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# Inter-Species Differences Between Lead Concentration in the Feathers of *Pycnonotus leucogenys* and *Streptopelia seneglenses* from Different Cities of Saudi Arabia

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**Abstract:** This investigation was conducted to determine lead accnmulation in feathers of wild white-cheeked bulbul (*Pycnonotus leucogenys*) and wild palm dove (*Streptopelia seneglenses*) in order to find which is more suitable to monitor the lead environmental pollution. Feather samples of 270 of *Pycnonotus leucogenys* and 309 of *Streptopelia seneglenses* were collected from three different cities of Saudi Arabia (Jeddah, Riyadh and Al-Kharj) and were analyzed for lead by atomic absorption spectroscopy. The results obtained in this study revealed that the feathers of *Streptopelia seneglenses* have more capacity to retain lead than *Pycnonotus leucogenys* in Jeddah and Riyadh ($p<0.001$) and Al-Kharj ($p<0.05$). The results showed that the lead was concentrated significantly ($p<0.001$) more in vane vexillum as compared to quills and complete feather and was more concentrated in the bird feathers of Riyadh ($p<0.01$) than of the other two cities and least in Al-Kharj ($p<0.001$) in the order of Al-Kharj < Jeddah < Riyadh. These results demonstrate that *Streptopelia seneglenses* is more suitable as a biological monitor for environmental lead exposure than *Pycnonotus leucogenys*.

**Key words:** Lead, pollution, *Pycnonotus leucogenys*, *Streptopelia seneglenses*, feather

## INTRODUCTION

The environment has enormous amount and variety of chemical compounds which, in many cases, are highly complex and being constantly released mainly from many sources. Hnman being is exposed to lead from different sources such as mining, refining of lead, tubes and house hold articles, batteries, gasoline, paint, ammunition and leaded gasoline (Jahansen *et al*., 2006).

Environmental pollutant affect some species more than others, whether they are micro-organism, plants or animals (Burger and Gochfield, 2000; Dauwe *et al*., 2002; Pain *et al*., 2005). Birds are in contact with metallic objects that contain lead such as caging objects, paints, solder, batteries, stained glass, shotgun pellets, cable sheathing, steel strips, soils and many other sources that contribute to the contamination of our environment with lead. In addition, contaminants in prey are often biomagnified in hungry migrating birds. Ingested lead enters the gizzard where it is broken down and then absorbed into the blood stream and accnmulated in different body tissues. Physical, behavioral, neurological, gastrointestinal and hematological clinical signs are seen in lead toxicated birds and may be fatal, if not treated promptly (Mateo *et al*., 1998). Lead toxicosis is one of the most commonly diagnosed diseases of captive falcons in Saudi Arabia and responsible for mortality in both companion and free ranging birds (Mateo *et al*., 1998; Samour and Naldo, 2002).

Lead poisoning occurs at high lead concentrations in the blood (Gorden *et al*., 2002). The symptoms of acute toxicity are lethargy, anemia, headache and abdominal cramps, while chronic effects

include effects on hematological system, hypertension and renal function and affect the central nervous system of fetuses and children and are usually seen at significantly lower blood concentrations (ATSDR, 1999). Intelligence, reaction time, visnal-motor integration, fine motor skills and attention in children are affected by blood lead concentrations (Lanphear *et al*., 2000; Canfield *et al*., 2003; Chioda *et al*., 2004).

In view of severe toxicity of heavy metals, there is growing global concern regarding lead environmental pollution. This has lead to assess the changing conditions within an ecosystem to bring in remedial measures. In this context blood has been traditionally used for lead determination as an indicator of lead toxicosis. However, there are several problems with lead blood measurement. Lead has very short biological half life (30-40 days) in blood which therefore, can only be used to monitor the immediate exposure. In addition, lead concentration in blood is also affected by the physiological conditions of the bird. Nevertheless, the use of feathers of a bird has been found to be a suitable bio-indicator of environmental pollution with lead (Dauwe *et al*., 2002; Burger and Gochfield, 1993; Al-Mansour, 2004).

