Indexed, Abstracted and Cited: ISRA Journal Impact Factor, International Impact Factor Services (IIFS), Directory of Research Journals Indexing (DRJI), International Institute of Organized Research and Scientific Indexing Services

World Journal of Biology and Medical Sciences

Published by Society for Advancement of Science®

ISSN 2349-0063 (Online/Electronic)

Volume 1, Issue- 3, 76-98, July-September 2014

WJBMS 1/3/27/2014

www.sasjournals.com

A Double Blind Peer Reviewed Journal wjbmedsc@gmail.com / wjbms.lko@gmail.com

RESEARCH PAPER

Received: 13/08/2014 Revised: 23/08/2014 Accepted: 24/08/2014

Metal Toxicity in Black Kites, *Milvus migrans govinda* in Bundelkhand Region of India

Ragni Gupta and Amita Kanaujia

Department of Zoology, University of Lucknow, Lucknow, U.P. India

ABSTRACT

The impact of metal toxicants on the environment can be a serious threat to the stability of the ecosystem. Effects of metal toxicant exposure may be contributing to the decline of many birds. The aim of this study is to study the metal toxicants in Milvus migrans govinda in Bundelkhand region. Concentrations of metals were measured in 12 carcasses of Milvus migrans govinda in between 2007-2011 collected from different districts of Bundelkhand region. Feathers, organs and bones were taken from dead Milvus migrans govinda. Concentrations of metal toxicants were also reported in feathers of Milvus migrans govinda collected from their roosting and breeding sites. Samples were defrosted and wet digested with nitric acid perchloric mixture. The residues of metals were determined by atomic absorption spectrophotometer. Metals as Pb, Cd, Cu, Zn and Fe were reported below their lethal limits in the present study. The values reported for species could serve as base-line data for future studies.

Keywords: Metal Toxicity, Milvus migrans govinda, Atomic absorption spectrophotometer, with Nitric acid perchloric mixture and Eco system.

INTRODUCTION

Raptors in particular are regarded as suitable biomonitors or bioindicators of environmental pollution, because they may express contamination risk for both ecosystem and human health [Burger and Gochfeld 2001; Eulaers *et al.*, 2011]. This is due to a very important feature; the position as top predator, and thus the possibility of biomagnification of contaminants [Castro *et al.*, 2011; Furness and Greenwood 1993; Martinez *et al.*, 2012; Movalli 2000]. They are the members of Accipitridae family [Thiollay, 1994]. They kill other animals for food and are good scavengers of nature as well.

There is obvious increasing public concern regarding environmental contamination, which has led to increasing activity on the part of researchers and specialists to monitor, evaluate, manage and remediate ecological damage [Movalli, 2000]. Heavy metals are dangerous because they bioaccumulate in living tissue and decrease or even block the intracellular biochemical processes. The absorption, accumulation and toxicity of each heavy metal are affected by diverse factors, including interactions with other metals, both essential and toxic [Lopez-Alonso *et al.,* 2007; Pappas *et al.,* 2010]. Accumulation of heavy metals has been particularly well documented for aquatic food chains, where species such as sea eagles, *Haliaetus* spp. and ospreys, *Pandion haliaetus* have shown poor breeding and enhanced mortality in association with different pollutants [Palma *et al.,* 2005]. Rachel Carson´s "Silent Spring" (1962) was the first book to raise public awareness about birds' vulnerability to pollution. Several years later before seeing how her assertions were to be proven true and before seeing how her courageous publication helped to launch the environmental movement. A number of anthropogenic activities such as mining, industrial, battery recycling units, painting industries contribute to the elevated levels of pollutants including toxic metals in the environment. In the competition of urbanization and industrialization man has contributed pollution to the life and ecology of plants and animals.

There is a need to analyze relationships between population status of *Milvus migrans govinda* in Bundelkhand region and metal toxicants. This study has planned for examine the utility of a top-level avian predator, *Milvus migrans govinda* in assessing accumulation and effects of exposure to environmental contaminants.

MATERIALS AND METHODS

STUDY AREA

Bundelkhand region is located between 23^o 20' and 26^o 20' N latitude and 78^o 20' and 81^o 40' E longitude bounded by the Yamuna in the north, the Chambal in the North West, erupted ranges of the Vindhya in the south east. Bundelkhand region including 13 districts of Uttar Pradesh and Madhya Pradesh. Bundelkhand region includes Jhansi, Lalitpur, Jalaun, Hamirpur, Banda and Mahoba in Uttar Pradesh and Sagar, Chattarpur, Tikamgarh, Panna and Damoh in Madhya Pradesh including parts of Gwalior, Datia, Shivpuri and Chanderi (Figure 1).

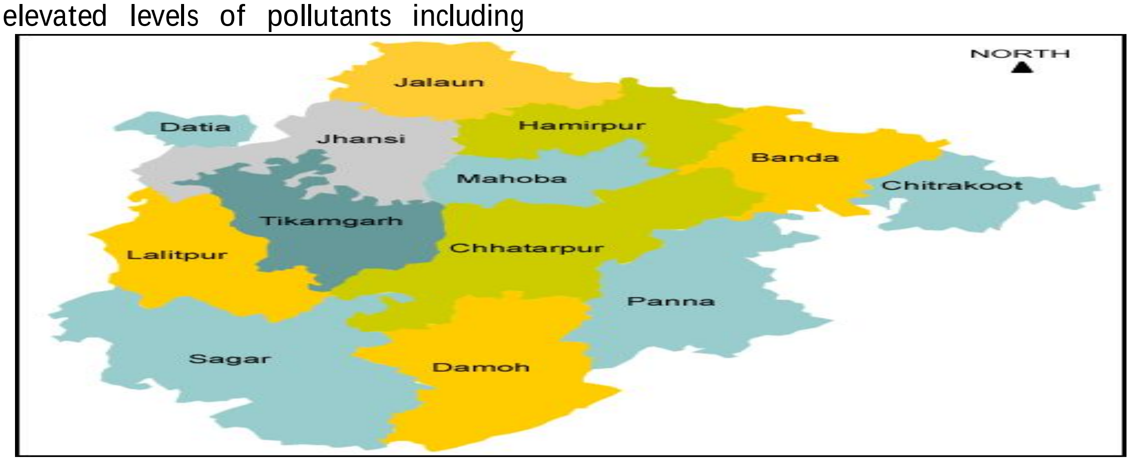


Figure 1. Map of study area "Bundelkhand region"

Source: http://www.apnabundelkhand.com

Feathers, organs and bones were taken from 12 carcasses of *Milvus migrans govinda* in Bundelkhand region. Concentrations of metal toxicants were also reported in feathers of *Milvus migrans govinda* collected from their roosting and breeding sites. Samples were defrosted and wet digested with nitric acid perchloric mixture. Two analytical blanks were run simultaneously with batch of digestion and diluted with distilled water. The residues of metals were determined by atomic absorption spectrophotometer [Kolmer *et al.,* 1951].

RESULTS

Metal concentrations are presented in Tables 1 and 2 expressed as ppm. Concentrations of metal toxicants were reported in feathers of *Milvus migrans govinda* collected from their roosting and breeding sites. Lead concentrations were found between 0.10 ppm-2.50 ppm and cadmium concentrations were found between 0.10 ppm-1.50 ppm. Concentrations of copper were reported 2.10 ppm-45.10 ppm and Zn concentrations 3.50ppm- 35.45ppm were noted. Iron concentrations were found between 0.10 ppm-95.10 ppm.

Lead concentrations were reported between 0.50 ppm-0.95 ppm and cadmium concentrations were found between 0.60 ppm-0.80 ppm in carcass of *Milvus migrans govinda* MA1 collected from Chattarpur. Copper concentrations were noted between 4.50 ppm-15.20 ppm and zinc concentrations were found between 20.50 ppm- 26.50 ppm. Iron concentrations were reported between 21.40 ppm-35.10 ppm.

Lead concentrations were noted between 0.10 ppm-0.15 ppm and cadmium concentrations were found between 0.20 ppm-0.40 ppm in carcass of *Milvus migrans govinda* MA2 collected from Chattarpur. Copper concentrations were reported between 6.10 ppm-45.50 ppm and zinc concentrations were found between 15.40 ppm-30.10 ppm. Iron concentrations were reported between 22.50 ppm-50.20 ppm.

Lead concentrations were found between 0.10 ppm-1.05 ppm and cadmium concentrations were found between 0.15 ppm-2.5 ppm in carcass of *Milvus migrans govinda* MA3 collected from Jhansi (Khilli). Copper concentrations were noted between 2.30 ppm-25.30 ppm. Zinc concentrations were reported between 10.20 ppm-35.10 ppm and iron concentrations were found between 20.50 ppm-35.40 ppm.

Lead concentrations were noted between 0.10 ppm-1.05 ppm and cadmium concentrations were found between 0.45 ppm-0.80 ppm in carcass of *Milvus migrans govinda* MAS collected from Jhansi (Khilli). Copper concentrations were reported between 10.50 ppm-35.40 ppm and zinc concentrations were reported between 20.30 ppm-35.50 ppm. Iron concentrations were found between 40.10 ppm-50.75 ppm.

Concentrations of lead were reported between 0.15 ppm-1.05 ppm and cadmium concentrations were found between 0.065 ppm-0.75 ppm in carcass of *Milvus migrans govinda* MA4 collected from Jhansi (Khilli). Copper concentrations were found between 7.50 ppm-35.75 ppm and zinc concentrations were reported between 10.50 ppm-35.70 ppm. Iron concentrations were found between 0.30 ppm-82.30 ppm.

Concentrations of lead were reported between 0.10 ppm-1.80 ppm and cadmium concentrations were found between 0.50 ppm-1.090 ppm in carcass of *Milvus migrans govinda* MA5 collected from Jhansi (Khilli). Copper concentrations were found between 6.50 ppm-25.65 ppm and zinc concentrations were reported between 20.85 ppm-33.50 ppm. Iron concentrations were found between 15.30 ppm-89.60 ppm.

Lead concentrations were noted between 0.50 ppm-1.75 ppm and cadmium concentrations were found between 0.75 ppm-1.30 ppm in carcass of *Milvus migrans govinda* MA6 collected from Jalaun (Orai). Concentrations of copper were found between 10.50 ppm-30.50 ppm and zinc concentrations were noted 10.90 ppm-35.50 ppm. Iron concentrations were found between 35.60 ppm-89.90 ppm.

Concentrations of lead were reported between 0.10 ppm-0.80 ppm and cadmium concentrations were found between 0.15 ppm-0.95 ppm in carcass of *Milvus migrans govinda* MA7 collected from Jalaun (Orai). Concentrations of copper were found between 7.50 ppm-30.40 ppm and zinc concentrations were reported between 7.60 ppm-35.40 ppm. Iron concentrations were found between 10.80 ppm-80.50 ppm.

Lead concentrations were found between 0.15 ppm-0.60 ppm and cadmium concentrations were found between 0.35 ppm-0.75 ppm in carcass of *Milvus migrans govinda* MA8 collected from Jalaun. Concentrations of copper were found between 12.50 ppm-20.40 ppm and zinc concentrations were reported between 19.50 ppm-30.40 ppm. Iron concentrations were reported between 65.80 ppm-80.90 ppm.

