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What might be the consequences of adapting wild animals, such as wapiti, to a farm environment?

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ABSTRACT

North American wapiti (*Cervus elaphus* sub species) evolved within, and inhabit, an extremely varied environment generally not apparent within any pastoral farm environment. Normal farm management practices also reduce disease and predation; modify or prevent behavioral strategies such as migration, wallowing and isolation at calving; impose artificial mate selection; result in the removal of antlers in velvet, and premature dissociation of familial groups.

Whilst the objective of these practices is to utilise deer for animal production, primarily meat and velvet antler, the vast changes imposed will undoubtedly result in rapid changes in genetic, physiological, morphological and behavioral characteristics of the animals.

Deer provide a unique opportunity to study and manipulate the effects of farming in a large ruminant, but at the same time the ecological requirements of the animal should be considered.

Keywords: deer, wapiti, wild, farmed, physiology, behaviour, genetics, morphology.

INTRODUCTION

Most farmed animal species have been domesticated for thousands of years (Protsch and Berger, 1973; Clutton-Brock, 1981) whilst deer, at least in New Zealand have been farmed for less than 25 years. Domestication of more traditional farm animals began as a gradual process whilst, in comparison, the farming of deer has been largely driven by economic factors and, as a consequence, has begun very rapidly (Caughley, 1983). This process may result in changes in genetic, physiological, morphological and behavioral characteristics.

Here we examine the evidence for and consequences of the premise: if you change the way you grow and manage the animal, then you change the animal (Fukuoka, 1978). Wapiti or elk (*Cervus elaphus* sub-species) native to much of North America, are used as an example, to examine what might happen to the animal when its environment is markedly altered, by considering the changes these animals face when being farmed.

Evolution of wapiti

Cervidae, evolved during the mid-Miocene period about 16 million years ago. The cooling of the earth's surface and development of arid zones are thought to be the primary factors involved in the development of grassland ecosystems (Van Soest, 1982). With this changing vegetation ruminants emerged with their ability to transfer cellulose to energy. This enabled a variety of plant materials to be utilized and attributed to their successfulness in the plant animal interaction of evolution.

Wapiti had arrived in North America from Eurasia by the Bering-Chukchi platform by the Illinoian glacial period approximately 120,000 years ago (Bryant and Maser, 1982) and moved southward from Alaska into what is now the United States during the advancement of the Wisconsin glaciation about 70,000 years ago. The drying and cooling trend that followed the end of the Wisconsin glaciation (about 10,000 years ago) saw the eastward retreat of deciduous forest and replaced with the southward movement of grasslands resulting in the major vegetation types now found in North America. Thus, through landforms and vegetation types the wapiti were segregated into six geographically and vegetatively different areas and through this isolation the six subspecies of wapiti in North America evolved (Table 1). With such a range in plant diversity in conjunction with variability in climatic conditions throughout the year, the wapiti diet is constantly changing. The ability of wapiti to consume and digest such fluctuating varieties of forage is the primary reason for their successful adaptation to and evolution in North America.

History of wapiti in New Zealand

Wapiti were first successfully liberated in New Zealand at George Sound, Fiordland in 1905, two earlier introductions failing to survive (King, 1990). The population became established and dispersed, occupying an area in northern Fiordland, west of Lake Te Anau. As red deer dispersed into the slowly expanding wapiti range, the two species hybridised producing a wapiti-type animal with "a combination of genes and adaptations that is unique to New Zealand" (Dratch, 1987).

With the development of deer farming in the 1970's, pure-bred wapiti from North America were again introduced into New Zealand (van Reenen, 1981; Moore 1981/82). For simplicity, it is these animals, directly imported from the wild and transferred straight to farms, which we will consider.

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TABLE 1: The diversity in habitat utilized by different sub-species of wapiti (*Cervus elaphus*) in North America. From Bryant & Maser (1982) and Skovlin (1982). The wide variety of ecosystems suggests the species is capable of adapting to a diverse environment.

