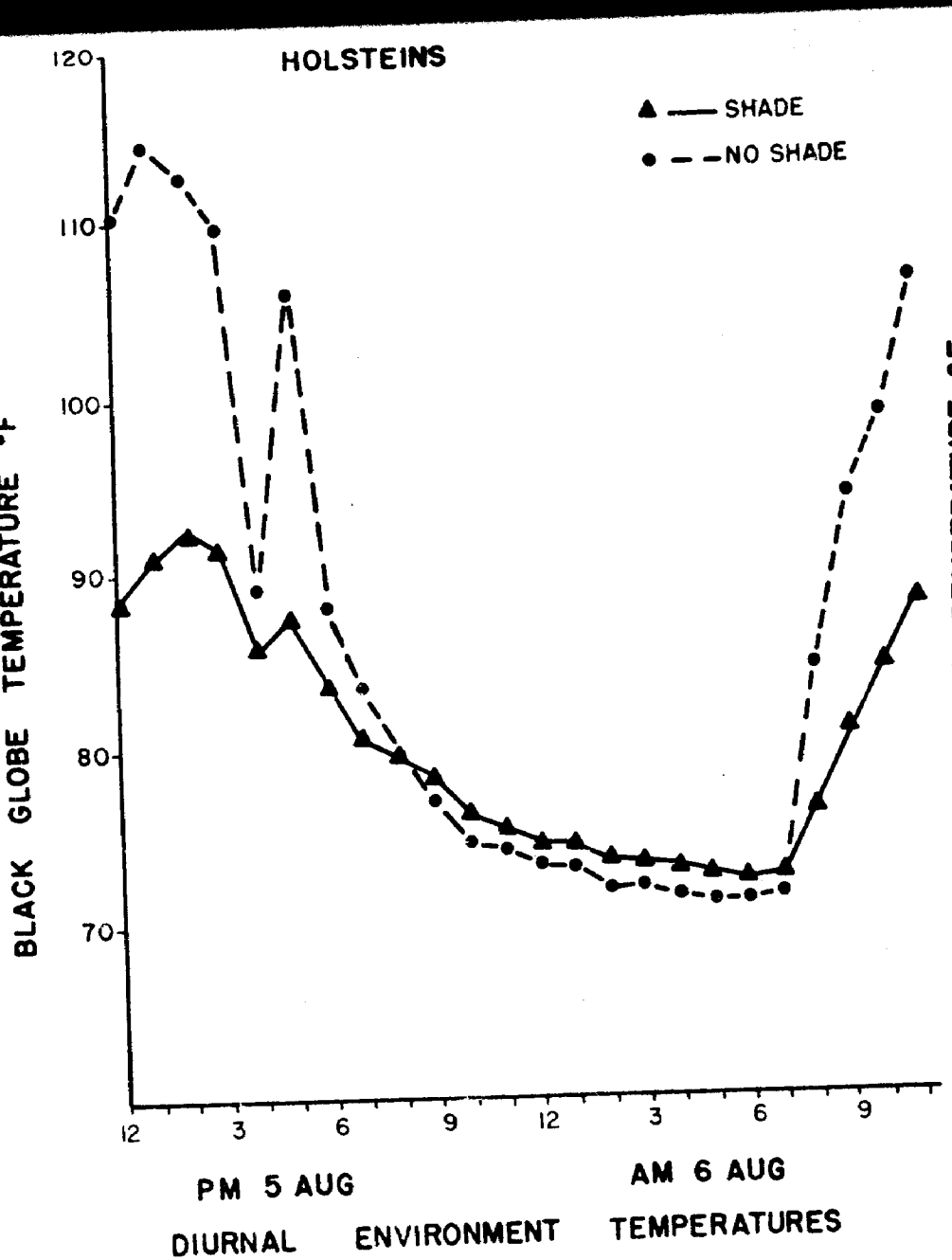
Figure 2 depicts rectal temperatures of Holstein and Jersey cattle under shade or in the adjacent no shade area. Points on the graph are means of five animals for each treatment. Rectal temperatures of Holsteins were higher than those of Jerseys during daylight

