



# Lead : toxic effects and sources in wildlife

**Philippe Berny, DVM, Ph D**

Professor of Toxicology

Vetagro Sup – Campus Vétérinaire

Marcy l'étoile - France



# Introduction

- Lead and wildlife
  - Many species, many places, many times
  - Waterfowl exposure
    - Thousands of birds killed every year
    - Population exposure may be very high
      - 7.5-50% mallards in Argentina (*Ferreyra et al., 2014*)
      - 25-33% mallards in Ebro delta (Spain) (*Guitar et al., 1994, Mateo et al., 1998*)
      - 45% mallards in Camargue, France (*Pain, 1990*)



# Introduction

- Lead and wildlife
  - Many species, many places, many times
  - Birds of prey exposure
    - Often described in individuals (bird rescue centers)
    - Evidence of population exposure
      - Griffon vultures (*Gyps fulvus*)
      - Red kites (*Milvus milvus*)
      - California condor (*Gymnogyps californianus*)
      - Bearded vulture (*Gypaetus barbatus*)
      - (...)

# Introduction

Species	Country	% (N)	Note	Ref
<i>Gyps fulvus</i>	Spain	91%(23)	[Pb]>200 µg.l <sup>-1</sup>	Garcia-Fernandez et al., 2005
	France	7%(92)	[Pb]>6 mg.kg <sup>-1</sup> (dw, liver)	Berny et al., 2015
	Israël	20%(25)	[Pb]>200 µg.l <sup>-1</sup>	Shlosberg et al., 2012
<i>Gymnogyps californianus</i>	USA	50-88%(150) 20%	[Pb]>100 µg.l <sup>-1</sup> [Pb]>450µg.l <sup>-1</sup>	Finkelstein et al., 2012
	USA	47- 92%(>1500, 5 years)	[Pb]>200 µg.l <sup>-1</sup>	Kelly et al., 2014
<i>Gypaetus barbatus</i>	Spain	6%(87)	Pb]>200 µg.l <sup>-1</sup> [Pb]>6 mg.kg <sup>-1</sup> (dw, liver)	Hernandez et al., 2009
	France	12,5%(8)	[Pb]>6 mg.kg <sup>-1</sup> (dw, liver)	Berny et al., 2015

# Lead toxicity in wildlife

- A high susceptibility ?
  - Lead particles in gizzard
    - Mechanical digestion
    - Waterfowl+++ in hunting areas
    - Ingestion by birds of prey
  - Low pH
    - A Bearded vulture can digest bones in <48h
  - Persistence in gizzard folds
    - $\text{Pb}(\text{metal}) \rightarrow [\text{Pb}^{++}]$  absorbed



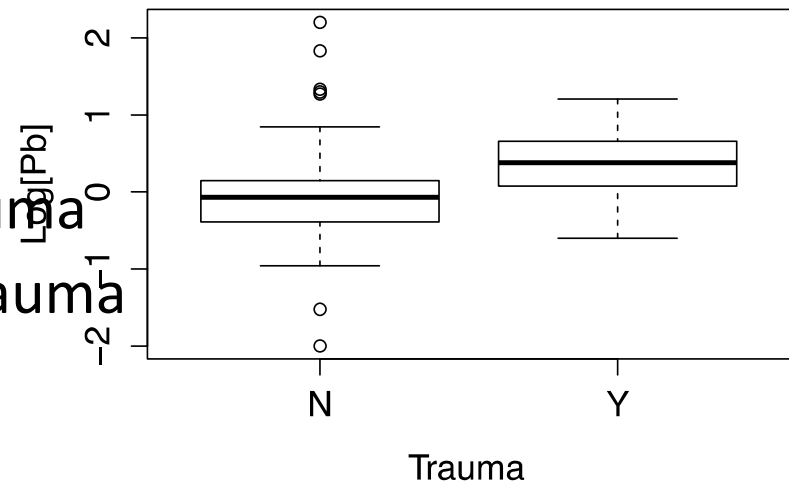


# Lead toxicity in wildlife

- Acute poisoning
  - Neurological and digestive signs
    - Weakness
    - Limb weakness
    - Limber neck
    - Blindness
    - Green diarrhea
    - Weight loss
  - Often (not always !) presence of lead particles
    - Gizzard/proventriculus
    - Whole body X-Ray

# Lead toxicity in wildlife

- Chronic toxicity : Pb is cumulative
  - Weakness
  - Weightloss
  - Anemia (?)
  - Dilatation and impaction of proventriculus
  - Neurological / digestive disorders
    - Blindness
    - Behavioral disorders
  - Sub-clinical effects ?
    - $[Pb]_{liver} 1.52 > 0.84$  if trauma
    - $[Pb]_{kidney} 2.44 > 0.86$  if trauma





# Lead toxicity in wildlife

- A bad story...



Red kite found dead with...

