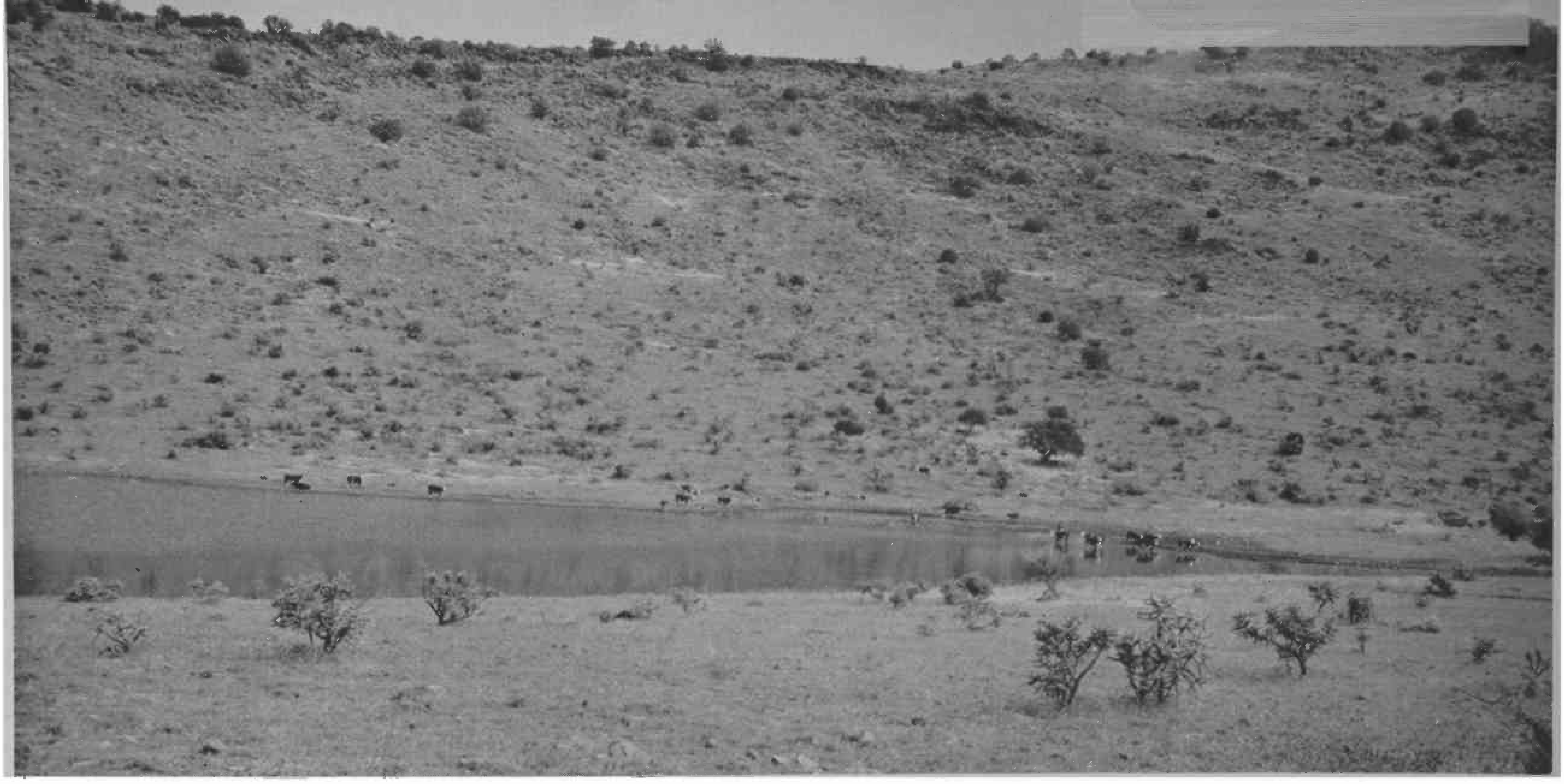


IN WARM SUMMER months, range cattle tend to stay in, close by, or within easy walking distance of water. Range grass distant from water is not, therefore, fully utilized.

WHAT, AFTER ALL, IS THIRST?

Laboratory Rats May Lead Way To More Efficient Range Cattle

Carl B. Roubicek

You see it as you drive past Arizona's semi-desert cattle ranges. At one point, on a hot summer afternoon, you'll see an earth tank with a little water still in it. Near by, resting in the shade, or perhaps standing knee deep in the water, will be a number of cows and calves. (See photo above.)

Scattered in a half-mile radius will be other animals, grazing the sparse range plants but staying close to water.

Two miles away from the water supply will be better range, but it is scarcely grazed in the warm months of the year, except by wild animals.

