Mallard *Anas platyrhynchos* lead poisoning risk in central Portugal

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Lead pellet ingestion by Mallards of Central Portugal ranged from zero to 100%, 99 being the highest number of lead pellets detected in a single gizzard. On rice fields, lead poisoning risk increased during the shooting season through the accumulation of lead pellets on land surface, since ingested lead pellets were only detected three weeks after the beginning of the season. Livers analysed showed lead concentrations indicating abnormal and acute exposure to lead contamination which most probably resulted in the indirect and direct cause of death of the birds studied. As this study proved that lead poisoning is a cause of waterfowl mortality also in Portugal, Portuguese authorities should implement, as soon as possible, measures concerning the replacement of lead pellets by alternative non-toxic materials.

Key Words: *Anas platyrhynchos*, Iberian Peninsula, lead accumulation, rice fields.

Lead poisoning on Anatidae was recognised more than a century ago (Grinnell 1894) and is documented in at least 21 countries. In the 1950s it was estimated to result in the death of 1.4-2.6 million waterfowl annually in the Unites States of America (Bellrose 1959) and it is also known to induce sub-lethal physiological effects concerning neurological and immunity malfunctions (Dieter & Finley 1978; Rocke & Samuel 1991; Mauvais 1993). The surveys on Anatidae lead poisoning in USA induced the ban of lead for shooting to all waterfowl species in 1991. Since then, hunting in wetlands can only be performed using steel pellets or other non-toxic material.

European lead poisoning studies in waterfowl (eg Clausen & Wolstrup 1979; Mudge 1983) have also persuaded some countries to ban lead in waterfowl hunting (Denmark, The Netherlands, Finland and Norway in the early 1990s, England in 1999, Wales and Spain in 2001).

In Portugal this subject is still poorly studied, although Rodrigues (1998) published some results that showed that 5.3% of Mallards shot in rice fields of Mondego Lowlands during late August had ingested lead.

The objective of this study was to estimate the occurrence of lead poisoning in waterfowl of Central Portugal, characterising the lead poisoning risk in Mallard *Anas platyrhynchos* - the most important waterfowl quarry species - by determining the rate of ingestion.

Methods

The Mallard populations studied were those occurring in wetlands of central Portugal, ie in Mondego Lowlands and Vouga Lowlands (Rodrigues & Fabião 1997), both being mainly resident (Rodrigues *et al.* 2000).

The risk of bird lead poisoning has been assessed by the rate of ingestion (Ti) of lead pellets observed in the gizzard (Schricke & Lefranc 1994), through visual examination or X-ray. Visual analysis only detects c. 65% of the lead pellets observed by X-rays (Pain & Eon 1993). More than 90% of the ingested lead pellets are eroded or travel through the digestive system within three weeks after being ingested. Therefore, the evaluation of blood lead concentration is more accurate than visual observation or X-ray detection, because blood lead levels stay high during two-three months after lead ingestion (Dieter & Finley 1978). The liver is an accumulating tissue of this heavy met al, so liver lead concentration analysis provides a complement to blood analysis for the assessment of lead poisoning. However, as blood and liver lead analysis are expensive, generally Ti is accepted to be a good indicator of lead poisoning risk (eg Shricke & Lefranc 1994). Ti was determined by visual observation of the gizzards sampled, according to the methodology described by Pain & Eon (1993).

In Mondego Lowlands sampling was performed in Foja Farm rice-fields (600 ha), situated in Mondego River lower course (40°12'N, 08°44'W). These rice fields are the main feeding area for the local Mallard population (Rodrigues & Fabião 1997). The gizzards were extracted from shot Mallards obtained from Foja Farm shooting club members, mostly from 15 August to late September of 1993, 1994 and 1995.

In the Vouga Lowlands, gizzards were extracted from Mallards shot mostly on rice fields by local hunters, and from dead Mallards found in S. Jacinto Dunes Natural Reserve (40° 40'N, 08° 45'W), which is the only refuge in this study area (Rodrigues & Fabião 1997). Determination of liver lead concentration was performed on dead birds found in the refuge area. Lead

concentration was determined by flame atomic absorption spectrophotometry at the National Veterinary Research Laboratory (Lisbon).

