Hollow Crowns: Overgrazing, Undergrazing, or Old Age?

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For those who are interested in Western ranges, one peculiar condition of some native perennial grasses is apparent: some grasses exhibit a ringed growth form with a dead or hollow center. Closer observation limits this phenomenon to bunch grasses, perhaps to particular species of bunch grasses.

Inquiries to resource managers such as range conservationists, wildlife biologists, and agronomists and to resource users such as ranchers elicit three major types of explanations of the hollow crown condition.

One experienced rancher in central Nevada attributes the dieback of the centers of *Oryzopsis hymenoides* (Indian rice grass) to undergrazing by livestock. He explains as an example that rice grass which is protected from grazing in fenced highway rights-of-way dies back in the center as the grass chokes itself out and is forced to grow outward for adequate space and water. Some range conservationists and wildlife biologists support this theory with their observations of fenced range exclosures. Their experience shows that other bunch grass species such as *Festuca idahoensis* (Idaho fescue) and *Stipa* spp. (needlegrasses) also exhibit the ringed growth form after being protected from grazing, often for decades. The plants appear, after several years of not being grazed, to lose vigor, die back in the centers, and direct growth outwards by tillering. Some plants break the ringed growth form and develop into separate plants (which for the purposes of frequency counts are tallied as individual plants). As time passes, the individual plants also exhibit the ringed growth form. The "physiological" theory advanced is that grazing stimulates growth by cropping (pruning).

Other range conservationists and wildlife biologists hold an opposite theory that overgrazing by domestic livestock and wild horses causes hollow crowns. The explanation advanced is that too heavy grazing or defoliation at critical periods in the growth cycles of grasses weakens the plants and causes a lessening of vigor. The plants respond by dying back in the center and growing outward into areas with more available soil moisture and nutrients. This viewpoint is based on the observation that hollow crowns occur on grazed rangelands as well as in exclosures. If grazing prevents stagnation and stimulates growth and vigor, the bunch grasses on rangelands used by livestock should not exhibit the

Early phase of the hollow crown phenomenon in a needlegrass plant (Stipa thurberiana).

Advanced center die-back and the formation of new plants in needlegrass (Stipa thurberiana).

Editor's Note: We are pleased to publish this article in *Rangelands* and hope it will stimulate research into the hollow crown phenomenon.

ringed growth form. Thus, these professionals theorize that grazing, especially heavy grazing, may speed the onset of old age and the eventual death of a bunch grass plant.

A few range conservationists and wildlife biologists, as well as most agronomists and naturalists, advance a third explanation which theorizes that hollow crowns are a natural phenomenon, a normal developmental stage of a bunch grass plant. This explanation views bunch grasses as exhibiting a ringed growth form due to the exhaustion of available soil moisture and nutrients by the root mass and the consequent tillering outward toward more available soil moisture and nutrients. Grazing is incidental as the process will occur naturally. Some species such as *Muhlenbergia torreyi* (ring muhly) exhibit hollow crowns more than others, but all bunch grasses will go through the process eventually.

The only research obtainable is on a small longevity study started at Kamloops, B.C. in 1936 by Dr. E.W. Tisdale and followed later by Dr. Alastair McLean of the Kamloops Experiment Station. The study showed that in 1963, of 10 plants of *Agrogyron spicatum* (bluebunch wheatgrass), 8 were still alive, but 7 of these showed either hollow centers or death of 1/2 or more of the original plant. Dr. Tisdale agreed that the condition of hollow crowns in bunch grasses is a common one and represents a normal condition, thus supporting the third type of explanation.

Other theories are also advanced such as the hollow crowns being caused by small rodents which utilize the plant centers as nests and the succulent net growth each year as a food source. Such use was observed in an exclosure in Nevada by Dr. Joseph Robertson in *Agropyron desertorum* (crested wheatgrass) plants.

A literature search for relevant research yields few results. Textbooks on plant ecology, agronomy, grassland management, and rangeland management contain no references to the hollow crown phenomenon. Hundreds of photographs and illustrations of grasses have been reviewed in the author's study, but no plants exhibit dead centers. Research reported in various journals of range management reveals much information on grass growth and the relationships of grasses to their environments, but no information on the hollow crown growth form. A review of *Herbage Abstracts* indicates a void in this area exists also in international research and publications.

From the lack of information in the literature, one could conclude that the hollow crown phenomenon is of little research or management interest. The lack of published research could, in part, explain the diametrically opposed field explanations of the phenomenon which, by necessity, are based on the individual resource manager's or observer's own personal experiences and opinions.

Lacking research results, one could speculate on the causes of the phenomenon based on the actual experiences underlying all three theories. The facts appear to be that certain bunch grasses exhibit a hollow crown growth form. This form occurs both in grass plants which are grazed by domestic livestock and wild horses at varying intensities and in grass plants which are protected from all grazing. Some grass species such as ring muhly exhibit the growth form in a conspicuous manner while others such as Idaho fescue, Indian ricegrass, wheatgrass, and needlegrass sometimes have hollow crowns and sometimes don't, and others rarely do such as *Elymus cinereus* (Great Basin wild rye).

Thus, the issue of hollow crowns of some species of bunch grasses is subject to several interpretations. Theoretically, each theory may be correct, in part, as the process may be a natural one which is slowed down by proper grazing (removing choking litter and stimulating growth) or speeded up by overgrazing or undergrazing (weakening the plant and including die back and ringing), or other factors (rodent use).

Indian ricegrass plant (Oryzopsis hymenoides) *showing moderate to heavy grazing with the dead center still intact.*

To test these speculations, experiments could be designed to check the validity of the theories in which grazing would be the independent variable. Difficulties with controlling dependent variables could be hard to overcome. For example, perhaps a significant age threshold must occur before a grass plant initiates ringing. Perhaps particular soils, or soil moistures or other plants also influence the hollow crown condition.

The physiology of hollow crowns could be investigated. Is the die back a result of the exhaustion of available soil moisture and nutrients by some critical fibrous root mass of a bunch grass plant? Does litter unremoved by grazing "choke out" the plant, reduce infiltration and tie up nitrogen, forcing the plants to tiller outward toward more available moisture and nutrients? Can plants tiller inward if the litter is removed from the center?

Other areas of inquiry could be pursued. Of what evolutionary advantage would the hollow crown growth form be, if any? One range specialist suggests that before the arrival of the settlers on the Western ranges, fire may have functioned as the force which renewed stagnating bunch grasses and controlled shrub populations. With fires controlled, grass plants may go through indefinite cycles of new growth, die back, ring breakup, new growth, etc. Also of interest is the theory that by occupying more ground area, ring growth plants decrease the area available for other plants to establish themselves. A practical question which could be investigated is what effect, if any, does the hollow crown growth form have on pounds of forage produced per acre.

The issue has important management implications since the hollow crown growth form is used to "prove" overgrazing or undergrazing by different resource interests. A more thorough understanding of this phenomenon, as well as other "obscure" areas of range ecology and plant physiology, could lessen range mythology and improve good range management practices.