Sub-species	Habitat	Region
Roosevelt *C.e. roosevelti*	dense, coastal, coniferous rain forests	Pacific Northwest & northern California
Tule *C.e. nannodes*	non-forested, inland valley bottoms and annual grasslands	California
Merriam* *C.e. merriami*	dry forest and chaparral mountains	southwest US & Mexico
Manitoban *C.e. manitobensis*	most prairie grasslands and cool shrub forests	central North American regions
Eastern† *C.e. canadensis*	mixed conifer-hardwood forests	eastern US & south western Canada
Rocky Mountain *C.e. nelsoni*	inland mountain ranges	Rocky Mountains and adjacent ranges

* now extinct; † may be extinct

Whilst these wapiti have become well established on New Zealand farms, they are not performing to their genetic potential, at least in terms of growth rates and velvet production (Fennessy and Pearse, 1990). The reason for this poor performance is largely unknown although health problems including ryegrass staggers, copper deficiency and internal parasitism have been identified (for example see van Reenen, 1989; Mackintosh, 1992; Waldrup and Mackintosh, 1992). This suggests a complex of factors may be involved, with the possibility of a common underlying cause, such as an inappropriate diet. Anecdotal comment has also suggested that intensive confinement may affect production through social and spatial restriction.

Characteristics of natural existence changed by farming

Wild wapiti in North America, unlike farmed wapiti in New Zealand, are exposed to predation, mainly by mountain lions, bears and recreational hunting by sportsmen. Farmed wapiti are unable to migrate, which in the wild may occur locally, or up to 100 km, in response to seasonal forage availability and changing climatic conditions (Adams, 1982). This unrestricted movement of wapiti may be beneficial in preventing disease often associated with more confined animals.

Farming may also modify or prevent a number of other behavioral strategies, such as isolation from the rest of the herd at calving (Geist, 1982), and prevention of wallowing. Most farmed wapiti are removed from their dams and weaned immediately before or after the first mating season after birth, i.e. at about 4-6 months of age. In the wild lactation may persist until late in the next pregnancy (Flook, 1970), when the calf may be up to 7-8 months of age, and it may not leave the dam until just prior to the birth of her next calf. Matrilineal associations may even be evident for longer periods in red deer (Clutton-Brock *et al.*, 1982).

Other changes induced by farming may include a greater population density, supplementary feeding including concentrates, routine anthelmintic treatment, manipulated seasonal patterns in growth and reproduction, and a decrease in natural mortality. Farm practices often segregate the herd by age and sex classes and may create social disorder with as yet unknown consequences.

However, two of the perhaps more profound changes imposed by farming are probably in habitat diversity and mate selection.

Habitat diversity

Wapiti, like many other wildlife species, show a marked preference for ecotones and make disproportionately more use of riparian zones, because of the increased plant diversity, herbage biomass and available cover that they offer. This diversity in available forage is reflected in the number of species eaten by Rocky Mountain elk, for example: 76 grasses and grass-like plants, 142 forbs (legumes and daisy-like flowers), ferns and lichens and 111 shrubs and trees (Nelson & Leege, 1982). In essence, wapiti have adapted to a number of habitat types and have made use of the available forage (Nelson and Leege, 1982).

In marked contrast, there are few forage or browse species available on many New Zealand pastoral farms. Ryegrass and white clover dominate although there are some 80 species of grasses, legumes and weeds of importance (Daly, 1973). Whether the nutritional preferences and requirements of wapiti are met on such farms is unknown, but it is obvious that few would match the diversity of habitat seen in their native landscape. Since wapiti are an opportunistic, intermediate type between grass-roughage eaters and concentrate selectors (Hofmann, 1985), it may be beneficial to provide a more diverse diet, for example by including browse, especially that which can be readily utilized and can regenerate quickly.

Mate selection

In the wild, bulls advertise and compete to maintain a harem and mate with the cows. This advertisement and competition involves vocalising or bugling, thrashing shrubs and saplings and digging with antlers, sparring with other bulls, urine spraying and wallowing (Struhsaker, 1967; Geist, 1982). In this combative, harem-holding system, mate selection (Kirkpatrick and Ryan, 1991) may be influenced by indicators of fitness such as health, vigour, size, dominance and the ability to compete. Cows may even assess a bull's fitness, partly on the basis of his antlers. This complex of behavioral strategies presumably acts to maximise the fitness of the offspring. Physical competition between bulls then, is probably one of most potent selective forces operating in wild populations (Bronson, 1989).

