

POSTURING HORSES: XENOPHON ON BIOMECHANICAL SOUNDNESS
IN *THE ART OF HORSEMANSHIP*

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

As early as the Bronze Age, ancient Greek horses shared in the social status of the military elite. The ritual inclusion of horses and their equipment in burial practices from the Bronze Age to the Classical period marked the elevated status of horses and the wealth of those who cared for them. It is possible to discern the level of care elite equines received through artistic depictions on Athenian pottery and from literary descriptions on the training, care, and stable management of horses as found in Xenophon's manual, *The Art of Horsemanship*. The longevity of military and sport horses indicates the level of care they received. Based on the detailed practices Xenophon recommended for the selection, care, and training of 4th century BCE cavalry horses, it is possible to discern the ideal conformation (*εἶδος*) and posture (*σχηματοποιεῖσθαι*) that he desired for a horse. A comparison of Xenophon's anatomical vocabulary to modern equine anatomy and physiology shows that he preferred riding practices that align with biomechanically sound training.

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Dedication

For the horses
who have carried us throughout history,
and who carry us still.

For the donkeys and mules
who are not forgotten.

And for the humans that love them.

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List of Abbreviations

ISES	International Society for Equitation Science
LSJ	Liddell, Scott, & Jones, <i>A Greek-English Lexicon</i> (1996)
NFACC	National Farm Animal Care Council, Canada

INTRODUCTION

The irony of Xenophon's work is that many classicists do not study his manual, *The Art of Horsemanship*, beyond its measure as a technical treatise on riding a horse. Compared to this disciplinary lacuna, the majority of equestrians know of its significance to the foundation of horsemanship (even if they have not read it), but they are not aware of his other works that classicists commonly study, such as his other manuals, his philosophical, historical, and political works. The impact *The Art of Horsemanship* has had on horses, riders, and the cavalry, is without doubt, very significant.¹ It is consistently referenced by riders, trainers, and veterinarians as a reliable work on equine conformation, training, riding, and care.² Like many things in the modern world, the origins of horsemanship are traced back to ancient history, and Xenophon's treatise is one of the oldest surviving manuals that exists on the topic.

The Art of Horsemanship receives mixed reviews from horsewomen and horsemen. Some rave about his work as he comments on the fair and equitable treatment of horses. In other places though, he recommends harsh and abusive methods that would violate modern international regulations on horsemanship, in both equipment and training methods.³ The influence Xenophon's manual has had on horsemanship cannot be stated enough, yet a biomechanical

¹ Crossley 1985, 90. Xenophon's manual was rediscovered in the sixteenth century CE when the High School of classical equitation and dressage was developing (Baker 1985, 21.) Dressage in its modern form began its development in the seventeenth and eighteenth centuries when the French royal écuyer at Versailles, François de la Guérienièrre, built upon Xenophon's *Art of Horsemanship* to create his own manual, *l'Ecole de Cavalerie* (Crossley 1985, 90; Loch 2002, 26.) De la Guérienièrre's manual serves as the basis for all contemporary training and "the work perpetuated at the great academy of the Spanish Riding School at Vienna which stands as the arbiter of true classical riding across the world" (Crossley 1985, 90.) Classical riding is considered the most biomechanically sound riding (Heuschmann 2009, 38.) The term "classical dressage" comes from its association with Xenophon and the Greeks, who are attributed with first developing classical horsemanship (Loch 2002, 8, 10.)

² Heuschmann 2009, 40; van Weeren 2001, 5; Easley 2011, 12; Loch 2000, 22, 28, 32; Baker 1985, 20; Thomas 2005, 276; Loch 2002, 10-13; Nicholson 2006, 158; van Weeren 2019, 809.

³ See Boot 2013, 367-375.

examination of his work has not been undertaken. The closest undertaking to such an examination is in the reference to Xenophon's manual by Dr. Heuschmann in his book *Tug of War: Modern vs Classical Dressage* and an article called "Περὶ Ἴππικῆς: On Ancient Greek Horsemanship" by Carol Mattusch, from the National Sporting Library and Museum in Virginia.⁴ Even so, these works recite information from Xenophon's manual without assessing the biomechanical positioning of the horse, which can range from sound to unsound. In many regards, it seems to be taken for granted that such an assessment is not possible.

The absence of a deeper assessment of Xenophon's work first became apparent to me when reading *Tug of War: Modern vs Classical Dressage* in 2012.⁵ The book examines riding from a biomechanical perspective and brings awareness to the very real problem of whether horses are being ridden soundly or unsoundly in modern sport. Emphasizing the importance of fair and biomechanically sound riding, Dr. Heuschmann references Xenophon as one of the works to study to learn valid riding principles from a great horse master.⁶ There was, however, a troubling question about the context and understanding of Xenophon's manual I am still asking: *what do we truly know about Xenophon's recommendations on riding a horse?*

The scholarship on *The Art of Horsemanship* is limited. Xenophon's text is only now being studied by a branch of equestrianism referred to as Equitation Science, which examines the manual for proper training characteristics that are beneficial for the horse by animal welfare standards.⁷ While they examine the training methods recommended by Xenophon, the context of

⁴ Mattusch 2017, 53-63. Xenophon has also been included in the works by C. Willekes, see especially *The Horse in the Ancient World* (2016).

⁵ Within the same period of time, I was training and completing certification in a modality of equine therapy that required the study of anatomy, physiology, and the biomechanical integrity of horses to treat lameness and compensation patterns in unsound horses.

⁶ Heuschmann 2009, 40.

⁷ Boot 2013, 367-375.

anatomical and biomechanical positioning of the horse when ridden and trained is not included. Such an assessment has yet to be completed, and it is the intent of my thesis to fill in this gap. To discern the posture of the horse as recommended by Xenophon, whether that be biomechanically sound or unsound, an examination of the key components of his manual will be compared to modern biomechanical theory.

The equine body, despite being fast, well-muscled, and captivating to the human eye, is also quite delicate. Ridden horses are prone to lameness and great care was taken in preventing injury to the horse, just as it is now. Despite modern research on equine biomechanics being readily available, it can be difficult for horses to be ridden and trained in a biomechanically sound manner regardless of discipline. It is this phenomenon that Dr. Heuschmann addressed in his book. Even though he focuses on the modern English discipline of Dressage, the fundamental principles of biomechanical soundness can be applied to all disciplines and horses.⁸ This is possible because underlying “biological principles of horse construction and action” are consistent regardless of age, breed, sex, or size, and it is in understanding the anatomy and physiology of a horse that they can be assessed conformationally and biomechanically.⁹ Even if slight conformational variations occur in individual horses, the biomechanical posture of a horse can always be assessed based on key anatomical indicators.¹⁰ One of these key indicators are parts of the horse’s skeleton that are physically and visually palpable underneath the horse’s skin, known as the bony landmarks. In addition to the known placement of the bony landmarks, the muscles of the neck, shoulders, back, and hind-end provide insight into how the horse is

⁸ Heuschmann 2009, 40.

