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# Metal Levels in a Cuvier's Beaked Whale (*Ziphius cavirostris*) Found Stranded on a Mediterranean Coast, Corsica

J. P. Frodello, D. Viale, B. Marchand

Laboratory Parasites and Mediterranean Ecology, University of Corsica, Sciences and Technology Faculty, B. P. 52, 20250 Corte, France

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Marine mammals are known to accumulate metal contaminants due to their position at the end of the food chain (Caurant et al. 1994; Frodello et al. 2000; Law et al. 1997; Viale 1977; Wageman and Muir 1984). Strandings of *Ziphius cavirostris* are fairly infrequent along the northern coasts of the Western Mediterranean and are rare along the Corsican coastline. To our knowledge, very few studies have been published which provide metal levels in the tissues of this species (Marcovecchio et al. 1994; Storelli et al. 1999; Viale 1977). In the present study, we report total mercury, lead, cadmium, copper and zinc levels measured in the lung, liver, kidney, skin, muscle and bone of an individual found stranded in Corsica (France).

## MATERIALS AND METHODS

The dead animal was autopsied where it had grounded (Prunete beach in Upper Corsica), on January 28$^{th}$, 1997. During the autopsy fragments of skin, kidney, liver, lung, muscle and bone were rapidly sampled at the center of the organ, with scalpel, to avoid contamination. The samples were stored at –20°C. After lyophilization at 40°C for a period of 48 hours, the samples were ground. For the analysis of metal levels, 0.25g of dry matter was mineralized in a teflon bomb using 7 ml of ultra pure nitric acid. Only materials for analytical techniques were used (Pyrex, porcelain, plastic bag).

In order to determine the quantities of total mercury present the Hatch and Ott (1968) method was used. The mercury was quantified using a flameless atomic absorption spectrophotometer (Coleman Mercury Analyser MAS B 50, Perkin Elmer). The cadmium, copper and zinc were quantified using a flame atomic absorption spectrophotometer GBC 904 AA for copper and zinc analysis and an atomic absorption spectrophotometer equipped with a graphite oven for cadmium measurements. The lead was quantified using a Unicam Solar 939 QZ atomic absorption spectrophotometer. A standard curve was generated. The method was controlled using a reference material (lobster hepato-pancreas) supplied by the National Research Council of Canada (table 1).

*Correspondence to:* J. P. Frodello

**Table 1.** Certified and measured values of the standard reference material *TORT-2*

| | Total mercury | Lead | Cadmium | Copper | Zinc |
|---|---|---|---|---|---|
| Certified values | 0.27 ±0.06 | 0.35 ±0.13 | 26.7 ± 0.6 | 106 ± 10 | 180 ± 6 |
| Measured values | 0.24 ±0.01 | 0.37 ± 0.16 | 27.0 ±0.7 | 101 ±1 | 177 ±2 |
| Blank values | 0.05 | 0.001 | 0.001 | 1 | 1 |

Mean ± SD, n = 3; TORT-2 lobster hepato-pancreas kindly provided by the National Research Council of Canada; expressed in $\mu g.g^{-1}$ dry weight, and blank values. Blank values are in $\mu g.l^{-1}$.

Three measurements were carried out for each analysis. The limit detection for zinc and copper is 1 $\mu g.l^{-1}$; for lead and cadmium is 0.001 $\mu g.l^{-1}$ and for total mercury is 0.05 $\mu g.l^{-1}$.

## RESULTS AND DISCUSSION

The stranded *Z. cavirostris* studied here was a 535 cm female (measured from the extremity of the rostrum to the base of the caudal fin). The metal concentrations recorded in the six organs examined are provided in table 2.