but were similar between midnight and 7 a.m. This probably is due to the Holsteins' greater body mass and milk yield. Both Holstein and Jersey cattle in the no shade area had higher rectal temperatures than they did under shade during daylight. However, Jerseys in the no shade area cooled much faster than Holsteins without shade. The well known heat tolerance of the Jersey is no doubt due in part to this ability to cool rapidly. If one uses a rectal temperature of 38.4°C as inside the normal temperature range it is evident that Jerseys reached this temperature by 9 p.m. while Holsteins did not until 1 a.m. It appears that Holsteins have a much greater heat load than Jerseys to dissipate during the night.

Figure 3 illustrates respiration rates of the cattle in these studies. Increased respiration frequency is a major avenue of heat dissipation in the heat stressed dairy cow. The respiration rates paralleled rectal temperatures. Holsteins and Jerseys in the shade and likewise in the no shade area had similar respiration rates during hours of peak environmental temperatures. However, respiration rates of Jerseys in the no shade area dropped quickly following sunset, whereas those of Holsteins declined much more slowly. Respiration rates of Jerseys in the no shade area agreed with rectal temperatures and indicated that these cattle were as cool as the Jersey cattle under the shade by 7 p.m. Respiration rates of Holstein cattle also paralleled their rectal temperatures and indicated that Holstein cattle in the no shade area were dissipating excess heat until approximately 1 a.m. or 6 hours longer than Jersey cattle under the same environmental conditions. These data indicate that respiratory frequency is not a major factor in heat tolerance but rather an indication of the heat load an animal is carrying.

Figure 4 depicts rumen contractions per 2 min for Holsteins and Jerseys in the shade and no shade areas. Both Holsteins and Jerseys in the no shade area had lower rumen contraction rates than their counterparts in the shade area during the afternoon. After sunset rumen contraction rate speeds up in animals housed without shade. Thus, it appears that heat stress adversely affects rumen contraction rates and could be involved in reduced milk yield of heat stressed cows.

In conclusion, it is evident that the use of a shade structure to alleviate environmental stress reduces rectal temperatures and respiration rates and prevents a decline in rumen contraction rates in cattle. Jersey cattle do not build up as great an excess heat load as Holstein cattle and cool off much more quickly following sunset. We postulate that hair coloration, body mass and milk yield are primary factors in causing a greater excess heat load in the Holstein cow. However, Holstein cows can carry on a greater level of milk yield than Jersey cows despite this greater heat buildup during the day.


HOLSTEINS
SHADE
NO SHADE
BLACK GLOBE TEMPERATURE °F
120
110
100
90
80
70
12
3
6
9
12
3
6
9
PM 5 AUG
AM 6 AUG
DIURNAL ENVIRONMENT TEMPERATURES

