

**INVESTIGATION OF SPECIFIC STEREOTYPIC BEHAVIORS IN HORSES**

**By**

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## ABSTRACT

### INVESTIGATION OF SPECIFIC STEREOTYPIC BEHAVIORS IN HORSES

By

**Carissa L. Wickens**

Gastrointestinal irritation has been implicated in crib-biting (CB) in horses. Eighteen horses, 9 CB and 9 non crib-biting (NCB), were used to determine 1) prevalence and severity of gastric mucosal damage, and 2) effect of concentrate feeding on circulating gastrin concentrations in CB and NCB horses. Endoscopic examinations (EE) of the squamous mucosa were performed and gastric fluid sampled after 24-28 hr feed removal. Three days after EE, blood was collected at 1400 hrs on pasture, following 12-hr feed removal (0 min), and at 60 and 120 min after consuming 1 kg of a pelleted concentrate. There were no differences in the number ( $P > 0.05$ ) and severity ( $P > 0.05$ ) of ulcers and prevalence of hyperkeratosis ( $P > 0.05$ ) between CB and NCB. There was no difference ( $P = 0.87$ ) in gastric pH of CB compared to NCB (3.92 vs. 3.78, respectively, SEM = 0.60). There was no effect of CB ( $P = 0.56$ ) on serum gastrin concentration (14.22 vs. 12.16 pg/ml for CB and NCB, respectively, SEM = 2.46) with free access to hay and pasture. Concentrate feeding increased gastrin concentration ( $P < 0.01$ ). Serum gastrin concentration within CB was greater at times 60 and 120 min compared to 0 min ( $P < 0.01$ ). Compared to 0 min, serum gastrin concentration in NCB tended to differ at 60 minutes ( $P = 0.07$ ) and was greater at 120 minutes ( $P < 0.05$ ). Serum gastrin concentration at 60 minutes was greater ( $P < 0.05$ ) in CB compared to NCB. Compared to NCB, there was a trend for greater serum gastrin concentration in CB horses at 120 minutes post-concentrate feeding ( $P = 0.06$ ). The results suggest gastric

mucosal damage is not associated with CB in mature horses maintained on pasture. Greater gastrin response to concentrate feeding in CB may indicate altered gastrointestinal function in CB, which could result in a more acidic gastric environment following the consumption of concentrate feed.

Weaving and crib-biting behavior (WCB) are two of the most recognizable equine stereotypies (repetitive, invariant behaviors with no apparent function), and are viewed as a management and welfare concern. A web-based questionnaire was developed to investigate WCB in Michigan horses. Responses from 293 individuals were received representing a total of 2,181 horses. The percentage of horses exhibiting weaving (W) and CB was 2.7% and 5.2%, respectively. The proportion of respondents attempting to stop CB (81.0%) was greater ( $P < 0.01$ ) compared to W (37.5%). Methods employed to stop or reduce W included increased turn-out (21.4%) and provision of toys (14.3%). Cribbing collars (77.6%), alteration of CB surfaces (55.3%), and increased turn-out (54.1%) were used most frequently to stop or reduce CB. Many owners used a combination of methods. A negative association was identified between hours of daily turn-out and the probability of WCB ( $P < 0.01$ ). Risk of CB was greater for horses with visual contact only (Adjusted odds ratio (OR) = 5.61) and for horses without social contact (Adjusted OR = 6.26) compared to horses allowed turn-out with conspecifics. Contrary to previous studies, a larger daily amount of concentrate was associated with a decrease in the odds of W ( $P < 0.05$ ) and CB ( $P < 0.01$ ). Michigan horse owners expressed concern about WCB and attempted to control WCB. Additional research into the risk factors associated with WCB is needed, as well as careful documentation of the development of these behaviors in order to improve horse management and welfare.

