High exposure rates of anticoagulant rodenticides in carnivorous birds and mammals in Danish landscapes

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DOI: 10.5073/jka.2011.432.078

Abstract

We analyzed anticoagulant rodenticides (ARs) in birds of prey, owls and small mustelids to assess exposure rates and levels in Denmark. ARs were detected in 84-97% of individuals in all species. High AR prevalences and concentrations were recorded in all seasons in both birds and mammals. Prevalence of ARs was considerably higher than reported elsewhere with similar exposure scenarios. Further research on the potential effects of these high AR exposure levels on population levels of non-target species is warranted.

Keywords: HPLC, mustelids, non-target species, owls, raptors, secondary poisoning

Background

Use of anticoagulant rodenticides (AR) is an efficient and widely used method to control rodent populations (WHO, 1995). The use of ARs also poses a risk of secondary poisoning of non-target carnivorous species (Eason et al., 2002, Laasko et al., 2010). Incidents of fatal poisoning have been documented in a wide range of species but relatively few studies have addressed the exposure rates and concentrations in free-ranging carnivorous birds and mammals (Shore et al., 2003, Walker et al., 2008). We surveyed the AR exposure rates and concentrations in non-target carnivorous species from Danish landscapes dominated by intensively managed agricultural lands. In Denmark rodent control is almost exclusively done as chemical control in bait boxes using primarily the most toxic and persistent second generation ARs.

Materials and methods

Carcasses of raptors, owls and small mustelids were collected opportunistically, e.g. as road kills. The carcasses were collected in typical Danish agricultural landscapes. Residues of five commonly used ARs (bromadiolone, brodifacoum, coumatetralyl, difenacoum and flocoumafen) were analyzed by HPLC coupled with a fluorescence and photodiode array detector in liver tissues (Jones, 1996; Shore et al., 2003). Residues were extracted from homogenized tissue with acetone/dichloromethane and analyzed using a Hypersil 5μ C18 column. The mobile phase consisted of a gradient of 0-9 min methanol:ammonium acetate:acetonitrile; 9-45 min ammonium acetate:acetonitrile and 45-55 min water:acetonitrile. Blank and spiked control samples were processed and analyzed for quality assurance.

Results

ARs were detected in 84-97% of individuals of each species (Tab. 1). ARs were also detected in all individuals in a small number (<10) of red kite (*Milvus milvus*), marsh-harrier (*Circus aeruginosus*), short-eared owl (*Asio flammeus*), Eurasian eagle-owl (*Bubo bubo*), and little owl (*Athene noctua*). More than 60% of birds and 80% of mustelids had detectable levels of more than one substance. No differences in AR prevalences and concentrations were detected between gender, age, season or cause of death in birds. In stoats and weasels the highest concentrations were found in animals from autumn and winter (negative binominal regression; χ^2=18.92, p<0.001). A similar trend was also seen amongst some of the birds. Potentially fatal concentrations (>200 ng/g ww) were recorded in all seasons in birds and mammals. AR concentrations were highest in stoats and weasels with unknown cause of death (χ^2=11.32, p<0.01) and body condition was weakly but significantly correlated with total AR concentration (r=-0.28, p<0.05).

Tab. 1 Frequency of occurrence of anticoagulant rodenticides and total mean, median and range of concentrations in carnivorous birds and mammals from Denmark with detectable levels of anticoagulant rodenticides. Hepatic AR concentrations above 200 ng/g ww have been associated with mortalities in raptors and small mustelids.

Species	n	Occurrence %	Mean concentration ng/g ww	Median concentration ng/g ww	Proportion >200 ng/g %	Range ng/g ww
Weasel *Mustela nivalis*	69	97.1	141.9	70.9	17.4	0-1,660
Stoat *M. erminea*	61	96.7	149.4	59.0	18.0	0-1,419
Common kestrel *Falco tinnunculus*	66	89.4	99.0	46.0	13.6	0-690
Common buzzard *Buteo buteo*	141	93.6	74.5	50.0	5.7	0-721
Rough-legged buzzard *B. lagopus*	31	83.9	40.8	26.5	0.0	0-139
Tawny owl *Strix aluco*	44	93.2	78.4	39.0	9.1	0-534
Barn owl *Tyto alba*	80	93.7	114.1	71.0	13.7	0-1,092
Long-eared owl *Asio otus*	38	94.7	19.4	13.5	0.0	0-84

Discussion

The prevalence of ARs in Danish birds of prey, owls and mustelids were markedly higher for most species than reported elsewhere. After correcting for differences in analytic detection limits prevalence was approximately twice the levels reported in e.g. Great Britain (Shore et al., 2003; Walker et al., 2008). Similar exposure levels have only been reported in small mustelids during widespread field campaigns of rodents in New Zealand (Murphy et al., 1998). Possible explanations for the high exposure levels in Denmark may include intensive human land use, mandatory control of rats and the use of ARs by private householders. Abundance of most raptors and owls has been stable or increased during the past decades in Denmark. Thus, the high exposure levels by ARs does not have a crucially adverse effect on the population level for raptors and owls, but locally intensive use of ARs may cause increased chick mortality in some birds (unpublished data). Stoats and weasels are assumed to be widespread but in decline due to habitat destruction and fragmentation in Denmark. The high AR exposure rates and concentrations suggest that the present AR use and application methods and policies may pose an additional significant risk to the conservations status for stoats and weasels in Denmark. Further studies to determine the impact of AR use and secondary poisoning of individual animals on a population level, and risk assessments of different AR application scenarios are urgently needed.

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