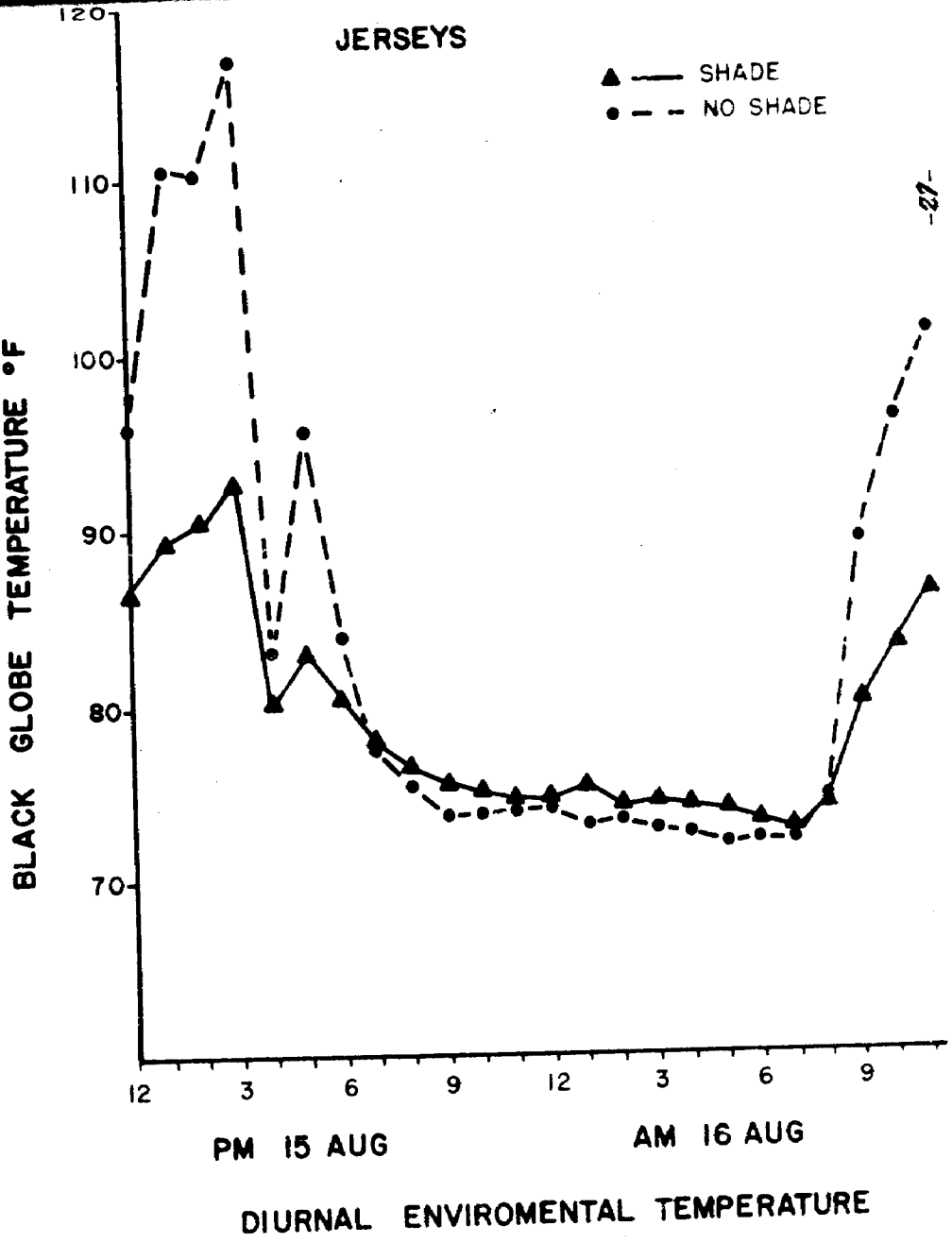

JERSEYS
SHADE
NO SHADE
BLACK GLOBE TEMPERATURE °F
120
110
100
90
80
70
12
3
6
9
12
3
6
9
PM 15 AUG
AM 16 AUG
DIURNAL ENVIROMENTAL TEMPERATURE

