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How important are avian trophic pathways for the secondary exposure of predators to second generation anticoagulant rodenticides (SGARs)?

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Background

Secondary exposure of predators to second generation anticoagulant rodenticides (SGARs) is globally widespread. The main transfer pathway is thought likely to be through consumption of small mammals that have consumed SGAR bait. Secondary exposure in predators would therefore be expected to be highest in species that feed predominantly on small mammals.

Sparrowhawks (*Accipiter nisus*) feed largely on birds. However, recent analysis of sparrowhawks from Scotland[1] indicated that the % of birds with detectable liver SGAR concentrations was similar to that in raptors that eat small mammals. This was unexpected as it suggests secondary exposure may equally result from eating contaminated birds or rodents.

Our aim was to determine if the findings from Scotland were typical of birds from throughout Britain. We compared liver SGAR concentrations in 174 barn owls (*Tyto alba*) and 42 sparrowhawks that had been found dead between 2010 and 2012 from across Britain. Samples were collected through the Predatory Bird Monitoring Scheme (PBMS - http://pbms.ceh.ac.uk/) and liver SGAR residues were quantified by Liquid Chromatography Mass Spectrometry.

Results

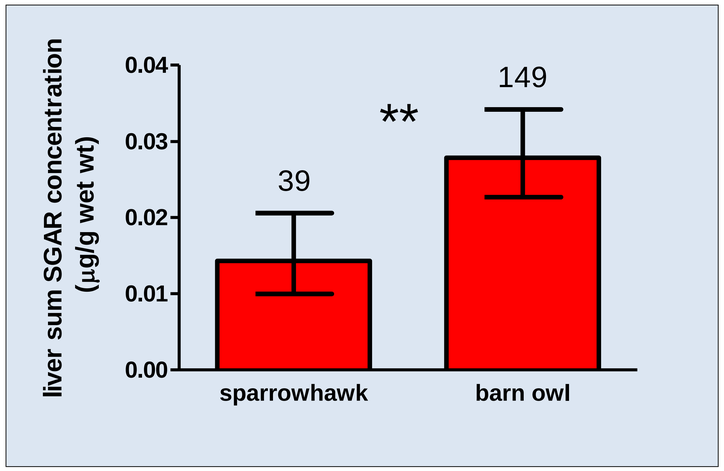
Difenacoum, bromadiolone and brodifacoum were the main residues detected in both barn owls and sparrowhawks.

	barn owls		sparrowhawks	
	no/	*%*	*no/*	*%*
2nd Generation (SGAR)				
bromadiolone	124	71	23	55
difenacoum	112	64	33	79
flocoumafen	9	5.2	0	0
brodifacoum	83	48	27	64
difethialone	1	0.6	1	2
Any SGAR	149	86	39	93
Multiple SGARs	108	62	31	74

Table 1. Number (and % of sample) of barn owls and sparrowhawks with detected liver SGAR residues

Predatory Bird Monitoring Scheme
http://pbms.ceh.ac.uk/

Overall (Table 1), 149 barn owls (86% of the sample) had detectable liver residues of one or more SGAR compared with 39 sparrowhawks (93%). This difference between species in the proportion of birds with detectable residues was not significant (Fisher's Exact test P>0.05).



The geometric mean sum liver SGAR concentration in birds with detectable residues was two-fold higher in barn owls than sparrowhawks (Figure 1; $t_{(186)}$=2.96,P=0.003).

*Figure 1. Geometric mean (±95% Confidence Interval) of liver sum SGAR concentrations in sparrowhawks and barn owls with detected residues. ** indicates P<0.01.*

Discussion

Our findings[2] confirm there is widespread low-level contamination of sparrowhawks with SGARs in Britain. In fact , the % of sparrowhawks and barn owls that contained residues was almost twice that of birds from Scotland only.

Our results also suggest that, surprisingly, avian and mammalian trophic pathways may pose broadly similar risks of SGAR transfer to predators. The higher concentrations of SGARs in barn owls than sparrowhawks may however indicate contamination is greater in small mammal than avian prey and/or the frequency of exposure events is greater in barn owls, although other factors cannot be ruled out.

Further exploration of the factors governing SGAR exposure and residue accumulation in sparrowhawks is merited .

[1]Hughes, J., Sharp, E., Taylor, M.J., Melton, L. & Hartley, G. (2013). Monitoring agricultural rodenticide use and secondary exposure of raptors in Scotland. *Ecotoxicology,* 22, 974-984.

[2]Walker, L.A., Chaplow, J.S., Moeckel, C., Pereira, M.G., Potter, E.D., & Shore, R.F. (2014). *Anticoagulant rodenticides in predatory birds 2012: a Predatory Bird Monitoring Scheme (PBMS) report.* Centre for Ecology & Hydrology, Lancaster, UK. 18pp https://wiki.ceh.ac.uk/display/pbms/Recent+PBMS+reports

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