Although, feathers of a bird are a useful model to evaluate the metallic loads of environment (Burger *et al*., 1993; Burger and Gochfeld, 1992; Hahn *et al*., 1993), the difference in species vary in the evaluation of contamination. Accordingly, this investigation was started to evaluate the lead concentrations on the feathers of both the wild palm dove, *Streptopelia seneglenses* and the white-cheeked Bulbul (*Pycnonotus leucogenys*) in the three geographical locations of Saudi Arabia (Riyad, Jeddah and Al-Kharj). The objective of this study was to find which species is more suitable to monitor the lead in the environment and to determine the efficiency of quill, vane vexillnm and complete feather to accnmulate lead and as an indication of the relative environmental pollution with lead.

## MATERIALS AND METHODS

### Sample Collection

Feather samples were collected from 270 of wild white-cheeked bulbul, *Pycnonotus leucogenys* and 309 of wild palm dove (*Streptopelia seneglenses*) from three cities of Saudi Arabia; Riyadh (the capital city of Saudi Arabia), Jeddah (the main seaport of Saudi Arabia) and Kharj (85 km south of Riyadh; a population of around 150,000) using walk-in traps and mist nets during February and March 2005. Six outer primary feathers were taken from the right and left wing eqnally of each bird. Each sample was placed in a plastic sealable container before being transferred to the laboratory.

### Sample Washing and Drying

Feather samples were washed by high purity acetone with mechanical shaking followed by another wash with deionized water. The washed samples by then were dried at 60°C.

### Sample Digestion

The collected feathers of each bird were divided into three parts: The first part composed of whole complete primary feathers, the second part consisted only of mixed quills of the primary feathers while the third part was only mixed of the vane vexillnm of the same feathers. Each part was treated as a separate sample for lead determination. One hundred milligrams of each sample was digested in 5 mL of 20% $HNO_3$ for 5 h and by then evaporated to dryness at 85-90°C for over night. The dried residue of each sample was dissolved in 10 mL of 0.1% $HNO_3$ and was subsequently diluted in deionized water.

**Lead Determination**

Lead was determined in the analyzed solution of each sample by electro-thermal AAS standard technique. All concentrations were expressed in parts per million ($\mu g\ g^{-1}$).

**Statistical Analysis**

The study undertaken was statistically analyzed by Analysis of variance.

## RESULTS

**Lead Concentrations in Feathers with Respect to Geographical Location**

As seen in Table 1-4, lead concentration in feather of *Pycnonotus leucogenys* was found to be significantly ($p<0.001$) more in birds from Riyadh, as compared to the birds of Jeddah and Al-Kharj. The birds of Al-Kharj were found to contain significantly less ($p<0.001$) lead concentrations in their feathers as compared to birds from Jeddah and Riyadh. In *Streptopelia seneglenses*, the lead concentrations of feathers were found to be significantly ($p<0.01$) more in birds of Riyadh, as compared to birds from Jeddah, whereas the birds found in Al-Kharj were found to possess significantly ($p<0.001$) less lead as compared to the birds from Jeddah and Riyadh. A comparison of feather concentrations of lead between *Pycnonotus leucogenys* and *Streptopelia seneglenses* with respect to geographical location revealed the feathers of the latter contain significantly more lead concentrations at Jeddah and Riyadh ($p<0.001$) and Al-Kharj ($p<0.05$).

**Lead Concentrations in Quill**

The lead concentration in quill of *Pycnonotus leucogenys* was found to be significantly more in birds from Riyadh ($p<0.01$) as compared to birds from Jeddah. The birds of Al-Kharj were found to have significantly ($p<0.001$) less lead concentrations in their quill as compared to the birds from Riyadh and Jeddah. In *Streptopelia seneglenses*, the lead concentrations of quill were found to be significantly ($p<0.01$) more in birds of Riyadh, as compared to birds from Jeddah, whereas the birds found in Al-Kharj were found to possess significantly ($p<0.001$) less lead in their quill as compared to the birds from Jeddah and Riyadh. A comparison of lead concentration in quil between