FIGURE 1

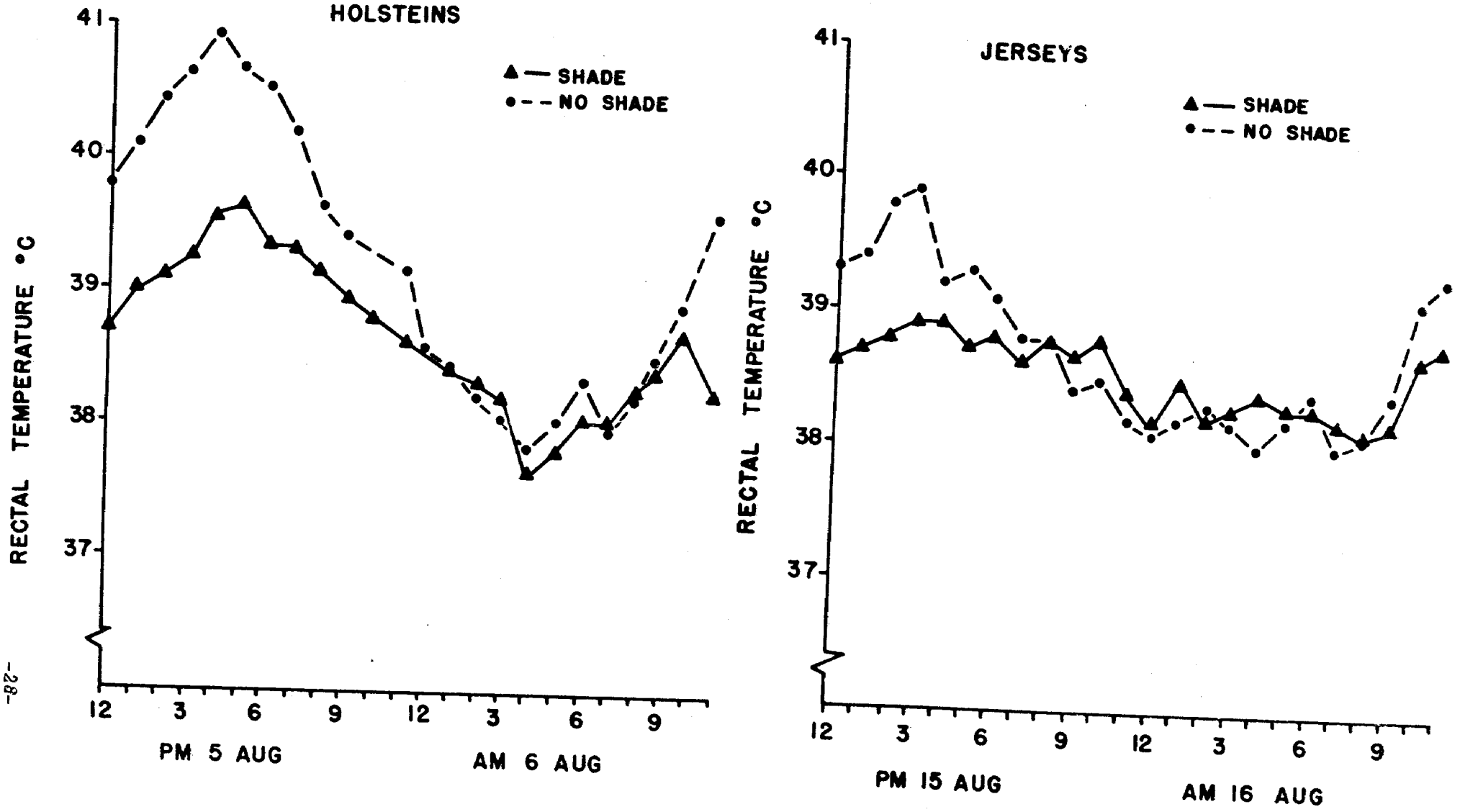