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## LIST OF ABBREVIATIONS

CB	Crib-biting
DA	Dopamine
EE	Endoscopic examinations
MES	Michigan Equine Survey
MSU	Michigan State University
NCB	Non crib-biting
OR	Odds ratio
OSR	Office for Survey Research
P	P-value
SST	Serum separator tube
W	Weaving
WCB	Weaving and Crib-biting

PREVIEW

## INTRODUCTION

Stereotypies are defined as repetitive, relatively invariant patterns of behavior with no apparent goal or function (Mason, 1991). Development and continued performance of stereotypic behavior has been linked to sub-optimal environments (Ödberg, 1987; Cooper and Albentosa, 2005). Specifically, stereotypic behavior can develop within the following contexts: when an animal is unable to execute a behavior pattern that it is highly motivated to perform, such as nesting or feeding behavior; when it cannot escape or avoid a stressful or fearful situation; or when it is kept in confinement or social isolation (Mason, 1991). Stereotypies have been observed in several species kept in captivity (Mason, 1991; Mason and Rushen, 2006). The performance of stereotypic behavior has been used as an indicator of poor welfare (Broom, 1983; Mason and Latham, 2004) although it is often difficult to determine whether the behavior is the result of poor welfare in the past or due to current adverse conditions. Ethologists and welfare scientists have employed a multidisciplinary approach to address questions related to stereotypic behavior including the use of behavioral and physiological measures, as well as application of epidemiological research methods.

Studies conducted in Canada (Luescher et al., 1991) and the United Kingdom (McGreevy et al., 1995a) have reported that greater than 13% of domesticated horses exhibit stereotypies. The primary classifications assigned to stereotypic behavior patterns observed in domestic horses (Houpt and McDonnell, 1993; Mills, 2002) and captive wild horses, e.g. Przewalski horse, (Boyd, 1986) are oral and locomotor. Crib-biting and weaving behavior are two of the most widely recognized equine stereotypies (Kiley-Worthington, 1983). Crib-biting is an example of an oral stereotypic behavior in which

the horse anchors its top incisor teeth on a fixed object (e.g. fence, stall or building structures), pulls backward, contracting the neck muscles, and draws air into the cranial esophagus emitting an audible grunt (McGreevy et al., 1995a,b). Weaving is a locomotor stereotypic behavior pattern characterized by a lateral swaying movement in which the head, neck, forequarters and sometimes hindquarters are engaged (McGreevy et al., 1995c). The average prevalences of crib-biting and weaving behavior in Europe and Canada are 4.1% and 3.3 %, respectively (Nicol, 1999a). In the United States, the reported prevalence of crib-biting behavior is 4.4%. Crib-biting and weaving are recognized as both a management and a welfare concern, and many owners attempt to physically prevent horses from engaging in these behaviors (McGreevy and Nicol, 1998; McBride and Long, 2001). The primary problem with physical prevention, e.g. attempting to stop crib-biting using a cribbing collar or by removing crib-biting surfaces, is that these approaches fail to address the underlying causes of the behavior and may further reduce equine welfare (McBride and Cuddeford, 2001).

Although the underlying cause of crib-biting behavior remains to be elucidated, there is some evidence to suggest a link between crib-biting behavior and gastrointestinal irritation. Nicol (1999b) proposed that the behavior is an adaptive response to gastric acidity and that the act of crib-biting may raise gastric pH as a result of increased flow of alkaline saliva. A study conducted by Moeller et al. (2008) demonstrated that crib-biting behavior stimulates salivation, lending support to this hypothesis. Crib-biting behavior recently has been associated with gastric ulceration in foals, with gastric ulceration and inflammation present in 60% of cribbing foals compared to 20% of non-cribbing foals (Nicol et al., 2002). In addition, crib-biting foals had greater severity of ulceration and

inflammation upon initial endoscopic examination (Nicol et al., 2002). In adult horses, crib-biting has been associated with lower basal and post-feeding gastric pH (Lillie et al., 2004) and long-term treatment with antacids has reduced the frequency of crib-biting (Mills and Macleod, 2002). However, an association between crib-biting behavior and gastric ulceration in mature horses has never been documented.

Few experimental studies have been conducted specifically to address weaving behavior. However, the provision of mirrors in the stable reduced the performance of weaving (McAfee et al., 2002) suggesting that this behavior may be performed in response to social isolation. Stable designs that increased visual horizons, such as open stable doors providing access to views of adjacent horses and surrounding fields also reduced weaving behavior (Cooper et al., 2000). Ninomiya et al. (2007) found that weaving behavior was mainly observed before feeding, and that investigation of bedding was more likely to follow eating. These results suggested that weaving also may be performed in an attempt to cope with frustration associated with meal anticipation.