It was 25 years ago that Professor E. B. Stanley of our Animal Science Department first pointed out the importance of adequate water for Arizona range cattle. He found that from a quarter mile to half a mile from water the range forage would be 50 percent utilized. From there up to a mile only 25 percent would be eaten by the cattle, and beyond two miles from water there was only 15 percent utilization of forage.

Water Is Limiting Factor

In other words, distance to water is a definite limit on range utilization. Professor Stanley also learned the extreme seasonal differences in water uptake by cattle. On Southern Arizona desert ranges around 2½ gallons of water per day will do in the cool winter season, but in summer that jumps to 11½ gallons per day — four and a half times as much!

Millions of words have been written about the need for more water for Arizona, but let's turn that argument around and look at it from a new direction. Can we develop economic animals and plants that can get along with less water?

Can we develop a cotton which needs less irrigation water? Or a cow which will use less water, and therefore will graze those ranges two and three or four miles from the water tank?

University of Arizona scientists are working on these things, both with plants and with animals. If we can't bring the mountain of water to Mohammed, perhaps we can develop a camel-like cow which will go to the mountain, and a desert-adapted cotton with a cactus thirst.

It all begins with cages and cages of laboratory rats, carefully watched, watered and weighed.

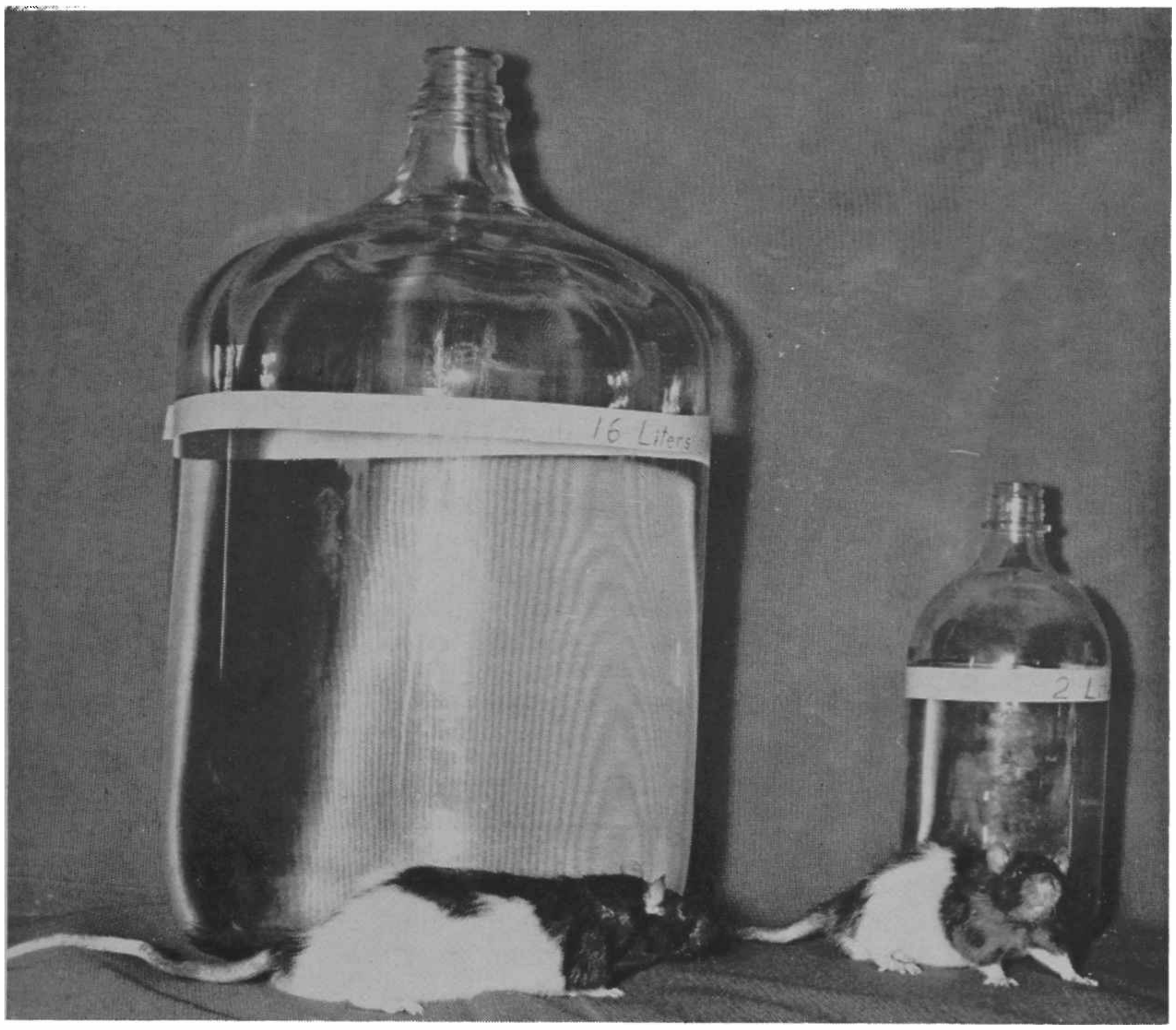
Temperature and Thirst

First of all, of course, we need to know something about thirst, about the need for water, which plant and animal life share. We know that each species of plant and animal thrives at certain temperatures. (The grasses which cattle graze in Alberta and Saskatchewan wouldn't last a single summer in Arizona, and our grasses would die in their first winter in that climate.)

Humans, as any anxious mother with a thermometer in her hand can tell you, have a normal body tem-

(Continued on Next Page)

The author is a Professor of Animal Science. This investigation was supported in part by a Public Health Service research grant from the National Institute of Health.



LABORATORY EXPERIMENTS by Dr. Roubicek, using over 2,000 rats, indicate the possibility of breeding strains of animals which can thrive and make normal gains with much less water than other ← ones. Animal at left, in photo at left, drank 16 liters of water in 13 week test, while rat at right drank two liters in the same period. Translated to commercial animals, this hints at possibility of range cattle which can get along with less water, range farther from the water holes.

(Continued from Previous Page)

perature and any great departure from that temperature means danger to life. When the thermometer says 98.6 we assume the youngsters are well, but when it says 102 we call the doctor.

But we must cling rather closely to that 98.6 whether it is 10 below zero outside or 110 degrees in July. The ability of a person — or of any animal — to survive or to become adapted to high environmental temperatures depends upon his ability to maintain this normal body temperature.

Water Helps Regulate Heat

Since we recognize that an increase of just a few degrees in body temperature is fatal, from that safe 98.6 to 106, for example, we know that excess body heat must be disposed of in some way. This is true of all warm-blooded animals, and it is a pressing factor when environmental temperature exceeds body temperature.