- Broken wing
- Cachexia
- Lung hemorrhages
- Green diarrhea
- Lead bullets (thigh, wing)
- [Pb]Liver =  $21.2 \mu\text{g.g}^{-1}$  (dw)

Conclusion :

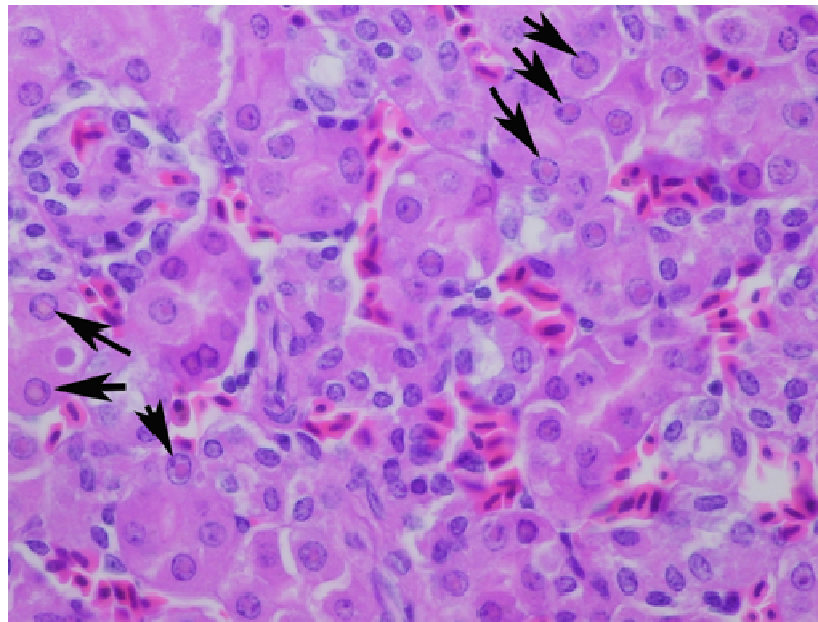
Shot, Pb poisoning, blindness  
neuro-behavioral disorders, feeding ?  
- collision, broken bone...

*Photos : Dr L. Vilagines*



# Lead toxicity in wildlife

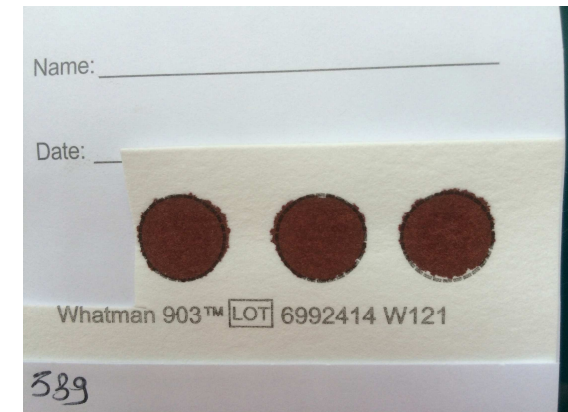
- Lesions
  - Macroscopic lesions
  - Acidophilic inclusions in liver/kidney



©Dr K. Lemberger, VetDiag

# Lead toxicity in wildlife

- Diagnostic testing
  - Blood lead :
    - Whole blood
      - $>100 \mu\text{g/L}$  « exposure »
      - $<250 \mu\text{g/L}$  « background »
      - $>500 \mu\text{g/L}$  toxic
    - Dry Blood Spots
  - Liver :
    - $<2 \text{ mg.kg}^{-1} \text{ (ww)}$
    - $> 6 \text{ mg.kg}^{-1} \text{ (dw)}$  Exposure
    - $>15\text{-}20 \text{ mg.kg}^{-1} \text{ (dw)}$  Poisoning
    - $/3.3$  for ww





# Lead sources

- From soil to trophic web...contamination of plants, herbivores, predators
- Aerial pollution ? No evidence of impact
- Environmental (soil) lead (local issue)
  - Geological exposure : old mines, old mountain areas
  - Mining activities : active sites
  - Use of old mine wastes in fields
- Industrial sources (local issue)
  - Lead pipes (water)
  - Batteries
  - (Paints) : cases in rehabilitation centers
  - (Leaded gas) : not a concern in the EU