Survey studies in the UK and Canada have demonstrated an association between various management practices and stereotypic behavior. For example, Waters et al. (2002) found young horses fed concentrate feed post-weaning to be 4 times more likely to develop crib-biting behavior than foals not receiving concentrate. Management factors associated with a *reduced* risk of stereotypic behavior include increasing forage intake, allowing visual contact between stalled horses, and increasing the amount of time spent outside the stable (McGreevy et al., 1995a,c; Redbo et al., 1998). Management factors associated with an *increased risk* of stereotypic behavior include the feeding of

concentrates (Redbo et al., 1998; Waters et al., 2002; Bachmann et al., 2003) and stabling/stalling of foals prior to weaning (Parker et al., 2008)

Certain breeds of horses may be more likely to exhibit stereotypic behavior than others. This was demonstrated by Bachmann et al. (2003) in a survey of stereotypic behavior in Swiss horses in which Warmbloods and Thoroughbreds were at 1.8 and 3.1 times greater risk of performing stereotypic behavior, respectively, compared to other breeds. Vecchiotti and Galanti (1986) also have suggested the involvement of a genetic component in the performance of stereotypic behavior with the finding that certain Thoroughbred lines were more susceptible to developing stereotypic behavior. Stereotypic behavior has never been investigated in horses in Michigan. Specifically, there is a paucity of information regarding the prevalence and owner perceptions of, and risk factors associated with crib-biting and weaving behavior within the Michigan horse population.

The overall goal of this dissertation is to provide a further understanding of crib-biting and weaving behavior in horses. The specific objectives of this research were to: 1) determine prevalence and severity of gastric mucosal damage in mature crib-biting horses, 2) determine the effect of feeding on circulating gastrin concentrations in crib-biting and non crib-biting horses, 3) assess the perceptions of weaving and crib-biting behavior held by Michigan horse owners, and 4) investigate risk factors associated with these behaviors in the Michigan horse population. The first and second objectives are addressed in Chapter 2 using video endoscopy and measurement of serum gastrin concentrations in crib-biting and non crib-biting horses following free-access to pasture/hay and in response to pelleted concentrate feeding. We hypothesized that horses

exhibiting crib-biting behavior would have a higher degree of gastric mucosal damage and greater serum gastrin response to concentrate feeding compared to non crib-biting horses.

The third and fourth objectives are addressed in Chapter 3 utilizing a web-based questionnaire. It was hypothesized that Michigan horse owners would express concern regarding weaving and crib-biting behavior and that the majority of owners attempt to stop or reduce performance of these behaviors. Additionally, the author hypothesized that certain housing and feeding strategies, for example, those which limit a horse's time out of the stable, limit contact with other horses, or limit foraging opportunities, would result in an increased probability of horses exhibiting weaving and/or crib-biting behavior. Some of the specific predictions were that increased turn-out would reduce the probability of a horse being a weaver or crib-biter and that the probability of being a weaver or crib-biter would be increased in horses with no visual or tactile contact with other horses. Furthermore, those horses fed larger amounts of concentrate would be more likely to weave or crib-bite.

The rationale for hypothesizing greater mucosal damage and gastrin response to concentrate feeding in mature crib-biting horses is based on the associations between crib-biting behavior, concentrate feeding, and gastrointestinal irritation identified in the literature. The rationale behind the hypotheses and predictions related to horse owner perceptions and risk factors associated with weaving and crib-biting behavior in Michigan are based on findings of previous survey and epidemiological research. Weaving behavior was included in the Michigan horse behavior survey study for two reasons. First, in comparison with crib-biting behavior, the number of studies dedicated

specifically to weaving remains low and we wanted to add to the body of knowledge regarding this locomotor stereotypy. Secondly, because information about stereotypic behavior has never been collected within the Michigan horse industry, we were interested in learning about more than just one behavior. However, crib-biting behavior is the main focus of the dissertation. Thus, the purpose of Chapter 1 is to provide the reader with a relatively comprehensive review of what is currently known about crib-biting behavior in horses. Chapter 4 provides a summary of the main findings of the dissertation research and implications for the equine industry.

PREVIEW

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## CHAPTER 1

### CRIB-BITING BEHAVIOR IN HORSES: A REVIEW

#### **Abstract**

During the past decade, stereotypic behavior in horses, specifically crib-biting behavior, has received considerable attention in the scientific literature. Epidemiological and experimental studies designed to investigate crib-biting behavior have provided valuable insight into the prevalence, underlying mechanisms, and owner perceptions of the behavior. The findings of these studies have demonstrated how the management of horses can influence their behavior and well being. The work of previous authors also has been vital in generating additional research questions and hypotheses related to crib-biting. The findings of several survey and experimental studies are reviewed, with emphasis on research conducted since the late 1990's, in an attempt to provide the reader with a relatively comprehensive look into what is currently known about crib-biting behavior in horses. Knowledge deficiencies and areas for future research are identified.