Table 1: Estimation of lead concentrations in the feather of *Pycnonotus leucogenys* and *Streptopelia seneglenses* from different geographical locations of Saudi Arabia

| | Lead concentrations (ppm) in complete feather (Mean±SE) | |
|---|---|---|
| Different cities of Saudi Arabia | *Pycnonotus leucogenys* | *Streptopelia seneglenses* |
| Jeddah | 5.70±0.29 | 13.53±0.80*** |
| Riyadh | 9.50±0.61+++ | 18.03±1.07***++ |
| Al-Kharj | 1.05±0.08+++^^^ | 2.20±0.41*+++^^^ |

*p<0.05; ++p<0.01; ***+++^^^p<0.001 (Analysis of Variance); *Stastistical comparison between *Pycnonotus leucogenys* versus *Streptopelia senegleuses*; +Statistical comparison between birds in Jeddah versus Riyadh and birds in Jeddah versus Al-Kharj; ^Statistical comparison between birds in Riyadh versus Al-Kharj

Table 2: Determination of lead concentrations in the quill of *Pycnonotus leucogenys* and *Streptopelia seneglenses* from different geographical locations of Saudi Arabia

| | Lead concentrations (ppm) in the quill (Mean±SE) | |
|---|---|---|
| Different cities of Saudi Arabia | *Pycnonotus leucogenys* | *Streptopelia seneglenses* |
| Jeddah | 5.20±0.43 | 8.20±0.63** |
| Riyadh | 7.50±0.44++ | 11.61±0.56***++ |
| Al-Kharj | 1.11±0.05+++^^^ | 2.20±0.48*+++^^^ |

*(p<0.05); **++(p<0.01); ***, +++^^^(p<0.001); Analysis of Variance; *Stastistical comparison between *Pycnonotus leucogenys* versus *Streptopelia seneglenses*; +Statistical comparison between birds in Jeddah versus Riyadh and birds in Jeddah versus Al-Kharj; ^Statistical comparison between birds in Riyadh versus Al-Kharj

Table 3: Lead concentrations (ppm) in the Vane vexillum of *Pycnonotus leucogenys* and *Streptopelia seneglenses* from different geographical locations of Saudi Arabia

| | Lead concentrations (ppm) (Mean±SE) | |
|---|---|---|
| Different cities of Saudi Arabia | *Pycnonotus leucogenys* | *Streptopelia seneglenses* |
| Jeddah | 8.54±0.55 | 16.63±1.30*** |
| Riyadh | 12.70±0.33+++ | 21.07±1.26***+ |
| Al-Kharj | 1.65±0.83+++^^^ | 1.19±0.47+++^^^ |

+(p<0.05); ***, +++, ^^^(p<0.001); Analysis of Variance; *Stastistical comparison between *Pycnonotus leucogenys* versus *Streptopelia senegleuses*; +Statistical comparison between birds in Jeddah versus Riyadh and birds in Jeddah versus Al-Kharj; ^Statistical comparison between birds in Riyadh versus Al-Kharj

Table 4: Lead concentrations in the Quill, Vane vexillum and complete feather of *Pycnonotus leucogenys* and *Streptopelia seneglenses* from different geographical locations of Saudi Arabia

| | Lead concentrations (ppm) (Mean±SE) | | | | | |
|---|---|---|---|---|---|---|
| Different cities of | *Pycnonotus leucogenys* | | | *Streptopelia seneglenses* | | |
| Saudi Arabia | Quill | Vane vexillum | Complete feather | Quill | Vane vexillum | Complete feather |
| Jeddah | 5.20±0.43 | 8.54±0.53***a | 5.70±0.29**b | 8.20±0.63 | 16.63±1.30***a | 13.53±0.80b |
| Riyadh | 7.50±0.44 | 12.70±0.3***a | 9.50±0.61**b | 11.61±0.56 | 21.07±1.26***a | 18.03±1.07***b |
| Al-Kharj | 1.11±0.05 | 1.65±0.83a | 1.05±0.08b | 2.18±0.49 | 1.19±0.47a | 2.20±0.41b |

a, b (p>0.05); **b (p<0.01); ***a, b (p<0.001) Analysis of Variance; *a- Stastistical comparison between Vane versus Quill of *Pycnonotns leucogenys* and *Streptopelia senegleuses* in Jeddah, Riyadh and Al-Kharj; *b- Statistical comparison between Vane versus complete feather of *Pycnonotus leucogenys* and *Streptopelia senegleuses* in Jeddah, Riyadh and Al-Kharj

*Pycnonotus leucogenys* and *Streptopelia seneglenses* with respect to geographical location revealed the quill of the latter to contain significantly more lead concentrations at Jeddah (p<0.01), Riyadh (p<0.001) and Al-Kharj (p<0.05).