⁹ Bennett 2012, vol. 1, 5.

¹⁰ Bennett 2012, vol. 1, 5.

using its body. Along with these elements, the overall posture and positioning of the horse within the gaits indicates whether it is moving in a biomechanically sound or unsound manner.

According to modern experts, biomechanically sound training requires an investment in both time and money. To reach the height of competitive dressage sport, a horse needs a minimum of eight years to be fully trained in an optimal manner.¹¹ The first two years should encompass unspectacular, systematic training of the horse's physical development.¹² Even in the development of the cavalry horse in the nineteenth and twentieth centuries, horses required a minimum of two to three years for basic training.¹³ Conventional standards also state that a horse should not be started under saddle until it is three, not undergo serious training until it physiologically mature around five, and then be trained in earnest when the horse's muscles and conformation are ready around the age of eight.¹⁴ Training must also be done over a long period of time "[t]o protect the horse from long-term damage and to maintain his ability to carry a rider's weight."¹⁵

There are also a variety of influences and costs associated with horse ownership that can determine the horse's ability to perform at an optimal level, regardless of discipline or use in competition. These areas of influence include the rider, trainer, nutrition, veterinarian, tack (saddles, bits, harnesses), body workers (chiropractors, acupuncturists, massage therapists, etc.), farriers, and the age and chosen discipline of the horse.¹⁶ The stabling and land needed to care

¹¹ Heuschmann 2016, 13.

¹² Heuschmann 2009, 97, 75.

¹³ Heuschmann 2009, 41.

¹⁴ Schleese 2017, 92. This is not typically practiced in modern sport and concerns for this are expressed by Dr. Heuschmann in his recommendations to re-design current competitions for three-year-olds (Heuschmann 2009, 127.)

¹⁵ Schleese 2017, 93.

¹⁶ Schleese 2017, 25.

and feed horses is also not insignificant.¹⁷ These key factors are all interdependent, but they each have an impact on the horse's conformation and ability to perform.¹⁸ In addition to these influences, a horse's conformation can also change over the course of its lifetime due to its age and training.¹⁹ Biomechanically sound training can increase the longevity and health of the horse by supporting its natural physiology, where unsound training practices increase deterioration of the musculoskeletal system resulting in pain and lameness.²⁰ Both types of training have an associated cost, but biomechanically sound training helps reduce and prevent long-term injuries. Correct physiological training therefore supports the long-term health of the ridden horse.

Time is needed to allow the young horse's musculature to develop or to re-train an older horse, which is also dependent on the rider and trainer's implementation of biomechanically sound training practices.²¹ While the full training process of a horse will not be discussed here, there are key indicators that show whether a horse is being ridden in a biomechanically sound or unsound manner. This is possible to determine based on the anatomy and physiology of the horse, as well as the biomechanical function. If the horse is ridden in a biomechanically sound manner, the poll (the *atlanto-occipital* joint) is the highest point of the spine.²² The topline of the horse is rounded with well-developed muscles on the upper (*dorsal*) half of the horse's neck. The root of the neck is lifted where the cervical (neck) vertebrae meet the thoracic vertebrae (the

¹⁷ A modern rule of thumb is to allow a minimum of 1.2-2.5 acres per horse depending on the type of horse and the grazing and forage conditions of the land (ni.gov.uk.) In Canada, the "minimum space allowance per horse, in m², is 2 to 2.5 times the height of the horse (at the height of the withers) squared" when kept outdoors (NFACC 2013, 13.)

¹⁸ Schleese 2017, 26.

¹⁹ Schleese 2017, 25.

²⁰ Heuschmann 2009, 58-59, 75, 83. The entirety of "Tug of War: Classical versus 'Modern' Dressage" is dedicated to this problem. For a summary of the effects sound versus unsound riding methods have, see 104-105.

²¹ For the correlation between biomechanically sound training principles, Classical dressage, and the horse's age, see Heuschmann 2009, 37-41.

²² This is the area right behind the ears, where the first cervical vertebra, the atlas, attaches to the back of the skull, the occiput (Heuschmann 2009, 48.)

vertebrae associated with the ribcage).²³ The horse is lifted through the withers and ribcage, which supports the rider's weight. The horse's hind end is engaged and rounded underneath its body. The back is also rounded, or appears straight, acting as the bridge between the forehand and hind end (fig. 1).²⁴ This is true in all gaits and exercises. There are additional indicators within gaits and exercises, such as the angle of the horse's legs, which reveal whether the horse is being ridden in a biomechanically sound manner. These features will be examined as they are relevant to the representation of biomechanics in Xenophon's manual.

Physiological indicators are also used to determine a biomechanically unsound posture, which are nearly opposite to a biomechanically sound posture. In the unsound posture, the highest point of the horse's skeleton becomes the joint between the second and third vertebrae, as it is the weakest point in the horse's neck.²⁵ The root of the horse's neck is dropped with a corresponding sunken withers and ribcage. The back is tight and shorter than the underside of the horse's belly. The top of the pelvis (*tuber sacrale*) rotates toward the ears with the point of the buttocks (*tuber ischii*) pointing upwards rather than downwards (fig. 2).²⁶ In the biomechanically sound and unsound postures described above, the horse's nose is near or on the vertical.

In modern sport, great emphasis is placed on the position of the horse's nose. A biomechanically sound posture typically includes the horse's nose being on – or near – the

²³ Bennett 2019.

²⁴ For an additional description of a biomechanically sound horse, see Heuschmann 2009, 85-86, "Relative elevation".

²⁵ Heuschmann 2009, 93. This is located approximately "two hand spans behind the poll" (Heuschmann 2009, 92.)