*Keywords:* Horse, Behavior, Crib-biting, Welfare, Review

## **1. Introduction**

Stereotypies are defined as repetitive, relatively invariant patterns of behavior with no apparent goal or function (Mason, 1991). Development and continued performance of stereotypic behavior have been linked to sub-optimal environments (Ödberg, 1987; Cooper and Albentosa, 2005). Specifically, stereotypic behavior can develop within the following contexts: when an animal is unable to execute a behavior pattern that it is highly motivated to perform, such as feeding behavior; when it cannot escape or avoid a stressful or fearful situation; or when it is kept in confinement or social isolation (Mason, 1991). It has been suggested that stereotypic behavior may serve as a coping mechanism, functioning to reduce stress or to provide the animal with some form of control over its environment (Mason, 1991; Cooper and Albentosa, 2005). The presence of stereotypies has been used as an indicator of poor welfare (Broom, 1983; Mason and Latham, 2004) although whether the welfare is currently poor or has simply been poor in the past is more difficult to determine. Stereotypies have been observed in several species (Mason, 1991) and in captive ungulates, performance of oral stereotypic behavior is common (Bergeron et al., 2006; Mason and Rushen, 2006). Specific examples include object-licking in giraffes, bar-biting and sham chewing in sows, tongue-rolling in cattle, and crib-biting in horses (Mason and Rushen, 2006).

Horses exhibiting crib-biting behavior anchor their top incisor teeth on a fixed object (e.g. fence, stall or building structures), pull backward, contract the neck muscles, and draw air into the cranial esophagus emitting an audible grunt (McGreevy et al., 1995a,b; Dodman et al., 2005). The behavior is not known to occur in feral, free-ranging horses, but is observed in domestic (Haupt and McDonnell, 1993; Mills, 2000) and

captive wild horses, e.g. Przewalski horse (Boyd, 1986). Performance of crib-biting behavior has been reported to occupy from 15% (Nicol et al., 2002) up to 65% (Bachmann et al., 2003a) of the daily time budget.

It is widely reported in the literature that crib-biting, and other stereotypic behaviors, are viewed by owners as being problematic and undesirable (Kiley-Worthington, 1983; Houpt and McDonnell, 1993; Nicol, 1999a; Mills, 2002). Crib-biting behavior has been linked to unthriftiness (weight loss and poor condition) in horses. This is thought to be a result of increased energy expenditure and/or a decrease in the amount of time spent eating and grazing during performance of the behavior (Houpt and McDonnell, 1993; McGreevy and Nicol, 1998a). The behavior also has been associated with excessive tooth wear (Owen, 1982; Boyd, 1986), which in severe cases may impair the horse's ability to graze or result in dental disease. Two recent studies have demonstrated an association between epiploic foramen entrapment, a specific form of colic, and crib-biting behavior (Archer et al., 2004, 2008). Despite the latter findings however, evidence for direct negative consequences of crib-biting behavior on horse health remains largely anecdotal, requiring further empirical investigation and careful documentation.

The precise etiology of crib-biting behavior has yet to be elucidated, and it is likely that the cause is multifactorial. Several studies have been conducted to investigate the potential biological mechanisms underlying crib-biting behavior. For example, crib-biting has been associated with altered neuroendocrine physiology (Gillham et al., 1994; Lebelt et al., 1998; McBride and Hemmings, 2005) and brain function (Hemmings et al., 2007; Parker et al., 2008a). There is also some evidence to support a role of

gastrointestinal irritation in performance of the behavior (Mills and Macleod, 2002; Nicol et al., 2002; Lillie et al., 2004). The findings of these studies have greatly enhanced our understanding of the behavior, but in some cases, results have been conflicting or insufficient, and warrant further investigation. Application of survey research methodology to questions about crib-biting behavior has provided some insight into the prevalence of and risk factors associated with the behavior. Specific factors found to be associated with crib-biting behavior include time spent out of the stable, forage and concentrate feeding, breed and sex of horse (McGreevy et al., 1995c; Luescher et al., 1998; Redbo et al., 1998; Bachmann et al., 2003b) and method of weaning (Waters et al., 2002; Parker et al., 2008b). Some of the more recent epidemiological studies have also attempted to assess owner awareness and perceptions regarding crib-biting behavior (McBride and Long, 2001; Albright et al., 2009; Wickens, Chapter 3) in an effort to determine the current level of concern with and knowledge about the behavior within the equine community.

