THE AOUDAD SHEEP
AN EXOTIC INTRODUCED IN THE PALO DURO CANYON OF TEXAS[1]

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ABSTRACT

A ten-year study of the reaction and adaptability of the introduced Aoudad sheep (*Ammotragus lervia*) in the Palo Duro Canyon of Texas was begun in the winter of 1957-58. At that time, forty-two sheep from the McKnight Ranch, Picacho, New Mexico, were released into the half-million acre Palo Duro Canyon.

The exotic sheep were introduced into the canyon to fill a separate ecological niche and to share the vast reaches of the canyon, noncompetitively, with native mule deer. The aoudad, a hardy big game animal, was to become a real challenge to sportsmen in the rugged terrain of the Palo Duro Canyon.

The first six years of the study were spent in trying to determine an adequate census technique, habitat preference, reproduction, and sheep movement studies. In the seventh year after the aoudad sheep release, an adequate population was thought to be present in order to have a limited experimental hunt. Four, either sex, hunts have been held with 247 sheep permits being issued, and 57 aoudad sheep harvested with a hunter success of 23.08 percent.

Reproductive organs, stomach, and blood samples were collected at department-operated check stations during the four hunts. Thirty-one rams and twenty-six ewes have been harvested. Of the 26 ewes, 16 were pregnant with 27 fetuses. Stomach sample analyses have indicated that shinoak, mesquite, and mountain mahogany are the major vegetative forms browsed by the aoudad. All blood samples registered negative to Brucellosis and three serotypes of Leptospirosis.

A helicopter census initiated three years ago to determine relative sheep population has been the most successful census method to date. The helicopter is the only conveyance that can successfully cover large tracts of land in a relatively short period of time and permit observers to see firsthand where sheep range. A CO_2 paint pellet pistol was used experimentally to mark the sheep and to acquire a more reliable estimate of the population with the Lincoln Index.

The aoudad sheep, since 1957, has populated and expanded their range a distance of over 20 airline miles from the two release sites. In ten years the 42 original sheep have grown into an estimated population of 600.

Native to the Atlas Mountains of North Africa, aoudad sheep (*Ammotragus lervia*) were first imported into this country by the Jersey City Zoo on December 14, 1900. The zoo stock prospered, and other zoos and private individuals acquired the surplus aoudad sheep. In 1950, New Mexico obtained a herd of the drought-resistant sheep from the McKnight Ranch near Picacho, New Mexico, and released them near the mouth of the Canadian River gorge where native bighorn restocking programs had failed. The McKnight stock was acquired from the Hearst Ranch, San Simeon, California, which originally obtained their sheep from zoo surplus.

Since released in the Palo Duro Canyon, in 1957, it is believed the original 42 aoudads (12 rams, 22 ewes, 10 lambs) have multiplied into

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a herd of approximately 600. The aoudad sheep is an attractive big game animal with horns on both sexes gracefully curving backwards. The ruddy or buff colored coat has a fringe of long hair around the throat extending down to the forequarters, which forms the mane. Long hair called chaps is also present on the anterior surface between the front legs. Dead air-celled hair protects the sheep from a harsh environment. Natives in the dry Sahara Desert mountains made ropes using the long hair of the sheep. The aoudad's eyes, reputed to be of telescopic power, have a horizontal pupil and a brilliant yellow iris.

The aoudad's new home in Texas, the Palo Duro Canyon, is comprised of some half million acres. The name of the canyon is a Spanish term for "hard palings" (hard wood) and, as it implies, the canyon abounds with hardwood or junipers which were commercially logged during the 1890's and early 1900's. The canyon was formed entirely by erosion. It is a rocky, very rugged area and most suitable to the hearty aoudad.

DISTRIBUTION

Since 1957 when 31 sheep were released in Armstrong County, southwest of Claude, they have dispersed a distance of 20 airline miles to the south of the release area and westward within and surrounding the Palo Duro State Park. Aoudad sheep were seen in the park on three separate occasions in 1966, two of which were consecutive days during the late winter when there was little or no public park activity. Sheep herds of up to 43 in number have been observed on the Christian, Harrell, and Ransom ranches, southwest of Claude.

Near the Quitaque release site where 13 sheep were released in 1958, reports of sheep sightings have been more frequent during the 1965-66 and 1966-67 years than during any of the previous years since their introduction into Briscoe County. From the number of reported sightings in the northeast portion of Floyd County (Los Linguish Canyon), there seems to be a tendency for the sheep in this area to expand southward. Three new counties, Donley, Hall, and Swisher, have been included to make aoudad sheep game animals. This was done to keep pace with the ever-expanding aoudad sheep movement and population along the Palo Duro Canyon and its associated water courses.

