Rodenticide toxicity in Australian wildlife

Fact sheet

February 2023

Key points

- Many wildlife species are at risk of primary or secondary rodenticide toxicity in Australia.
- Rodenticide exposure in native wildlife may be malicious or accidental and is probably under recognised.
- Rodenticides should only be used for approved purposes in the recommended manner.
- Reporting of poisoning events in wildlife is recommended and is often a stated requirement under the permit system.
- Further work is required to better understand and manage the risks of rodenticide exposure in native fauna.

Introductory statement

There are increasing reports of toxicities associated with rodenticide exposure in Australian wildlife, including birds, mammals, reptiles and amphibians. Effects of rodenticides have been studied in some wildlife species overseas, however there is limited information for Australian native animals. This fact sheet summarises information on commonly reported rodenticide toxicity events in Australian wildlife, with an emphasis on native species. See also WHA submission to the Australian Pesticides and Veterinary Medicines Authority Chemical Review of anticoagulant rodenticides: https://wildlifehealthaustralia.com.au/Portals/0/ResourceCentre/Submissions/WHA_submission-APVMA_rodenticides_Feb_2022.pdf.

Sources of toxin

Rodenticides in Australia are used in domestic, industrial, and agricultural settings to kill rodents. Rodenticides include **non-anticoagulant** (e.g. zinc phosphide (ZnPhos) coated onto grain) and **anticoagulant** (e.g. coumatetralyl in bait stations) products. **Primary toxicity** can occur in non-target wildlife that directly consume anticoagulant or non-anticoagulant baited material (e.g. galahs, cockatoos, rodents, possums). This risk is greatly reduced when the products are used strictly in accordance with the label directions [1]. **Secondary toxicity** in non-target wildlife (e.g. magpies, kookaburras, quolls and goannas) can occur with some anticoagulant rodenticides as they accumulate through the food chain, leading to lethal doses ingested by birds of prey and other animals that feed on sick or dead target and non-target animals (e.g. rodents and possums).

One Health implications

Wildlife and the environment: there is evidence globally that rodenticides are widely distributed in the environment and food chain, and negative impacts are not limited to birds of prey. The acute and chronic effects of rodenticides on wildlife and the environment are poorly understood.

Domestic animals: rodenticides may be accidentally consumed by domestic pets and livestock, with potentially serious international trade implications if residues are detected in exported products.

Humans: rodenticides that cause toxicity in wildlife can also result in effects in humans, however in most cases humans are unlikely to be exposed to the chemicals through the same avenues as wildlife. Due to the human health risks of phosphine gas release, care is required when handling or performing necropsies or analysis on animals suspected to have died from ZnPhos intoxication [2].

Anticoagulant rodenticides

Background

Anticoagulant rodenticides (ARs) bind to enzymes responsible for recycling of vitamin K and impair blood clotting. Non-target poisoning of native wildlife with anticoagulant rodenticides is a significant global concern [3, 4], particularly for some classes of animals such as birds of prey due to secondary poisoning [consumption of prey species such as rodents] [5]. In Australia, AR exposure in wildlife has not been broadly studied, but there is evidence that it is a significant issue for many species here [6-8] and toxicity has been confirmed in multiple events.

Anticoagulants are used in Australia as lethal pest control methods for introduced rats and mice. Anticoagulants are classified as first generation or second-generation products; first-generation poisons are less toxic and require several feeding events over several days to kill an animal, whereas second generation anticoagulant poisons are much more toxic and may kill an animal after only one feeding event and remain active in the carcass of dead animals.

Sources and poisoning

Anticoagulant rodenticide exposure and suspected poisoning have been reported in native Australian wildlife in a broad range of species and geographic areas. Anticoagulant toxicity in wild animals generally occurs as a secondary event in non-target species, but cases of primary toxicity are also reported. Anticoagulant rodenticides include the first-generation products warfarin, coumatetralyl, diphacinone and pindone, as well as second-generation products like brodifacoum and bromadiolone. These are the two main ingredients in many domestic, commercial, industrial and agricultural rodent baits and are generally not approved for use in crops because they do not meet safety requirements, specifically in relation to residues and the environment. Although most wildlife species may be affected, toxicity varies with species and the type of anticoagulant involved. Bromadiolone and brodifacoum have been implicated in the majority of Australian wildlife anticoagulant poisoning events (see **Appendix 1**).

