Blood lead levels in White-Backed Vultures (Gyps africanus) from Botswana, Africa

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Blood lead levels in White-Backed Vultures (*Gyps africanus*) from Botswana, Africa

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Introduction

Currently vulture populations in sub-Saharan Africa are dramatically declining due to direct and indirect poisoning with pesticides (Ogada 2014, Virani 2011). During a tagging and radio telemetry study from 2012 thru 2015 involving several species of vultures in Botswana, the Denver Zoological Foundation in collaboration with Raptors Botswana investigated lead exposure as another issue that might affect the persistence of vultures in Africa in the future.

Lead toxicity in avian species manifests itself as a cumulative, multi-systemic disease affecting the liver, kidney, heart, gastrointestinal, hematopoietic, reproductive, and nervous systems (Locke & Thomas 1996, Redig & Cruz-Martinez 2009). It is the most common heavy metal poison reported for avian species, including raptors (Mautino 1997). Lead toxicity from hunter-spent lead ammunition is the major impediment to the recovery of the California Condor (*Gymnogyps californianus*) in North America (Finkelstein *et al.* 2012, Stringfield 2012). There have been documented lead toxicity reports for vultures from both the New World (South and North America) and the Old World (Europe, Africa, and Asia). Vulture species reported with lead toxicity include the New World Andean

Condor (*Vultur gryphus*), California Condor, and Turkey Vulture (*Cathartes aura*) and the Old World Griffon Vulture (*Gyps fulvus*), Pyrenean Bearded Vulture (*Gypaetus barbatus*), Eurasian Black Vulture (*Aegypius monachus*) and Egyptian Vulture (*Neophron percnopterus*) (Hernández & Margalida 2009, Mateo 2009, Nam & Lee 2009, Rodriguez-Ramos *et al*. 2009, Kelly *et al*. 2011, Lambertucci *et al*. 2011, Stringfield 2012). However, we discovered no published reports for lead toxicity in African vultures.

Methods

We captured vultures in several regions of Botswana. For capture we used bait and a gas-propelled canon net system (WCS NetBlaster™, Wildlife Control Supplies, East Granby, CT 06026, USA) with a portable nitrogen tank to charge the canon and a 13 m x 17.3 m braided nylon net with a 5.1 cm mesh and 21.8 kg breaking strain. We restrained captured birds in dorsal recumbency for venipuncture from the ventral ulnaris vein. We transferred blood to a purple-top tube (ethylenediaminetetraacetic acid tube, 250-500 µl fill, Capiject, Terumo Medical Corporation, Elkton, Maryland 21921, U.S.A.) for lead analysis. We obtained blood samples from 477 White-Backed Vultures (WbV, *Gyps africanus*) for blood lead testing. Blood lead level (BLL) analyses were performed with the portable LeadCare® I clinical analyzer in 2012 and the LeadCare® II clinical analyzer in 2013 thru 2015 (LeadCare® I & II, Magellan Diagnostics, North Billerica, Massachusetts 01862, U.S.A.).

The LeadCare® I reports BLLs down to 0 µg/dl and the LeadCare II® reports values <3.3 µg/dl as "Low" and both the LeadCare® I & II analyzers report values >65 µg/dl as "High". For statistical analysis we assigned a value of 1.6 ± µg/dl for levels determined as "Low" and a value of 66 µg/dl for levels reported as "High" from both analyzers. There were 72 results reported as "Low" and 7 as "High". We therefore consider our results to be conservative for BLLs.

Results

Across all samples (*n* = 477), mean BLL was 10.6 µg/dl (SE ±0.52 µg/dl) , and the median BLL was 6.8 µg/dl. We divided the results into three categories; <10 µg/dl, 10 - <45 µg/dl, and >45 µg/dl (Figure 1). As per Finkelstein *et al.* (2012), for California Condors, a blood level

≥10 µg/dl is consistent with exposure while ≥45 µg/dl is toxic and a candidate for chelation therapy. Applying these categories to this study 28.51% (*n* = 136) of the birds had BLLs consistent with exposure while an additional 2.31% (*n* = 11) of the birds were consistent with toxicity (Figure 1). Therefore 30.77% of these randomly captured birds exceeded the background 10 µg/dl level. We immediately released birds following processing and prior to analysis so there was no possibility to follow up or treat individuals with elevated BLLs.