POPULATION

Seventeen lambs were observed with 55 adults during the 1965 helicopter census, 32 lambs were observed in the 1966 census along with 90 adults, and 24 lambs with 90 adults were observed in the 1967 census.

The four aoudad hunts netted 26 ewes of which 16 were pregnant with 27 fetuses (10 males, 12 females, 5 unknown). Five ewes had eight lambs by their sides, and three were not pregnant. Of the pregnant ewes, one had triplets, nine had twins, and six had single fetuses.

Recorded information from the four hunts tend to corroborate other data leading to a high reproductive rate for the aoudad sheep. As noted previously in the hunt data, ewes (with a gestation period of 5.5 to 6 months) are almost always pregnant or lactating.

Lambs have been seen during most of the year, but the greatest increase in observances is during March, April, and May.

At present there is no indication of the sheep population. However, there are definite indications that the population is steadily increasing. Sheep observations by ranchers and game department personnel have been increasingly more frequent, and sheep are being sighted in areas where they have not been reported before (i.e., Los Linguish Canyon, Floyd County and Prairie Dog Town Fork of the Red River in Hall County).

With over one-half million surface acres in the canyon, the aoudad has much room to expand before a stabilized sheep population will exist. The author believes that there are approximately 600 sheep in the Palo Duro Canyon and its other associated rugged areas.

There have been 10 known sheep deaths since the release of the

aoudad into the Palo Duro Canyon. One ewe was illegally shot in 1961. Three were believed to have died as a result of a snow storm during February of 1964 when 17 inches of snow fell in 3 days. One ram had its neck broken in 1965. Four other aoudads were too badly decomposed to determine the cause of death. One ram was illegally shot in March, 1967, in Los Linguish Canyon; the carcass had been caped out.

There has been no known predation upon the aoudad sheep. Bobcats are plentiful in the Palo Duro Canyon; some coyotes are there also; but it is doubtful if predation is of much consequence because of the aoudad's ability to live in and scale terrain which would impede the potential predators.

HABITAT PREFERENCE

When the aoudad sheep were introduced into the canyon, it was thought that the sheep, because of their habit of staying in the roughest terrain, would not compete directly with other animals. In effect, they would occupy a separate ecological niche, utilizing vegetation that was not accessible to either livestock or deer. Observation has borne this theory out, but at the same time the sheep have been competing with livestock by coming into winter wheat fields tangent to the canyon. This has been reported for the past four winters. In 1962 one farmer lost five acres of winter wheat directly attributable to the aoudad sheep. In January and February of 1967 approximately 40 acres of shocked grain sorghum was lost to sheep on the Ransom Ranch, due in part to the severe seven-month dry spell when browse in the canyon was at its poorest condition.

Aoudad sheep are usually seen in close association with the naked shale bluffs which may serve two important functions for the sheep. Usually these clay bluffs are very steep and hard for anything except sheep to traverse. They also offer bedding sites which seem quite important to the species.

The helicopter censuses allowed project personnel to go into parts of the Palo Duro Canyon where no other type of conveyance could travel. As a result of the aerial census, more information about the habitat preference of the aoudad sheep was discovered. The sheep were found mainly on the very roughest areas of the canyon where the terrain is almost inaccessible to humans. The sheer wall, the first step (shelf) down from the caprock, is where the majority of the sheep were found. Sheep were not found on the bottom of the canyon; or up on the caprock unless they were driven there. They would not run parallel with the helicopter as mule deer would. Mule deer seen during the helicopter census were found on the lower reaches and on the bottom of the canyon. No deer have been observed with aoudad sheep.

Periodic checks of browsing were made in the Palo Duro Canyon. Mountain mahogany (*Cercocarpus montanus*) lends itself well to browsing checks because it is not as plentiful in the canyon as the other types of preferred vegetation. When browsed, this species takes on a shrubby appearance. Some of the shrubs are browsed much more heavily than others, depending upon the proximity of the plant to sheep trails. The most severe browsing pressure is put on mountain mahogany along the rim of the canyon where the sheep and deer have made trails up and out of the canyon. Droppings are found around these shrubs in considerable quantities. Deer compete with aoudad sheep for this species.