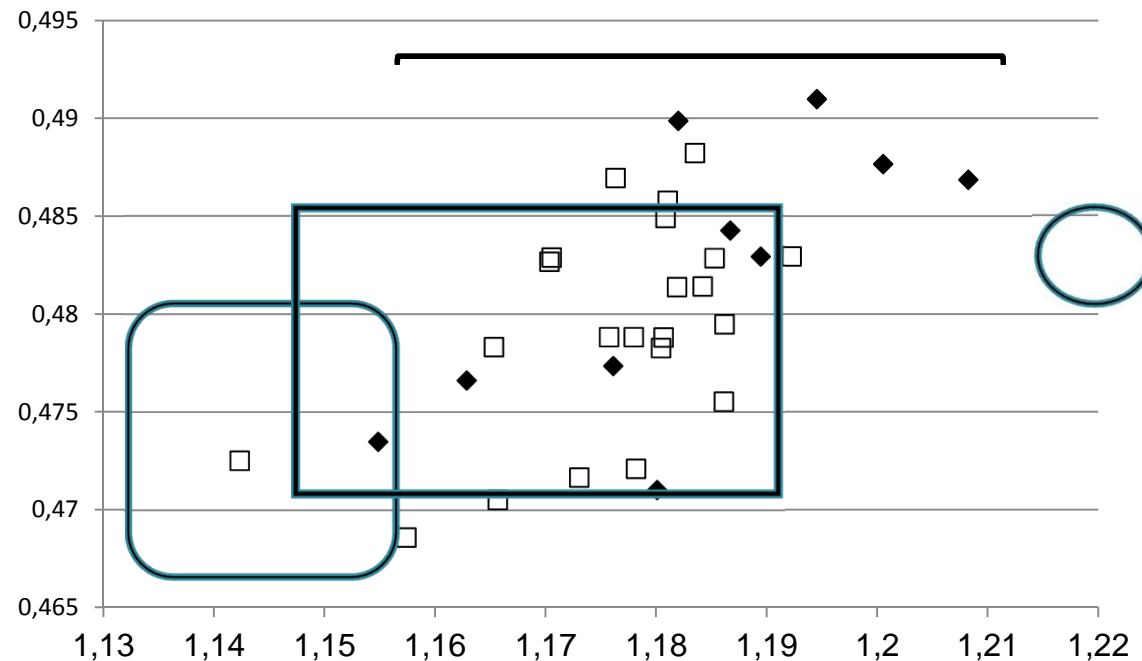


# Lead sources

- Lead ammunition in feeds : major concern
  - First evidence in waterfowl : lead in gizzard/crop
  - In birds of prey
    - Lead ammunition in surviving preys / fragmentation
    - California condor 26 to 67% of identified cause of death (*Rideout et al., 2011*)
    - Major source (Lead isotope analyses) (*Finkelstein et al., 2012*)
      - Isotopes issued from other radio-active elements = geological source signature
    - Described / suspected in many species

# Lead sources

- Lead ammunition in feeds



**Lead isotope ratios ( $^{206}/^{208}\text{Pb}$  vs  $^{206}/^{207}\text{Pb}$ ) in birds of prey (liver) and from various published sources.**

Open squares :  $[\text{Pb}]_{\text{liver}} > 2 \mu\text{g.g}^{-1}$  (dry weight).

Rectangle: lead in European ammunition (Thomas et al., 2009);

Round-edge rectangle: lead in Pyrenean ancient mines (Cardellach et al., 1996);

Circle: lead in Basq county (Monna et al., 2004);

line: lead in US ammunition (Lambertucci et al., 2011).

Leaded gas ( $< 1.08$  on X axis) could not be represented on this graph

# Lead sources

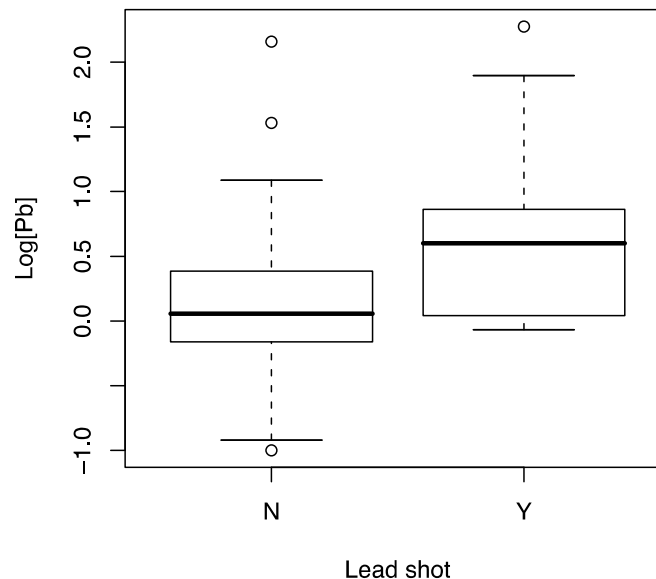
- Lead ammunition in animals shot
  - Supposedly harmless ?
  - Evidence of clinical effects in individuals
    - Very few published data
    - One recent paper (*LaDouceur et al., 2015*)
    - 2 birds out of 14 (Lead shots) w/ high [Pb]liver = 14%





# Lead sources

- Lead ammunitions in animals shot
  - Supposedly harmless ?
  - Evidence of higher exposure in individuals
    - $[\text{Pb}]_{\text{liver}} 1.24 > 0.92$  if shot
    - $[\text{Pb}]_{\text{kidney}} 2.68 > 0.92$  if shot



# Conclusion

- Lead poisoning
  - Is a major concern worldwide for birds of prey
  - Is primarily related to
    - Food-exposure
    - Lead ammunitions in preys
  - May also be linked to
    - Lead shots in the body
    - Less frequently : local/other industrial sources

Thank you for your attention