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Case Report

Using an alternate light source to detect electrically singed feathers and hair in a forensic setting

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ABSTRACT

Mortality due to electrical injury in wildlife may occur in the form of lightning strike or power line contact. Evidence of electrical contact may be grossly obvious, with extensive singeing, curling, and blackening of feathers, fur, or skin. Occasionally, changes may be subtle, owing to lower current or reduced conductivity, making a definitive diagnosis of electrocution more difficult. We describe the use of an alternate light source in the examination of cases of lightning strike and power line contact in wildlife, and the enhanced detection of changes due to electrical currents in the hair and feathers of affected animals. Subtle changes in the wing feathers of 12 snow geese and 1 wolf that were struck by separate lightning events were made obvious by the use of an alternate light source. Similarly, this technique can be used to strengthen the evidence for power line exposure in birds.

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1. Introduction

Electrical injury may occur due to contact with physical producers of electricity, such as power lines, or through discharges of atmospheric energy in the form of lightning. Electrocution via contact with power lines is a significant cause of continued mortality in birds worldwide [1–3]. Contact between two portions of a power line – either wire-to-ground or wire-to-wire – is required for an electrical current to course through a body and deliver an electrical shock [4]. Diagnosis of electrocution as the cause of death in birds generally takes into account the initial location of the dead bird (i.e. proximity to power lines), visible singeing of the feathers, or changes in the soft tissues that are consistent with electrocution injury [5]. Singeing may be obvious, and a strong electrical current can occasionally cause amputation and cauterization of appendages. In some cases of electrocution, however, changes in the skin and plumage are very subtle and easily missed on routine examination.

Lightning mortality has been documented in various species of livestock [6,7], and has rarely been described in wildlife [8]. Diagnosis of lightning strike in animals often depends on the visualization of linear tracts of singed hair, but this change is not always noted.

Tunable or alternate light sources (ALS) are often used in forensic science to analyze for fingerprints, body fluids, or trace evidence [9]. The principles behind ALS technology capitalize on the light absorptive or photoluminescent qualities of the item under examination. For example, because blood absorbs shorter wavelengths and reflects longer wavelengths in the range of 635–700 nm, visualization of blood and bruising can be enhanced by exposing the area to wavelengths in the blue or violet spectrum (400–480 nm). These wavelengths are absorbed by the blood and little such light is reflected, making the area appear significantly darker. An item that exhibits photoluminescent qualities will absorb light of a certain wavelength, and emit light of a longer wavelength.

In this work, we describe the use of an ALS to detect and highlight the singeing of feathers and hair that have come into contact with overhead power lines or a weather-related electrical current (lightning).

2. Materials and methods

Specimens in the study included six bird skins (animals 1–6), sixteen intact birds (animals 7–10, and 12–23), and one intact wolf (animal 11). Gross, unenhanced, external examination of the animals occurred under standard fluorescent lighting in an enclosed space with no windows to the outside. Birds that were chosen for the study had grossly detectable evidence of electrocution, or lacked gross evidence but were suspected to have been electrocuted based upon conversations with the

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specimen-submitting parties. The wolf was scanned with the ALS as part of the routine post-mortem investigation of this species. The skins were examined from animals that had been previously necropsied; all other animals were scanned either prior to undergoing necropsy examination (animals 7–17), or as part of an external-only examination (animals 18–23). Singeing of feathers and fur in animals with subtle changes was confirmed by the use of a Nikon SMZ-10 dissecting microscope.

An Omnichrome Spectrum 9000+ alternate light source was used to scan the feathers/fur, head, and feet/legs of the animals examined. The wavelength settings of 400 nm, 450 nm, 485 nm, 530 nm, 570 nm, and 700 nm were used, and the operator wore red filter glasses. ALS examinations occurred in a darkened room with mild to minimal infiltrative fluorescent light. Documentary photographs were taken with a tripod-mounted Canon Powershot G11 fitted with a red gel filter.

For control purposes, human hair and body feathers from an eagle were singed with flame from a lighter. The singed feathers and hair were examined with the ALS using the visual filter and wavelengths previously described.

3. Results

Results of the study are outlined in Table 1. All of the 23 animals examined had feathers, hair, or skin that exhibited photoluminescence under the ALS. In all cases, singeing was highlighted and, thus, easier to detect using the ALS as compared with gross visual examination under standard room lighting. In positive animals, photoluminescence was observed through red glasses at settings of 450 nm, 485 nm, 530 nm, and 570 nm, with the strongest glow seen at 570 nm.

On 15 animals, only the feathers or hair were affected. The feet were affected in five birds (see Fig. 1), including two for which the feet were the only anatomic structure affected. Burns were detected on the beak of three birds, in combination with foot lesions in one bird, and feather changes in two others. Feathers were entirely unaffected in three birds, all of which had foot lesions, and one of which also exhibited burns on the beak.