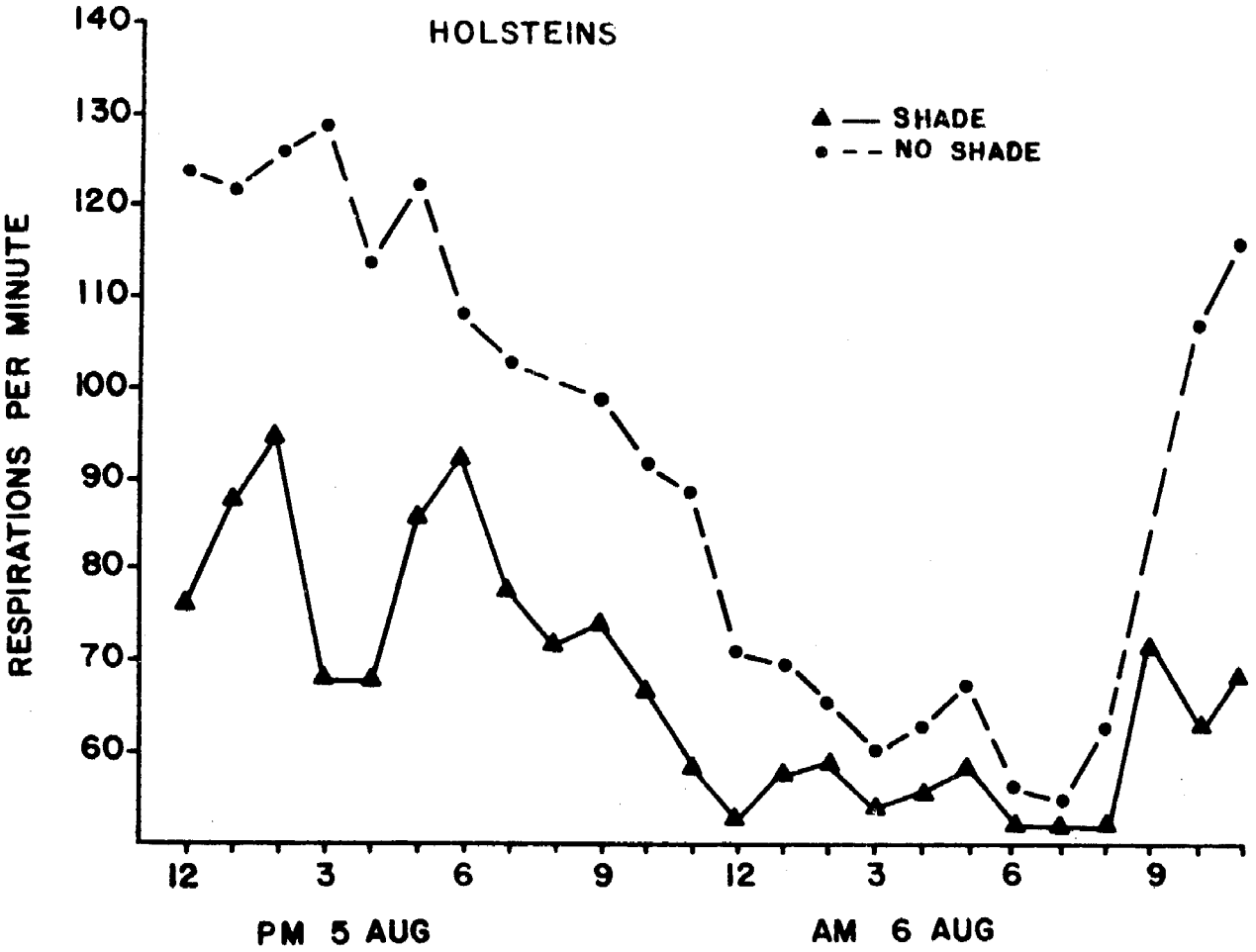