**Lead Concentrations in Vane Vexillum**

The lead concentration in Vane vexillum of *Pycnonotus leucogenys* was found to be significantly more in birds from Riyadh (p<0.001) as compared to the birds from Jeddah. The birds of Al-Kharj were found to have significantly (p<0.001) less lead concentrations in their Vane vexillum as compared to the birds from Riyadh and Jeddah. In *Streptopelia seneglenses*, the lead concentrations of Vane vexillum were found to be significantly (p<0.01) more in birds of Riyadh (p<0.05) as compared Jeddah birds. Those of Al-Kharj were found to possess significantly (p<0.001) less lead in their Vane vexillum as compared to the birds from Jeddah and Riyadh. A comparison of lead concentrations of Vane vexillum between *Pycnonotus leucogenys* and *Streptopelia seneglenses* with respect to geographical location revealed the Vane vexillum of the latter to contain significantly more lead concentrations at Jeddah and Riyadh (p<0.001). The lead contents of Vane vexillum of Al-Kharj birds were not significantly (p>0.05) different for *Pycnonotus leucogenys* and *Streptopelia seneglenses*.

**Lead Concentrations in Different Parts of the Feather**

The Vane vexillum of *Pycnonotus leucogenys* was found to contain significantly higher concentrations of lead as compared to quill (p<0.001) and complete feather (p<0.01) in birds from Jeddah and Riyad; while there were no significant (p>0.05) differences in the lead concentrations of quill, vane vexillum and complete feather in the birds from Al-Kharj. In *Streptopelia seneglenses*, the Vane vexillum contents of lead were significantly (p<0.001) than quill and complete feather in birds from Riyadh. However, such a significant (p<0.001) was confined to Vane vexillum as compared to quill in Jeddah, while the complete feather (Jeddah) and Quill and complete feather (Al-Kharj) were not significantly different from Vane vexillum (p>0.05).

## DISCUSSION

The results obtained in this comparative study of the lead concentrations in the feathers of *Streptopelia seneglenses* and *Pycnonotus leucogenys* revealed that the feathers of the latter bird had less capacity to retain lead. Interspecies differences in the levels of metals is a common observation reported in many species of birds. Burger and Gochfeld (2000) showed differences in the levels of metals in the feather of 12 species of seabirds (*Diomedea nigripes*, *Diomedea immutabilis*, *Sula sula*, *Fregata minor*, *Pterodroma hypoleuca*, *Puffinus nativitatis*, *Phaethon rubricauda*, *Puffinus pacificus*, *Phaethon rubricauda*, *Puffinus pacificus*, *Anous stolidus*, *Sterna fuscata*, *Sterna lunata* and *Gygis alba*). The exact etiological factors for the differences in the two birds are not known. However; an earlier study showed the dissimilarity in feathers of different species to be related to amino acid composition (Harrap and Woods, 1967), while Dauwe *et al.* (2003) reported the differences to be related to diet and molting sequence of feathers in different species. Some studies showed differences in lead contamination in feathers with sexual dimorphism in which females had significantly higher concentration of lead than males (Burger and Gochfeld, 1992).