AOUDAD SHEEP HUNTS

During the four hunts a total of 247 permits have been issued, and 57 sheep (31 rams, 26 ewes) have been bagged. Since the total aoudad sheep population is still unknown, permits were issued on a conservative basis using landowner acreage, sheep signs, and sheep observation as a scale. An either sex hunt was decided upon because of little sexual dimorphism and also to collect reproductive organs from the ewes harvested. The area involved in the sheep hunt was over 160,000 acres. A three-day hunting season was scheduled for the second week-end in

December. From previous information, this period would be about 45 days after the peak of the breeding season. This period would be advantageous to the game manager for the collection of reproductive specimens.

In 1966 of the 85 permits issued, 8 were not issued to hunters. The 77 that did hunt harvested 19 sheep (10 rams, 9 ewes) for a hunter success of 24.67 percent. During 1965, 70 permits were issued, and 16 sheep (8 rams, 8 ewes) were bagged; in 1964, 50 permits were issued, and 13 sheep were harvested (7 rams, 6 ewes); and in 1963, 42 permits were issued, and 6 rams and 3 ewes were bagged for a total of 9.

The sheep bagged were brought to either of two department-operated check stations for the purpose of collecting data from the sheep. Blood, stomach samples, and reproductive organs were collected. Standard measurements and the hog-dressed weight of each animal were recorded (Table 1). The largest sheep killed, a ram, weighed 230 pounds dressed

TABLE 1 — AOUDAD SHEEP CHECK STATION DATA — 1966

Sheep Number	Sex	Dressed Wt. in Lbs.	Horn Length	Approximate Age
1	Female	82	16 3/4	6
2	Female	110	18 3/4	3
3	Female	70	11 3/4	2
4	Female	95	17	2.5
5	Female	85	15 1/4	3
6	Female	115	18 1/2	4
7	Female	85	16 1/2	3
8	Female	150	26 3/4	4
9	Female	89	10	2
10	Male	[1]	26 3/4	7
11	Male	200	23 1/2	4
12	Male	178	28 15/16	4
13	Male	230	29 1/4	5
14	Male	145	21 15/16	4
15	Male	230	31 1/2	7
16	Male	200	18 1/2	3
17	Male	175	26 1/2	5
18	Male	131	13 1/2	4
19	Male	220	30	6

[1] Cape only was brought out of the canyon.

with a horn curl length of 31.5 inches while the smallest, a ewe, weighed 56 pounds.

Blood samples were taken to the Northwest Texas Bangs Laboratory in Childress for testing of Leptospirosis (3 serotypes) and brucellosis. Forty-seven samples taken during the past four hunts have registered negative for both diseases.

One-quart stomach samples were taken from each sheep when possible. The samples were then washed and air dried. Thirty-five samples were examined, and the vegetation recorded by species. The analysis of stomach samples during all years has shown shinnery oak (*Quercus havardi*) as the predominant species. Mountain mahogany and mesquite (*Prosopis juliflora*) were of less importance. Grasses were not present in the sheeps' stomachs in large quantities in 1966 due to a five-month dry spell previous to the sheep hunt.

All sheep harvested have been brought to the check stations except two rams in 1965 and one in 1966. These three were shot in such difficult terrain that only the capes of the rams were brought out.

On the average, it was necessary for the successful hunters to hunt 13 hours and 43 minutes to bag each sheep. One hunter bagged his sheep in 20 minutes; while, at the other extreme 26 hours was necessary for a hunter to shoot his sheep. The sheep are difficult to locate. Once located and stalked, they are fairly easy game. In 1966, 19 successful hunters

fired 56 shots with 31 hits on the sheep, an average of 1.8 hits to down a sheep, with a spread of 1 to 7 shots fired and 1 to 3 hitting the sheep.

The average distance shot in 1966 was 262 yards, with extremes of 25 to 500 yards. All hunters used binoculars in locating the sheep, and most used telescopic sights in shooting the sheep.

The aoudad sheep hunts were prompted by a desire to obtain more scientific data coupled with the landowners desire to hunt. Out of state hunters have come from Michigan, Illinois, Florida, and Colorado.

HELICOPTER CENSUS

To obtain a better indication of the aoudad sheep population, a helicopter has been experimentally tried for the past three years in the early spring of 1965, '66, and '67. A Hughes 300 helicopter was used for 20 hours, 25 hours, and 32 hours, consecutively. Flights were made in the morning or late evening hours which were assumed to be the times of the greatest sheep activity. It was quickly learned that speeds over 30 miles per hour were too fast for best observance.

The 1967 helicopter census was enlarged in scope to include Briscoe County along with the two-time-censused Randall and Armstrong Counties. For the second year aoudad sheep were to be marked if possible with a Nelspot 707, CO_2 paint pellet pistol. A surgical rubber slingshot was also used because of its rapid firing capabilities. Sheep were marked for movement studies.