In this *Z. cavirostris* specimen, the liver is the organ presenting the highest mercury levels. The bone contain the highest concentrations of lead, followed by the kidney. Cadmium is primarily localized in the kidney. The organs exhibiting the highest levels of copper are the muscle, followed by the lung. The skin, followed by the bone, are the two organs presenting the highest levels of zinc.
The values of the table 2 obtained by other authors must be considered with caution as there may be variability depending on the species, age and sex of the whales and his geographical location but also as a result of differing sampling and analytical protocols. The values found in the present study are markedly higher than those reported by Viale (1977) for a female specimen of *Z. cavirostris* found stranded in Corsica in 1974; for mercury, lead and cadmium in the lung, for mercury in the liver and kidney and for lead in the liver. They are lower for the lead and cadmium in the liver and for cadmium in the kidney. This comparison must take into consideration the improvement in protocols techniques for atomic absorption spectrophotometry since 1977. However, the analyses in both studies were carried out on a single individual, we are unable to determine the occurrence of an evolution in the metal levels present in the organs of this species, despite the fact that the individual stranded in 1997 exhibited higher metal levels than those recorded for the individual stranded in 1974. The only notable result is the great variability observed between the values obtained for the two *Z. cavirostris*. The values reported here are higher than those recorded by Storelli et al. (1999); for a female of *Z. cavirostris* found stranded along the Italian coast in the southern Adriatic in 1996; for mercury levels in the lung, liver and muscle and for lead levels in the lung, liver, kidney and muscle. The female stranded along the Adriatic coast presented higher cadmium concentrations in the lung, liver and kidney. Another stranded *Z. cavirostris* specimen, on the Atlantic coast of Argentina, was studied by Marcovecchio et al. (1994). The total mercury

concentrations recorded by these authors for the liver, kidney and muscle are markedly lower than the results of the present study. According to Marcovecchio et al. (1994), the very low mercury levels measured are due to the very young age of the stranded specimen.

Food source is considered to be one of the main mechanisms of metal pollutant entry in an organism. Metal levels for the *Z. cavirostris* specimen of the present study were thus compared to values available in the literature for other marine mammals having a similar diet (*Physeter macrocephalus* and *Globicephala melas*) (table 3). The diet of *Z. cavirostris* is made up of 60 % cephalopods and 30 % fish, the diet of *G. melas* is made up of 75 % cephalopods and 25 % fish, for *P. macrocephalus* is made up of 70 % cephalopods and 20 % fish (Pauly et al. 1998). Mercury levels in the liver of *Z. cavirostris* are 13 to 46 times higher than those found in *P. macrocephalus* and 14 times higher than in *G. melas*. Lead concentrations in the liver are 4 times greater than observed in *P. macrocephalus*. Cadmium, copper and zinc levels in *Z. cavirostris* are lower than those reported for the liver of these two species (except for the 7 *P. macrocephalus*). The copper and zinc values found here for *Z. cavirostris* are in the same range to those established by Law (1996) for *P. macrocephalus*. Conversely, Law et al. (1997) considered the lead values they found to be low, which helps explain the higher lead values recorded here. Compared to the kidney of *G. melas* from the Faroe Islands (Caurant et al. 1994), mercury values are 13 times higher in *Z . cavirostris* the cooper concentrations are also higher. Conversely, cadmium and zinc levels are higher in *G. melas*.

Law *et al.* (1997) suggested that high cadmium concentrations are linked to a diet of cephalopods whereas high mercury levels can be attributed to fish-eating whales. Squids are know to have high levels of cadmium (Caurant and Amiard-Triquet 1995). This would help explain the elevated cadmium levels observed in *G. melas* from the Faroe Islands, as 75 % of this whale's diet is made up of cephalopods. The fact that cadmium levels in *Z. cavirostris* stranded in the Mediterranean are lower than those recorded in other whale species stranded in other geographic regions, while mercury levels are higher, could be due to a difference in diet.

