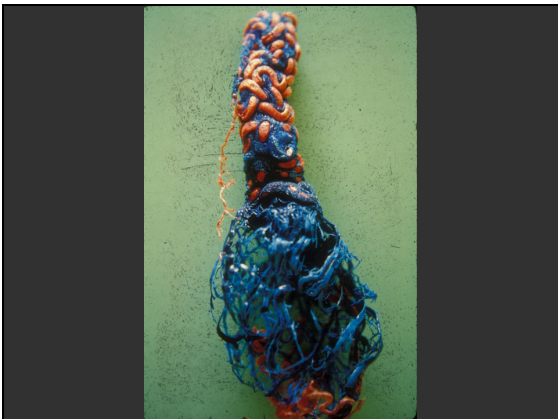
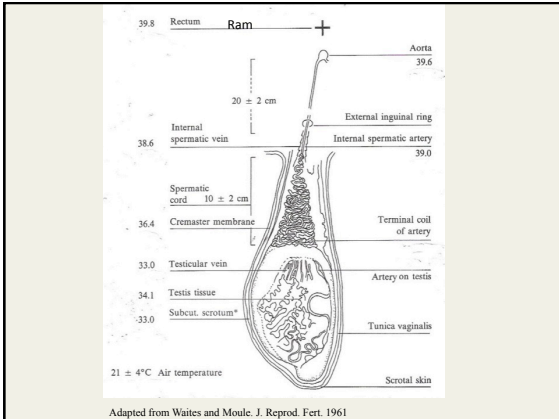


# Impact of Heat Stress on Male Fertility

Bob Wettemann and Brit Boehmer  
Oklahoma Agricultural Experiment Station

- ### Introduction
- Testicular temperature must be 2 to 6 °C cooler than body temperature.
  - Exposure to elevated ambient temperature reduces semen quality (Casady et al., 1953; Skinner and Louw, 1966).
  - Local heating of the scrotum reduces the number of ejaculated sperm (Austin et al., 1961; Gerona and Sikes, 1970).
  - Heat stress has a minimal effect on testicular hormone production (Minton et al., 1981; Barth and Bowman, 1994).
  - Breeding seasons often occur during periods when ambient temperature is elevated.
  - One bull influences many matings.

- ### Temperature of Testes
- Testes are maintained 2 to 6 °C less than body temperature
    - Scrotal skin – much vascularization and sweat glands
    - Tunica dartos muscle – controls surface area
    - Cremaster muscle – positions scrotum from the body
    - Spermatic vasculature and counter-current heat exchange

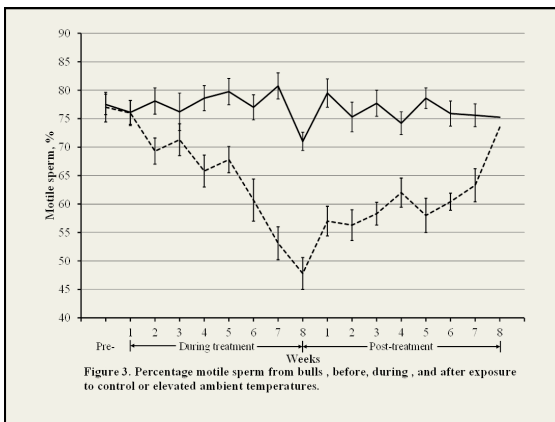
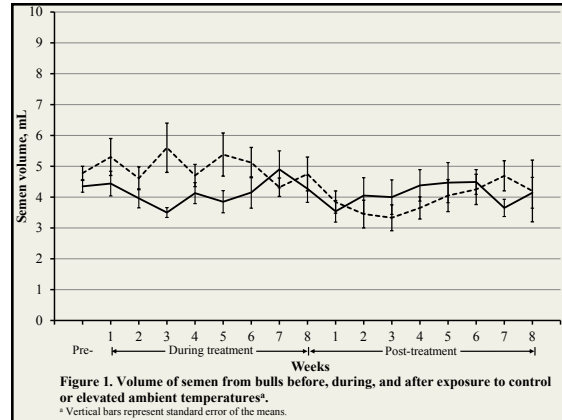


