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See No, Smell No, Taste No Evil: How Sage-Grouse Detect Toxic Sagebrush

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Abstract

There is increasing evidence that sage-grouse selectively consume individual and species of sagebrush that have the lowest concentrations of chemical defenses, or toxins. We propose that this selection requires the ability to see, smell or taste specific chemicals or groups of chemicals that vary quantitatively and qualitatively in sagebrush available throughout the winter range of sage-grouse. We are developing methods to determine if and how selected and avoided sagebrush may differ in color, smell and taste. We used ultraviolet and near infrared detectors to determine the variation in the "color" of phenolics in sagebrush. We used gas chromatography to determine the variation in the "smell" of monoterpenes in sagebrush. We are developing microscopy techniques to determine if sage-grouse possess receptors in the beak and tongue that could taste chemicals in sagebrush. Our goal is to develop detectors that can act as sage-grouse eyes, nose and mouth and allow managers to identify and conserve the least toxic sagebrush for foraging sage-grouse.

Disciplines

Ornithology

See No, Smell No, Taste No Evil – How Sage-Grouse Detect Toxic Sagebrush

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See

- Some toxins, like phenolics, reflect light in the UV and visible spectrum (Fig. 1, “see” activity)[1]

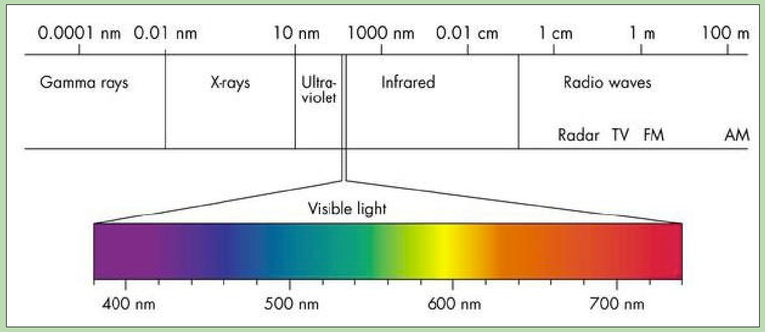


Fig 1. The electromagnetic spectrum showing the ranges of visible light and ultra-violet (UV) light.

- Grouse and other birds can see in the UV spectrum[2,3]
- Species of sagebrush selected and avoided by sage-grouse differ in spectral profiles (Fig. 2)

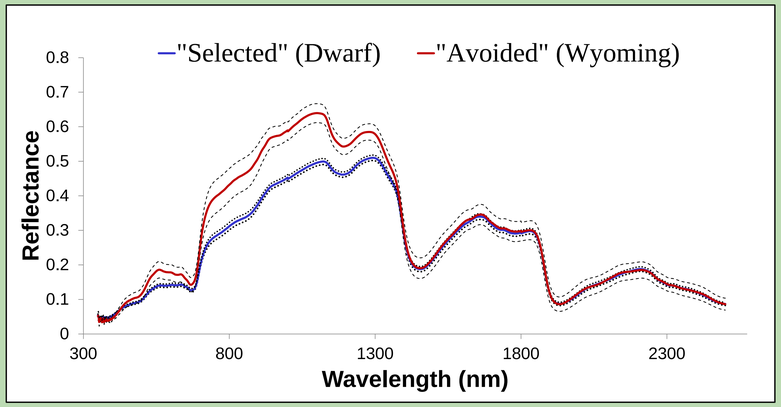


Fig 2. Average spectral profile of a sagebrush species (*Artemisia nova*) preferred (n=144) and a species avoided (*Artemisia tridentada wyomingensis*) (n=22) by sage-grouse.

We propose that sage-grouse could select less toxic plants by sight

Smell

- Monoterpenes are a class of small volatile, aromatic chemicals found in sagebrush (“smell” activity)
- Gas chromatography allows us to visualize these smells
- Sagebrush species differ in their monoterpene profile (Fig. 3)

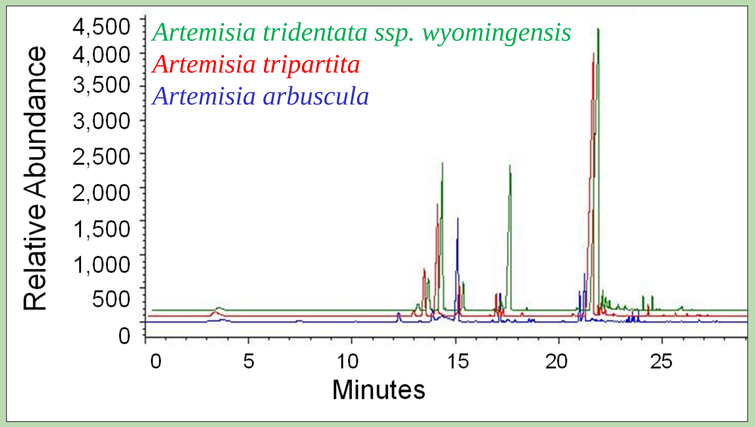


Fig 3. Gas chromatogram showing the different retention times of monoterpenes in three species of sagebrush, *Artemisia tridentata ssp. Wyomingensis* (green), *Artemisia tripartita* (red), *and Artemisia arbuscula* (blue).

- Species differ in amount of monoterpenes (Fig. 4)

We propose that sage-grouse could select less toxic plants by smell

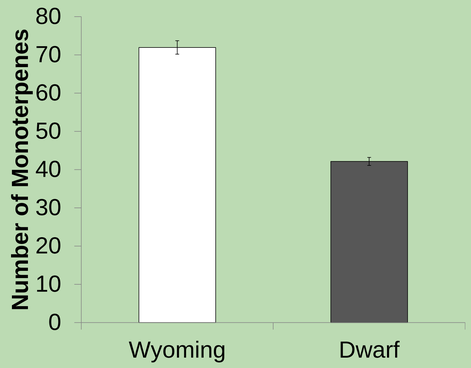
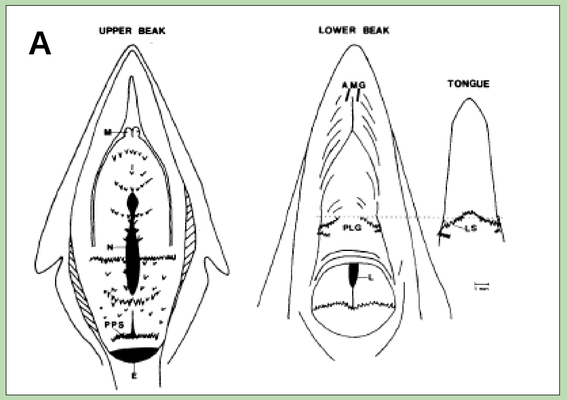
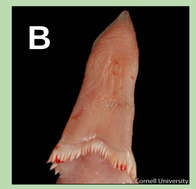


Fig 4. Number of monoterpenes detected in two species of sagebrush available to wintering sage-grouse

Taste

- Birds have approximately 100 oral taste buds (Fig. 5), vs. 9000 in humans[4]
- Birds have a diversity of taste receptors[5]
- Bitter taste influences diet selection in birds[6,7]
- Chemicals in sagebrush have a bitter taste (“taste” activity)[8]





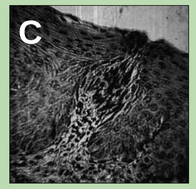


Fig 5. A. Map of taste buds (black dots) in the upper and lower beak and tongue of domestic chickens[9], B. Bird tongue showing fold and wings and C. Pictomicrograph of taste bud[10].

We propose that sage-grouse could select less toxic plants by taste

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