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ELECTROCUTION OF A CARIBOU HERD CAUSED BY LIGHTNING IN CENTRAL ALASKA

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Abstract: Fifty-three caribou *(Rangifer tarandus)* were electrocuted by lightning in the Alaska Range in early June 1972. A giant Lichtenberg pattern, found engraved onto the Arctc tundra terrain at the kill site, is described. It is estimated that an event of this type would be expected to occur in Alaska at a frequency of once every several decades.

Fifty-three Alaskan caribou evidently were killed by a single lightning flash in the early summer of 1972. The carcasses of 48 adults and five recently born calves were discovered in a mountain valley of the Alaska Range in late June by a U.S. Army helicopter crew on a routine flight-training mission. The find was immediately reported to the Alaska Department of Fish and Game and subsequent examination by one of us (KAN) of the decomposed remains, which had been nearly consumed by scavengers, failed to reveal any obvious signs of the cause of the mass mortality. Representative samples of rumen contents were taken for toxicological examination, but analyses by personnel of the Denver Laboratory of the U. S. Fish and Wildlife Service failed to reveal any evidence of a number of toxic substances of possible interest. These included: 1080, strychnine, thallium, mercury, lead, selenium, organophosphates. Arsenic (0.03 ppm) and the chlorinated hydrocarbon DDE (0.3 ppm) were detected at insignificant levels. It is also worth noting that there were no signs in the general vicinity of the kill-site of dead scavengers or other caribou carcasses. Two other bands of caribou within 1-2 km of the kill-site appeared normal in all respects.

Subsequently, it appeared advisable to return to the kill-site to evaluate lightning as a possible cause of the deaths and the senior author was invited to participate. On this occasion, weather and other conditions were more favorable for low-altitude, visual inspection of the overall kill-site and the physical signs of lightning stroke as described below were readily evident. Because five calves were among those killed, it was possible, by considering the normal period of calving, to set the most probable date of the kill on or about June 5.

The animal carcasses were found at an elevation of 1450 m above mean sea level at approximately the center of a broad U-shaped glacial valley drained by a small creek. The approximate coordinates of the site are 64°22'N, 146°11'W. The terrain immediately surrounding the site is flat with a slope of one in ten toward the NW. The only vegetation in the vicinity is that typical of alpine tundra, extending only several centimeters above the soil surface.

This valley is located in the foothills of the Alaska Range, and the site is near several individual mountain peaks. Mount Moffit, elevation 4020 m, is 11 km to the southwest; McGinnis Peak, elevation 3480 m is located 9.5 km to the south and the valley itself descends from a subsidiary unnamed peak with an elevation of 2740 m; this peak is located 4 km southwest of the site.

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The Alaska Range is large enough to create its own weather patterns, and thunderstorm activity is relatively high in the summertime. Lightning-caused brush fires were reported during the first week of June in the vicinity of the Alaska Range, indicating there was lightning activity present at approximately the time when the animals expired.

A surveillance of the area was made by helicopter on August 5, 1972 during relatively good weather conditions. From the air, the most obvious manifestation of a lightning stroke was the presence of a giant Lichtenberg figure engraved on the ground at the kill site. This pattern, easily recognizable from both the air and the ground, consisted of a series of radial lines that extended outward from a circular central area of about 5 m in diameter composed of a complex pattern of interwoven marks. Outside of this central area there were approximately nine individual spokes, some larger and more distinct than others, which ran outward in tortuous paths, becoming smaller as they progressed outward.

When the Lichtenberg pattern was inspected at close range from the ground, it was found that the markings were actually trenches dug into the tundra. There was no evidence of burning, but it is possible that the intervening weeks of growth of the tundra may have obliterated any original burn marks. In some instances, we noticed that roots extending into the trenches showed a slight darkening that may have resulted from burning or heating.

Radial trenches that emanated from the central area were typically about 18 cm in breadth and 8 cm in depth. As one followed them outward, they became narrower, and also shallower, until they eventually disappeared. On the average, the trenches extended out to a distance of some 30 m; however, one trench was followed for a radial distance of 65 m.