Lead concentrations were noted between 0.80 ppm-1.90 ppm and cadmium concentrations were found between 0.80 ppm-0.90 ppm in carcass of *Milvus migrans govinda* MA9 collected from Banda (Atara). Concentrations of copper were found between 23.50 ppm-25.90 ppm and zinc concentrations were reported 27.50 ppm-30.85 ppm. Iron concentrations were found between 25.90 ppm-55.00 ppm. Concentrations of lead were reported between 0.40 ppm-1.85 ppm and cadmium concentrations were found between 0.05 ppm-2.70 ppm in carcass of *Milvus migrans govinda* MA10 collected from Banda (Atara). Copper concentrations were found between 11.10 ppm-23.70 ppm and zinc concentrations were reported between 10.50 ppm-30.50 ppm. Iron concentrations were noted between 60.50 ppm-75.90 ppm.

Lead concentrations were noted between 0.90 ppm-1.50 ppm and cadmium concentrations were found between 0.20 ppm-1.85 ppm in carcass of *Milvus migrans govinda* MA11 collected from Banda (Karbi). Concentrations of copper were found between 8.50 ppm-15.75 ppm and zinc concentrations were reported between 11.50 ppm-35.75 ppm. Iron concentrations were noted between 35.50 ppm-95.50 ppm. The maximum concentrations of Pb, Cd, Cu, Zn and Fe in feathers (collected from districts of region) were 2.50 ppm, 25 ppm, 45.10 ppm, 35.45 ppm and 95.10 ppm respectively. The maximum concentrations of Pb, Cd, Cu, Zn and Fe in carcasses were 1.90 ppm, 1.85 ppm, 45.50 ppm, 35.75 ppm and 95.50 ppm. Concentrations of Pb, Cd, Cu, Fe and Zn in wing bone of *Milvus migrans govinda* were reported not significant when they compared with all districts and carcasses (Graph 1-5). Concentrations of Cd in leg bone of *Milvus migrans govinda* were found significant when they were compared to all districts and carcasses but others were found not significant (Graph 6-10). Concentrations of Pb, Cd, Cu, and Zn in kidney of *Milvus migrans govinda* were reported not significant when they were compared to all districts and carcasses but concentrations of Fe were found significant (Graph 11-15). Concentrations of Pb, Cd, Cu, Fe and Zn in heart, of *Milvus migrans govinda* were reported not significant when they compared with all districts and carcasses (Graph 16-20). Concentrations of Cu in intestine of *Milvus migrans govinda* were reported significant when they compared with all districts and carcasses and others were found not significant (Graph 21-25). Concentrations of Pb, Cd, Cu, Fe and Zn in stomach (Graph 26-30), liver (Graph 31-35), pancreas (Graph 36-40) and spleen (Graph 41-45) of *Milvus migrans govinda* were reported not significant when they compared with all districts and carcasses.

Table 1. Concentration of metal toxicants in feathers collected from districts of Bundelkhand region.

S. No	Nature of samples	District	Pb conc in ppm	Cd conc in ppm	Cu conc in ppm	Zn conc in ppm	Fe conc in ppm
1	Feather	Jhansi	0.30	0.65	1.10	17.30	45.10
2	Feather	Jhansi	0.20	0.75	3.30	23.10	70.50
3	Feather	Lalitpur	2.20	ND	34.30	15.30	46.50
4	Feather	Lalitpur	1.50	0.45	11.20	20.40	35.10
5	Feather	Jalaun	2.10	**1.50***	5.20	14.40	30.80
6	Feather	Jalaun	0.45	0.30	25.40	21.75	45.10
7	Feather	Banda	ND	0.65	10.50	18.50	51.65
8	Feather	Banda	0.20	0.80	2.10	10.30	40.10
9	Feather	Mahoba	ND	ND	4.10	11.50	20.25
10	Feather	Mahoba	0.45	0.30	2.35	20.45	7.10
11	Feather	Hamirpur	1.30	0.10	15.10	3.50	0.10
12	Feather	Hamirpur	0.750	0.30	20.50	15.30	85.50
13	Feather	Panna	0.35	ND	**45.10**	ND	2.10
14	Feather	Panna	0.95	0.45	2.50	10.40	65.50
15	Feather	Gwalior	**2.50**	1.50	7.50	4.10	22.50
16	Feather	Gwalior	2.40	0.90	15.40	9.50	12.40
17	Feather	Sagar	0.55	0.70	5.60	11.40	45.10
18	Feather	Sagar	0.10	0.85	35.20	30.75	45.50
19	Feather	Shivpuri	ND	0.95	ND	15.50	**95.10**
20	Feather	Shivpuri	ND	ND	2.30	35.40	55.10
21	Feather	Chanderi	0.90	0.95	4.50	10.50	3.50
22	Feather	Chanderi	ND	ND	3.70	25.10	40.10
23	Feather	Damoh	1.10	1.50	11.50	**35.45**	80.50
24	Feather	Damoh	0.85	ND	5.50	14.50	45.30
25	Feather	Chattarpur	0.60	0.80	11.50	4.10	20.30
26	Feather	Chattarpur	0.75	0.60	4.10	12.10	45.35
27	Feather	Datia	0.95	0.75	15.50	10.10	6.50
28	Feather	Datia	0.75	0.55	2.90	20.25	40.60
29	Feather	Tikamgarh	ND	ND	20.10	5.10	35.25
30	Feather	Tikamgarh	0.30	0.50	30.50	4.10	25.40

Table 2. Concentration of metal toxicants in carcass of *Milvus migrans govinda* from Bundelkhand region.

S. No	District	Nature of sample	Pb conc in ppm	Cd conc in ppm	Cu conc in ppm	Zn conc in ppm	Fe conc in ppm
MA1	Chattarpur	Wing bone	0.50	0.75	5.80	23.10	27.30
		Leg bone	0.50	0.65	4.50	26.50	21.40
		Feather	0.95	0.60	11.10	20.50	35.10
		Feather	0.85	0.80	15.20	30.10	23.50
MA2	Chattarpur	Wing bone	ND	0.35	**45.50**	15.40	40.50
		Leg bone	ND	0.40	42.50	25.40	50.20
		Feather	0.10	0.25	ND	30.10	35.10
		Feather	0.15	0.20	6.10	21.10	22.50
MA3	Jhansi (Khilli)	Kidney	ND	ND	2.30	10.50	35.10
		Heart	0.20	0.15	5.10	ND	ND
		Intestine	0.15	0.30	7.50	10.20	25.10
		Stomach	1.45	0.95	15.40	10.50	20.50
		Liver	1.50	0.65	20.30	35.10	30.10
		Pancreas	ND	ND	2.45	10.40	35.25
		Spleen	0.10	2.5	6.50	15.20	30.25
		Wing bone	0.25	0.40	10.40	10.45	25.30
		Leg bone	0.15	0.35	15.40	20.30	30.50
		Feather	1.10	0.95	20.50	15.10	35.40
		Feather	1.50	0.80	25.30	18.50	32.50
MAS	Jhansi (Khilli)	Kidney	0.75	0.55	35.40	20.50	45.40
		Heart	0.60	0.45	30.50	25.10	40.30
		Intestine	0.50	0.60	15.50	20.30	45.20
		Stomach	0.75	0.40	20.50	30.50	40.10
		Liver	1.05	0.80	15.50	25.30	50.50
		Pancreas	0.55	0.65	18.40	24.40	40.50
		Spleen	0.30	ND	20.15	30.10	40.90
		Wing bone	ND	ND	ND	ND	ND
		Leg bone	0.10	0.75	20.50	35.20	50.75
		Feather	0.80	0.70	15.10	30.35	40.75
		Feather	0.60	0.80	10.50	35.50	45.50
MA4	Jhansi (Khilli)	Kidney	ND	0.35	35.75	20.50	40.10
		Heart	0.15	0.65	25.20	35.40	55.80
		Intestine	0.35	ND	20.15	10.50	82.30
		Stomach	0.90	0.75	30.35	26.70	50.25
		Liver	1.05	0.080	7.50	23.40	45.60
		Pancreas	ND	0.065	10.15	20.35	42.20
		Spleen	0.50	ND	ND	ND	0.30
		Wing bone	0.85	0.30	15.50	30.30	15.50
		Leg bone	ND	0.60	10.30	25.40	18.70
		Feather	0.70	0.25	15.15	25.50	35.50
		Feather	0.95	ND	25.30	35.70	45.85

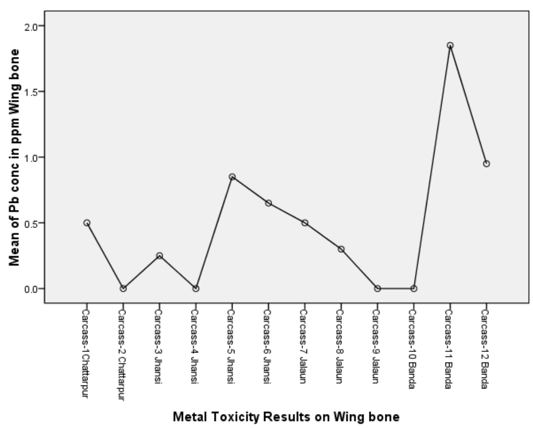
S. No	District	Nature of sample	Pb conc in ppm	Cd conc in ppm	Cu conc in ppm	Zn conc in ppm	Fe conc in ppm
MA5	Jhansi (Khilli)	Kidney	ND	1.090	6.50	21.60	35.65
		Heart	0.15	1.050	12.50	33.50	40.70
		Intestine	ND	0.50	10.50	30.50	45.80
		Stomach	0.55	0.90	11.80	28.85	89.60
		Liver	1.80	0.95	25.65	23.75	75.80
		Pancreas	ND	0.65	ND	ND	15.30
		Spleen	ND	ND	10.50	20.85	35.50
		Wing bone	0.65	0.70	15.85	25.80	30.50
		Leg bone	0.10	0.65	20.60	23.80	25.45
		Feather	0.95	0.70	22.50	28.75	40.70
		Feather	1.05	0.95	25.40	ND	50.80
MA6	Jalaun (Orai)	Kidney	1.75	1.20	27.50	35.10	80.70
		Heart	0.90	1.30	30.50	30.40	89.90
		Intestine	0.95	0.95	26.20	32.50	60.75
		Stomach	0.50	0.75	25.30	27.80	55.90
		Liver	1.80	0.80	15.80	21.40	70.65
		Pancreas	ND	ND	12.60	35.50	65.20
		Spleen	0.80	ND	15.65	13.40	55.80
		Wing bone	0.50	0.85	11.15	10.90	38.70
		Leg bone	0.65	0.95	10.50	23.50	45.75
		Feather	1.05	1.00	16.50	19.80	35.60
		Feather	ND	0.95	15.70	21.85	70.00
MA7	Jalaun (Orai)	Kidney	0.80	0.85	11.75	20.75	65.90
		Heart	ND	ND	ND	ND	55.00
		Intestine	0.10	0.25	25.00	35.00	45.80
		Stomach	0.50	0.85	22.40	32.80	65.70
		Liver	0.35	ND	30.40	35.40	30.50
		Pancreas	ND	ND	ND	ND	15.50
		Spleen	0.50	0.15	10.30	22.10	35.80
		Wing bone	0.30	0.35	15.30	21.45	80.50
		Leg bone	ND	0.95	ND	ND	45.50
		Feather	ND	ND	ND	ND	ND
		Feather	0.15	0.20	7.50	7.60	10.80