One of the important means of cooling the body is by sweating or panting, which really is the original evaporative cooler, developed by Mother Nature. This loss of heat by evaporation depends on the fact that a certain amount of heat is required to change water to water vapor at the same temperature.

We can measure this in a laboratory. In the case of a human body, *each gram of water evaporated from the skin at room temperature results in a heat loss of 500 calories.* (To convert that to measurements in your own kitchen, an eight-ounce tumbler of water is about 228 grams.)

Mother Nature's evaporative cooler in man is much more efficient than the one on your roof. In fact, the heat loads handled by sweat glands and cutaneous blood vessels in man are very impressive. Sweating pours out water at the rate of more than two gallons a day. This increased movement of water from the body is equivalent in activity to moving more than an additional two tons of blood circulated through the skin each 24 hours.

Must Replace Lost Water

Let's go back to that evaporative cooler on your roof. When the little water pump becomes clogged, the fans circulate hot air through the house, the house warms up, people begin to grumble and Dad has to get out the ladder and make repairs, so those cooling pads will be water-drenched again. Likewise, in the human body, water lost by evaporation must be replaced. When it's hot you sweat, and when you sweat a while you get thirsty. Blood volume and the water volume in your tissues must be maintained in order for other body functions to perform properly.

When animals are not completely adapted to hot weather, thirst is a lagging guide to water requirements. At such times, and under natural conditions, water intake is not adequate for water requirements. This, in turn, results in partial dehydration, which can be an important factor in affecting heat tolerance, because the rise in body temperature is in direct proportion to the water deficit.

Even under conditions of negative water balance, when water intake is inadequate, sweat secretion continues to be active. This, in turn, aggravates the already troublesome condition of an inadequate water supply in the body tissues. Thus, it is important that the thirst process be brought

(Continued on Next Page)

Table 1. Average Water Consumption (cc.) for 13-Week Test Period at 95° F. and 72° F. Environmental Temperatures

	Environmental Temperature			
	95° F.		*72° F.*	
Selected Group	*Males*	*Females*	*Males*	*Females*
High water consumption	7430	6915	4933	4907
Low water consumption	2865	2565	2783	2261
Controls	4604	4358	3607	3127

(Continued from Previous Page)

into balance with water requirements as soon as possible.

"Control Tower" in the Brain

The physiological basis of thirst is not at all clearly understood. It is considered that the brain has a specific area which functions as a complicated computer. This area is connected to various nerves that form a system which samples the effective osmotic pressure of the body tissue, blood volume, and temperature receptors located at various parts of the body. It then transfers this information into appropriate actions for regulation of kidney activity and water consumption behavior. This specialized regulating center appears to be located in the hypothalamus, a small "control tower" located at the floor of the brain.