- ### Effect of whole body heat stress of bulls
- (Meyerhoeffer et al., 1985)
- Angus bulls (n=16) in environmental chambers at 73 ° for 8 wk; treated for 8 wk; recovery at 73 °F for 8 wk
    - **Heat-stressed** – 95 °F for 8 h, 88 °F for 16 h
    - **Control** – 73 °F
    - Semen collected twice weekly with an AV for 8 wk of treatment and 8 wk after treatment
    - Quantity and quality of semen was evaluated

**Influence of heat-stress on body functions of bulls.**

Characteristic	Treatment	
	Control	Heat-stressed
Respiratory rate, b/min	30 ± 2 <sup>a</sup>	54 ± 2 <sup>b</sup>
Rectal temperature, °C	38.2 ± 0.1 <sup>c</sup>	38.7 ± 0.2 <sup>d</sup>
Water consumption, L/d	17 ± 1 <sup>c</sup>	27 ± 1 <sup>d</sup>

<sup>a,b</sup> P < 0.001; <sup>c,d</sup> P < 0.01.



**Influence of whole body heat stress on semen characteristics**

- Volume of semen was not influenced
- Percentage motile sperm was decreased
- Total sperm per ejaculum was not effected
- Reduction in the percentage of normal sperm
- Spermatogenesis in bulls requires about 60 days. Ejaculation of sperm with normal motility did not occur until 8 weeks after the end of heat stress.
- Reduction of pregnancy rates with summer and early fall breeding may be caused by decreased semen quality associate with heat stress.

**Short term heat stress can alter spermatogenesis similar to long term heat stress**

- Exposure of bulls to 40 °C and 35-40% relative humidity (RH) for 12 or 24 h, or for 6 d decreased the percentage of motile sperm (Skinner and Louw, 1966). (104 °F)
  - 8 week lag from the end of heat stress until normal semen quality.

**Influence of short term heat stress (93°F) on characteristic of semen of bulls<sup>a</sup>.**

Criteria	Time of evaluation			
	4 d before trt		2d after trt	
	Control	Heat stressed	Control	Heat stressed
Volume, mL	5.9	5.0	6.6	7.0
Motile sperm, %	64	69	84 <sup>b</sup>	65 <sup>c</sup>
Live sperm, %	67	71	74 <sup>b</sup>	58 <sup>c</sup>

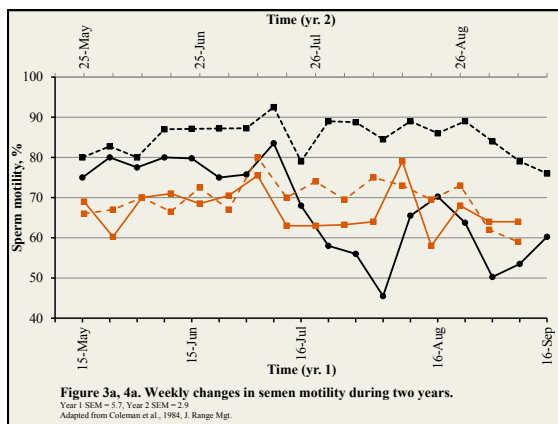
<sup>a</sup> Bulls were electroejaculated (Minton et al., 1981).  
<sup>b,c</sup> Differ P < 0.05.

### Insulation of the scrotum of bulls

- Increased testes temperature by 1-1.5 °C for 4 days decreased the percentage of live sperm (Barth and Bowman, 1994).
- 6 week lag from the end of treatment until normal sperm

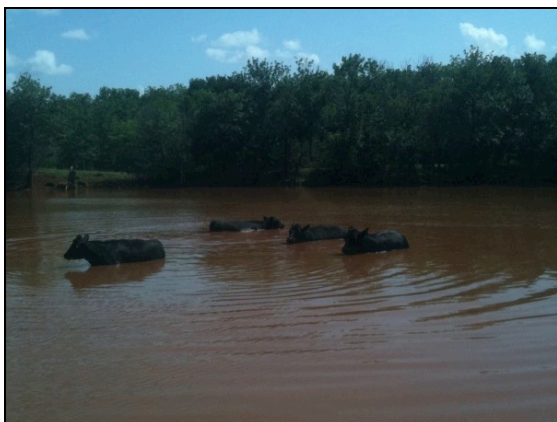
### Management to Reduce Heat Stress

- Air temperature less than 33 °C (91 °F)
- Provide bulls with shade – tendency to have greater motility and more live sperm (Meyerhoeffer et al.)