S. No	District	Nature of sample	Pb conc in ppm	Cd conc in ppm	Cu conc in ppm	Zn conc in ppm	Fe conc in ppm
MA8	Jalaun	Wing bone	ND	ND	12.50	24.50	65.80
		Leg bone	0.15	ND	15.40	19.50	70.85
		Feather	0.60	0.75	20.40	20.50	75.60
		Feather	0.20	0.35	16.05	30.40	80.90
MA9	Banda	Wing bone	ND	ND	ND	ND	30.20
		Leg bone	ND	ND	ND	ND	25.90
		Feather	**1.90**	0.80	23.50	27.50	30.85
		Feather	0.80	0.90	25.90	30.85	55.00

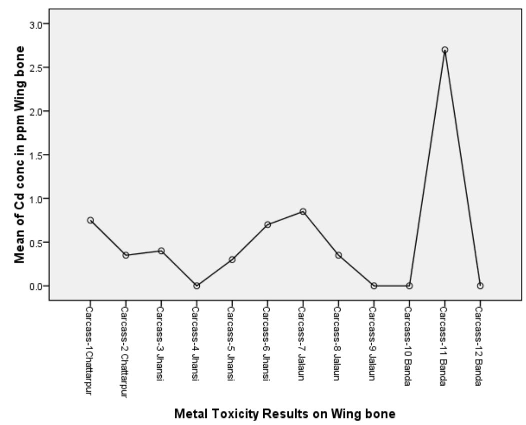
MA10	Banda	Wing bone	1.85	2.70	23.70	12.30	75.90
		Leg bone	0.95	0.05	19.90	15.90	65.10
		Feather	0.40	0.90	11.10	10.50	60.50
		Feather	ND	0.40	15.40	30.50	75.80
MA11	Banda (Atara)	Wing bone	0.95	ND	ND	11.50	35.50
		Leg bone	ND	0.20	8.50	25.75	89.00
		Feather	1.50	1.85	10.75	30.75	90.85
		Feather	0.90	0.75	15.75	**35.75**	**95.50**

Metal toxicity results carcass

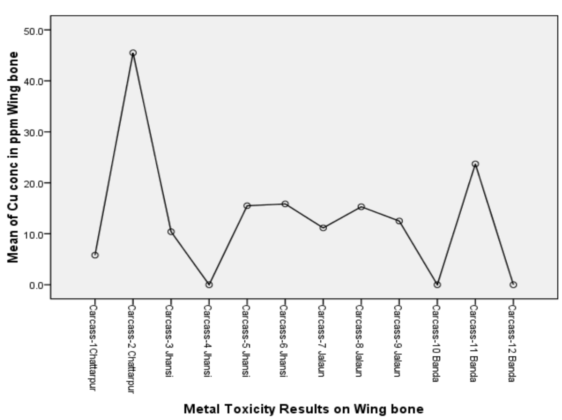
Means plots metal toxicity results on wing bone



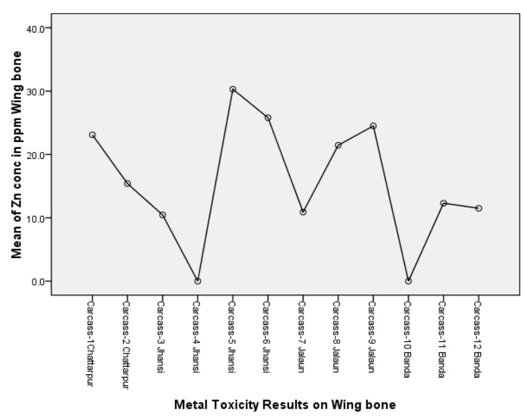
Graph 1. Mean of concentration of Pb in wing bone of carcasses of *Milvus migrans govinda*



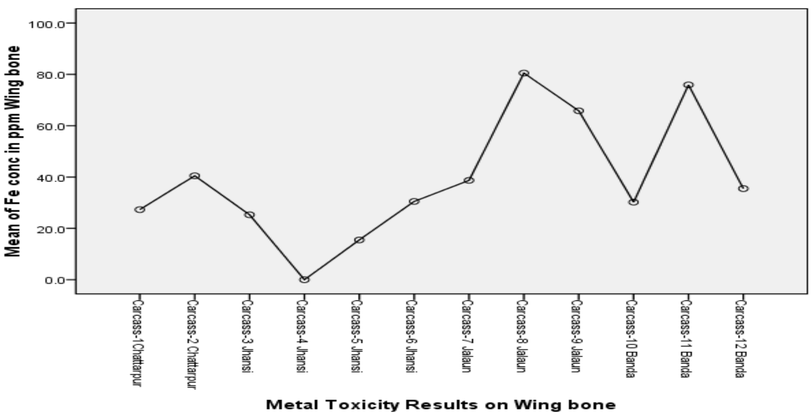
Graph 2. Mean of concentration of Cd in wing bone of carcasses of *Milvus migrans govinda*



Graph 3 Mean of concentration of Cu in wing bone of carcasses of *Milvus migrans govinda*

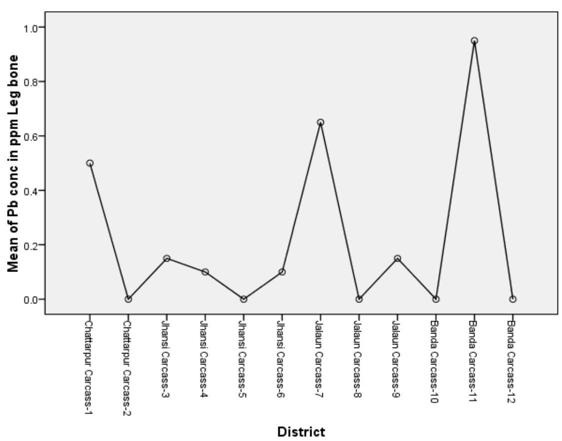


Graph 4 Mean of concentration of Zn in wing bone of carcasses of *Milvus migrans govinda*

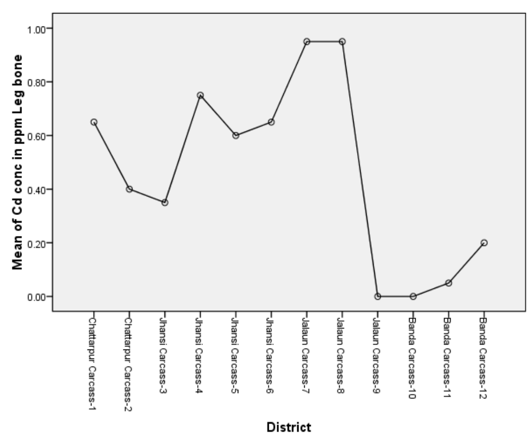


Graph 5. Mean of concentration of Fe in wing bone of carcasses of *Milvus migrans govinda.*

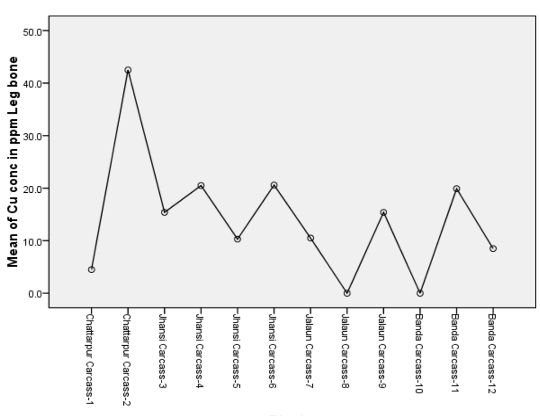
Means plots



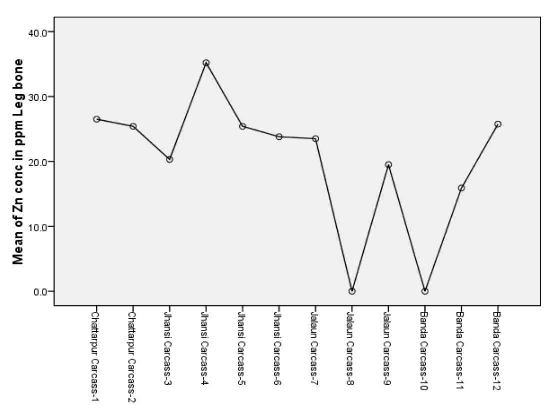
Graph 6. Mean of concentration of Pb in leg bone of carcasses of *Milvus migrans govinda*



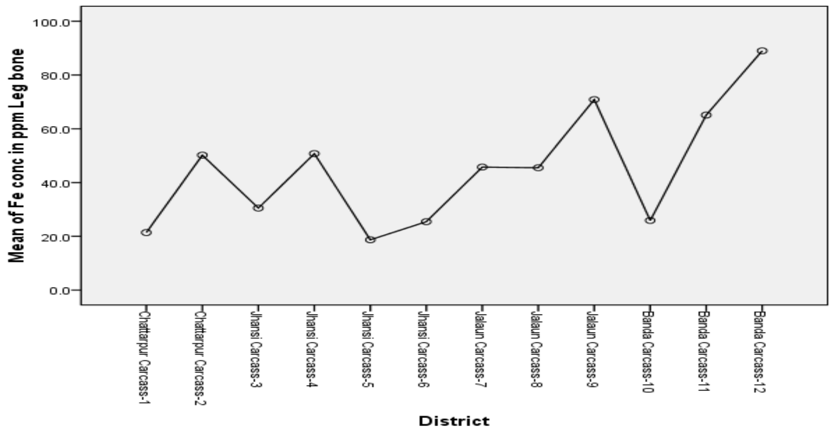
Graph 7. Mean of concentration of Cd in leg bone of carcasses of *Milvus migrans govinda*



Graph 8. Mean of concentration of Cu in leg bone of carcasses of *Milvus migrans govinda*

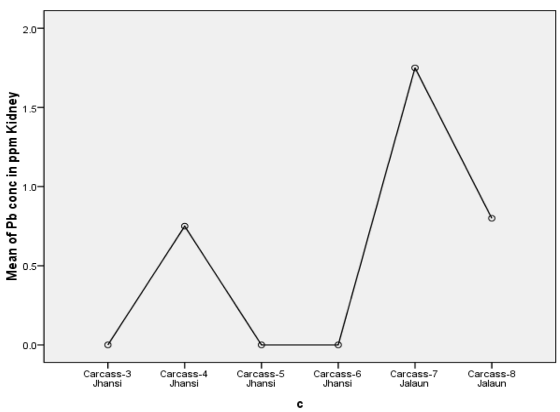


Graph 9. Mean of concentration of Zn in leg bone of carcasses of *Milvus migrans govinda*