²⁶ For a description of an unsound posture, see Heuschmann 2009, 86-87, "absolute elevation". There are other ways in which a horse can be ridden in a biomechanically unsound manner. In modern sport, this includes the practice of "hyperflexion" where the horse is ridden with its nose pulled deeply into its chest causing an overextension of the horse's spine (Heuschmann 2009, 88-90.) Likewise, the horse can be positioned in an unsound manner with its nose in the air, although this is not typical in modern sport which focuses on getting the horse in a particular "frame" with the nose on the vertical (Bennett 2019.) For more information on unsound biomechanics of a high headset, see Heuschmann 2016, 26; Bennett 2008, 4.)

vertical. When ridden in a biomechanically sound manner, the horse's nose will typically fall on the vertical due to the physiology of the horse's *atlanto-occipital* joint.²⁷ Biomechanically unsound training typically derives from the rider trying to achieve this vertical nose position before the horse has developed the strength to achieve this on their own. This is known as “hand-riding” or being ridden “front to back.”²⁸ Xenophon does not mention where the horse's nose should be positioned, although this is possible to discern in art. It is also important to note that what is popular in modern horsemanship and biomechanically sound models (with the horse's nose being on the vertical), is not the same as what was practiced in ancient Greece. The assessment of a biomechanically sound or unsound posture based on current riding trends was therefore broadened to include a physiological model that does not require the horse's nose to be on the vertical to be considered a sound posture.²⁹

Before determining whether the ancient Greeks were training and riding to ensure sound biomechanical positioning, I first discuss the importance of the horse to ancient Greeks. As will be shown, horses were immensely valued in ancient Greece as status symbols. Of all domesticated animals, horses were the most expensive, cared for, and highly trained. Ancient Greeks invested heavily in their horses, a point that will be made by an overview of burial practices and grave monuments. From here, the care that was given horses in training, grooming, and feeding as outlined by Xenophon indicates that the prevention of injury and illness to horses was important. The proficiency in providing this care to top performing horses is indicated by the

²⁷ Bennett 2019; Heuschmann 2009, 104. For developing correct physiology of the head and neck axis in the young horse, see Heuschmann 2016, 24-27.

²⁸ Heuschmann 2009, 46-47.

²⁹ The basis for this can be found in training concepts for young horses where the nose can be positioned above the vertical while they develop their strength and balance (Heuschmann 2016, 26.) This head-neck position does not compromise the integrity of the joints in the neck, such as is seen in the biomechanically unsound model discussed above. For various degrees of collection including different angulations of the nose in well-trained and developed horses, see Heuschmann 2016, 53.

age of select horses recorded in literary sources, and in a limited capacity, burial remains. The third chapter will examine Xenophon's awareness of biomechanical soundness as indicated in the manual, *The Art of Horsemanship*.

In his manual, Xenophon indicates the ideal conformation and posture of the horse and refers to specific anatomical features. These anatomical features correspond to actual anatomical locations and functions and can therefore be placed on a realistic diagram of a horse. The consistent vocabulary between ancient and modern practices, as well as the consistent anatomical locations, provide the basis for determining biomechanically sound posturing between the two time periods. This correlation provides the foundation for assessing the posture Xenophon recommended riders have their horses assume. By examining Xenophon's technical treatise on horsemanship through the anatomical markers that are consistent in every horse, a more thorough understanding of the ideal biomechanical positioning of horses in the Classical period can be understood than has been traditionally brought forward from antiquity.

CHAPTER ONE: ELITE EQUINES FROM THE BRONZE AGE TO THE CLASSICAL PERIOD

From the earliest of Greek history, a meaningful connection between horses and humans can be seen in archaeological, artistic, and literary evidence. The focus of this chapter will be on equine skeletal remains, equipment, and horse-themed artwork in burials of the Late Bronze and Iron Ages, and of more scant burial remains from the Archaic and Classical periods. Because funerary ritual invites the family of the deceased to show the depth of their loss *and* assert the status of the deceased, grave goods and funerary monuments are crucial elements in understanding how status and cultural standing is shaped. As will be shown, horses were marked with a unique status very early and played an important role in asserting the social and military standing of the elite. Equine skeletal remains, funerary monuments, and grave goods connected to horses - bits, pottery, toys - marked the wealth, martial prowess, and standing of the deceased. In turn, we can also assume that special care, feed, and training, was given to horses.

The funeral in ancient Greece served several purposes. Grave goods were offered by the living to provide for the deceased in the afterlife. Elaborate funerals and luxurious grave goods also honoured the deceased and asserted their status through the ritual display of wealth in grave goods and on funerary markers. The higher the status of the individual and family, the greater the display of wealth amongst the community.³⁰ Grave goods associated with military equipment could include items such as swords, armour, or axes. Other indicators of wealth and status included jewelry and pottery. It could also include animal sacrifices for companionship and

³⁰ Morris 1989, 32. For further information on the relationship between the living and the dead, the necessary funerary rites to maintain social hierarchy and dominance, and the stages of mourning, see Morris 1989, 29-43.

feasting. Finally, wealth could be seen in the physical structures and grave monuments that housed and marked the graves of the deceased and their family members.

The graves of the elite often included horses, as they were the individuals who had enough wealth to acquire and maintain them. It is therefore significant when horses are found in burials as they were perhaps the most expensive animal to keep in ancient Greece.³¹ The sacrifice of horses during the funerary rites thus demonstrates the wealth of the family and the individual to the community. By associating the deceased with horses, either through the sacrifice of an animal and the offering of equestrian equipment, or through representation on pottery, funerary vessels, and grave markers, the family was declaring to the community that they were of an elevated status.

I. BRONZE AGE (3300-1150 BCE)

In the Bronze Age, horses were connected with the elites who owned and used them. Typically reserved for aristocratic men, horses were expensive to own, train, and maintain, and served little practical use for the majority of Greeks. The owner would need to have land to graze and feed horses, grooms to handle them, and the necessary equipment for their use, such as chariots, harnesses, bits, whips, and grooming tools.³² Horses were also used almost exclusively

³¹ Vermeule 1972, 299.

³² The cost of horse ownership and care can be seen in the representations of horses on Mycenaean pottery and frescos. The depictions of horses on terracotta kraters show decorated chariots, harnesses, bridles, and bits, and horses with well-groomed and embellished manes (Metropolitan Museum of Art, 74.51.964; Metropolitan Museum of Art, 74.51.966; British Museum, GR. 1911.4-28.1.) In addition to the expensive elements decorating the horses and equipment, the owners also needed to own or pay individuals to train and care for the horses. Frescos found in the Peloponnese depict horses being led and cared for by grooms and huntsmen (National Archaeological Museum Athens, 2915; National Archaeological Museum Athens 5878), and chariots were often occupied by a driver and an attendant (National Archaeological Museum Athens, 5882. Although, this fresco is unusual in that it depicts two females.) For additional information on horsemanship in the Bronze Age, see Vermeule 1972, 261-264. For a discussion on the frescos depicting horse care and chariotting, see Immerwahr 1990, 123-125.

for activities requiring speed, such as hunting, fighting, and competing in funerary games, activities which were in the realm of the elite.³³ Fighting with horses and chariots in the Bronze Age was reserved for the military aristocracy, as they were the only individuals trained to fight in chariots and who had the land to maintain them.³⁴ In contrast, other equids, such as mules and donkeys, were used for hard labour, carrying heavy loads, and farm work.³⁵

The special connection horses had with the elite can be seen in the tombs of the individuals who owned them. The remains of horses and their equipment have been found in Mycenaean tombs dating as early as the 16th-14th centuries BCE.³⁶ Horse skeletons have been found in the dromos or tholos of at least ten tombs across 13-14 sites.³⁷ The burials containing equine remains are predominantly in the Peloponnese, Central Greece, and Boeotia; the widespread inclusion of horses in burials indicates that it was a consistent funerary practice for elite Mycenaeans across mainland Greece in the Bronze Age.