Results

In the Mondego Lowlands, gizzards were collected between 1993 and 1995. The values of the ingestion rates are presented in **Table 1.** A maximum of 99 lead pellets in a single gizzard was observed, and another contained 52 pellets. Another nine gizzards (6.9%) contained lead pellets as the result of the charge that killed the bird, since there were entry holes in the gizzards and pellets were not eroded (Mudge 1983).

In the Vouga Lowlands, gizzards were collected from hunter-shot birds between August and early September (1993 to 1999). Gizzards were also collected from two birds found dead at S. Jacinto. The liver of one Mallard found dead in November of 1998 that showed signs of possible lead poisoning (with very low body mass and without signs of possible predation), had a lead concentration of 50 mg kg^{-1} (dry weight), which represented 2.5 times the known toxic level (20 mg kg^{-1}, Pain *et al.* 1993), and the bird had six lead pellets in the gizzard. The other bird found dead in October 1999, killed by an *Accipiter gentilis*, had one lead pellet in the gizzard and a liver lead concentration of 7.2 mg kg^{-1}, which confirmed the abnormal exposure to lead contamination (Mateo *et al.* 1994).

Discussion

Lead poisoning in Mallards of central Portugal was confirmed, suggesting that it may be an important cause of death in Portuguese waterfowl. However, only the results of an ongoing project studying lead poisoning on ducks, rails and their raptor predators, will allow more complete and definitive conclusions. Dieter & Finley (1979) concluded that the ingestion of only one lead pellet can cause irreversible brain damage in ducks. Bellrose (1959) suggested that a duck that had ingested only one lead pellet had a probability 1.5 to 2.3 times higher

Table 1 Percentage lead ingestion rates on Mallard from central Portugal. (Sample size shown in parentheses.)

Area	Total	After 7 September
Mondego Lowlands - shoot	4.6% (131)	11.5% (52)
Vouga Lowlands - shoot	0% (55)	-
Vouga Lowlands - found dead	-	100% (2)
Vouga Lowlands - total	3.5% (57)	100% (2)

of being shot by hunters and could die directly by lead poisoning. This study suggests that this increased vulnerability, as a result of the ingestion of only one lead pellet, should also be extended to the vulnerability to duck natural predators.

Mateo *et al.* (2000) showed that ducks feeding on rice are more prone to ingest lead pellets confusing it with grit. However, on rice fields lead poisoning risk seems to increase during the shooting season, through the accumulation of lead pellets on the land surface (ingested lead pellets were only detected after 7 September). The soil mobilisation for preparation of seeding seems to reduce lead pellet concentration and the availability of those pellets over the soil surface, as concluded by Fredrickson *et al.* (1977). Probably the Ti would be higher if more samples were obtained from late Autumn and Winter, and this will be further investigated. If the increased availability of lead pellets on rice fields during the shooting season is confirmed, that could also mean that in natural wetlands lead poisoning risk could be higher than that obtained in this study. This could also be true for the small reservoirs that are abundant in the south of Portugal, where most duck shooting usually occurs. The possible increased concentration of lead pellets in the soil surface of rice fields during the shooting season also suggests that some caution should be used in comparing the results from lead poisoning studies in this habitat.

Legislative instruments in relation to the replacement of lead pellets by alternative non-toxic materials should be prepared as soon as possible by national authorities. The previous international experience on replacement, indicates that lead poisoning continues to occur long after the ban of lead (Anderson *et al.* 2000), because lead pellet availability continues for decades (Mateo *et al.* 1998). Lead poisoning continues to be a world-wide mortality factor for *Anatidae* and other aquatic birds, and even for vulnerable species like raptors (eg Pain *et al.* 1993). As expected, the present study supports concerns in the wetlands of central Portugal. As Spain banned the use of lead for shooting in wetlands, a future ban of lead in Portugal will be effective for Mallard as it is a resident species in the Iberian Peninsula (Rodrigues *et al.* 2000; Saez-Royuela & Martinez 1985). For the migratory species the total resolution of the problem will only be accomplished when all the countries of the flyways of ducks reaching Portugal also ban the use of lead (Thomas & Owen 1996).

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