### **1.1 Aim of the review**

Within the past decade, equine scientists have conducted a number of studies designed to examine the etiology of crib-biting behavior. The purpose of this paper is to review the existing literature on crib-biting behavior with special attention directed toward research carried out after the publication of equine stereotypic behavior review articles in the mid- to late- 1990s (Winskill et al., 1995; Cooper and Mason, 1998; Nicol, 1999b). Emphasis is placed on our current understanding of the role of neuroendocrine and brain physiology and of gastrointestinal irritation in the performance of the behavior, as well as the contribution of horse characteristics and environmental factors to crib-

biting behavior. Recommendations concerning areas needing additional research are made throughout.

## **2. Neuroendocrine physiology and brain function in crib-biting horses**

The repetitive and persistent nature of stereotypic behavior has led authors in the past to describe such behavior in horses as “obsessive compulsive disorder” or OCD (Luescher et al., 1991; Shuster and Dodman, 1998). However, because obsessions involve recurrent, intrusive thoughts, a capability that horses are not known to possess, the terms “compulsive disorder” (Luescher et al., 1998), and “stereotypic behavior” (Mills and Nankervis, 1999) are preferred. Nonetheless, implication of the serotonergic system in compulsive disorders in both humans and horses represents a commonality between the two species in the underlying pathology of such repetitive or stereotyped behavior patterns. Serotonin reuptake inhibitors have been used to treat compulsive disorders in humans (Bandelow, 2008) and have been reported to reduce stereotypic behavior in horses (McDonnell, 1998). However, Lebelt et al. (1998) expressed uncertainty regarding whether these drugs selectively affect stereotypic behavior or result in changes in behavior by way of a general sedative effect. Lebelt et al. (1998) did find a trend for lower basal serotonin levels in crib-biting compared to non-stereotypic horses, suggesting that the serotonergic system of crib-biters may differ from that of non crib-biting horses. The precise role of serotonin in the development or maintenance of the behavior remains unclear however, and the results obtained by Lebelt et al. (1998) have yet to be confirmed or refuted through additional experimental studies of the serotonergic system in crib-biting horses.

Endogenous opioids have been suggested to facilitate and reinforce stereotypic behavior (Dodman et al., 1987; Gillham et al., 1994; Zanella et al., 1996). In a study conducted by Dodman et al. (1987), infusion of opioid antagonists reduced crib-biting behavior, lending support to this hypothesis. Similarly, McBride and Cuddeford (2001) demonstrated a reduction in crib-biting behavior by administering naloxone, but the authors suggested that a general sedative effect of the opiate antagonist might have influenced performance of the behavior. Measurement of plasma  $\beta$ -endorphin in crib-biting horses has produced conflicting results. Gillham et al. (1994) reported significantly lower baseline concentrations of  $\beta$ -endorphin in crib-biting horses compared to non crib-biting controls, whereas Lebelt et al. (1998) found 3 times higher basal  $\beta$ -endorphin concentrations in crib-biting horses. Pell and McGreevy (1999), however, found no significant difference in plasma  $\beta$ -endorphin concentrations between crib-biting and normal horses. Lebelt et al. (1998) and Nicol (1999) have suggested that peripheral plasma  $\beta$ -endorphin concentrations may not reflect concentrations in the central nervous system that would be responsible for producing behavioral changes. Pell and McGreevy (1999) have proposed that a failure to detect differences in plasma  $\beta$ -endorphin concentrations between crib-biting and normal horses may indicate greater sensitivity of opioid receptors in stereotypic horses.

Crib-biting behavior also has been proposed as a means to alleviate a horse's stress. Heart rate and nociceptive threshold were lowered in horses during periods of crib-biting (Lebelt et al., 1998). McBride and Cuddeford (2001) reported a significant reduction in plasma cortisol concentration following bouts of crib-biting, providing evidence that the act of crib-biting may reduce stress. McGreevy and Nicol (1998b)