The greatest concentration of horse remains found in burials of the elite can be found in the Peloponnese.³⁸ Currently, the oldest remains of a horse skeleton were found on Rhodes dating to LM IA (*ca.* 1600-1500 BCE), burials of horses increased on mainland Greece from LH

³³ Vermeule 1972, 205.

³⁴ Vermeule 1972, 261.

³⁵ MacKinnon 2021, 114. For burial remains of donkeys in the Bronze Age, see Pappi 2015, 475-476; Recht 2018, 65-94. The use of horses, mules, and donkeys is intricate as the animals themselves were associated and used to represent social hierarchy in literature and art, especially in the Archaic and Classical periods. See Griffith, M. "Horsepower and Donkeywork: Equids and the Ancient Greek Imagination", Part I, II. (2006).

³⁶ Pappi 2015, 476. The earliest known example of a horse buried near a human is from Rhodes, and dates to LM IA (*ca.* 1600-1500 BCE) (Pappi 2015, 476.) Horse sacrifices have been found on Crete but only at a few sites, from the LM II (*ca.* 1450-1350 BCE) and LM III A2-B period (*ca.* 1350-1200 BCE). Although Minoan and Mycenaean cultures intermingled, the sacrifice of horses on Crete derived from a different tradition than the tradition of mainland Greece and was only performed for very special occasions (Kosmetatou 1993, 34.) Given the difference in burial customs, the remainder of the burials discussed will be from mainland Greece as these customs would influence later inhabitants.

³⁷ Kontorli-Papadopoulou 1995, 120; Recht 2011, 103. For a comprehensive overview of all Bronze Age horse remains, see Pappi 2015, 476-477.

³⁸ Pappi 2015, 477.

II (*ca.* 1575 BCE) onward.³⁹ The earliest horses were found in pairs at Marathon and Dendra. Two complete horse skeletons were found in the dromos of a tholos tomb at Marathon, and are from LH IIB (*ca.* 1450-1350 BCE).⁴⁰ At Dendra two pairs of horse remains were found within tumuli B and C, and two additional pairs of horses were found near tumulus B, but not within discernible burial pits.⁴¹ The dating of the first two horse pairs (horses 1-4) was done contextually and were estimated to belong to the MH period (*ca.* 2025-1575 BCE), although this date is now considered too early.⁴² Recent isotope dating of the two horse pairs found outside of Tumulus B (horses 5-8) indicates that they were buried in LH IIIA-C (*ca.* 1431-1132 BCE).⁴³ Six of the eight horses have been examined by zooarchaeologists and were older male horses ranging in age from 13-15 years old, 15-17 years old, or older.⁴⁴ The horses are thought to have been sacrificed to accompany the chieftain as chariot horses in the afterlife, although no equipment has been found with the horses in the tumuli at Dendra or Marathon.⁴⁵ As harnesses were made of natural materials, such as leather, they would have decomposed over time. Even though the equipment was not found, the presence of horse remains shows that these animals were sufficiently important to be included in the burials of the elite as a final show of their wealth and status.

The remains of horses have been found in other locations across mainland Greece. The chamber tomb at Kokla contained the remains of four horses dating to LH III A2-III B1 (*ca.* 1350-1200 BCE), and the skull of a horse was found in a tholos tomb at Kallithea from LH I-

³⁹ Marketou 1998, 61; Pappi 2015, 476. Unless otherwise states, the conversion of dates from relative to chronological are taken from Dickinson 1994, 19.

⁴⁰ Vermeule 1972, 298-99; Pappi 2015, 476.

⁴¹ Protonotariou-Deilaki 1990, 94; Pappi 2015, 472, fig. 2.

⁴² Protonotariou-Deilaki 1990, 94; Pappi 2015, 470-471.

⁴³ Pappi 2015, 476. The chronological dates were supplied.

⁴⁴ Protonotariou-Deilaki 1990, 94; Pappi 2015, 474.

⁴⁵ Protonotariou-Deilaki 1990, 102. This view has recently been challenged, see Pappi 2015, 477-478.

IIIC (*ca.* 1550-1075 BCE).⁴⁶ The remains of horses were typically found as whole skeletons, and otherwise as skulls, which is common across the sites.⁴⁷ Horses were also found whole more often than with other domesticated animals, such as the dog.⁴⁸ Some skeletal fragments of horses have tool marks indicating that they were eaten, such as on the horse remains found at Lerna.⁴⁹ When found as whole skeletons, the presence of horses suggests an association with the elite military status of the deceased. This correlation can be seen with the horse remains found at Dendra, who “were military draft animals...yoked to the chariot of the chieftain whom they followed to the grave.”⁵⁰ The age of the horses found at Dendra also suggests that they were possibly sacrificed at the end of their useful life, indicating that the horses were trained and cared for extensively to reach a mature age prior to their sacrifice.⁵¹ The burial of whole horse remains with military elites was therefore a formulaic expression of wealth and warrior status in Mycenaean culture.

When horse remains were not present, the inclusion of associated equestrian equipment as a grave good could provide a similar symbol of social and military status. In addition to rich grave goods including pottery and jewelry, these types of burials also contained metal horse bits. In Mycenae, a bronze bit was found in chamber tomb 81, which is considered to be one of the richest chamber tombs in Mycenae.⁵² In addition to the bronze bit, the chamber tomb also had

⁴⁶ Hamilakis 1996, 162, Table 4; Pappi 2015, 477.

⁴⁷ Recht 2011, 103.

⁴⁸ Recht 2011, 103-104.

⁴⁹ Reese 2013, 455. The Lerna horse could also have been dumped, see Pappi 2015, 477.

⁵⁰ Protonotariu-Deilaki 1990, 102. The interpretation that the horses at Dendra were specifically sacrificed with the chieftain has been challenged, however, the association between the sacrifice of horses as a symbol of elitism within a hierarchical society in funerary rites is strengthened by the alternate interpretation offered by the author (Pappi 2015, 477-478.)

⁵¹ Pappi 2015, 478.

⁵² Steinmann 2020, 400.

richly adorned weapons marking the individual as a charioteer and elite member of society.⁵³ Given the expense of owning horses, it is not surprising that the only bit found at Mycenae is connected with the richest chamber tomb of the cemetery.