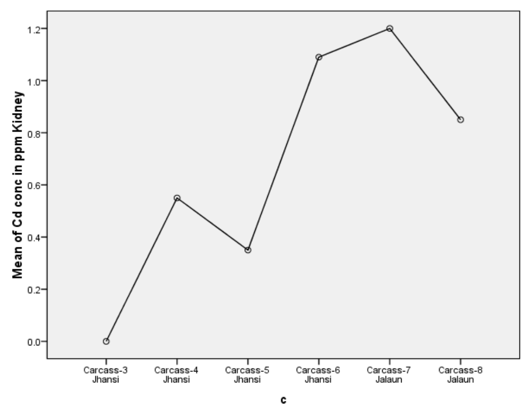


Graph 10. Mean of concentration of Fe in leg bone of carcasses of *Milvus migrans govinda***.**

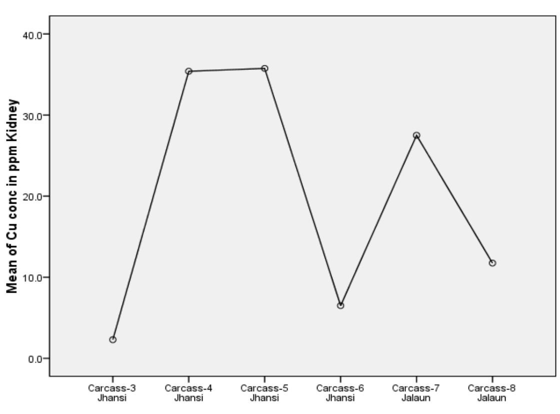
Means plots



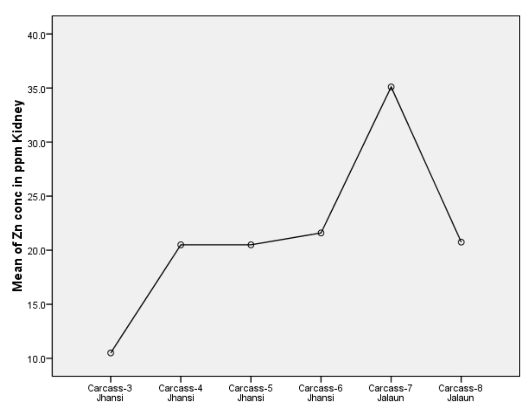
Graph 11. Mean of concentration of Pb in kidney of carcasses of *Milvus migrans govinda*



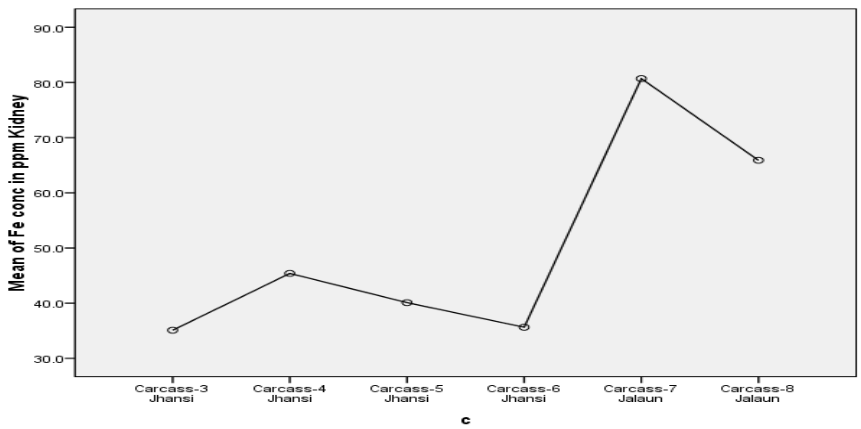
Graph 12. Mean of concentration of Cd in kidney of carcasses of *Milvus migrans govinda*



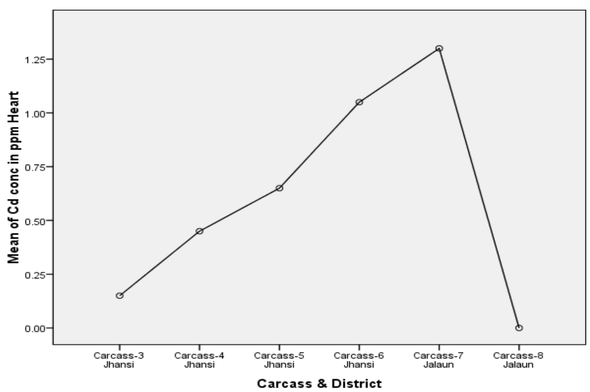
Graph 13. Mean of concentration of Cu in kidney of carcasses of *Milvus migrans govinda*



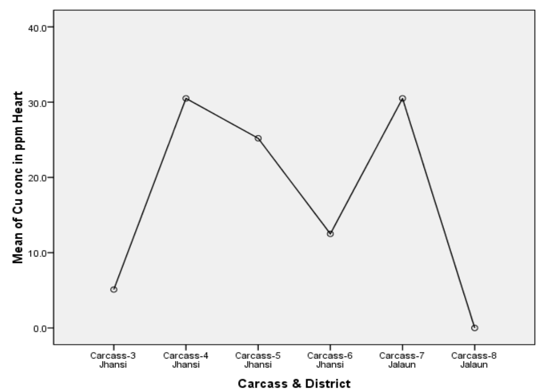
Graph 14. Mean of concentration of Zn in kidney of carcasses of *Milvus migrans govinda*



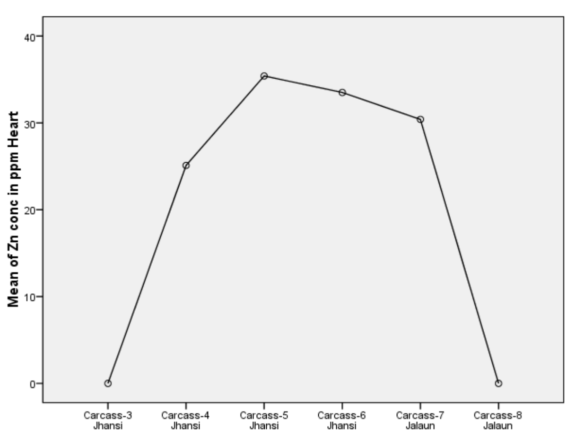
Graph 15. Mean of concentration of Fe in kidney of carcasses of *Milvus migrans govinda.*



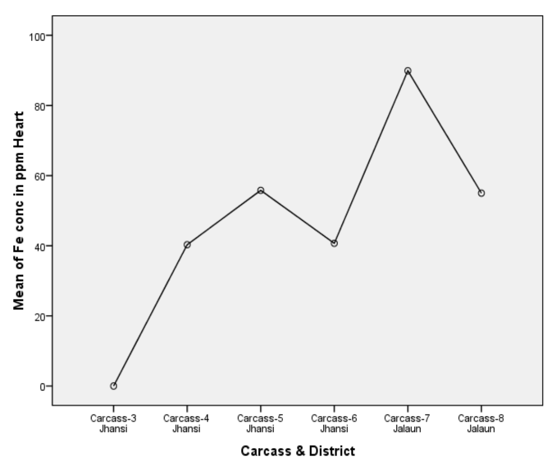
Graph 16. Mean of concentration of Cd in heart of carcasses of *Milvus migrans govinda*



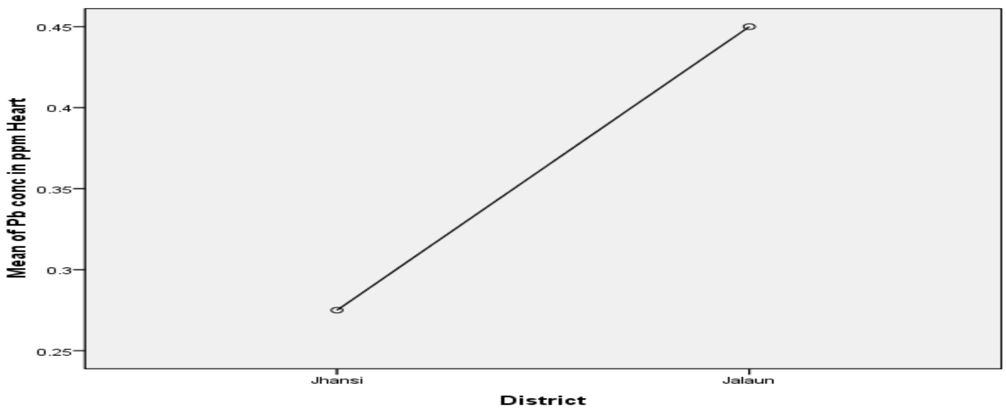
Graph 17. Mean of concentration of Cu in heart of carcasses of *Milvus migrans govinda*



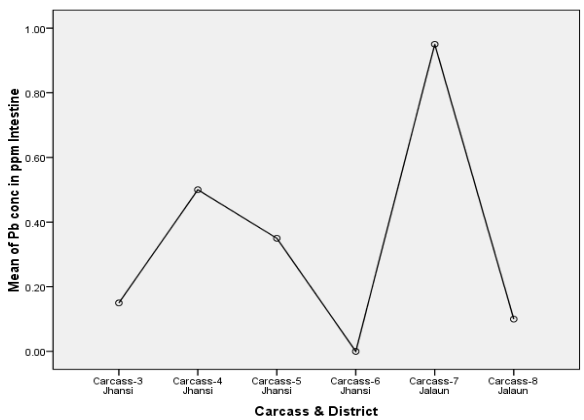
Graph 18. Mean of concentration of Zn in heart of carcasses of *Milvus migrans govinda*



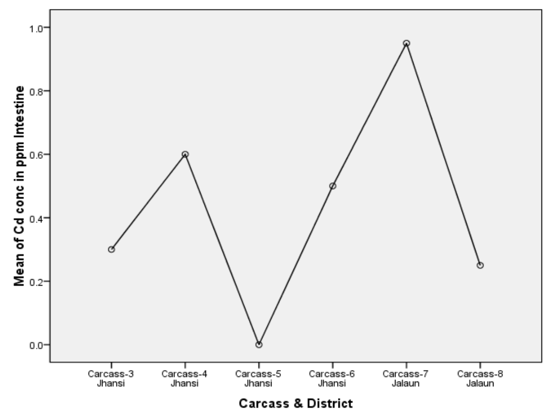
Graph 19. Mean of concentration of Fe in heart of carcasses of *Milvus migrans govinda*



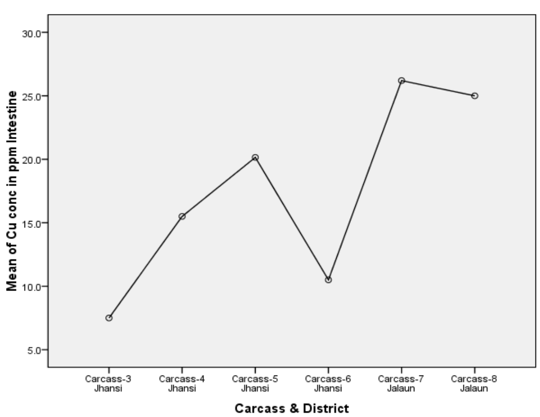
Graph 20. Mean of concentration of Pb in heart of carcasses of *Milvus migrans govinda.*