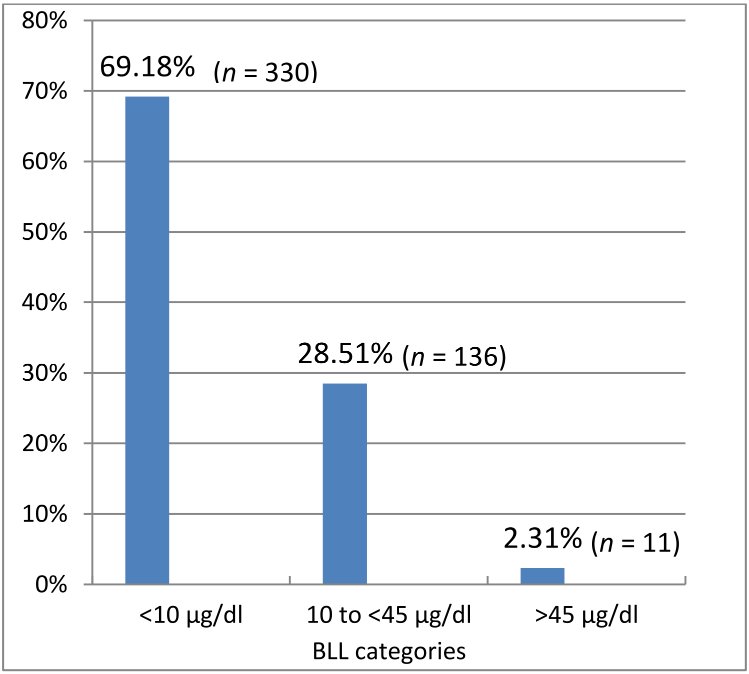

Figure 1: Percentage of 477 White-backed Vultures (WbV, *Gyps africanus*) with different blood lead levels (BLL) for in Botswana.

Discussion

We did not determine the definitive source/s for elevated BLLs in this study but hypothesize that potential sources are hunter-spent lead ammunition, soil, and/or water. The highest mean BLL we determined was 17.7 µg/dl (*n* = 33) on a hunting ranch while the lowest was 6.4 µg/dl (*n* = 42) in a National Park. We therefore suspect that spent lead ammunition is at least partially responsible for the WbV BLLs. We plan to continue sampling other areas in Botswana, including hunting ranches and protected areas, and analyze and report on statistically significant differences between capture sites.

As previously described lead poisoning from hunter-spent ammunition is a significant issue negatively impacting the recovery of the California Condor. Spent lead ammunition in Botswana may originate from legal hunting or illegal poaching activities. Modern firearms achieve high velocities causing lead-based bullets to fragment widely along the wound tract (Stroud & Hunt 2009). In a deer study, 74% of the offal piles examined contained >100 fragments distributed along the wound channel (Hunt et *al*. 2006). This degree of fragmentation would potentially expose many vultures to lead fragments from carcasses or gut piles left in the field. We have no knowledge if there is significant lead contamination in soil or water and available to avian scavengers in Botswana.

The Centers for Disease Control and Prevention (CDC) has adopted the position that there is no acceptable BLL for humans (Pain 1995, Brown & Wheeler 2013). All the known effects of lead on living organisms are deleterious, so there is no safe BLL (Pain 1995). The subtle effects of low-level chronic lead exposure may go unnoticed, but affected animals may be less fit and more susceptible to morbidity and mortality. We are concerned that the cumulative subclinical negative effects from chronic lead toxicity may affect long-term survival for these long-lived and slow reproducing vulture species.

In conclusion, pesticide poisoning is one of the main factors responsible for the major reduction of vulture populations in sub-Saharan Africa and certainly requires an immediate response by the conservation community. In this report we have described an additional problem for vultures – the ingestion of lead. Our results show that this is already happening in Botswana and we suspect in other African countries. Following hunting activities, carcasses or gut piles with lead ammunition fragments left in the field are available for scavengers. As with pesticides, lead-poisoned birds may die and go unnoticed in the bush. More insidious is chronic low-level lead poisoning which might reduce fitness pushing increasingly smaller populations closer to extinction. Solutions to lead poisoning should be proactive, science-based and address ecological, social, economic, and political concerns. A first step in reducing lead levels in the avian scavenger environment would be to replace lead-based ammunition with non-lead substitutes. Soil and water as sources for lead in vultures also merit additional future investigation.

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