Raptors such as barn owls (*Tyto alba*) and kestrels (*Falco* sp.) may acquire secondary anticoagulant toxicity via consumption of rabbits or rodents that have ingested poison. ARs have been implicated in a number of wild bird mortality events in Australia, including threatened species [9, 10]. AR

exposure was detected in 72.6% of southern boobook owls (*Ninox boobook*) in WA [9], and in 74% of Tasmanian wedge-tailed eagles (*Aquila audax fleayi*) [11]. Poisoning of Pacific black ducks (*Anas superciliosa*) has been reported [12].

Native mammals and reptiles are also susceptible to AR poisoning [6, 8, 13] and may be a source of secondary poisoning in predator species. Predation of poisoned native fauna was suspected as a major source of AR exposure in powerful owls (*N. strenua*) in Vic, [14] and tiger snakes (*Notechis scutatus*), shingleback lizards (*Tiliqua rugosa*) and dugites (*Pseudonaja affinis*) in WA [13].

Clinical signs and diagnosis

Toxicity causes blood loss, resulting in general pallor of the carcass and muscles, and free blood may be present in the body cavities and mouth. Superficial wounds may be seen on the legs and feet [15]. Exposure to sub-lethal doses of ARs has been proposed as a contributing factor to mortality through sub-clinical impacts on fitness, reproduction and immune function [9, 16].

Diagnosis of AR toxicity is dependent on the detection of poison in the ingesta or internal organs, or by measurement of clotting parameters such as prothrombin time in blood. However, clotting parameters in birds can be variable and species-specific. Assessment of packed cell volume (PCV) and timing of whole blood clotting in a serum collection tube have been recommended when assessing raptors admitted to care [17, 18].

Toxicological testing is most commonly undertaken in a research context or if a malicious poisoning event is being investigated and is rarely undertaken in veterinary practice due to logistical difficulties and high costs.

In-clinic diagnostic testing or response to treatment are usually used to confirm clinical suspicion, in combination with circumstantial evidence. This is especially the case in wildlife where funds are often unavailable for testing and reference ranges for AR levels are lacking. The severity of clinical signs and the extent of abnormal blood clotting are not necessarily correlated to measured internal AR concentration in all species [19].

Anticoagulant rodenticide toxicity may be suspected if one or more of the following findings are present:

- pale mucous membranes, unusual or excessive bruising or external haemorrhage without evidence of primary trauma
- reduced PCV, anaemia, abnormal blood clotting time, significant haemorrhage into body cavities on necropsy, coloured bait in gastrointestinal tract or faeces
- history of animal eating bait or of recent local baiting
- response to Vitamin K treatment, the antidote for anticoagulant rodenticides.

Treatment

Vitamin K therapy is used to treat anticoagulant poisoning in animals. An experimentally intoxicated wedge-tailed eagle was successfully treated after 15 days following dosing with pindone [20, 21].

Non-anticoagulant rodenticides – zinc phosphide

Background

Zinc phosphide (ZnPhos) is used in Australia to control mice around grain silos, and during mouse plagues it may be applied, under permit, more extensively in crops [1, 22]. It is usually coated onto grains for use. When ingested, ZnPhos reacts with acid in the stomach to generate phosphine gas, which distributes rapidly throughout the body and can result in hypoxia and eventual death [23].

Sources and poisoning

Cases of primary poisoning of livestock, pets, and wild animals have been reported. Horses, cattle, pigs, poultry, dogs, cats, game birds and non-target rodents have died after eating bait residues [6]. The susceptibility to ZnPhos toxicity varies between species [24]. Rodents are more sensitive than carnivores, and gallinaceous birds (pheasants, turkeys, other large terrestrial birds) are more sensitive than other avian species, however, some passerines (songbirds) are also sensitive [25]. ZnPhos is classed as very highly toxic (LD50 <10 mg/kg) for geese and galliforms and highly toxic (LD50 <50 mg/kg) to many other bird species [1]. Many bird species can distinguish and avoid ZnPhos baits or will regurgitate the toxicant.