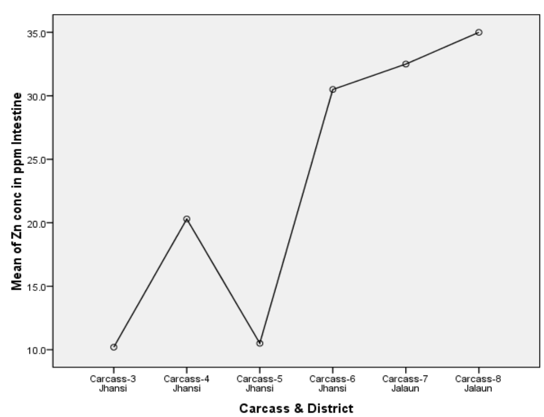
Graph 21. Mean of concentration of Pb in intestine of carcasses of *Milvus migrans govinda*



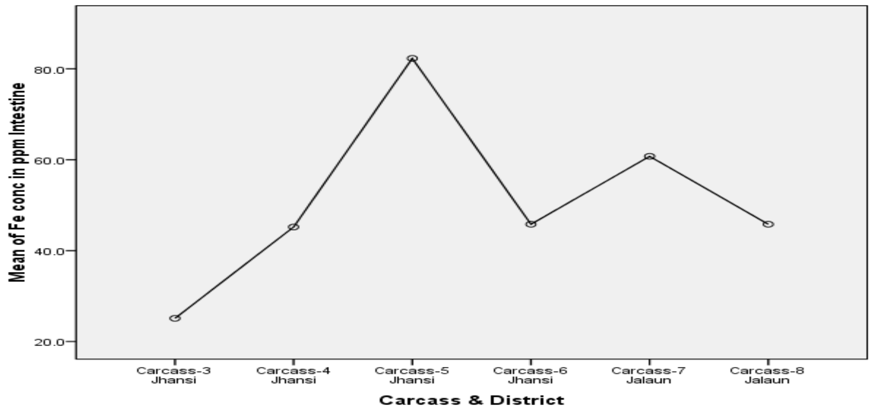
Graph 22. Mean of concentration of Cd in intestine of carcasses of *Milvus migrans govinda*



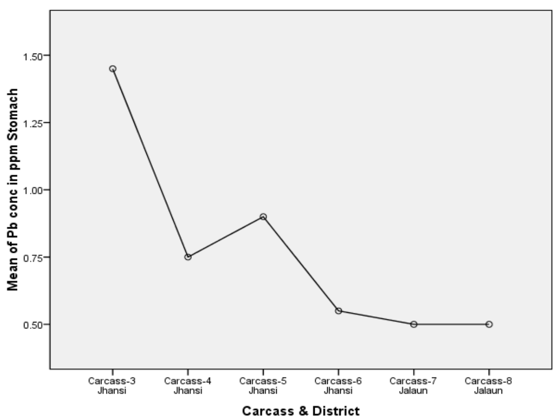
Graph 23. Mean of concentration of Cu in intestine of carcasses of *Milvus migrans govinda*



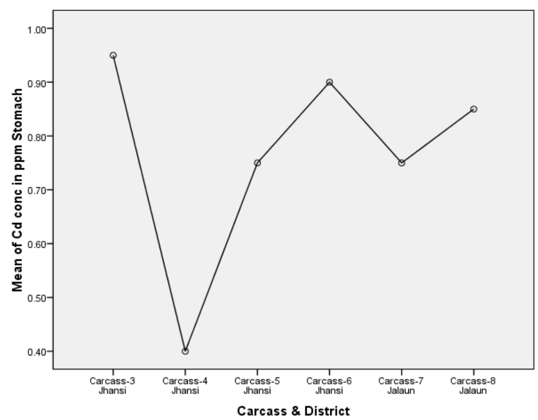
Graph 24. Mean of concentration of Zn in intestine of carcasses of *Milvus migrans govinda*



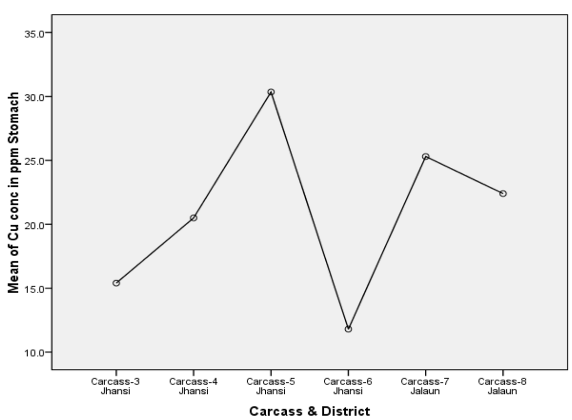
Graph 25. Mean of concentration of Fe in intestine of carcasses of *Milvus migrans govinda.*



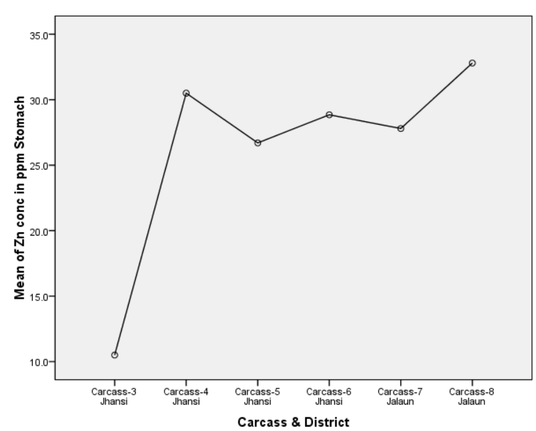
Graph 26. Mean of concentration of Pb in stomach of carcasses of *Milvus migrans govinda*



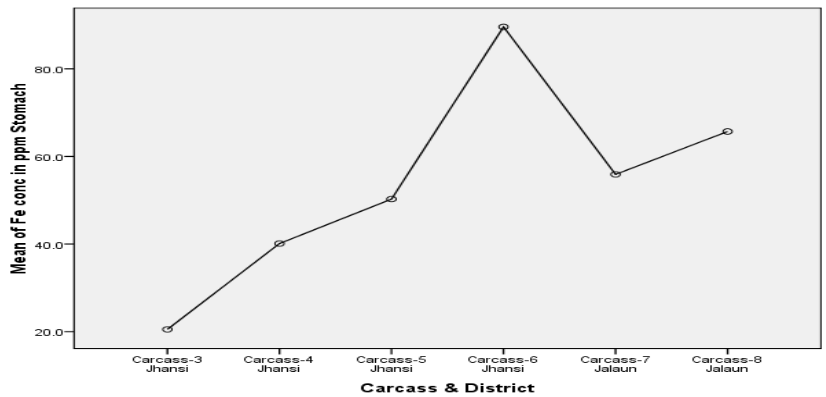
Graph 27. Mean of concentration of Cd in stomach of carcasses of *Milvus migrans govinda*



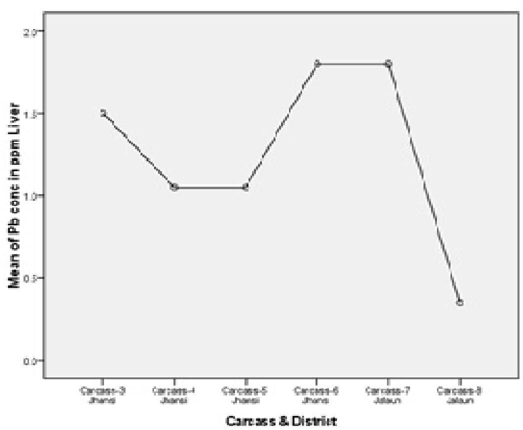
Graph 28. Mean of concentration of Cu in stomach of carcasses of *Milvus migrans govinda*



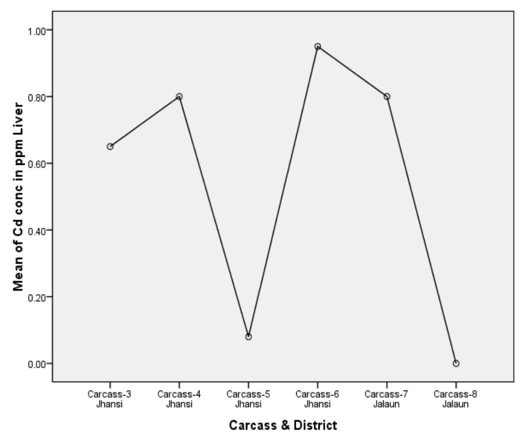
Graph 29. Mean of concentration of Zn in stomach of carcasses of *Milvus migrans govinda*



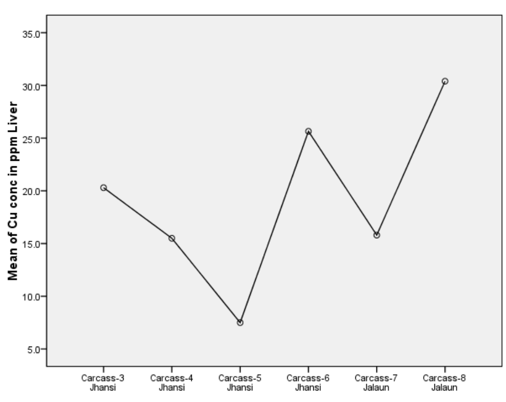
Graph 30. Mean of concentration of Fe in stomach of carcasses of *Milvus migrans govinda.*



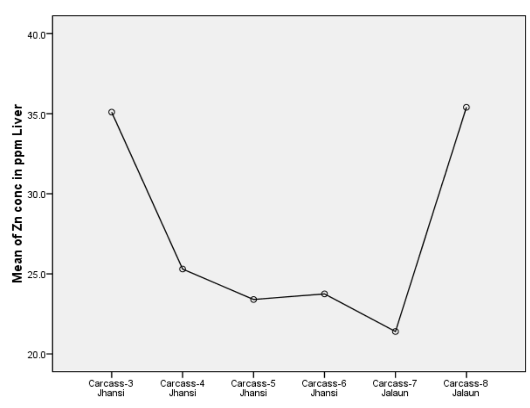
Graph 31. Mean of concentration of Pb in liver of carcasses of *Milvus migrans govinda*



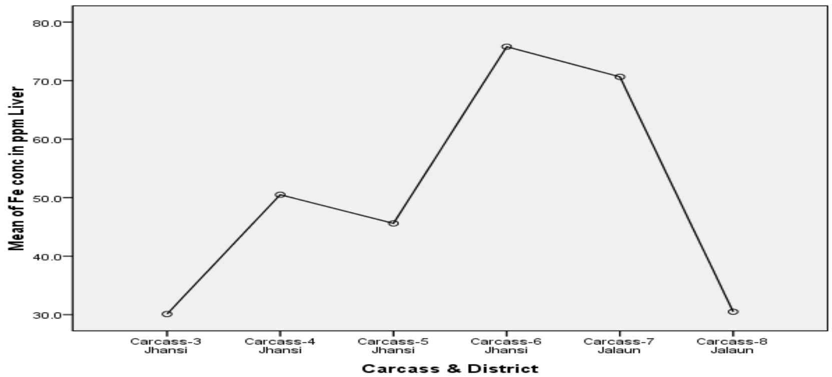
Graph 32. Mean of concentration of Cd in liver of carcasses of *Milvus migrans govinda*