Whether from thieving or burial practices, finding metal bits is incredibly rare. However, two more metal bits were recently found in the chamber tomb of a Boeotian male in Orchomenos, Greece. The chamber tomb was found intact and dates to LHIII A-B (*ca.* 1370-1200 BCE). In addition to the metal bits, other grave goods were found indicating that the individual was “from the upper echelons of the local society,” according to the director of the site, Dr. Yannis Galanakis.⁵⁴ The presence of bits also indicates that investment was placed on the training and care of horses, as the individual would need to know how to correctly use and communicate with the horse through the bit.

It was possible to mark the individual as a member of the elite through the inclusion of horses and horse related equipment as charioteering itself was reserved for elite male warriors. They were the only members of society who were trained in horsemanship and participated in the related activities, such as fighting and hunting.⁵⁵ The presence of bits, chariots, and scenes of equine care on pottery and frescos indicate that these practices were sufficiently developed for horses to have been actively used up until their late teens in the Late Bronze Age. As the training

⁵³ Steinmann 2020, 401. The tomb is dated to LH II-III A1 (*ca.* 1425 BCE). The bit was difficult to trace, but the bronze bit discussed by C. Blegen is likely this same bit (Blegen 1952, 287.) Ancient bits were also constructed of natural materials, such as rope, leather, wood, and horn (Vermeule 1972, 299.)

⁵⁴ University of Cambridge, 2017. The information was found in published news source, an archaeological report was not found.

⁵⁵ Vermeule 1972, 261. Many scenes of charioteering can be seen on the chariot kraters dating to the Bronze Age which commonly show scenes of war, hunting, and funerary games. These kraters were generally found in tombs, but not always (Vermeule 1972, 204-206.) Images also included horse handlers, see Crouwel 1991, 65-68.

and use of horses was culturally and economically limited to the military elite, horses and the related equipment became emblems of wealth and status within the community.

The ritual inclusion of horses in the elite military burials in the Bronze Age, not only provides a symbol of status to the deceased, but it also shows that these animals were given special significance. In the absence of a horse, metal bits were used to signify the close connection the deceased had with horses. This tradition was a consistent practice which involved the ritual sacrifice of horses to accompany the elites in death.

II. IRON AGE (1150-750 BCE)

The tradition of elite warriors being buried with horses and horse equipment established in the Bronze Age continues into the Iron Age. On the island of Euboea, this can be seen in the Toumba at Lefkandi, a building repurposed into a funeral mound, and the surrounding cemetery where two horse burials containing iron bits were found. Two burials from the Athenian agora will be examined as they also indicate that horses were connected with the elite, although the treatment of horses in the burials of men and women was different.

LEFKANDI

The most notable burials containing horses from the Iron Age are those found at Lefkandi. Dating as early as 1000 BCE, the graves in the Toumba building and adjoining cemetery contain the remains of wealthy people as indicated by the grave goods. Not only do the grave goods show that trade connections existed with Athens and across the Mediterranean, but

weapons, jewelry, pottery, and ceramic statues have been found amongst the deceased.⁵⁶ The weapons, made from precious metals, such as iron and bronze, and the jewelry, made of gold and jewels, show that the deceased and their family were wealthy to afford these items.⁵⁷ The wealth and status of those buried at Lefkandi are also reflected in the quantity and location of the horse graves, as well as the number of horses found within them. In total, two horse graves were found, one in the Toumba structure and one in the adjoining cemetery.⁵⁸ Similar to the burial practices of the Bronze Age elites, the first grave containing four horses was found alongside a cremated warrior and the inhumation of his wife in the central room of the Toumba suggesting a bond between the warrior and horses. In most instances, horses from the Bronze and Iron Age were interred in pairs or individually, so a single grave containing four equipped horses is unique.⁵⁹ These horses were likely buried fully equipped as iron bits were found in the mouths of the two upper horses, although none of the other harnessing equipment remains as it would have been made of decomposable materials.⁶⁰ The sacrifice of the four horses and the traces of their equipment within a single grave shows not only the elevated status of the couple compared to

⁵⁶ Popham 1989, 123. One of these ceramic statues is an equine figurine believed to be a child's toy due to its design and burial context (Coldstream 2004, 2; Popham 1989, 120, fig. 16.) A similar toy was found amongst the bones of a child in an Attic grave dating to 650 BCE (Coldstream 2004, 2.)

⁵⁷ Images of the grave goods from the cemetery can be found throughout "Lefkandi III: The Toumba Cemetery: The excavations of 1981, 1984, 1986 and 1992-4: Plates", by M. Popham and I.S. Lemos (1996).

⁵⁸ For a site diagram of the cemetery and Toumba building burials, see Popham 1996, Plate 3, 4. Plate 3 shows the cemetery and the burial of the horse pair, located in grave t.68. The Toumba building, indicated as "Heroon" on Plate 3, can be seen in more detail on Plate 4, where the four horses were buried in the northernmost grave within the structure.

⁵⁹ Four horses were found in the chamber tomb at Kokla, although the burials of these horses seem to be an exception compared to the other Bronze Age remains. They are also distinct from the four horses found in the Toumba grave at Lefkandi, who were all found in a single grave. At Kokla, there were two male and two female horse skeletons, and they were found in different layers within the tomb (Pappi 2015, 477.) One male was found at the entrance of the tomb in the lower layer, and the other three horses were found as partial remains in the upper layer of the tomb (Pappi 2015, 477.)

⁶⁰ Popham 1993, 21.

those buried in the nearby cemetery, but it also indicates the military status of the cremated male who had his team of four chariot horses sacrificed alongside him.

Horses in the Iron Age were used by the military elite as transportation in battle and for hunting, similar to the activities of the equestrian elites in the Bronze Age. In the *Iliad* for instance, Achilles' horses (who were uniquely a team of three) were used for transporting Achilles between the camp and battlefield.⁶¹ In addition to his armour, he would have also had the equipment needed for his team of horses. Achilles is also not mentioned as having cared for his horses directly, and instead it was Patroklos who cared for them by anointing their manes with olive oil after washing them.⁶² Upon Patroklos' pyre, Achilles sacrificed four horses and Achilles' own horses are described as having wept for the loss of their caregiver.⁶³ Homer was likely describing the burial rites of the kings and leaders of the Bronze and Iron Age, as the burial of the four horses at Lefkandi predates the *Iliad*.⁶⁴ Patroklos' funerary passage does however provide insight into the roles and relationships of the elite male warrior with their horses, both in the care given as well as the correlation to burial practices.

In the cemetery located adjacent to the structure where the warrior, woman, and four horses were buried are the descendants of the couple from within the Toumba.⁶⁵ Amongst the

⁶¹ Homer. *Il.* 19.392-403. A detailed account of how the horses were used in battle can be taken from book 16, when Patroklos used Achilles' armour and horses in battle. Patroklos alternates between fighting from the chariot and fighting on foot (see especially, 16.394-428, 684-685, 733-734.) He was transported to battle in the chariot, but it is only Automedon (the driver) who is carried away from the skirmish with Hektor (16.218-220, 864-867.) By their own words in book 19, Achilles' immortal horses promise to return him safely to camp (19.400-403, 408.)

