Anticoagulant Rodenticides: Secondary Poisoning of Wildlife in California

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What are Anticoagulant Rodenticides?

- Cause death by internal bleeding.
- Several days between exposure and death.
- Used in agricultural and residential settings.
- Nontarget exposure: primary and secondary.
## Two different kinds of ARs.

<table>
<thead>
<tr>
<th>1&lt;sup&gt;st&lt;/sup&gt; Generation</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Multiple feedings</td>
<td>- Intended for single feeding (more toxic)</td>
</tr>
<tr>
<td>- Less persistent in tissues</td>
<td>- More persistent in tissue</td>
</tr>
<tr>
<td>- Commensal and outdoor use</td>
<td>- Registered only for commensal use</td>
</tr>
<tr>
<td>- Chlorophacinone, diphacinone, warfarin</td>
<td>- Brodifacoum, bromadiolone, difethialone, difenacoum</td>
</tr>
</tbody>
</table>
Persistence of anticoagulants in liver tissue (USEPA)

- **Bromadiolone**: 248 days
- **Brodifacoum**: 217 days
- **Difethialone**: 118 days
- **Diphacinone**: 90 days
- **Warfarin**: 35 days
Acute Oral Toxicity to Dogs
(LD50 values in mg ai/kg)

Brodifacoum: 0.25 - 1
Difethialone: 4
Bromadiolone: 8.1
Diphacinone: 3 - 15
Warfarin: 20 - 50
Chlorophacinone: 50 - 100
Legal Use of SGARs

- Used indoor or outdoor
- Within 100 feet of structure
- Commensal rodents only
In the early 1990’s, DFG began receiving animals with signs of anticoagulant toxicosis. Symptoms include unexplained bleeding in the body cavities and subcutaneously and lack of clotting in blood. Mostly result of secondary exposure. In 1999, DFG requested that DPR place products with brodifacoum in re-evaluation based on 58 cases of exposure. USEPA was also considering issue so no action by DPR.

- **Brodifacoum** (66%)
- **Bromadiolone** (19%)
- **Diphacinone** (8%)
- **Chlorophacinone** (7%)
- **Difethialone** (1%)

Necropsies of Anticoagulant Cases
Also sublethal impacts

- More toxic to embryos
- Susceptibility to disease
- Other?
Species Exposed

- Golden Eagles
- Great-horned Owls
- Barn Owls
- Red-tailed Hawks
- Cooper’s Hawks
- Canada Geese
- Coyotes
- Sj Kit Foxes
- Bobcats
- Kangaroo Rats
- Mountain Lions
- Turkey Vultures
- Martens
- Minks
- Fishers
Summary of Monitoring Data
San Joaquin Kit Foxes in Bakersfield

- San Joaquin Kit Fox (Vulpes macrotis) – permanent reproducing population in Bakersfield.
- Diet: rodents and rabbits.
- Federally endangered and State threatened.
## Results: Foxes with AR Detections

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Bakersfield n=77</th>
<th>Lokern n=13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brodifacoum</td>
<td>74%</td>
<td>0%</td>
</tr>
<tr>
<td>Bromadiolone</td>
<td>36%</td>
<td>8%</td>
</tr>
<tr>
<td>Chlorophacinone</td>
<td>8%</td>
<td>0%</td>
</tr>
<tr>
<td>Diphacinone</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>All ARs</td>
<td>79%</td>
<td>8%</td>
</tr>
</tbody>
</table>
Mountain Lions in California

- DFG is required to necropsy mountain lions taken in California.
- Started analyzing livers for ARs a couple of years ago.
- Of the 14 lions analyzed in the last year, all 14 contained ARs (*Brodifacoum*, *bromadiolone*).
Raptors in California
(Lima and Salmon 2010)

- Tested anticoagulant residues in livers of 96 birds of 11 raptor species in California. (Birds had died of other causes).
- 2 locations
  - San Diego (relatively urban)
  - Central Valley (more rural, agricultural use)

### Raptors in California

(Lima and Salmon 2010)

<table>
<thead>
<tr>
<th></th>
<th>San Diego</th>
<th>Central Valley</th>
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<tbody>
<tr>
<td><strong>First generation ARs</strong></td>
<td>0/53</td>
<td>2/43</td>
</tr>
<tr>
<td><strong>Second generation ARs</strong></td>
<td>49/53</td>
<td>37/43</td>
</tr>
</tbody>
</table>

Bobcats and mountain lions in Southern California
Riley et al 2007

- Study area: Coastal mountain ranges around southern California (Santa Monica, Simi Hills, Santa Susana)
- Collected bobcats and mountain lions and analyzed livers for anticoagulants.

Bobcats and mountain lions in Southern California
Riley et al 2007

Bobcats:
- 35/39 had ARs
- 27/39 had 2 or more ARs
- 31/39 had Brodifacoum

Mountain Lions:
- 4/4 had ARs
- Brodifacoum and Bromadiolone in all 4
- 2 died of AR poisoning
Fisher Project

- Fishers live in old growth forests in northern California.
- 2 small populations in California
- ~1,100 individuals
- Project to re-establish population of fishers. Radiocollaring and tracking.
California Fishers (*Martes Pennanti*)

CA Dept. Fish and Game Status: Species of Special Concern
Federal Status: Endangered Species Act Candidate species
Mourad W. Gabriel, 2012 Unpublished Data

- Total of 58 California fishers tested
  - 46 of 58 (79%) exposed ≥ 1 AR
  - FGAR: 13% of exposed fishers
  - SGAR: 96% of exposed fishers
  - Four Mortalities
All Four Mortalities and exposures confirmed by Board-certified wildlife pathologist and toxicologist

Mourad W. Gabriel, 2012 Unpublished Data
What do these studies tell us?

- Widespread exposure of predators and scavengers
- Mortalities caused by exposure
- Multiple exposure scenarios: Urban, Rural, Wilderness
- Illegal/Legal Use?
Pot Farms
## Illegal vs. Legal Pesticide Use

<table>
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<tr>
<th>Illegal Use</th>
<th>Legal Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss due to illegal application</td>
<td>Loss due to legal application</td>
</tr>
<tr>
<td>- Pesticide application not according to label</td>
<td>- Due to normal (legal) use of pesticides</td>
</tr>
<tr>
<td>- Subject to prosecution by DFG and fines from CAC</td>
<td>- Not subject to prosecutions or fines</td>
</tr>
</tbody>
</table>

- Monitor problem – modify use if necessary
USEPA regulations

- 2008: Risk Mitigation Decision: 2nd Generation ARs not available for homeowner use. Will still be available to pest control companies. Took effect in 2011.
- Loophole: availability at farm stores in large packages.
- 2011: 3 pesticide companies refused to comply and USEPA is deciding whether to cancel their products.
Here in California:

- CDFG has recommended that Department of Pesticide Regulation make 2nd Generation ARs Restricted Use Materials (need a license to buy or use).
- The goal of this recommendation is to reduce availability to the public.
Alternatives to SGARs

- Habitat modification
- Trapping
- Other non-anticoagulant rodenticides: Bromethalin, zinc phosphide, cholecalciferol. Less risk of secondary poisoning.
- 1st generation anticoagulants: chlorophacinone and diphacinone – less toxic, less persistent.
Questions?