The limit of tolerance for mercury in marine mammals hepatic tissue seems to be within the range 400-1600 $\mu g.g^{-1}$ dry weight (Wageman and Muir 1984). Total mercury levels in the liver of *Z. cavirostris* studied is higher. May be it play a part in the death. This species thus exhibits metal levels that can be higher (mercury) or lower (the four other metals examined) than those found for two other whale species for which cephalopods represent a major dietary input (75 % for *G. melas* and 70 % for *P. macrocephalus*). Other analyses are necessary to clearly determine the pollutant levels present in *Z. cavirostris* from the Mediterranean. This pelagic whale species is rarely found stranded and the cadavers are often in an advanced state of decomposition due to the presence of this species, and ultimately its death, far from the coastline.

**Table 2.** Metal concentrations found in the present study, in *Ziphius cavirostris*, and published values for *Ziphius cavirostris*, *Physeter macrocephalus* and *Globicephala melas*.

| Species | N | Location | % of dry matter | Organs | Total mercury | Lead | Cadmium | Copper | Zinc | authors |
|---|---|---|---|---|---|---|---|---|---|---|
| *Ziphius cavirostris* | 1 | Mediterranean sea/ French coasts | | Lung | 1027 ±52 | 3.1 ± 0.03 | 3 ± 0.12 | 4.1 ± 0.4 | 48 ± 0.7 | Present study |
| | | | | Liver | 4730 ±98 | 1.3 ±0.07 | 11 ± 0.8 | 2.7 ±0.2 | 39 ±1.1 | |
| | | | | Kidney | 306 ±8 | 3.6 ±0.02 | 46 ± 0.5 | 34 ±0.6 | 122 ±1.2 | |
| | | | | Skin | 14 ±0.1 | 2.7 ±0.05 | 0.29 ± 0.01 | 3.8 ±0.4 | 688 ±13 | |
| | | | | Muscle | 194 ±1.3 | 2.5 ±0.04 | 0.8 ± 0.3 | 9.6 ±0.7 | 68 ±1.6 | |
| | | | | Bone | 0.34 ±0.02 | 4.2 ±0.06 | 0.04 ± 0.01 | 1 ±0.01 | 390 ±6.4 | |
| *Ziphius cavirostris* | 1 | Mediterranean sea/ French | 25 | Lung | **92*** | **0.36*** | **0.8*** | | | Viale 1977 |
| | | | | Liver | **1760*** | 2.8* | 24* | | | |
| | | | | Kidney | **122*** | **0.8*** | 114.8* | | | |
| *Ziphius cavirostris* | 1 | Adriatic sea Italian coasts | 25 | Lung | **183.2*** | | 3.4* | | | Storelli et al. 1999 |
| | | | | Liver | **1037*** | **1.12*** | 73.96* | | | |
| | | | | Kidney | 237.3* | **0.4*** | 109.56* | | | |
| | | | | Muscle | **38.7*** | **0.28*** | **0.56*** | | | |
| *Ziphius cavirostris* | 1 | South-western Atlantic Ocean | 25 | Liver | **0.4*** | | | | | Marcovecchio et al. 1994 |
| | | | | Kidney | **0.68*** | | | | | |
| | | | | Muscle | **0.92*** | | | | | |
| *Physeter macrocephalus* | 7 | North sea | 23.9 | Liver | **102*** | **0.33*** | 90* | 102* | **6.9** | Law et al. 1997 |
| *Globicephala melas* | 194 | Faroe Islands | 25 | Liver | **208-336*** | | 132-364* | 19.6-28.8* | 216-436* | Caurant et al. 1994 |
| | 97 | | | Kidney | **19.6-22.8*** | | 220-372* | **15.2-19.2*** | 140-172* | |

N = number of individuals. Minimum, maximum or mean values are expressed in $\mu g.g^{-1}$ dry weight. Values below those of the present study are in bold and higher values are in normal type. *Results given in wet weight have been converted on a dry weight basis using the dry weight percentage provided by the authors or by using a value of 25 % dry weight (Becker et al. 1995).

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