⁶² Homer. *Il.* 17.426-440, 23.280-282.

⁶³ Homer. *Il.* 23.171-172; Hom. *Il.* 23.283-284; Hom. *Il.* 17.426-440.

⁶⁴ Popham 1993, 22. The horse burials in Cyprus are also reminiscent of the Homeric epics as well as the Mycenaean traditions (Popham 1993, 22.) The horses of the 7th century BCE Cyprian burials were typically sacrificed in pairs along with their equipment, which uniquely contain traces of precious metals, like gold (Kosmetatou 1993, 34; Karageorghis 1965, 290.) Horses on Cyprus were also sacrificed for elite women which is another differentiating factor between the horse burials of Cyprus and Greece (Kosmetatou 1993, 34.)

⁶⁵ Popham 1989, 123.

graves in the cemetery, a burial containing a pair of horses was found near the human graves.⁶⁶ These horses, as well as those within the Toumba, date to no later than 950 BCE, and are the only examples of horse burials belonging to this period on mainland Greece.⁶⁷ Two iron bits were also found in the grave, but otherwise, it was empty.⁶⁸ The proximity of the horses to the human graves signifies the importance these horses had. Not only is the status of the individuals in the cemetery elevated, but the horses are honoured as well. A reciprocal relationship between the status of the human and the status of the horse is therefore fostered and created through these burial practices. While it may never be known to whom the horses in the cemetery belonged, it is evident that horses were important to display rank within the community.

ATHENS

Additional remains of horses and horse equipment dating to the Iron Age have been found in the Athenian agora. The two most important graves containing associations with horses from the Northern slope of the agora, are the Booties Grave and the Warrior Grave. They reveal the different manner horses were displayed in burials in relation to the gender of the deceased. Elite warriors were consistently marked out by their status as horse owners and riders.

The Booties Grave (Tomb 11), containing the remains of an adult female aged 20-25, was one of the richest burials of the area and dates to approximately 900 BCE.⁶⁹ She was buried with a wealth of grave goods including a pyxis with a horse on its lid and fragmentary pieces of an

⁶⁶ Popham 1989, fig. 1.

⁶⁷ Popham 1993, 22.

⁶⁸ Popham 1993, 22.

⁶⁹ Liston 2017, 531; Papadopoulos 2017, 77. Liston re-assessed the human remains from the previous assumption of the remains being a couple based on the presence of the ceramic boots amongst the grave goods.

equine skeleton.⁷⁰ The grave goods, along with the known wealth of the woman, show that there would have been socially acceptable correlations between horses and women, but in a limited capacity and different to those of men. This can be seen when examining the context of the fragmentary equid bones and the horse-lidded pyxis in particular.

While the full horse from the pyxis lid has not been recovered, the attachments for the tail, hind hooves, and left front hoof remain. It is the earliest of its kind.⁷¹ The pyxis was a common feminine grave good as it was used by women in life for their accessories and cosmetics, and elevates the status of the woman in the Booties Grave through the ornamentation of the horse. As a woman, she would have been restricted from participating in any activity relating to the external world and would most certainly not have ridden or driven a chariot, both of which were the purview of Greek men. The figurine on the pyxis lid would therefore have connected her with the status symbol of horses in a socially acceptable manner.

It would be easy, and perhaps desirable, to conclude that because of the pyxis lid, the fragmentary equid remains were deposited intentionally as a grave offering, but this is unlikely. The fragmentary remains of the equid included fragments of long bone types and a tibial tarsal bone, which is a bone from the hock joint of a hind leg, but an insufficient quantity of bone fragments was present to be considered as a funerary item.⁷² This conclusion is consistent with horses being reserved for male burials. Aside from the Booties Grave, equid bones were found in only one other grave in the agora, which also dates to the Early Iron Age, and it was “the burial

⁷⁰ Papadopoulos 2017, 77ff. For the specific references for the Pyxis vessel (T11-2), see Papadopoulos 2017, 86; and for the horse remains (T11-31), see Papadopoulos 2017, 83.

⁷¹ Papadopoulos 2017, 86.

⁷² Ruscillo 2017, 572, Table 4.2. There is controversy as to whether the remains were part of the initial burial as they are unburned unlike the rest of the animal bones present and could have instead been part of the backfill. It would, however, not be surprising to find unburned equid remains as horses were considered companion animals rather than a food source for ritual feasts (Ruscillo 2017, 561-562.)

of a cremated adult male.”⁷³ This shows that as with the Bronze Age, horses were buried with elite males in the Iron Age.

In another grave located within three meters of the Booties Grave, dating to the Early Geometric Period (*ca.* 850 BCE), is the Warrior Tomb (Tomb 13).⁷⁴ This burial contained the remains of a male aged 35-45, who was clearly a warrior as evidenced by the inclusion of a battle axe, two arrowheads, and a sword wrapped around the handle of the cremation urn in his grave.⁷⁵ Two metal snaffle bits were also amongst the grave goods connecting this individual to the wealth and status associated with horses, and possibly his utilization of horses in war.⁷⁶ An analysis of the remains also revealed that the man had herniated discs and an arthritic spine, injuries consistent with paleopathological markers on the bones of Scythian horsemen and modern horse-back riders.⁷⁷ The presence of horses in burials examined thus far was consistent with the typical function of horses for charioteering, but through this grave, it is evident that horses were being ridden as well.

The wealth and status displayed in the Booties Grave and the Warrior grave are significant, especially considering that both contained references to horses. Elite women were distantly associated with horses through figurines on feminine vessels, whereas males were directly correlated with horses through skeletal remains or equipment. The wear patterns on the male skeleton in the Warrior Grave, which also contained two bits, indicates that horses were associated with elite males that participated in all equestrian activities. Given the very limited roles of women, and their ideal locations being within the house, and that horses were used for

⁷³ Ruscillo 2017, 573.

⁷⁴ Papadopoulos 2017, 108.

⁷⁵ Papadopoulos 2017, 105-106.

⁷⁶ Papadopoulos 2017, 116. The snaffle bits are grave goods T13-15, T13-16.

⁷⁷ Liston 2017, 512, 533. For further information on the bones of the Scythian horsemen, see Wentz and De Grummond, 2009.

male pursuits, such as hunting and fighting, it is not surprising that the majority of archeological, artistic, and literary evidence correlates horses with men.⁷⁸

III. ARCHAIC PERIOD (750-480 BCE)

In the Archaic period, the association of horses with deceased members of the elite begins to shift to artistic representations. This could be owing to the shift in social structure that is experienced at this time, as funerary practices as a whole also change. The elite Athenians used the Dipylon kraters in the Late Geometric period (760-700 BCE) to show their wealth through the size of the vessels and the iconography of funerary rituals, which associated them with the elite burial traditions of the previous generations. Despite the overall shift in funerary practices, the few instances of horse remains in burials shows that they were still an honoured animal companion and symbol of wealth to the military elite.