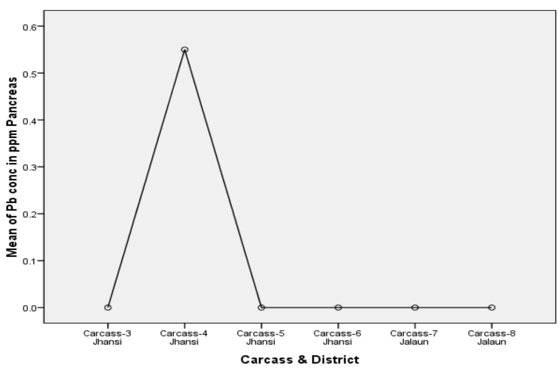
Graph 33. Mean of concentration of Cu in liver of carcasses of *Milvus migrans govinda*



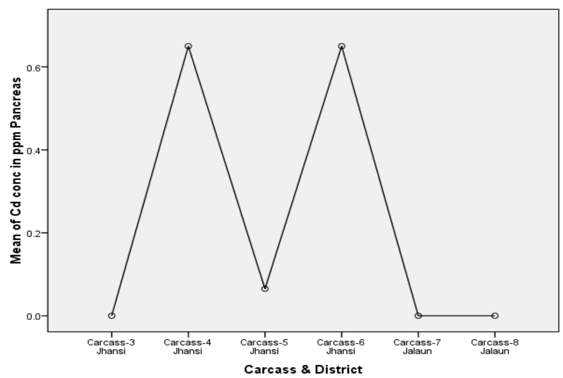
Graph 34. Mean of concentration of Zn in liver of carcasses of *Milvus migrans govinda*



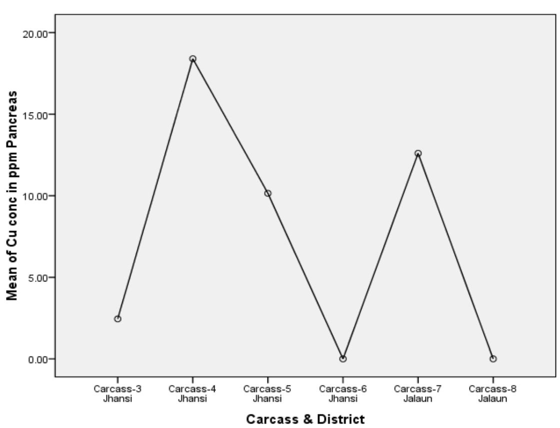
Graph 35. Mean of concentration of Fe in liver of carcasses of *Milvus migrans govinda.*



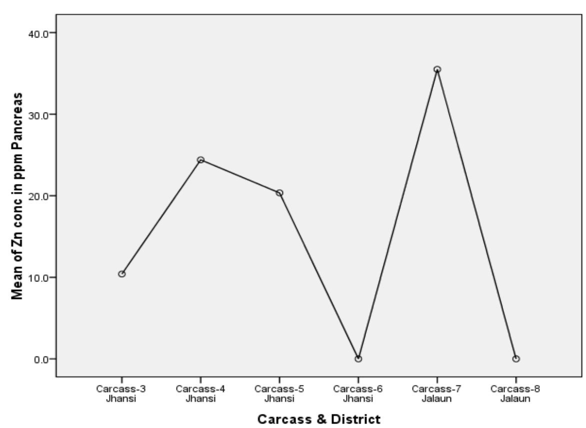
Graph 36. Mean of concentration of Pb in pancreas of carcasses of *Milvus migrans govinda*



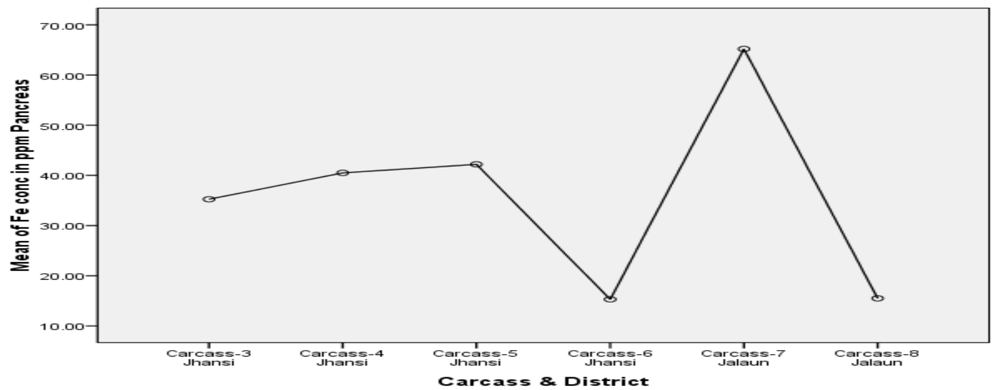
Graph 37. Mean of concentration of Cd in pancreas of carcasses of *Milvus migrans govinda*



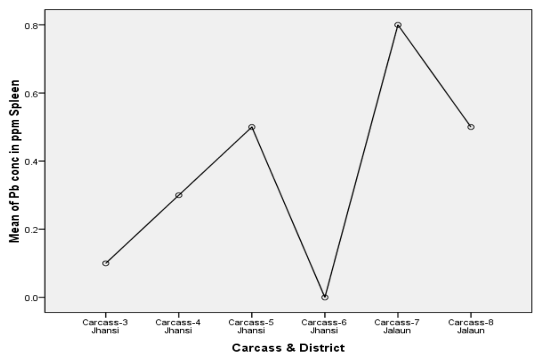
Graph 38. Mean of concentration of Cu in pancreas of carcasses of *Milvus migrans govinda*



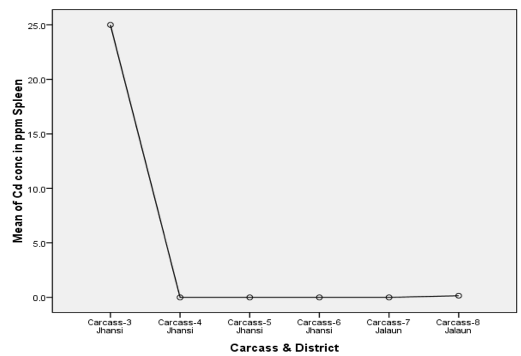
Graph 39. Mean of concentration of Zn in pancreas of carcasses of *Milvus migrans govinda*



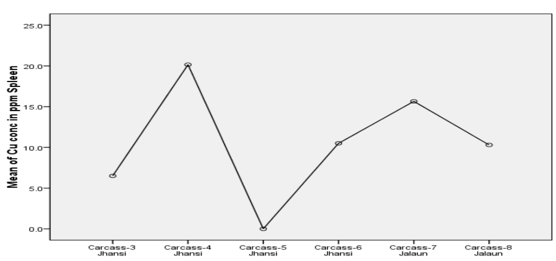
Graph 40. Mean of concentration of Fe in pancreas of carcasses of *Milvus migrans govinda.*



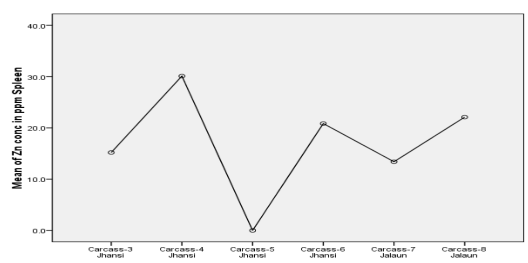
Graph 41. Mean of concentration of Pb in spleen of carcasses of *Milvus migrans govinda*



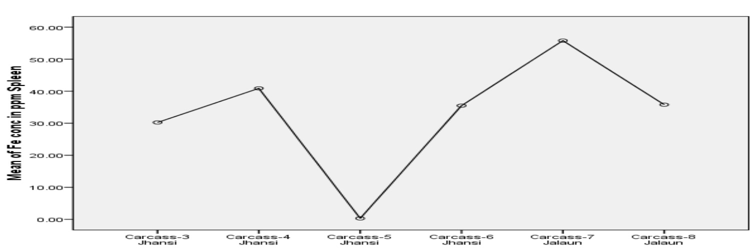
Graph 42. Mean of concentration of Cd in spleen of carcasses of *Milvus migrans govinda*



Graph 43. Mean of concentration of Cu in spleen of carcasses of *Milvus migrans govinda*



Graph 44. Mean of concentration of Zn in spleen of carcasses of *Milvus migrans govinda*



Graph 45. Mean of concentration of Fe in spleen of carcasses of *Milvus migrans govinda*

DISCUSSION

Metals are commonly found in the environment all around the world, their presence being associated with natural occurrence or as a result of anthropogenic activities [Fan, 1996]. The impact of heavy metals on the environment can be a serious threat to the stability of the ecosystem [Battaglia *et al.,* 2005]. Toxic elements can be harmful to birds even at low concentrations when ingested over a long period of time [Nolan, 1983; Young, 2005]. All these heavy metals can hamper the reproductive output or even cause death [Sanpera *et al.,* 2000], constituting a serious threat to the survival of wild bird species [Hernandez *et al.,* 1999].