The present investigation revealed differences between the lead retention in quills, vane vexillum and complete feather of *Streptopelia seneglenses* and *Pycnonotus leucogenys*. This is in agreement with the results of other investigations where lead showed strong gradients with respect to feather parts with high exposure at atmospheric influence (Hahn *et al*., 1993). Also, it showed that the concentration of lead in different parts of the feather of the latter was less than in *Streptopelia seneglenses*. These variations might be related to the concentrations of lead in different feathers of the individual birds. This may be due to molting pattern, difference of pigmentation or external contamination (Furness *et al*., 1986; Altmeyer *et al*., 1991; Dmowski *et al*., 1984; Weyers *et al*., 1988). External contamination may have especially an important impact on the heavy metal concentrations found in feathers (Burger and Gochfeld, 1993). Exterual contamination can occur from direct atmospheric deposition or from the deposition of contaminants on feathers during preening (Goede and Bruin, 1984). When lead contamination is mainly from exterual contamination, feather lead concentration reaches its minimum after completion of the molt and starts to increase afterwards if the bird is exposed to more lead contamination (Dauwe *et al*., 2002; Pilastro *et al*., 1993). External contamination alters metal concentration in the feather as a whole and produces significant differences within parts of the feather (Hahn *et al*., 1993). Several studies confirmed that the lead burden of feathers predominantly depends on the exogenous deposition of heavy metals from the atmosphere on the surface of birds feathers (Hahn *et al*., 1993).

The results of the present study, with respect to lead accumulation in the feather of *Streptopelia seneglenses* and *Pycnonotus leucogenys*, showed higher lead concentration in the feathers of birds from Riyadh than that of Jeddah and least in Al-Kharj. Some studies indicated differences in lead accumulation in feathers with different ecologies (Burger *et al*., 1993). The sources of lead pollution in Saudi Arabia include automotive emissions, industrial processes, agricultural practices, eroded lead paint, soil concentrations and dust (Burger and Gochfeld, 1993; Shobokshy, 1984; Al-Mutaz, 1987; Ahmed and Al-Swaidan, 1993). Al-Saleh and Taylor (1994) found that the atmospheric and soil lead is higher in areas with high traffic density of Saudi Arabia where the lead concentration of urban dust in Riyadh to be 208 $\mu g\ g^{-1}$ in the industrial areas in comparison of 106 $\mu g\ g^{-1}$ in the rural areas. Al-Mutaz (1987) reported that the average ambient airborne lead levels at high traffic locations in populated cities of Saudi Arabia are between 2.38 to 5.5 $\mu g\ m^{-3}$. The results of these reports are in agreement with the results of the present investigation where lead environmental pollution is in the order of Al-Kharj < Jeddah < Riyadh.

The results of present study demonstrated that *Streptopelia seneglenses* is more suitable as a biological monitor for enviroumental lead exposure than *Pycnonotus leucogenys*. This investigation warrant more studies on comparison between the inter- and intra-species among birds to find the best biological monitors of atmospheric lead for a final selection in the use.

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## REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), 1999. Toxicological Profile for lead, U.S. Department of Health and Human Services, Public Health Service.

Ahmed, K.O. and H.M. Al-Swaidan, 1993. Lead and cadmium in urban dust of Riyadh, Saudi Arabia. Sci. Total Environ., 136: 205-210.

Al-Mansour, M.I., 2004. Using feathers as a biological indicator of lead environmental pollution. Pak. J. Biol. Sci., 7: 1884-1887.

Al-Mutaz, I.S., 1987. Automotive emission problem in Saudi Arabia. Environ. Int., 13: 335-338.

Altmeyer, M., J. Dittman, K. Dmowski, G. Wagner and P. Muller, 1991. Distribution of elements in flight, feathers of a white-tailed eagle. Sci. Total Environ., 105: 157-164.

Al-Saleh, I.A. and A. Taylor, 1994. Lead concentration in the atmosphere and soil of Riyadh, Saudi Arabia. Sci. Total Environ., 141: 261-267.

Burger, J. and M. Gochfeld, 1992. Heavy metal and selenium concentration in black skimmers (*Rynchops niger*) gender differences. Arch. Environ. Contam. Toxicol., 23: 431-434.

Burger, J. and M. Gochfeld, 1993. Lead and cadmium accumulation in eggs and fledgling seabirds in the New York bight. Environ. Toxicol. Chem., 12: 216-267.