HOLSTEINS
SHADE
NO SHADE
RECTAL TEMPERATURE °C
41
40
39
38
37
12
3
6
9
12
3
6
9
PM 5 AUG
AM 6 AUG
JERSEYS
SHADE
NO SHADE
RECTAL TEMPERATURE °C
41
40
39
38
37
12
3
6
9
12
3
6
9
PM 15 AUG
AM 16 AUG

FIGURE 2


HOLSTEINS
▲ — SHADE
● - - NO SHADE
RESPIRATIONS PER MINUTE
140
130
120
110
100
90
80
70
60
12
3
6
9
12
3
6
9
PM 5 AUG
AM 6 AUG

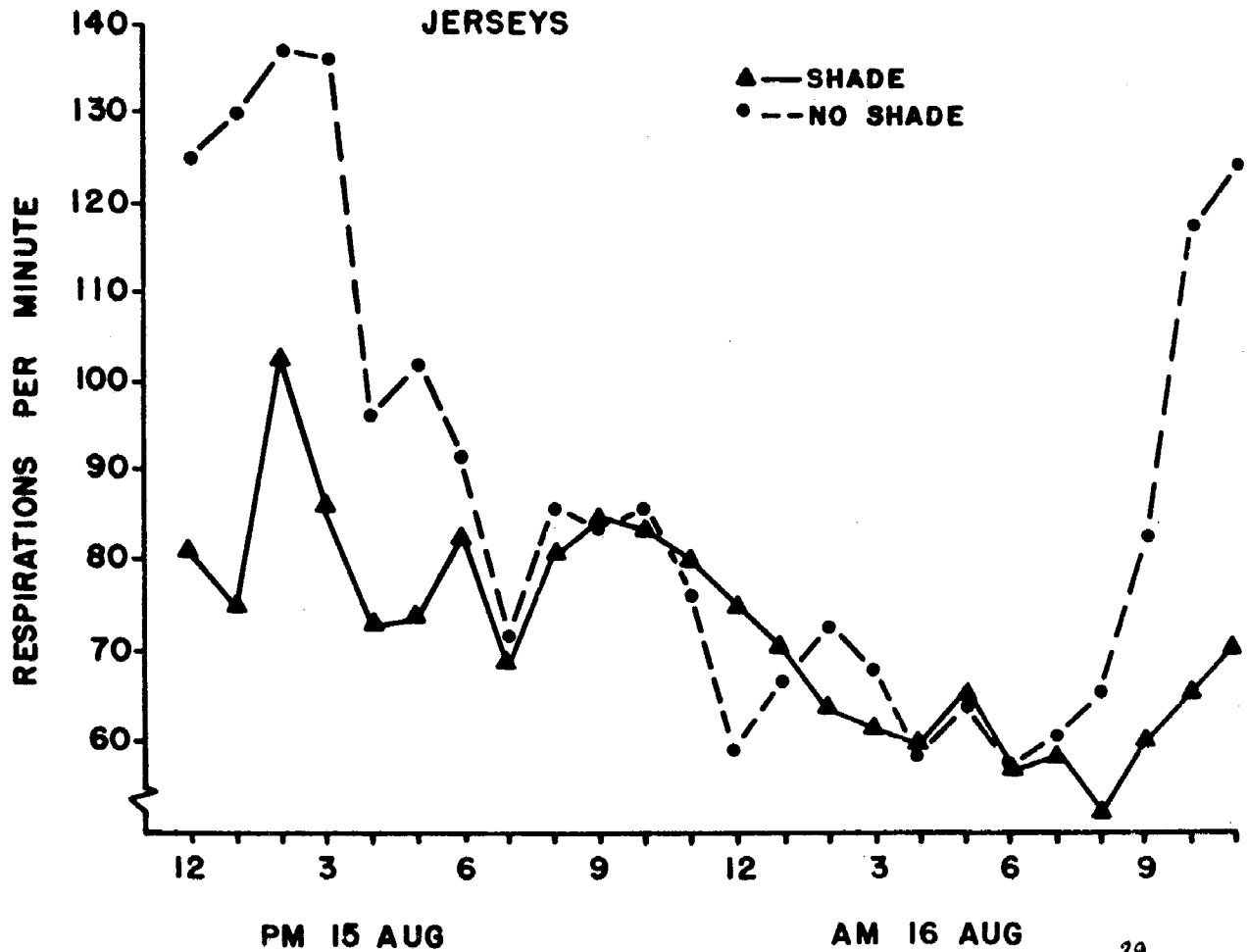

JERSEYS
▲—SHADE
●--NO SHADE
RESPIRATIONS PER MINUTE
140
130
120
110
100
90
80
70
60
12
3
6
9
12
3
6
9
PM 15 AUG
AM 16 AUG

