ISOTOPE RATIO INDICATORS FOR THE SOURCE OF LEAD POISONING IN MUTE SWANS

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Introduction

Water birds and wetlands in many parts of the world are affected by lead poisoning. It has been a cause of death of various species, including swans (Binkowski et al., 2015; Blus et al., 1989). The source of the poisoning is most often linked with fishing and hunting, which are common in this type of area. Spent lead pellets from hunting and fishing sinkers discarded in the area may be mistaken by birds for gastroliths. After ingestion and dissolving in the gizzard, Pb particles enter the bloodstream and cause poisoning (Franson et al., 2011).

Shotgun pellets and sinkers are not the only source of lead to which the birds are exposed. Fast verification of the chosen source is therefore needed. Isotope ratio comparison between tissues and potential source seem to be a reliable and useful method of verification (Scheuhammer et al., 1998). Lead isotope abundance ratios vary in different ores. As a result, this may be applied to the recognition of Pb from ore used to produce pellets and sinkers (Thomas et al., 2009).

We should look at tissue with a fast Pb turnover such as blood in order to verify the source of poisoning (Binkowski et al., 2013). We should also use all the lead isotopes in the study in order to ensure the method is accurate. We then compared Pb isotopic ratios between ammunition pellets and the blood of swans. We also determine whether the isotope ratio method may be useful in the monitoring of Pb poisoning from ammunition.

Methods

Blood samples were taken from 49 Mute swans (*Cygnus olor*) in 2012 and 2013 along Poland's Baltic coast near Gdansk. Samples of pellets (from shot cartridges cal. 12) available on the Polish market were bought in the same years. All the samples were mineralized with hot nitric acid. Pb analyses were carried out by ICP-MS (Agilent 7700 series). As the isotopic ratio analyzed we used 206/204, 206/207, 208/206 and 208/207 ratios. We conducted the test to find the differences between two coefficients of variation, the Cochran-Cox test to check the difference between the two means and Pearson correlation coefficients to show relationships between isotopic ratios in pellets and blood.

Results

We noted greater isotopic variation in the blood, except for the 206/204 ratio, which was comparable in both materials studied. The mean 206/207 and 208/207 ratios differed statistically between blood and pellet samples, but the difference between the means was only 0.9% and 0.4% respectively. The 208/206 ratio in both materials examined was comparable. The 206/204 ratio was lower (by 12.3%) in blood than in pellets (Fig. 1).

The correlation analysis between the isotopic ratios (between 206/204 and 208/207, as they include all the isotopes studied) showed a significant positive relationship in pellets ($r = 0.68$, $n = 45$, $p < 0.001$) and a lack of relationship in the case of blood ($r = 0.02$, $n = 42$, $p = 0.89$).

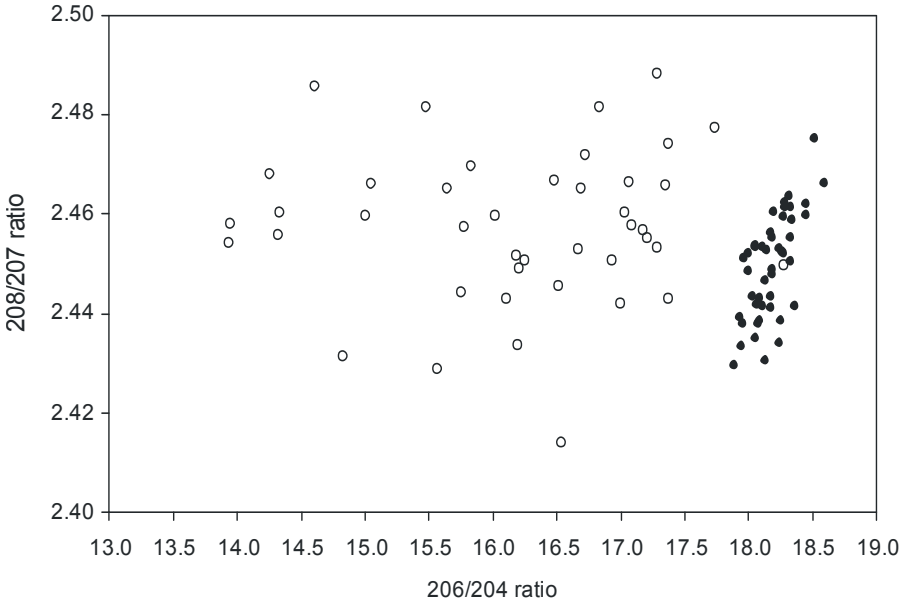

Figure 1. The relationship between 208/207 and 206/204 isotopic ratios in swans' blood and pellets (black dots).

Conclusion

Based on the discrepancies in isotopic ratios in blood and pellets, we conclude that the pellets available on the Polish market were not the main source of Pb in the blood of the swans studied (Binkowski et al., 2016). The protocol seems to be a good method for use in biomonitoring studies, but there is an urgent need to include in one study isotopic ratios of various materials (including pellets, bullets, and fishing sinkers from a wide area), as well as environmental and animal samples.

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