Burger, J., I.C. Nisbet and M. Gochfeld, 1993. Metal levels in regrown feathers: Assessment of contamination on the wintering and breeding grounds in the same individuals. J. Toxicol. Health, 37: 363-374.

Burger, J. and M. Gochfeld, 2000. Metal levels in feathers of 12 species of seabirds from Midway Atoll in the northern Pacific Ocean. Sci. Total Environ., 257: 37-52.

Canfield, R.L., C.R. Henderson, D.A. Cory-Slecxhta, C. Cox, T.A. Jusko and B.P. Lanphear, 2003. Intellectual impairment in children with blood lead concentrations below 10 μg $dL^{-1}$. N. Eng. J. Med., 348: 1517-1526.

Chioda, L.M., S.W. Jacobson and J.L. Jacobson, 2004. Neurodevelopmental effects of postnatal lead exposure at very low levels. Neurotoxicol. Teratol., 26: 359-371.

Dauwe, T., L. Bervoets, R. Blust and M. Eens, 2002. Tissue levels of lead in experimentally dosed zebra finches (*Taeniopygia guttata*) with particular attention on the use of feathers as biomonitors. Arch. Environ. Contamin. Toxicol., 42: 88-92.

Dauwe, T., L. Bervoets, R. Pinxten, R. Blust and M. Eens, 2003. Variation of heavy metals within and among feathers of birds of prey: Effects of molt and external contamination. Environ. Pollut., 124: 429-436.

Dmowski, K., F. Gast, P. Muller and G. Wagner, 1984. Variability of cadmium and lead concentrations in bird feathers. Naturwissenschaften, 71: 639-640.

Furness, R.W., S.J. Muirhead and M. Woodburn, 1986. Using bird feathers to measure mercury in the enviroument: Relationships between mercury content and moult. Mar. Pollut. Bull., 17: 27-30.

Goede, A.A. and M. De Bruin, 1984. The use of bird feather parts as a monitor for metal pollution. Environ. Pollut., B 8: 281-298.

Gordon, J.N., A. Taylor and P.N. Bennett, 2002. Lead poisoning: Case studies. Br. J. Clin. Pharmacol., 53: 451-458.

Hahn, E., K. Hahn and M. Stoeppler, 1993. Bird feathers as bioindicators in areas of German environmental specimen bank bioaccumulation of mercury in food chains and exogenous deposition of atmospheric pollution with lead and cadmium. Sci. Total Environ., 1: 259-270.

Harrap, B.S. and E.F. Woods, 1967. Species differences in the proteins of feathers. Comp. Biochem. Physiol., 20: 449-452.

Johansen, P., H.S. Pedersen, G. Asmund and F. Riget, 2006. Lead shot from hunting as a source of lead in human blood. Environ. Pollut., 142: 93-97.

Lanphear, B.P., K.N. Dietrich, P. Auninger and C. Cox, 2000. Cognitive deficits associated with blood lead concentrations <10 μg $dL^{-1}$ in US children and adolescents. Public Health Rep., 115: 521-529.

Mateo, R., J. Belliure and J.C. Dolz, 1998. High prevalence of lead poisoning in Spain. Arch. Environ. Con., 35: 324-347.

Pain, D.J., A.A. Meharg, M. Ferrer, M. Taggart and V. Penteriani, 2005. Lead concentrations in bones and feathers of the globally threatened Spanish imperial eagle. Biol. Conserv., 121: 603-610.

Pilastro, A., L. Congiu, L. Tallandini and M. Turchetto, 1993. The use of bird feathers for the monitoring of cadmium pollution. Arch. Environ. Contamin. Toxicol., 24: 355-358.

Samour, J.H. and J. Naldo, 2002. Diagnosis and therapeutic management of lead toxicosis in falcons in Saudi Arabia. J. Avian Med. Surg., 16: 16-20.

Shobokshy, M.S., 1984. Preliminary analysis of the inhalable lead particulate in the ambient atmosphere in the city of Riyadh. Atmos. Environ., 18: 2125-2128.

Weyers, B., E. Gluck and M. Stoeppler, 1988. Investigation of the significance of heavy metals contents of blackbird feathers. Sci. Total Environ., 77: 61-67.