A POSSIBLE SOURCE OF BRAIN ABSCESSES IN BULL MOOSE

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ABSTRACT: The presence of cranial infections and abscessations is well documented in males of multiple cervids in North America. The preponderance of such infections is related directly to antlers and all processes from antler growth, fighting, and through to casting. One proposed infection pathway is through an open wound at the pedicle formed at casting. Moose generally do not cast antlers in synchrony, and we propose that males irritated by the imbalance of a remaining antler are more likely to actively remove that antler by striking trees. This behavior is a possible explanation for the occurrence of cast antlers with attached bone and that antlers from bulls of all ages can have substantial amounts of parietal bone attached. The force of this activity may cause breakage of the parietal bone leaving either an opening to the meninges in the cranial vault or a significant depression in the bone. We propose that shed antlers with measurable parietal bone attached, estimated as high as 10% of cast moose antlers, would create abnormally large wounds and possibly an enhanced route of cranial infection and subsequent abscessations.

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Antlers are principally a secondary sexual characteristic critical in the reproductive behavior of cervids. They occasionally have structural abnormalities associated with either injury during the growth period or in response to a previous physical injury. Another type of abnormality is associated with the annual process of casting antlers. Specifically, multiple reports document cast white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and moose (*Alces alces*) antlers, and to a lesser extent caribou (*Rangifer tarandus)* antlers, with measurable parietal bone attached (Fig. 1). Surprisingly, during filming of deer engaged in antler sparring for an outdoor program, the host displayed a broken-off antler with part of the skull attached. Of consequence is that in this or a similar outcome after casting, a possible infection route into the cranial cavity and meninges may occur in open wound sites at the pedicle (W. Samuel, University of Alberta, retired).

Intracranial abscessations in male white-tailed deer are well documented in North America, seasonally focused in September-April, and presumed to be associated with breeding behaviors involving antlers (i.e., sparring, rubbing, and casting) (Davidson et al. 1990, Baumann et al. 2001, Cohen et al. 2015). These studies report a frequency of <10%, but Karns et al. (2009) documented a 35% rate of abscessations in a high-density deer population in Maryland; albeit, their sample size was less robust than the other studies. Infections are principally associated with *Arcanobacterium pyogenes* (Davidson et al. 1990, Baumann et al. 2001, Karns et al. 2009), a common bacterium that invades superficial wounds of ungulates (Zulty and Montali 1988). The infection

pathway is presumed to be through the open wound associated with either normal casting or abnormal antler breakage at the pedicle. In an examination of 4953 male deer from Georgia, Cohen et al. (2015) found 91 abscesses (1.8%) and higher probability of an abscess with increasing age; no cranial abscesses were found in 2562 females. Although they looked at site-specific variables, none were strongly associated with observations of infection. Van Ballenberghe (1982) noted an infection at the pedicle of an Alaskan moose that had prematurely cast an antler in early September prior to the peak of the rutting period.

Although documented reports are rare with moose, MacCracken et al. (1994) found a high frequency of cast moose antlers with attached pedicle bone in the Copper River Delta in Alaska; however, the authors attributed this to genetic and/or local geographic causes. Alternate hypotheses for this anomaly include trauma associated with antler rubbing, male confrontations during the rut, behavior and activity during the casting process (Davidson et al. 1990), and physiological stress associated with relative nutritional condition following harsh winters (Landete-Castillejos et al. 2010). Regardless of origin, these wounds and skull fractures presumably open a pathway for intracranial infection by *Arcanobacterium pyogenes* that could prove fatal.

It is suggested that the skeletal fractures, abscessations, and infection generally confined to male cervids are directly related to antlers. The origin of injuries to the pedicle area is not clear other than the fact that parietal bone is observed on some cast antlers. Both authors (biologist and licensed antler dealer) have observed multiple cast antlers (>1000; range – 1–10% annually) from moose, elk, and deer with a substantial piece of the skull attached (Fig. 1 and 2). We find this more common in moose and deer than elk, and although we have examined fewer, have documented erosion of the parietal bone in a caribou skull (Fig. 3). We and others searching

Fig. 1. Cast antler from a bull moose showing a portion of the parietal bone attached to the cast antler.

Fig. 2 . Antler from mature bull moose showing pedicle area totally covered with skull bone.