Although deaths have been recorded, ZnPhos baiting programs do not seem to pose a major threat to non-target wildlife, including local seed-eating birds [6]. In Australia, this toxin can only be applied in-crop, and the risk for many non-targets is considerably reduced if correct procedures are followed. Deaths in wild birds have been reported in Australia [6], but studies into the impact on wild bird populations are required.

Secondary poisoning in nontarget terrestrial vertebrates is less common because ZnPhos does not bioaccumulate in carcasses [23]. Secondary risks to wildlife and domestic animals mostly result from nontarget animals ingesting dosed animals with undigested ZnPhos in their gut. Instructions about appropriate use (label restrictions) help reduce the risk of significant exposure to humans and nontarget terrestrial vertebrates.

Clinical signs, diagnosis

Suspect carcasses should not be opened and should be frozen prior to submission for diagnosis, because release of the phosphine gas produced in the animal's stomach following ingestion of ZnPhos is a risk to human health. Zinc phosphide is toxic to the heart, liver and kidneys and death results from heart and kidney failure within 24 h. Animals may become prostrate with deep slow respiration, terminating in convulsions. Sublethal impacts in various bird studies include weight loss, lethargy and ataxia [23]. Post-mortem findings include congestion of the lung, heart, liver and kidney [26] and haemorrhage in the lungs and visceral organs [27]. Predators or scavengers that eat a target animal killed by ZnPhos may become listless and regurgitate [25].

Treatment

There is no antidote for ZnPhos toxicity, but some animals may survive with supportive care.

Management, control and prevention

Agricultural chemicals are regulated by the Australian Pesticides and Veterinary Medicines Authority (APVMA, http://apvma.gov.au). Information aimed at reducing or eliminating risks of adverse effects in wildlife must be included in both the product labels and in the necessary permits for use of products.

The risk of primary and secondary toxicity to wildlife can be reduced by following the label instructions. For example, bromadiolone bait labels state that they must be placed in and around buildings (within 2 m) or enclosed spaces (e.g. drains), and carcasses of affected rodents must be collected and disposed of appropriately. Information on the use of rodenticides during mouse plagues and in crop situations is available from the APVMA: https://apvma.gov.au/sites/default/files/publication/14856-pindone-review-final-report.pdf and https://apvma.gov.au/node/87226 [1, 22].

The APVMA's Adverse Experience Reporting Program (AERP) assesses reports of adverse experiences associated with the registered use of agricultural chemicals. State and territory regulators also enforce appropriate use of agricultural chemicals in Australia and report any adverse events directly to the APVMA. Reports mostly concern production or domestic animals, however some may involve wildlife; the most common of these are poisonings.

Research

Investigation and reporting of mortality events associated with rodenticide toxicity in wildlife can provide useful data to better understand the circumstances and susceptibilities of affected native wildlife. Further investigation is needed to determine how severely non-target species are affected by primary and secondary rodenticide exposure and toxicity, and the impact of rodenticides on native animal populations.

The importance of both sub-lethal and long-term exposure of native wildlife to ARs also needs consideration [4]. There is a need to investigate bioaccumulation, transfer and impact of ARs in food webs, and not just in species that are the targets for poisoning or their predators [14]. One major challenge is that the literature worldwide currently lacks validated thresholds for the differentiation of exposure from toxicity in free-ranging wildlife [19], with extrapolation from experimental species required [4].

Work is required to better understand:

- which species and groups of native wildlife are most susceptible to rodenticide exposure in Australia, and why (e.g. species-specific susceptibility to toxins, or increased exposure)
- exposure pathways
- appropriate diagnostic tests
- options for use of alternative rodenticides or control methods with lowered risk of wildlife toxicity.

Surveillance

Monitoring the exposure of wildlife to rodenticides is critical to understanding their impacts and assessing the effectiveness of regulations. We encourage those with information on wildlife poisoning events and laboratory confirmed cases of this condition to submit this information to the national system for consideration for inclusion in the national database. Access to information contained within eWHIS is by application. Please contact admin@wildlifehealthaustralia.com.au.

Wildlife disease surveillance in Australia is coordinated by the Wildlife Health Australia. The National Wildlife Health Information System (eWHIS) captures information from a variety of sources including Australian government agencies, zoo and wildlife parks, wildlife carers, universities and members of the public. Coordinators in each of Australia's States and Territories report monthly on significant wildlife cases identified in their jurisdictions. NOTE: access to information contained within the National Wildlife Health Information System dataset is by application. See the WHA website for more information: https://wildlifehealthaustralia.com.au/ProgramsProjects/eWHIS-WildlifeHealthInformationSystem.aspx.