### Management to Reduce Heat Stress

- Air temperature less than 38°C for several weeks
- Provide bulls with shade – tendency to have greater motility and more live sperm (Meyerhoeffer et al.)
- Sprinkling cattle and ground (Davis et al., 2003).
- Sprinkling dairy cattle in Florida with irrigation (Hansen)
- Ponds



Short term increases in body temperature of bulls for as short as 1 day can influence semen quality and fertility.

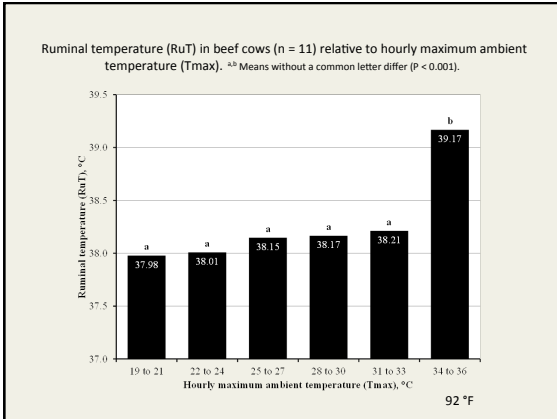
- Exposure to elevated ambient temperatures
- Absence of shade
- Infection or disease
- Concern for natural mating and semen collection for AI

When does elevated ambient temperature become **heat stress**?

- Mechanisms of body heat loss in cattle:
  - Radiation – when body temperature is greater than air temperature
  - Evaporative cooling: sweating and respiratory rate

Ambient temperature and ruminal temperature

- Ruminal temperature (RuT) is a noninvasive method to monitor body temperature in real time.
- Cows were maintained in a drylot with shade and ad libitum water and feed during the summer.