Lead poisoning in nature is of cumulative effect, many studies provide data that cases of lead poisoning in human, animals and of birds are on rise in this growing industrial world [Narayana and Al-Bader, 2011; Sanderson, 1986; Salisbury *et al.,* 1958]. Lead is a highly toxic element which can cause bird mortality [Ramo *et al.,* 1992; Mateo *et al.,* 1998] have sublethal effects [Ochiai *et al.,* 1992] or a negative effect on reproduction [Burger, 1995], depending on the dose. There are several evidences on effects of metals as Stanley N. Wiemeyer *et al.,* (1989) studied on environmental contaminants in blood of western Bald eagles, *Haliaeetus leucocephalus*. They detected low lead concentration 0.25 ppm in nestlings of Bald eagles, *Haliaeetus leucocephalus* from Oregon and elevated concentrations 0.40 ppm in Bald eagles, *Haliaeetus leucocephalus* in Oregon and northern California and migrants in Montana and most frequently in nestlings from Washington but at low concentrations 0.40 ppm. High lead concentration in eagles (10 ppm) in the liver was indication of lead poisoning from ingestion of lead pellets in prey that were killed or crippled by hunters and not from contamination of the environment from other sources [O. H. Pattee and S. K. Hennes, 1983]. Palma *et al.,* (2005) reported that accumulation of heavy metals has been particularly well documented for aquatic food chains, where species such as Sea eagles, *Haliaetus spp* and Ospreys, *Pandion haliaetus* have shown poor breeding and enhanced mortality in association with different pollutants. Although much less documented, population decline attributed to environmental contaminants has also been shown for raptor species feeding on terrestrial food chains [Palma *et al.,* 2005], even when those raptor species have been recognized as being very useful in biomonitoring studies [Des Granges *et al.,* 1998]. R. Scheifler *et al.,* (2006) studied on atmospheric lead concentrations in urban areas of most industrialised countries, they hypothesised that urban common Blackbirds, *Turdus merula* may still be contaminated by Pb concentrations of toxicological concern due to transfer from soil through the food chain. Concentrations in outer most tail feathers, breast feathers and blood were significantly higher in urban Blackbirds, *Turdus merula* than in rural individuals. Marcos Perez-Lopez *et al.,* (2008) reported that nocturnal raptors exceeded the threshold value for Cd (3 ppm), with a maximum corresponding to an individual Barn owl, *Tyto alba* (39 ppm). In both cases, although concentrations could not be directly related to lethal effect, they might constitute a serious environmental factor affecting the survival of the considered populations. Oliver Krone *et al.,* (2004) investigated 12 white-tailed sea eagles, *Haliaeetus albicilla groenlandicus* found dead between 1997 and 2000 in Greenland. They examined health status, including the causes of death and the burden of organochlorine contaminants and potentially toxic heavy metals. The determined causes of death were unspecific trauma (n = 6), lead poisoning (n = 2) with 36 and 26 ppm lead in the liver tissue, infectious diseases (n = 1), injuries sustained during intraspecific conflict (n = 1) and gunshot (n = 1). Levels of organochlorine pesticides, polychlorinated biphenyls, mercury, and cadmium in organs were moderate.

Samreen Riaz *et al.,* (2006) reported that highest Cd concentration was found in the kidneys of Pheasants, *Phasianus colchicus* fed. The lowest Cd concentrations were found in muscle. The mean levels of Cd in the blood of Pheasants, *Phasianus colchicus* fed low and high doses of Cd were observed. The Cd accumulation in the tissues caused decreasing Fe and Hb levels in the tissues. The Fe decrease stimulated hematopoiesis in the liver. Despite this, Hb levels were not kept at normal values. G. J. Harrison, 1986; M. Mautino, 1990; S. E. McDonald (1988) reported that lead causes pansystemic damage, particularly to the gastrointestinal, nervous, renal and haematopoietic systems. Clinical signs of lead intoxication in psittacine birds may include lethargy, depression, anorexia, weakness (wing droop, leg paresis), regurgitation, polyuria, diarrhea, emaciation, ataxia, head tilt, blindness, circling, paresis, paralysis, head tremors, convulsions and death. Signs related to nervous system impairment include lethargy, wing droop, leg paresis or paralysis, changes in phonation, head tilt, ataxia, blindness, circling, head tremors and seizures [L. N. Locke *et al.,* 1996; G. Dumonceaux, 1994]. Signs related to haematopoietic impairment can include weakness. Lead causes renal tubular necrosis and renal nephrosis resulting in polyuria, proteinuria and haematuria [S. M. Riggs, 2002]. The severity of clinical signs does not always correlate with whole blood lead concentration. Lead poisoning and high lead exposure in birds has been a concern for more than a century [Wayland *et al.,* 1999] and cadmium has been described as one of the most dangerous trace elements in food and in the environment, not only for its high toxicity but also for its persistence [Battaglia *et al.,* 2005]. Other heavy metals, such as zinc are essential, required to support biological activities, but when their environmental concentrations rise, they can generate serious toxicological problems [Perez-Lopez *et al.,* 2006]. Ek *et al.,* 2004; Walsh, 1990; Wenzel *et al.,* (1996) observed that zinc is an essential trace element for the functions of many enzymes, although an excess could well represent an additional source of stress to birds already facing stressful conditions. Moreover, as other essential elements, Zn can be regulated metabolically so that an increase in metal concentration is not directly proportional to the exposure to the metal and therefore decreases the potential for detecting variations in the environmental levels. A. Romagnano *et al.,* 1995; M Lloyd, 1992 and B. R. Howard, (1992) reported that zinc intoxication in birds are varied and nonspecific. They include lethargy, anorexia, regurgitation, polyuria, polydipsia, haematuria, haematochezia, pallor, dark or bright green diarrhea, foul-smelling feces, paresis, seizures and sudden death. E. van Wyk *et al.,* (2001) reported that Lappetfaced vulture, *Torgos tracheliotos* had a Zn level of 424.35 µg/g, which is higher than the effects range (Ross and DeLorenzo, 1997). The Zn concentrations measured in fat, kidney and bone in this study are higher than normal levels in birds which vary between 100 and 200 µg/g (Merian, 1991). J. Burger (1993) observed bullet fragments from four of the ten carcasses, copper appeared to be the metal most consumed by scavenging raptors. Approximately 113 mg, 10 mg, and 67 mg of copper were found in three carcasses. However, we did not analyze copper concentrations in blood and found little information in our literature review of copper toxicity in raptors. E. van Wyk *et al.,* (2001) reported that tissue Cu concentrations measured in his study were also well below 500 µg/g, which is considered to be the level at which toxic effects. A Mute swan, *Cygnus olor* with inanition, anemia and generalized weakness showed signs of toxicity with liver copper levels in excess of 3000 ppm and over 50 ppm copper in the kidneys [A. Frank and K. Borg, 1979]. Marcos Perez-Lopez *et al.,* (2008) investigated heavy metal Pb, Cd and Zn in different raptor species, both diurnal and nocturnal. Three of the maximal Pb levels were quantified in diurnal raptors, with a maximum reaching up to 18 ppm (dw), corresponding to an individual common buzzard, *Buteo buteo*. The highest liver concentrations from all the analyzed elements were found for Zn, ranging from mean values of 174.7–298.3 ppm (dw) in nocturnal raptors and 250.7–273.3 ppm (dw) in diurnal birds. The species that presented the highest mean level of this essential metal was the tawny owl, followed by the barn owl. The species that had the highest Cd mean concentration were the tawny owl and the Long-eared owl, *Asio otus*. The maximum absolute value for cadmium concentration was quantified in a Barn owl, *Tyto alba* reaching up to 39 ppm. Although, concentrations could not be directly related to lethal effect, they might constitute a serious environmental factor affecting the survival of the considered populations.

Mining operations in general have adverse environmental impacts [Ghose, 1989]. In Bundelkhand region, a number of rock crushing unit (RCU), geo-granite mining, drilling and blasting operations are going on in large scale which generated huge amount of silica and other types of mixing dust. The other fine particles originated from Parichha thermal power plant, Hiedel diamond cement industry and also brick manufacturing process units emits in the form of flyash, lime particulate matters and soil born dust respectively [Abhimanyu Singh *et al.,* 2013]. The mining activity comprising drilling, blasting, loading of waste, transport of overburden and crushing of ore is having considerable impacts on the air environment and well being of living organism. Metals like Cd, Pb, Cu and Fe concentrations were found to the above permissible limit at some places in different seasons and may cause health hazards in existing environment in Bundelkhand region [Gayatri Singh *et al.,* 2010]. The nonessential heavy metals lead and cadmium are emitted and globally distributed mainly through industry, road traffic, and consumption of fossil fuels [Kenntner *et al.,* 2003]. Villages of the study area, most of the population still cooks with wood, biomass, dung, fossil fuels and crops residues is contributed heavy metals. In present study ranges of metals were reported Pb 0.10 ppm - 1.90 ppm, Cd 0.065 ppm - 2.5 ppm, Cu 2.30 ppm - 45.50 ppm, Zn 7.60 ppm - 35.75 ppm, Fe 0.30 ppm – 95.50 ppm. Obtained data are comparable with those reported by other authors, which evaluated metal contamination in different raptor species and all indicative of a background exposure to the considered metals. Pb, Cd, Cu, Zn and Fe were reported below their lethal limits in the present study. The present study can be considered as a starting point in the study of a possible correlation between levels of pollutants and the appearance of any adverse effects in *Milvus migrans govinda* species in Bundelkhand region.

CONCLUSION

This study attempted to establish the level of metals in *Milvus migrans govinda* in Bundelkhand region. The study area is now facing many environmental threats created by anthropogenic activities and as a result the ecosystem is becoming contaminated with metal toxicants. In conclusion, it has been found that *Milvus migrans govinda* were acquiring Pb, Cd, Cu, Zn and Fe, although concentrations could not be directly related to lethal effect, they might constitute a serious environmental factor affecting the survival of the considered populations of *Milvus migrans govinda* in Bundelkhand region. This is the first study of this type in Bundelkhand region. More research needs to be completed of effects of toxic metals in *Milvus migrans govinda* in Bundelkhand region. However, this study did provide a starting point for future research to be based on metal toxicants in the study area.

The biological characteristics of *Milvus migrans govinda* can make these species useful sentinels for biomonitoring, as they can act as adequate local monitors of metal toxicants levels.

ACKNOWLEDGEMENTS

Authors are thankful to Prof. Madhu Tripathi, Head, Department of Zoology, University of Lucknow, Lucknow. I wish my sincere regards and deepest sense of gratitude to Dr. Mohini Saini, Senior Scientist, Centre for Wildlife, Indian Veterinary Research Institute, Izzatnagar, Bareilly, Uttar Pradesh for her scientist acumen in advanced field of toxicology, We are thankful to Forest department of Uttar Pradesh and Madhya Pradesh for providing the permission to study. Our sincere acknowledgements to all the local people of Bundelkhand region for their cooperation and help.

REFERENCES

Battaglia A., Ghidini S., Campanini G. and Spaggiari R. (2005). Heavy metal contamination in Little owl, *Athene noctua* and common Buzzard, *Buteo buteo* from northern Italy. *Ecotoxicol. Environ. Saf.* **60;** pp 61–66.

Burger J. (1995). A risk assessment for lead in birds. *J. Toxicol. Environ. Health* **45;** pp 369–396.

Burger J. (1993). Metals in avian feathers: Bioindicators of environmental pollution. *Rev. Environ. Toxicol.* **5;** pp 203-311.

Burger J. and Gochfeld M. (2001). On developing bioindicators for human and ecological health. *Environmental Monitoring and Assessment* **66;** pp 23-46.

Carson R. (1962). *Silent Spring*, published by Houghton Mifflin.

Castro I., Aboal J. R., Fernandez J. A. and Carballeira A. (2011). Use of raptors for biomonitoring of heavy metals: Gender, age and tissue Selection. *Bulletin of Environmental Contamination and Toxicology* **86;** pp 347-351.

Des Granges J. L., Rodrigue J., Tardif J. and Laperle M. (1998). Mercury accumulation and biomagnification in Ospreys, *Pandion haliaetus* in the James Bay and Hudson Bay regions of Quebec. *Arch. Environ. Contam. Toxicol.* **35;** pp 330–341.

Dumonceaux G. and Harrison G. H. (1994). Toxins. In: Ritchie B. W., Harrison G. J., Harrison L. R. (Eds). Delray Beach, Florida: Wingers publishing. *Avian Medicine: Principles and Application* pp1030-1052.