In the spring of 1967, 114 aoudad sheep along with 178 mule deer were sighted (Table 2), and 9 sheep were marked with the CO_2 pistol

TABLE 2 — 1967 AOUDAD SHEEP HELICOPTER CENSUS COMPARED WITH 1966 AND 1965 CENSUS

Date	Aoudad Sheep			Mule Deer			
	Adults	Juveniles	Total	Bucks	Does	Fawns	Total
1965							
February 16	24	4	28	6	13	4	23
February 17	7	2	9	5	4	4	13
April 27	24	11	35	2	24		26
	55	17	72	13	41	8	62
1966							
April 12	28	6	34	12	52		64
April 13	6		6	12	40		52
May 3	34	12	46		40[2]		40
May 4	22	14	36		24		24
	90	32	122	24	156		180
1967							
April 10	13	4	17	7	31	8	46
April 12	25	5	30	8	52	3	63
April 14	21	3	24[1]	6	13		19
April 15			0[1]	1	7		8
May 10	23	6	29		24[2]		24
May 11	8	6	14		19		19
	90	24	114	22	146	11	179

[1] Helicopter census in Briscoe County, all other flights in Randall and Armstrong Counties.

[2] The May 1966 and 1967 census indicated that all buck mule deer had lost their antlers between April 10 and May 3, and the fawns were as large as their mothers so that all mule deer were lumped into the doe category.

and slingshot. Twelve sheep were hit with the pellets, and three of the pellets bounced off the sheep when hit in soft areas of the body. Only adult rams were chased and marked, if possible, due to the size of the sheep, a bigger target; and it was thought that this experience would damage the rams less than ewes or lambs.

Helicopter flights were made a month later to count the number of marked aoudad sheep versus unmarked sheep and apply the Lincoln Index. Of the nine sheep marked during April, none were found during the May flights. It is very unlikely that the paint could have worn off in 30 days. A more plausible explanation is that the small area marked by the paint pellet was just not seen. It may have been such a traumatic experience for the sheep that they left the area or hid when they again heard the helicopter. However, there have been no reported sightings of the marked sheep.

Table 2 shows a comparison of the 1965 census and 1966 census with the 1967 census. Seventy-two sheep (4.50 per hour) were seen during the 1965 census as compared to 122 (4.88 per hour) seen during the 1966 census and 114 (3.50 per hour) in 1967. Sixty-two mule deer were counted in 1965, 180 in 1966, and 178 in 1967. Ninety aoudad sheep were seen in Randall and Armstrong Counties and 24 in Briscoe County.

For the best chance of sighting the sheep the ideal flight location for the helicopter is 100 feet down from the top of the canyon and about 100 to 200 feet away from the canyon wall. Most of the sheep were seen below the helicopter and to the wall side of the canyon. The noise of the approaching helicopter made the animals move. If the sheep had not moved, it would have been almost impossible to see them as the aoudad's coat color is nearly the same as that of the canyon wall. The sheep reacted differently to the approach of the helicopter. Some would trot a few yards and look curiously up at the helicopter; others would trot to hide under mesquite and juniper trees; while, other sheep continued to trot off away from the path of the helicopter. They would not run parallel to the helicopter. The sheep would not panic and run blindly but moved off into a set pattern of escape which was opposite of what mule deer would do.

The helicopter's ability to cover large tracts of land in a short time and to travel where no other conveyance can go tends to overshadow all other attempts to arrive at a sheep population estimate. While it is an experimental technique and may prove invalid or too variable, it is presently the best method. When used along with the helicopter census, the collective observations of ranchers and ranch employees along the Palo Duro Canyon tend to be the best criteria of sheep abundance at the present time.

DISCUSSION

The aoudad was introduced into the Palo Duro Canyon in order to increase the hunting potential in the Texas Panhandle. Until the release of the aoudad sheep, the canyon had little wildlife to hold the hunters' interest. Some mule and white-tailed deer lived around the perimeter of the canyon, but the population was small and little hunted.

As with every introduced exotic, competition is likely with some native game species. By stomach analyses, aoudad sheep compete directly with mule deer and to some extent with livestock in the Palo Duro Canyon. However, the aoudad sheep browses the more difficult and rugged areas of the canyon; while the mule deer usually stays on the gentler slopes of the canyon. The aoudad then uses vegetation that the deer will not or cannot browse.

The Palo Duro Canyon is surrounded by prairie and rolling plains country. The likelihood of an undesirable cursorial species expanding from the Palo Duro Canyon is very small.

For the sportsmen who want a truly difficult and sporting game trophy, the aoudad offers the best challenge in Texas.