Ten birds were determined to have had direct or indirect contact with power lines, including four bald eagles, three brown pelicans, two red-tailed hawks, and one American coot. Grossly, four of these birds had barely distinguishable singeing of the feathers and no epidermal involvement (gross grade 1), while another four had obviously singed feathers on the body (gross grade 2). In addition to extensive feather singeing, the skin on the feet of one bird was visibly coagulated and blackened (gross grade 3). One bird did not have grossly distinguishable changes referable to electrical contact (gross grade 0; see Fig. 2). Sites of feather

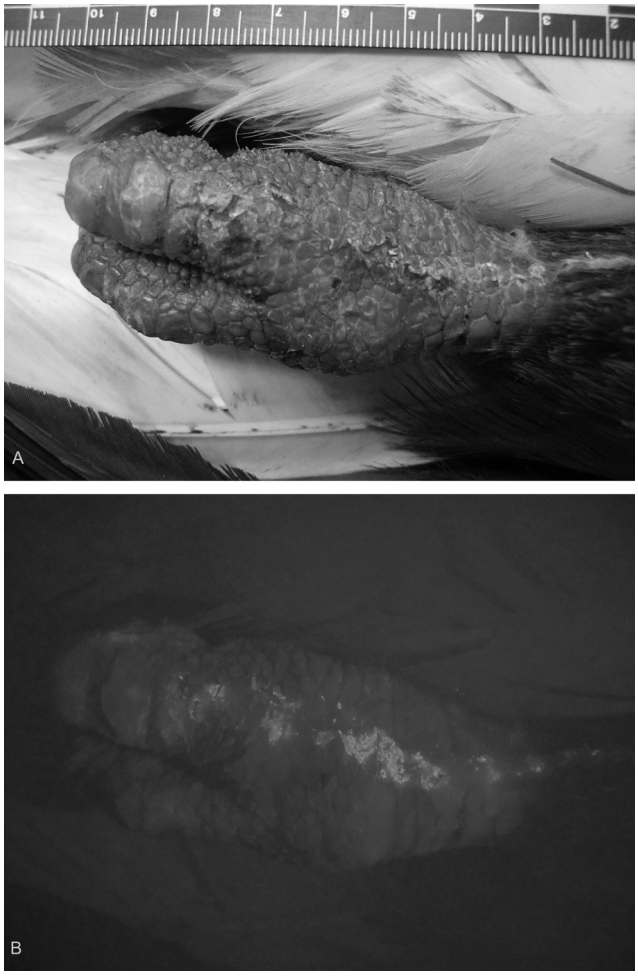

Fig. 1. Linear blistering and excoriation over the dorsum of the foot of a bald eagle (animal 9) electrocuted on a power line. Image 1A was taken under standard room light. Image 1B was taken through a red gel filter and under an alternate light source focused to 570 nm. Note the blackened area of the digit is not photoluminescent and, thus, not indicative of charred skin.

Table 1
Results of examining the plumage/pelage of select animals with an alternate light source for the detection of singed feathers or hair.

Animal #	Common name (*Taxonomic name*)	Gross change grade[a]	ALS results	Electrical contact
1	Brown pelican (*Pelecanus occidentalis*)	1	Feathers and beak positive	Power line
2	Brown pelican (*Pelecanus occidentalis*)	1	Feathers positive	Power line
3	Brown pelican (*Pelecanus occidentalis*)	1	Feathers positive	Power line
4	Bald eagle (*Haliaeetus leucocephalus*)	1	Feathers positive	Power line
5	Bald eagle (*Haliaeetus leucocephalus*)	2	Bottoms of feet positive	Power line
6	Red-tailed hawk (*Buteo jamaicensis*)	2	Feathers positive	Power line
7	Bald eagle (*Haliaeetus leucocephalus*)	2	Feathers positive	Power line
8	Red-tailed hawk (*Buteo jamaicensis*)	3	Feathers and foot positive	Power line
9	Bald eagle (*Haliaeetus leucocephalus*)	2	Feathers and foot positive	Power line
10	American coot (*Fulica americana*)	0	Feathers and debris on back positive	Power line
11	Mexican gray wolf (*Canis lupus baileyi*)	1	Hair positive	Lightning strike
12	Snow goose (*Chen caerulescens*)	0	Feathers positive	Lightning strike
13	Snow goose (*Chen caerulescens*)	1	Feathers positive	Lightning strike
14	Snow goose (*Chen caerulescens*)	1	Feathers positive	Lightning strike
15	Snow goose (*Chen caerulescens*)	0	Beak and feet positive	Lightning strike
16	Snow goose (*Chen caerulescens*)	1	Feathers positive	Lightning strike
17	Snow goose (*Chen caerulescens*)	1	Feathers and beak positive	Lightning strike
18	Snow goose (*Chen caerulescens*)	1	Feathers positive	Lightning strike
19	Snow goose (*Chen caerulescens*)	1	Feathers positive	Lightning strike
20	Snow goose (*Chen caerulescens*)	1	Feathers positive	Lightning strike
21	Snow goose (*Chen caerulescens*)	1	Feathers positive	Lightning strike
22	Snow goose (*Chen caerulescens*)	1	Feathers positive	Lightning strike
23	Snow goose (*Chen caerulescens*)	0	Feet positive	Lightning strike

[a] Gross change grade: 0 = no visibly detectable singeing; 1 = feather and skin burns barely visible; 2 = burns visible but very localized; 3 = obvious feather damage with damage to underlying skin.