Ek K. H., Morrison G. M., Lindberg P. and Rauch S. (2004). Comparative tissue distribution of metals in birds in Sweden using ICP-MS and laser ablation ICP-MS. *Arch. Environ. Contam. Toxicol.* **47;** pp 259–269.

Eulaers I., Covaci A., Herzke D., Eens M., Sonne C., Moum T., Schnug L., Hanssen S. A., Johnsen T. V., Bustnes J. O. and

Jaspers V. L. B. (2011). A first evaluation of the usefulness of feathers of nestling predatory birds for non-destructive biomonitoring of persistent organic pollutants. *Environment International* **37;** pp 622-630.

Fan A. M. (1996). An introduction to monitoring and environmental and risk assessment of metals. In: Magos L., Suzuki T. (Eds.), Toxicology of metals. CRC Lewis Publishers, Boca Raton. pp 5– 9.

Frank A. and Borg K. (1979). Heavy metals in tissues of the Mute swan, *Cygnus olor*. *Acta. Vet. Scand*. **20;** pp 447-465.

Furness R. W. and Greenwood J. J. D (1993). Birds as monitors of environmental Change.

Ghose M. K. (1989). Pollution due to air borne dust particles in coal mining, its monitoring and abatement measures. *Minetech*. **10(1);** pp 91–95.

Harrison G. J. (1986). Toxicology. In Harrison G. J., Harrison L. R. (Eds): Clinical Avian Medicine and Surgery. Philadelphia, WB Saunders Co. pp 491-499.

Hernandez L. M., Gomara B., Fernandez M., Jimenez B., Gonzalez M. J., Baos R., Hiraldo F., Ferrer M., Benito V., Suner M. A., Devesa V., Munoz O. and Montoro R., (1999). Accumulation of heavy metals and as in wetlands birds in the area around Donana national park affected by the Aznalcollar toxic spill. *Sci. Total Environ.* **242;** pp 293– 308.

Howard B. R. (1992). Health risks of housing small psittacines in galvanized wire mesh cages *JAVMA* **200;** pp 1667-1674.

Kenntner N., Krone O., Altenkamp R. and Tataruch F. (2003). Environmental contaminants in liver and kidney of free-ranging northern Goshawks, *Accipiter gentilis* from three regions of Germany. *Arch. Environ. Contam. Toxicol.* **45;** pp 128–135.

Kolmer J. A., Spaudling E. H. and Robinson H. W. (1951). Approved laboratory techniques. *Appleton Century Crafts, New York*. pp 1090-1091.

Krone O., Wille F., Kenntner N., Boertmann D. and Tataruch F. (2004). Mortality factors, environmental contaminants, and parasites of White-tailed sea eagles, *Haliaeetus albicilla groenlandicus* from Greenland. *Avian Diseases* **48;** pp 417– 424.

Lloyd M. (1992). Heavy metal ingestion: medical management and gastroscopic foreign body removal. *J. Assoc. Avian. Vet*. **6;** pp 25-29.

Locke L. N. and Thomas N. J. (1996). Lead poisoning of waterfowl and raptors. In: Fairbrother A, Locke L. N., Hoff G. L. (Eds.) Ames: Iowa State University Press. *Non infectious Diseases of Wildlife*. pp 108-117.

Lopez-Alonso M, Miranda M., Castillo C., Hernandez J., Garcia-Vaquero M. and Benedito J. L. (2007). Toxic and essential metals in liver, kidney and muscle of pigs at slaughter in Galicia, north-west Spain. *Food Addit Contam*. **24;** pp 943–954.

Martinez A., Crespo D., Fernandez J. A., Aboal J. R. and Carballeira A. (2012). Selection of flight feathers from *Buteo buteo* and *Accipiter gentilis* for use in biomonitoring heavy metal contamination. *Science of the Total Environment* **425;** pp 254-261.

Mateo R., Belliure J., Dolz C., Aguilar Serrano J. M. and Guitart R. (1998). High prevalences of lead poisoning in wintering waterfowl in Spain. *Arch. Environ. Contam. Toxicol.* **35;** pp 342–347.

Mautino M. (1990). Avian lead toxicosis. *Proc Assoc Avian Vet.* pp 245-247.

McDonald S. E. (1988). Lead poisoning in psittacine birds. In Kirk R. W. (Eds.): Small animal practice. Philadelphia W. B., Saunders Co. *Current Veterinary Therapy* **9;** pp 713-718.

Merian E. (1991). Metals and their compounds in the environment. VCH Verlagsgesellschaft, Weinheim.

Movalli P. A. (2000): Heavy metal and other residues in feathers of Laggar falcon *Falco biarmicus jugger* from six districts of Pakistan. *Environmental Pollution* **109;** pp 267-275.

Narayana K. and Al-bader M. (2011). Ultrastructural and DNA damaging effects of lead nitrate in the liver. *Exp. and Tox. Path*. **63;** pp 43-51.

Nolan K. R. (1983). Copper toxicity syndrome. *J. Orthomol. Psychiatry* **12;** pp 270-282.

Ochiai K., Jin K., Itakura C., Goryo M., Yamashita K., Mizuno N., Fuginaga T. and Tsuzuki T. (1992). Pathological study of lead poisoning in Whooper swans, *Cygnus cygnus* in Japan. *Avian Dis*. **36;** pp 313–323.

Palma L., Beja P., Tavares P. C. and Monteiro L. R. (2005). Spatial variation of mercury levels in nesting Bonelli's eagles, *Aquila fasciata* from Southwest Portugal: Effects of diet composition and prey contamination. *Environ. Pollut.* **134;** pp 549–557.

Pappas A. C., Zoidis E., Fegeros K., Surai P. F. and Zervas G. (2010). Relation of cadmium to other elements and the antioxidant system. In: Parvau P. G. editor. Cadmium in the environment. New York: Nova Science Publishers. pp 263–295.

Pattee O. H. and Hennes S. K. (1983). Bald eagles, *Haliaeetus leucocephalus* and waterfowl: The lead shot connection. *Trans. N. Amer. Wildl. Nat. Res. Conf.* **48;** pp 230-237.

Perez L. M., Cid F., Oropesa A. L., Hidalgo L. E., Lopez B. A. and Soler F. (2006). Heavy metal and arsenic content in seabirds affected by the Prestige oil spill on the Galician coast (NW Spain). *Sci. Total Environ*. **359 (1–3);** pp 209–220.

Perez L. M., Mendoza M. H. D., Beceiro A. L. and Rodriguez F. S. (2008). Heavy metal (Cd, Pb, Zn) and metalloid (As) content in raptor species from Galicia (NW Spain). *Ecotoxicology and Environmental Safety* **70;** pp 154–162.

Ramo C., Sanchez C. and Hernandez S. A. (1992). Lead poisoning of greater Flamingos *Phoenicopterus ruber*. *Wildfowl* **43;** pp 220–222.

Riaz S., Alam S. S. and Ikram A. (2006). Histopathological changes observed in the heart and gizzard of quail chicks *Coturnix coturnix japonica* administrated by the different levels of chrome shaving. *African Journal of Biotechnology* **5 (19);** pp 1765-1769.

Riggs S. M., Puschner B. and Tell L. A. (2002). Management of an ingested lead foreign body in an Amazon parrot, *Amazona*. *Vet. Hum. Toxicol*. **44;** pp 345-348.

Romagnano A., Grinden C. B., Degerness L *et al.,* (1995). Treatment of a hyacinth macaw with zinc toxicity. *J. Avian Med. Surg*. **9;** pp 185- 189.

Ross P. and Delorenzo M. E. (1997). Sediment contamination problems in the Caribbean Islands: Research and regulation. *Environ. Contam. Toxicol*. **16;** pp 52.

Salisbury R. M., Staples E. L. J. and Sutton M. (1958). Lead poisoning of chickens. *The New Zealand Veterinary Journal* **6;** pp 2-7.

Sanderson G. C. and F. C. (1986). Bell rose: A review of the problem of lead poisoning in Water fowl, Champaign J. L. 2nd (Eds) Illinois Natural history survey.

Sanpera C., Morera M., Ruiz X. and Jover L. (2000). Variability of mercury and selenium levels in clutches of Audouin's gulls, *Larus audouinii* breeding at the Chafarinas Islands, Southwest Mediterranean. *Arch. Environ. Contam. Toxicol*. **39;** pp 119–123.

Scheifler R., Coeurdassier M., Morilhat C., Bernard N., Faivre B., Flicoteaux P., Giraudoux P., Noel M., Piotte P., Rieffel D., de Vaufleury A. and Badot P. M. (2006). Lead concentrations in feathers and blood of common Blackbirds, *Turdus merula* and in earthworms inhabiting unpolluted and moderately polluted urban areas. *Science of The Total Environment* **371;** pp 197–205.

Singh A., Khan A. H. Zaidi J., Yadav N., Chauhan D. S. and Ganesh S. (2013). Health risks zonation vis-a-vis air-borne diseases in Bundelkhand region, India. *Advances in Applied Science Research* **4 (5);** pp 287-295.

Singh G. and Pal A. (2010). Environmental impacts of mining on Bundelkhand region of Uttar Pradesh, India. *Recent Research in Science and Technology* **2 (3);** pp 50-57.

Thiollay J. (1994). Family Accipitridae, hawks and eagles. In Hoyo D., Elliott A. and Sargatal J. (Eds.) handbook of the birds of the world. New world's vultures to Guinea fowl, *Numida meleagris* Barcelona: *Lynx Edicions* pp 52- 105.

Walsh P. M. (1990). The use of seabirds as monitors of heavy metals in the marine environment. In: Furness R.W., Rainbow P. S. (Eds), Heavy metals in the marine environment. CRC Press, Boca Raton. pp 183–204.

Wayland M., Neugebauer E. and Bollinger T. (1999). Concentrations of lead in liver, kidney and bone of Bald eagles, *Haliaeetus leucocephalus* and Golden eagles, *Aquila chrysaetos*. *Arch. Environ. Contam. Toxicol*. **37;** pp 267-272.

Wenzel C., Adelung D. and Theede H. (1996). Distribution and age-related changes of trace elements in kittiwake, *Rissa tridactyla* nestlings from an isolated colony in the German Bight, North Sea. *Sci. Total Environ.* **193;** pp 13–26.

Wiemeyer S. N., Frenzel R. W., Anthony R. G., McClelland B. R. and Knight R. L. (1989). Environmental contaminants in blood of western Bald eagles, *Haliaeetus leucocephalus*. *J. Raptor Res.* **23(4);** pp 140-146.

Wyk E. V., van der B. F. H., Verdoorn G. H. and Hofmann D. (2001). Selected mineral and heavy metal concentrations in blood and tissues of vultures in different regions of South Africa. *South African Journal of Animal Science* **31 (2);** pp 57-63.

Young R. A. (2005). Toxicity profiles: Toxicity summary for cadmium, risk assessment information system. University of Tennessee, Nashville, TN, USA.

Corresponding author: Dr. Ragni Gupta Department of Zoology, University of Lucknow, Lucknow, U.P. India

Email: Kanaujia.amita@gmail.com ragni.gupta@gmail.com