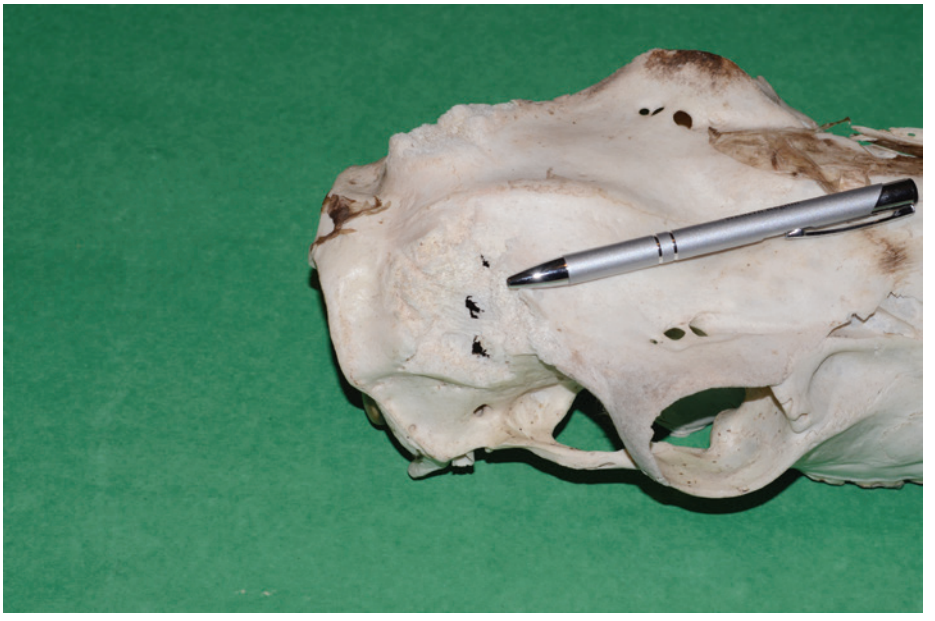

Fig. 3. Caribou skull showing erosion of the parietal bone at the point of antler attachment.

for cast antlers occasionally locate moose antlers at the base of trees which is suggestive of using trees to physically remove antlers.

The process as to how breakage occurs is not entirely clear given the multiple behavioral and nutritional explanations. For example, although breakage could occur from blunt force during rutting activity (sparring and fighting), antlers are not necessarily shed in synchrony when cast,

as single-antlered moose are frequently observed during the casting period. We suggest that some moose (1.5 years and older) facilitate casting of the remaining antler, which may be an irritant due to imbalanced weight distribution, by striking or rubbing the attached antler against trees or a rigid object in an attempt to dislodge it. Newsom (1937) observed that moose may facilitate casting by knocking their antlers against trees and such behavior may explain why some cast antlers are occasionally found at the base of trees. In moose, the torque force caused by the massive, horizontal antlers with a center of gravity far from the skull likely exceeds that in other cervids (Nygren et al. 1992). Although we have observed this phenomenon in all-aged bulls, larger antlers from animals > 2.5 years old generally have more attached parietal bone than those from younger animals.

We did not examine antlers for mineral content as done by MacCracken et al. (1994) and recognize that rutting behavior may cause weakening of or hairline fractures at the pedicle (Davidson et al. 1990), and that age (Hindelang and Peterson 1996) and environmental factors (Landete-Castillejos et al. 2010) influence antler growth, relative bone strength, and presence of osteolytic lesions on the skull. Nevertheless, we propose that a contributing factor to substantial pieces of parietal bone on cast moose antlers may be the physical force used to shed the remaining contralateral antler when striking it against solid objects, most often trees. In turn, associated larger wounds at the pedicle provide a possible route of infection for *Arcanobacterium pyogenes* to the meninges resulting in intracranial abscessations.

Will an antler grow in subsequent years if the pedicle is damaged? Field observations suggest that antlers may not develop normally from a damaged pedicle the following year, and bulls with a single antler are observed occasionally in summer (pers. observation, Crichton). However, permanent damage or failure to grow antlers is considered rare in advanced cervid species such as moose in which pedicle wounds have multiple months to heal between casting and regrowth (Bubenik 1982, Goss 1983). Regardless, reduced health and survival of moose, elk, deer, and caribou can occur from a cranial infection, and physically-forced antler casting may enhance that possibility. Consideration of such is warranted with regard to management strategies aimed at regulating or banning the use of antler traps that ensnare or knock off antlers forcibly.

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