FIGURE 3

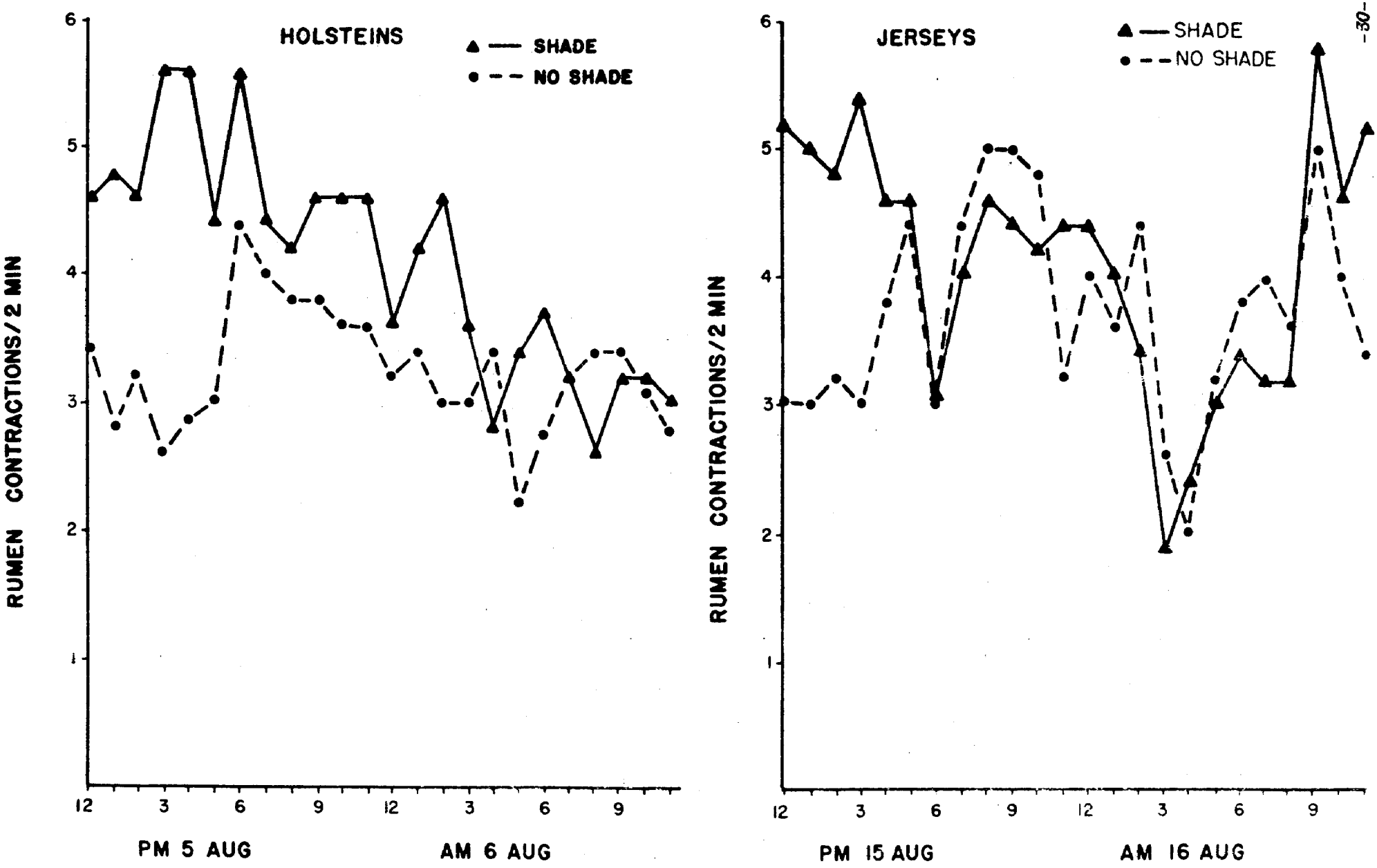

HOLSTEINS
SHADE
NO SHADE
RUMEN CONTRACTIONS/2 MIN
6
5
4
3
2
1
12
3
6
9
12
3
6
9
PM 5 AUG
AM 6 AUG
JERSEYS
SHADE
NO SHADE
RUMEN CONTRACTIONS/2 MIN
PM 15 AUG
AM 16 AUG

FIGURE 4