On farms, mating groups are often single-sire, which removes such competition and with it the element of female choice of mate. Thus advertisement by the bull, apparently becomes a superfluous exercise. The farmer uses indicators of production (such as live weight, antler value, temperament) to select a cow's mate. Antlers are removed prior to the mating season, as part of normal farm management, for either economic or safety reasons. While this system is no doubt proven in terms of increasing farm production and therefore financial returns, we need to ask whether it will maximise, or even retain, fitness of the species?

Genetic implications of the transition from the wild to the farm

Not all individuals adapt successfully to captivity and human use, however, considerable variation can arise in subsequent generations enabling adaptive responses to farming (Berry, 1969). The genetic mechanisms affecting the domestication process (Price, 1984) include artificial selection (the only genetic mechanism unique to domestication), genetic drift, inbreeding, natural selection and relaxation of natural selection. The direction and extent of these mechanisms may be difficult to predict, and the way we control these mechanisms will affect the domestication of deer.

Thus, as we are definitely changing the way we grow the animal, will a consequence be that we also change the animal. As there are little data on wapiti, we have to consider the evidence available from other species.

Effects of domestication in other species

Whilst the changes accompanying domestication may not necessarily be a direct result of domestication (Berry, 1969), when compared with their wild ancestors, there is little doubt that domesticated animals do show differences in morphological, physiological or behavioral traits (see Zeuner, 1963; Clutton-Brock, 1981; Price, 1984). There are many examples. Body size has increased in the horse and hen and decreased in the sheep and cat; there is a greater diversity in horns in sheep and cattle, many species have developed a piebald coat pattern; there is an increase in the number of tail vertebrae in sheep; increased fat and muscle deposition in sheep and cattle and the development of the woolly undercoat in sheep and hairlessness in the pig. Domestication also selects for behavioral traits such as docility, and the ability to cope with crowding stress, and there is a reduction in responsiveness to changes in the animal's environment, both physical and biological. Finally, there may be an acceleration in pubertal development, an increase in the length of the breeding season and an increase in fecundity (see Setchell, 1992).

Based on this information from other species, it appears highly probable that under farming conditions there will be morphological, physiological and behavioural changes in wapiti. This isn't surprising - many animal breeding programmes set out to do just that! The question is, which traits do we want to change and which can we not afford to change?

DISCUSSION

Clearly, New Zealand farmed wapiti occupy an environment that differs dramatically from that encountered in the wild in North America. Furthermore, present management practices mean a number of inherent behavioral strategies are abruptly modified. The changes in habitat diversity and the imposition of artificial selection may be particularly consequential.

Selection for productive traits such as velvet and venison production, tractability, fecundity and more flexible seasonality, may mean that rapid genetic change is made, and as a consequence economic returns increase. However, we need to carefully consider that other genetic mechanisms may operate to offset these "gains". Some characteristics of the animals phenotype may alter by pleiotrophy (genes affecting more than one characteristic). The changes may have positive and negative affects for farming. For example, selection for tameness in foxes shifted the seasonal reproductive pattern from 1 to 2 annual oestrous cycles and resulted in a reduction in fertility (Belyaev and Trut, 1975). Leanness and ovulation rate have been similarly linked in sheep (J.C. McEwan and P.F. Fennessy, pers. comm.).

As selection moves from natural to artificial, it may counter natural selection favouring fitness. Perhaps there is scope to incorporate strategies enabling greater natural selection within our normal farm management practices. An example, already practised, may be the culling of animals that require assistance at calving. However, greater use of natural selection may require a more natural farm environment.

Thus the environmental and genetic induced changes associated with the transition from the wild to the farm may act to change the characteristics of the animal. Farming wapiti alongside more traditional pastoral farmed species may be more practical, easier and viable, but will it result in an "immoral and economically inefficient copy of sheep and cattle" (Hofmann, 1985). On the other hand, we might benefit more by exploiting a more ecologically and behaviorally appropriate niche within agriculture, enabling utilization of natural behavioral and physiological interactions to enhance productivity. That is, should we be incorporating the inherent patterns of survival in our management or are we ignoring them at our peril (Anderson, 1991)? Deer, including wapiti, are amongst the first species being domesticated for which we have a good knowledge of their natural behaviour in the wild. We should make use of this knowledge!

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