A research project has been under way the past two years to provide information which would give us a better understanding of the genetic and physiological basis of thirst and water requirements. For this research, the laboratory rat was used as the experimental animal. At the start, parental stock was obtained from a large number of different sources to provide a wide genetic base. The resulting litters (there are 10 to 14 in a litter) were weaned when they were 21 days old and immediately placed on test.

Tests were conducted in two environmental chambers. Chamber 1 was maintained at a constant temperature of 72° F. with 50% relative humidity. Chamber 2 was kept at a constant temperature of 95° F. with 35% relative humidity. Immediately after weaning, each litter was divided, with half of the animals maintained in each environment. They are numbered and kept in individual cages for a 13-week period. During this entire test period, daily water consumption was measured for each animal.

Measure Water Intake

This can be done accurately, since the water is provided in a glass bottle hung on the outside of the cage. The bottle has a small bent tube inserted through a rubber stopper, and the rat obtains water by licking the end of the bent tube. Thus, there is no water loss by evaporation or spilling. The rat is early maturing and reaches sexual maturity by 10 weeks of age. Thus, the 13-week test period takes the rat from weaning to approximately mature body size. Since 102° F. is the lethal temperature for the rat, this test period at 95° F. is about the same as a person remaining at a constant 105° F. temperature from 4 years of age until 18 years of age.

The rat has few, if any, functional sweat glands in the skin. He does, however, have sweat glands on the foot pad, as does the dog. However, there is still water loss through the skin, probably by a process of diffusion rather than secretion.

At the completion of the 13-week test period, selections were made on the basis of their water consumption. At each environmental temperature, selection of males and females was made for both high and low water consumption. Their progeny, in turn, followed the same test procedure as was done previously. Random-mated control animals were also included in the testing to provide a base for comparing the effectiveness of this selection procedure.

The animals adjusted to the high temperatures very well. By the second generation the death loss was less than 5%, about equal to that of the 72° F. animals. In fact, animals transferred from 95° to 72° F. after the test period appeared rather uncomfortable for several days. We have also found that fertility does not appear to be appreciably affected by the long residence at the high temperature.

The selection for high and low water consumption at the two environmental temperatures has been effective. Averages of the 13-week water consumption for the selected groups and the control group are given in Table 1. Although the average values show marked differences among the groups, there is still considerable variation within each group.

Great Range of Intake

In the high water consumption group there were some individual animals that consumed more than 10,000 cc. of water during the test. In fact, during the first few weeks, some animals actually drank more than their own weight in water every day. Other animals under the same conditions drank only one-tenth of this amount.

It was also noted that litters in the high water consumption group at 95° F. were not generally in the high consumption group at 72° F. Those that consumed the least water at 95° F. had litter mates which were also in the low group at 72° F.

Certainly, adequate water consumption is necessary for the greatest animal gain. Still, the gain in weight for these selected test animals is not at all in proportion to their relative water consumption, especially with the high water consumption group.

Blood samples have been obtained from the test animals for laboratory analysis. These data will be used to determine what effect the relative water consumption has on various blood constituents. This work will continue for at least two more generations, in order to provide adequate numbers of animals of each performance group for more detailed physiological and biochemical studies.

PARKER VALLEY'S RECLAIMED LANDS YIELD BIG CROPS

Bumper crops are being harvested from some 2,000 acres of reclaimed land in the Parker Valley of Arizona — the nation's oldest irrigation project.

Irrigation came to this section of the Colorado River Indian Reservation in Yuma County in 1867. But much of the land had to be abandoned because of a rising water table which allowed salts to accumulate in the root zones.

Faulty drainage prevented the excessive water, and salts, from being carried off.

Then in 1955, a soils and drainage study by the Bureau of Indian Affairs led to the reclaiming of 2,000 acres with indirect benefits spreading to an adjacent 1,400 acres.

Bureau engineers cut a 16-foot drainage canal 2¾ miles long through the abandoned or marginal lands. It was then flooded with water for 60 days.

The results were shown in salt surveys of 1956 and 1961. In 1956, the survey showed salt deposits of 100,000 tons. Five years later, the salt was reduced to 7,000 tons.

Elwin Hanna of E & M Farms leases about 600 acres of the land. His first wheat crops in 1956 yielded three-fourths of a ton per acre. He rotated his crops and last year the yield went as high as two tons an acre.

Dixie Ranches produced an excellent cantaloup crop this year as well as premium alfalfa hay on some 1,460 acres. Also doing well are cotton and grains.

Tim Dye, land operations officer, says a close watch on the water table continues and that further reclamation work will be done as funds are available.