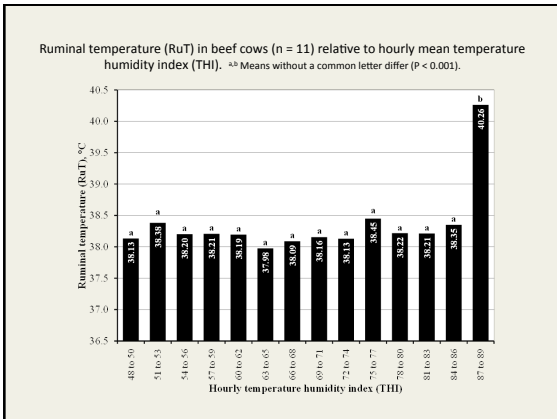


Temperature humidity index

Temperature (°F) - current hour	Relative humidity													
	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%
105	83	84	85	86	87	88	89	90	91	92	93	94	95	96
104	82	83	84	85	86	87	88	89	90	91	92	93	94	95
103	81	82	83	84	85	86	87	88	89	90	91	92	93	94
102	80	81	82	83	84	85	86	87	88	89	90	91	92	93
101	79	80	81	82	83	84	85	86	87	88	89	90	91	92
100	78	79	80	81	82	83	84	85	86	87	88	89	90	91
99	77	78	79	80	81	82	83	84	85	86	87	88	89	90
98	76	77	78	79	80	81	82	83	84	85	86	87	88	89
97	75	76	77	78	79	80	81	82	83	84	85	86	87	88
96	74	75	76	77	78	79	80	81	82	83	84	85	86	87
95	73	74	75	76	77	78	79	80	81	82	83	84	85	86
94	72	73	74	75	76	77	78	79	80	81	82	83	84	85
93	71	72	73	74	75	76	77	78	79	80	81	82	83	84
92	70	71	72	73	74	75	76	77	78	79	80	81	82	83
91	69	70	71	72	73	74	75	76	77	78	79	80	81	82
90	68	69	70	71	72	73	74	75	76	77	78	79	80	81
89	67	68	69	70	71	72	73	74	75	76	77	78	79	80
88	66	67	68	69	70	71	72	73	74	75	76	77	78	79
87	65	66	67	68	69	70	71	72	73	74	75	76	77	78
86	64	65	66	67	68	69	70	71	72	73	74	75	76	77
85	63	64	65	66	67	68	69	70	71	72	73	74	75	76
84	62	63	64	65	66	67	68	69	70	71	72	73	74	75
83	61	62	63	64	65	66	67	68	69	70	71	72	73	74
82	60	61	62	63	64	65	66	67	68	69	70	71	72	73
81	59	60	61	62	63	64	65	66	67	68	69	70	71	72
80	58	59	60	61	62	63	64	65	66	67	68	69	70	71
79	57	58	59	60	61	62	63	64	65	66	67	68	69	70
78	56	57	58	59	60	61	62	63	64	65	66	67	68	69
77	55	56	57	58	59	60	61	62	63	64	65	66	67	68
76	54	55	56	57	58	59	60	61	62	63	64	65	66	67
75	53	54	55	56	57	58	59	60	61	62	63	64	65	66
74	52	53	54	55	56	57	58	59	60	61	62	63	64	65
73	51	52	53	54	55	56	57	58	59	60	61	62	63	64
72	50	51	52	53	54	55	56	57	58	59	60	61	62	63
71	49	50	51	52	53	54	55	56	57	58	59	60	61	62
70	48	49	50	51	52	53	54	55	56	57	58	59	60	61

THI = T - (0.55 - 0.55 \* RH/100) \* (T - 59)

Potential heat stress category:  
 Normal < 70    Aware 70-74    Alert 75-78    Danger 79-83    Emergency > 83



**Heat stress categories for the Mesonet Cattle Comfort Advisor<sup>a</sup>.**

Categories:

Cattle Comfort Index, °F	Impacts
<b>Heat Danger &gt;105</b>	Animal deaths may exceed 5%
<b>Heat Caution &gt;85 to 105</b>	Decreased production, 20% or more Reduced conception, as low as 0%
<b>Comfortable 15 to 85</b>	

In Stillwater OK in 2012 and 2013 there were many days >85 between June 15 and August 31.  
<sup>a</sup> Mesonet.org

**Hypothesis - Males are more susceptible to heat stress than females.**

- **Boars 93 °F** 70% decrease in sperm motility
- **Gilts 104 °F**
  - Estrus cycle – no effect
  - 0-8 d pregnancy – 43% decrease in pregnancy rate
  - 8-16 d pregnancy – 22% decrease in pregnancy rate
  - Mid pregnancy – no effect
  - Late pregnancy – 42% decrease in live pigs
- **Bulls 95 °F** 35% decrease in sperm motility
- **Cows 99 °C**
  - Estrus cycle – no effect
  - Decreased conception during the first 3 days after breeding
  - @ 38% RH 8-16 d pregnancy – 50% decrease in conceptus weight
  - @ 27% RH 8-16 d pregnancy – no effect
  - Late pregnancy – shorter gestation

**Mid-late summer breeding seasons**

- More late spring calving when grass quantity and quality are greater
- Breeding in July and August
- Greater opportunity for heat stress

- Breeding soundness exams are essential to eliminate bulls with potential fertility problems.
- However, a day or two of elevated body temperature can decrease fertility.

**Bulls are often forgotten**

- Bulls are more susceptible to heat stress than cows.
- One bull influences many potential pregnancies.
- Management of body temperature of bulls before and during collection of semen for AI is a major concern.

**Summary**

- Testicular temperatures must be cooler than body temperature
- Exposure to elevated ambient temperature can reduce semen quality. Monitor RR and RT
- Spermatogenesis is a continuous process and semen quality is reduced for 8 weeks after the end of heat stress.
- One day of heat stress can reduce semen quality and potential fertility.
- Cooling of bulls is necessary when ambient temperature is greater than 91 °F.
- One bull influences the pregnancy rate of many cows.