Vancouver Island Marmots (Marmota vancouverensis) Consume Plants Containing Toxic Secondary Compounds

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I report 68 sightings of Vancouver Island Marmots (Marmota vancouverensis) feeding on Green False Hellebore (Veratrum viride), a plentiful but highly poisonous plant. Possible explanations for this novel foraging behaviour are presented.

Key Words: Vancouver Island Marmot, Marmota vancouverensis, plant alkaloids, foraging behaviour, diet, plant defensive compounds, Veratrum viride, False Hellebore, marmot foraging.

Plants display a variety of characteristics that provide a degree of protection from herbivores. One characteristic is the production of chemicals that are distasteful or toxic to herbivores (Freeland and Janzen 1974; Iason 2005). Green False Hellebore (Veratrum viride), a herbaceous perennial containing high concentrations of over 50 steroidal alkaloids, is considered to be highly poisonous (Taylor 1956). Ingestion of small amounts of this plant causes severe physiological impairment in humans (Underhill 1959; Jaffe et al. 1990; Prince and Stork 2000) and vertebrate herbivores (Pyles 1920; Dayton 1960; Cheeke and Shull 1985), and it can cause death (Gosselin et al. 1976). Small experimental doses of Veratrum californicum (California False Hellebore) administered to pregnant livestock have caused embryonic death, abortion, and fetal abnormalities (Binnns et al. 1972; U.S. Department of Agriculture 2006*).

Study Area and Methods

Observations of Vancouver Island Marmots (Marmota vancouverensis) were made during focal behaviour samples conducted at four mountain colonies (Heather Mountain, Green Mountain, Haley Lake, and Mount Washington) between May and October over four years (2002–2005). Werner (2005) and Brashears et al. (2010) detail this sampling methodology. For reporting purposes, multiple observations of a single individual made on the same day were scored as a single record. Green False Hellebore was positively identified in the field using Hitchcock and Cronquist (1973) and later corroborated in a laboratory setting (University of British Columbia Herbarium database; accessed 27 October 2002).

Results

Vancouver Island Marmots were observed eating Green False Hellebore (Figure 1) on 68 separate occasions, and at least 17 individual Vancouver Island Marmots were identified as having eaten Green False Hellebore on more than one occasion (in 9 of the 68 observations, the individual identity of the animal was not recorded).

On 27 June 2002, a two-year-old female that weaned young (Figure 1) consumed nearly 30 cm of the upper stem and connecting leaves of a single plant over an 11-minute period. This marmot suffered no visible effects, and she was re-sited 22 times during the following month. Similarly, in July 2005, a three-year-old female and one adult male (age unknown, but greater than four years) were observed feeding on the tips of Green False Hellebore leaves, and occasionally the flowers were consumed.

Young shoots were never observed to be eaten, nor were the roots, lower stems, or fruits. Vancouver Island Marmots fed on Green False Hellebore most frequently during July and August, although this may be an artefact of sampling effort (Figure 2). During April, May, and October, Vancouver Island Marmots were never seen consuming Green False Hellebore, despite considerable time spent in observation (nearly 400 hours combined during those months). During some years, snow persisted into late May and this resulted in Green False Hellebore being largely unavailable until June.

Discussion

These are the first confirmed cases of Vancouver Island Marmots feeding on Green False Hellebore and—to my knowledge—of any marmot species eating substantial quantities of plant parts (see Armitage 1979) containing secondary compounds considered injurious to herbivores and humans.

Marmots are likely capable of detecting plant secondary compounds (including alkaloids), and Yellow-bellied Marmots (Marmota flaviventris) are able to avoid ingesting species that contain them (Armitage 1979). Frase and Armitage (1989) report that Veratrum species were not eaten by Yellow-bellied Marmots during two years of observation, despite this plant contributing to upwards of 50% of the plant biomass at particular sites. In a 30-year retrospective, Armitage (2003) identified this plant genus as having never been recorded in the diet of Yellow-bellied Marmots.

Veratrum viride has been recognized as a possible food plant for marmots (Hansen 1975; Heard 1977;
Milko 1984; Nagorsen 1987; Barash 1989), although the authors provide no direct evidence for their claims and appear to have received direction from a single unpublished reference (Gray 1967*) that does not positively identify *V. viride* as part of marmot diet.

I consider three alternative explanations for Vancouver Island Marmots feeding on *Veratrum viride*: first, this marmot species may not possess sufficient discernment to completely minimize intake of Green False Hellebore during bouts of feeding. During feeding, Vancouver Island Marmots, Hoary Marmots (*Marmota caligulata*), Olympic Marmots (*M. olympus*), Yellow-bellied Marmots, Bobak (or Steppe) Marmots (*M. bobak*), Long-tailed (or Golden) Marmots (*M. caudate*), and Woodchucks (*M. monax*) employ rapid bite patterns between long pauses devoted to vigilance (Blumstein et al. 2001), and the number of plant species browsed often appears to be in proportion to what is immediately available (Werner and Brashares, unpublished data). However, selective foraging has been identified in the Vancouver Island Marmot (Milko 1984; Martell and Milko 1986) and other marmot species (Hansen 1975; Armitage 1979; Barash 1989; Frase and Armitage 1989; Stallman and Holmes 2002; Armitage 2003). Because Green False Hellebore was plentiful at all study sites and the Vancouver Island Marmots that were observed eating Green False Hellebore were all adults (range of two to six years or more), I assume these foraging choices were “intentional” rather than first-time experiences.

Second, it is possible that Vancouver Island Marmots are immune to the toxic qualities of specific alkaloid compounds. This is unlikely, however, given the widespread observations of lethal and sub-lethal effects of false hellebore intake in birds and amphibians (Christensen and McLean 1939), sheep, goats, and cattle (Fyles 1920; Binns et al. 1972; Cheeke and Shull 1985; Mulligan and Munro 1987), humans (Underhill 1959; Gosselin et al. 1976; Jaffe et al. 1990; Prince and Stork 2000), and other mammal species (Dayton 1960; U.S. Department of Agriculture 2006*).

A third possibility is that ingesting false hellebore may, at times, be beneficial. Eating plants which contain specific secondary compounds can be a strategy...
to neutralize other toxins (Foley et al. 1999; Rozman and Klaassen 2001), to enhance amino acid absorption (Iason 2005), to strengthen the immune system and/or to fight parasites (Marley et al. 2003) in mammalian herbivores. The consumption of Green False Hellebore by Vancouver Island Marmots likely contributes to a coherent nutritional strategy (Foley et al. 1999; Iason and Villalba 2006), and this finding has important implications for our understanding of marmot ecology and plant–herbivore interactions.

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Documents Cited (marked * in text)


Literature Cited


maternal ingestion of *Veratrum californicum*: hair lip, cleft palate, aplasia and hypoplasia of metacarpal and metatarsal bones. Clinical Toxicology 5: 245-261.


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