Animals appeared on geometric pottery in 800 BCE and horses were amongst the first to be depicted.⁷⁹ By the mid 8th century, funerary scenes appear on Dipylon kraters portraying the *prothesis*, the laying of the body, and the *ekphora*, the funeral procession where the body is placed on a four-wheeled chariot pulled by horses. Below the central panels showing the *prothesis*, the bands typically show battles on land and sea, funerary chariot races, and chariot processions with shield bearers.⁸⁰ Other funerary motifs displayed on these vessels include

⁷⁸ There are instances where women are directly associated with horses. In burial practices, horses were sacrificed for elite women in Cyprian burials in the Archaic period (Kosmetatou 1993, 34.) In artistic representations, Amazons are commonly depicted riding horses on famous Amazonomachiai, such as the Temple of Apollo at Bassae, and the west metopes of the Parthenon. From literary sources, it is reported that Cyniska, the Spartan princess, bred horses and won the Olympic games in 396 BCE with her own team (Xen. *Ages*. 9.6; Paus. 3.8.1.) Amazons and Spartan women engaged in quintessential masculine activities, such as war and sport, so it is perhaps not surprising that they of all ancient women are associated with horses.

⁷⁹ Biers 1996, 123.

⁸⁰ Biers 1996, 123.

mourning women.⁸¹ These funerary vessels were predominantly used in Athens as grave markers.⁸² They also appear at a time in Attica when great regional diversity in burial practices occurs, and “a much more diverse structure of statuses emerges in [the] cemeteries” than the preceding years.⁸³ At a time when social structural changes were occurring, the reference to horses would provide a formula to indicate the deceased as a member of an upper aristocratic family.

Despite the changing social structures and the use of decorative funerary monuments, the practice of burying horses with humans continued into the Archaic period. There are two examples from two Athenian cemeteries, and a third horse burial is known through literary sources. The first burial of note is from the Kerameikos cemetery in Athens and dates to *ca.* 650 BCE.⁸⁴ The horse was found with 12 human graves in the largest mound of the cemetery. The second example of horse burials is from the Phaleron necropolis, located in the southern coastal land of Athens. Here, the remains of 18 equids were found in the human cemetery that dates to the Archaic and Classical periods, and 14 of the equids have been confirmed to be horses.⁸⁵ Of these horses, some were found to be strategically positioned in their grave as if they were in motion.⁸⁶ The horses were positioned with bent front legs, straight hind legs, and an outstretched tail.⁸⁷ This posture closely resembles the movement of horses leaping and galloping in art.

⁸¹ Biers 1996, 123.

⁸² Biers 1996, 123.

⁸³ Morris 1989, 128.

⁸⁴ Morris 1989, 129-132. The single horse was found in the Rundbau plot (grave Rb 9). The mound shows evidence of a second burial, and the circumstances of the horse are not precisely known.

⁸⁵ Dibble 2022b (Northwestern University). The burials were found through a Greek newspaper and interview with the head archaeologist, Stella Chrysoulaki (Zikakou 2016.) A more detailed archaeological report would provide more context to the burials and indicate whether the horses were buried in the Archaic or Classical period. Information is forthcoming, with Dr. Flint Dibble as the lead zooarchaeologist.

⁸⁶ Dibble 2022b (Northwestern University). The research on the Phaleron horse sacrifices is on-going.

⁸⁷ Dibble 2022a (Hippus Lecture Series).

The archaeological remains of horses found within human cemeteries corroborates the literary evidence of Cimon, a prominent aristocratic Athenian of the Philaid family, having been buried with his four three-time Olympic winning horses.⁸⁸ Upon his death in 528/7 BCE, the four mares were sacrificed and buried near him in the family's tombs in Athens.⁸⁹ These horses are potentially displayed in an Attic black-figure pyxis dating to *ca.* 540 BCE found in a grave in ancient Myrrhinous.⁹⁰ The pyxis shows a rare unharnessing scene of four horses, possibly mares, with the name of Cimon's son, Stesagoras, written upon it.⁹¹ Even though the grave of Cimon's horses has not been found, the recording of this burial and the close association of the horses with the family shows that they were important symbols for the family's reputation and status. It also shows that the practice of burying horses with elite members of society was a known practice, consistent since the Bronze Age.

IV. CLASSICAL PERIOD (480-323 BCE)

During the Classical period, the presence of horses in burial contexts indicated the wealth and social status of the deceased, and in particular, their association with the cavalry. This is evident on Athenian grave stele, where "even modest gravestones depicting the deceased with the animal imparted a message of high social rank."⁹² In accordance with the civic duties of the deceased, horses appeared on the grave stele of warriors, hunters, horsemen, and travelers.⁹³ While horses served purposes outside of a military context, such as for hunting and travelling,

⁸⁸ Hdt. *Hist.* 6.103.3; Plut. *Lives. Marcus Cato.* 5.4.

⁸⁹ Hdt. *Hist.* 6.103.3; Plut. *Lives. Marcus Cato.* 5.4. According to Herodotus, the mares (adult female horses) were buried opposite him on the "Through the Hollow" road.

⁹⁰ Brauron Museum, Mer.1591. The horses won their first Olympic victory in 536 BCE (Nicholson 2005, 38.)

⁹¹ Immerwahr 1972, 182.

⁹² Grossman 2013, 49.

⁹³ Grossman 2013, 41. For horses on the grave stele of travellers, see Grossman 2013, 107.

their association on grave stele are largely in relation to military activity. Within these contexts, it is also possible to determine the training and care the horse received. Given this paucity of actual horse burials, we can turn to funerary depictions of horses in the late classical period for evidence of care, and biomechanically sound motion and posture. I will discuss two depictions below as they are referenced throughout the thesis, and they reflect training passages found in Xenophon's manual.

Two examples showing the military association between the male warrior and their mounts include the Dexileos stele and the Horse and Groom relief. From the Kerameikos cemetery, the Dexileos stele shows a young man on a horse rearing over the body of a fallen man (fig. 3); it was commissioned for the deceased after his death in the Corinthian War in 394/3 BCE.⁹⁴ The horse's stance is reminiscent of a pose described by Xenophon where he explains how to get a horse to rear when ridden. Xenophon explains that this can be achieved by pulling the horse up with the bit when the hind legs are planted so that the hocks bend, and the belly and sheath become visible from the front.⁹⁵ This pose has been "retained in modern dressage" as the *levade* and *pesade*, which are considered to be some of the most advanced exercises a rider can ask of a horse.⁹⁶ The horse on the Dexileos stele has been attributed with being intentionally positioned in the *levade* or the *pesade*, which both require a high degree of engagement and

⁹⁴ Grossman 2013, 5. The inscription on the Dexileos stele emphasizes the age of the deceased as to possibly distinguish himself from the cavalry members who supported the thirty tyrants in 404/3 BCE (Bugh 2022.)