The Lichtenberg pattern was slightly asymmetric; the majority of the tentacle arms ran toward a creek bed to the SE and a swampy area to the northwest. At the impact point of the flash there was no well-defined crater, and we found no fulmganite at the impact area nor did we find any other evidence of melted or fused sand or soil from ohmic heating.

The caribou carcasses were distributed throughout an elliptical area with major axis of about 130 m and minor axis of about 60 m. The impact point of the lightning flash was displaced 20 m to the SW from the center of the ellipse. Thus, the elliptical area containing the carcasses perhaps represented the outline of a caribou herd that happened to be resting or moving down the valley when the lightning flash occurred.

One can speculate as to whether or not the presence of the caribou on the relatively flat terrain had any effect on the ultimate impact point of the lightning channel. A vertical lightning rod yields an approximate zone of protection which can be described as a cone with a semivertex angle of about 45°. Extrapolating to a caribou standing 1.5 m high, one concludes that the animals must have had a negligible effect on changing the channel path direction and the flash probably would have occurred within a few meters of the same location whether or not the caribou were present.

Judging from the large horizontal extent of the lightning-caused trenches, the electric current transfer in the ground must have had an unusually large horizontal component. This is not too surprising when one considers that the ground was probably quite moist from melting snow and consequently the electrical conductivity was high in the tundra cover and within the top few centimeters of thawed soil. The soil moisture content drops rapidly as one penetrates down and there is an attendant drop in conductivity. Much of the current transfer was presumably by surface leaders. The caribou presumably died from the potential difference developed between the animals' front and back hooves caused by the large horizontal current flow along the ground.

One might suppose that lightning kills of wild animals occur relatively infrequently. To provide a crude estimation of the rarity of such an event, we present the following, admittedly crude,

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calculation which indicates that electrocution of wild animals by lightning might not be so rare as one might at first imagine.

Consider that there are an estimated 600,000 caribou in Alaska.[3] The area of Alaska is 1.51 x 10^6 km^3 (585,000 square miles) which yields a caribou density of 0.395 caribou/km^2 (about 1 per square mile). The estimation of lightning-frequency in Alaska is difficult, but to obtain an order of magnitude we can argue that the mean global earth-air conduction current (estimated as about 10^{-12} ampere/m^2) is balanced, on the average, by charge carried to earth by lightning.[2] Using a value of 4 Coulombs transferred to ground per lightning flash, one deduces that there is about one lightning flash every 2.6 seconds somewhere in Alaska during the summer.

If we assume that each caribou in Alaska is surrounded by a vulnerable area of some 4 m^2, then the ratio of the vulnerable area of caribou to the area in Alaska is of the order of 1.58 x 10^{-7}. Using a stroke frequency of 2.6/second, one deduces that caribou will be hit by lightning approximately once every 25 years. Naturally, we view this figure with a certain amount of skepticism, since obviously there are a number of complicating factors that have not been considered. However, the caribou of the Alaska Range, being an animal of the alpine tundra, quite often will be exposed to mountain thunderstorms and it is therefore conceivable that caribou in such areas might get struck by lightning at a frequency of once every several decades.

Considering the lack of evidence of other causes of mortality and the obvious signs of lightning stroke, electrocution by lightning must be considered the most likely cause of death. Lightning is well known as a source of mortality of domestic animals with as many as twenty head of cattle[1] known to have been killed by one stroke. A cursory search of the literature has failed to turn up incidents involving wildlife. However, we have heard of a lightning stroke that killed four African elephants (personal communication, Dr. William Longhurst, Univ. of Calif., Davis). Dr. Charles Cushwa, The Forestry Science Laboratory, University of Alaska, told us of the mass death by this means of five white-tailed deer (personal communication). No doubt mass mortalities of gregarious species of wildlife by lightning stroke occur more often than is indicated by the apparent paucity of records in the literature.

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