As part of Australia's general surveillance system, cases involving intoxications of wildlife may be reported directly to WHA. WHA will collect reports and liaise with the AERP regarding investigation of the incidents. The reporting of rodenticide intoxications in wildlife by WHA does not replace the processes already in place within each state and territory for management of adverse reactions.

The eWHIS database contains 77 records of suspect or confirmed anticoagulant rodenticide toxicity, from 2003-2021 (667 individuals of 29 different species, including mammals, birds and amphibians). Cases were reported from 62 different post codes across all states/territories except the ACT and NT. Further detail, including additional data from surveillance partners is available in the WHA submission to the APVMA Chemical Review of Anticoagulant Rodenticides: https://wildlifehealthaustralia.com.au/Portals/0/Documents/ProgramProjects/WHA_submission-APVMA_rodenticides_Feb_2022.pdf

Between 2018-2022, there were 7 records of suspect or confirmed ZnPhos toxicity (covering 904 individuals over 9 species) entered into eWHIS (see **Appendix 1 and 2**).

Appendix 1: Australian wildlife species reported in suspect or confirmed anticoagulant rodenticide toxicity events (1998-2021)

This dataset is described in detail in the WHA submission to the 2022 APVMA chemical review of anticoagulant rodenticides.

Birds – non-raptors
Cracticus tibicen / Australian magpie
Cacatua sanguinea / Little Corella
Columba livia / Rock (feral) pigeon #
Corvus coronoides / Australian raven
Corvus mellori / Little raven
Corvus orru / Torresian crow
Dacelo novaeguineae / Laughing kookaburra
Eolophus roseicapilla / Galah
Eudynamys scolopacea / Common koel
Grallina cyanoleuca / Australian magpie-lark
Larinae / Gulls
Manorina melanocephala / Noisy miner
Pitta versicolor / Noisy pitta
Podargus strigoides / Tawny frogmouth
Strepera graculina / Pied currawong
Sturnus vulgaris / Starling #
Threskiornis molucca / Sacred ibis
Trichoglossus / Lorikeet
Birds - raptors
Falco cenchroides / Australian kestrel
Haliastur sphenurus / Whistling kite
Ninox connivens / Barking owl
Ninox novaeseelandiae / Southern boobook
Ninox strenua / Powerful owl
Tyto alba / Barn owl
Mammals
Antechinus flavipes / Yellow-footed antechinus
Hydromys chrysogaster / Water rat
Isoodon macrourus / Northern brown bandicoot
Isoodon obesulus / Southern brown bandicoot†
Macropus giganteus / Eastern grey kangaroo
Petaurus breviceps / Sugar glider
Petaurus norfolcensis norfolcensis / Squirrel glider
Pseudocheirus occidentalis / Western ringtail possum
Pseudochirus peregrinus / Common ringtail possum
Rattus fuscipes / Bush rat
Rattus lutreolus / Australian swamp rat
Trichosurus caninus / Mountain brushtail possum
Trichosurus vulpecula / Common brushtail possum

Amphibians
Litoria peronii / Peron's tree frog
Reptiles
Morelia spilota variegata / Carpet python
Pseudonaja textillis / Eastern brown snake
Tiliqua rugosa / Shingleback (bobtail)

Non-native bird species included as these are non-target species and could be sentinels for native species.
† Endangered (EPBC Act 1999)*

Appendix 2: Australian wildlife species involved in suspect or confirmed zinc phosphide toxicity events (2018-2022)

Barnardius zonarius / Australian ringneck
Cacatua sanguinea / Little corella
Cacatua tenuirostris / Long billed corella
Cracticus tibicen / Australian magpie
Eolophus roseicapilla / Galah
Lepus europaeus / European hare #
Ocyphaps lophotes / Crested pigeon
Phalacrocorax varius / Pied cormorant
Phaps chalcoptera / Common bronzewing

Non-native species are included as they could be sentinels for native species.

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Find out more at www.wildlifehealthaustralia.com.au

Email admin@wildlifehealthaustralia.com.au

Or call +61 2 9960 6333