⁹⁵ Xen. *Eq.* 11.3.

⁹⁶ Mattusch 2017, 61; Kottas-Heldenberg 2014, 193. The *levade* and *pesade* are only performed in select schools across the world and are associated with the High School of Classical Dressage (Kottas-Heldenberg 2014, 193.) They are not movements required for competition, even at the Olympic level (Kottas-Heldenberg 2014, 193.) Arthur Kottas-Heldenberg, the author of the dressage book referenced, first joined the Spanish Riding School of Vienna in 1960, and became an Assistant Rider in 1964, a Rider in 1969, and a Chief Rider in 1981. He was the youngest to become First Chief Rider in 1995 until his retirement in 2002. I had the honour of having a lesson with him once on my own mare, Mattie, in 2016.

strength from the hind end.⁹⁷ Xenophon was aware that a horse needed a strong loin to stand on its hind legs, and that the horse needed to be able to extend its hind legs well underneath the body towards the forelegs.⁹⁸ A strong loin is required for collection and engagement of the hind end in all levels of riding, and is a critical component and indicator of biomechanical soundness.⁹⁹

Dating to *ca.* 320 BCE, the Horse and Groom relief depicts a young African groom holding the reins of a prancing horse that has only an animal skin on its back, emphasizing the absence of the horse's owner and rider (figure 4).¹⁰⁰ This stele was produced in the last years of sculptural grave monuments in Athens and concludes the representation of horses being used as status symbols on funerary markers.¹⁰¹ This horse, unlike the horse on the Dexileos stele, is shown with three of its four feet on the ground in a stance that more closely resembles a prancing horse, a pawing horse, or a horse transitioning between a walk and trot. While it is difficult to correlate the horse's pose with a specific gait, the horse is excited and in a forward motion while shifting its weight and center of gravity backwards. The horse expresses heightened energy through its bulging eyes, flared nostrils (indicated by the fullness of the nasal passages just above the damaged nostrils), bulging veins, and well-developed muscles. Even though the horse's pose is not as easy to define as the horse on the Dexileos stele, it is still possible to determine the

⁹⁷ Willekes 2022a; Mattusch 2017, 61; Kottas-Heldenberg 2014, 195-196.

⁹⁸ Xen. *Eq.* 11.2.

⁹⁹ Heuschmann 2009, 68. See especially the description for the croup muscles.

¹⁰⁰ Snowden 1976, 184. This stele is thought to contain Macedonian influences in its style and iconography, especially the horse resembling that of the horses on the Alexander sarcophagus (Palagia 2003, 148.) The author, Olga Palagia, also suggests that the stele was dedicated to Phokion by his family at public expense in 318 BCE (Palagia 2003, 150.)

¹⁰¹ Columnar monuments were used to mark burials in post-Classical Athens after 317/6 BCE (Grossman 2013, 14.)

biomechanical soundness of its overall posture and correlate its movement with passages in Xenophon's manual.

The type of care this horse is receiving can also be assessed. A closer look at the groom shows the handle of a long thin object in his right hand, which resembles the handle of a whip. Traces of an object painted red remain in his left hand, which could be either a lead rope or the reins, that the groom holds as he tries to control the spirited horse.¹⁰² The horse's open mouth and the small circular groove in the corner of the horse's lips indicates that the horse was possibly bitted. The horse's tongue is also curled as if it is making room for an object between its lower and upper jaw. The position of the groom's hands resembles a scene familiar to many horse handlers, where one hand is connected to the horse's head through the reins while the other hand holds a whip.¹⁰³ The left hand restrains the horse through the reins or lead, while the right hand lifts the whip as if to discipline the horse. In reality, the lifted whip would only cause the horse greater fear and concern, resulting in a more excited horse. Remarkably, this is the type of training that Xenophon recommends against in his manual.¹⁰⁴

Although more grave stelai depicting horses exist than the Dexileos stele and the Horse and Groom relief, these monuments show that horses were used throughout the Classical period to show the elite status of the deceased and their role in the military as cavalry members. The stance of the rearing horse on the Dexileos stele and the excited pose of the horse on the Horse and Groom relief are examples of two different ways in which the depiction of the strength and

¹⁰² Snowden 1976, 184.

¹⁰³ This is typical when lunging or training a horse. This hand positioning can also be seen on a Late Geometric Argive krater (750-730 BCE, Archaeological Museum of Argos, C.240); and on an Attic black-figured aryballos (ca. 500 BCE, Metropolitan Museum of Art, 62.11.11.) For more images of humans handling a horse with a lead or reins in one hand and a thin reed that could serve as a whip in the other, see British Museum, 1900.6-11.1; Museum of Fine Arts, Boston, 95.29.

¹⁰⁴ For example, Xenophon recommends that the groom should calm an excited horse when in public. (Xen. *Eq.* 2.5.)

motion of the horse were given priority over a biomechanically sound stance. In the manual, it is the biomechanically sound training and riding that was focused upon, something that was very different than the art. It is also possible to discern the investment made in the care and training of these horses as shown by the ability to ride the horse in battle and through the restraint of the horse by the groom. These scenes both correspond to Xenophon's manual on training, riding, and caring for horses, as will be shown in later chapters.

CONCLUSION

From the sixteenth century BCE, horses were used to show the elite status of the deceased and their family in mainland Greece. In the Bronze Age, this is most evident in the tholos and chamber tombs of Dendra and Marathon, where some of the oldest horse remains have been found. When horses were not sacrificed, bronze bits were used to indicate the deceased's status by associating them with war horses. The tradition of burying horses with elite members of society continues into the Iron Age and can be seen most especially at Lefkandi. Here, a grave containing four horses was found in the Toumba structure buried near a warrior and his female companion indicating the close connection they had with the deceased. Another grave in the adjoining cemetery contained the remains of two bitted horses, further identifying this area as one of prominent military and social status. The two upper horses from the Toumba grave also had bits in their mouths suggesting that these animals were sacrificed with their equipment, a rare and significant display of wealth on the mainland. The investment made in the training and care of horses is reflected in the grave goods accompanying the humans and horses.

In Iron Age Athens, the sacrifice of horses and their equipment was reserved for the burials of men. Elite women were also associated with horses, although this was accomplished through decorations on pottery. Horses continued to be buried with humans into the archaic and

classical periods as evidenced by the Phaleron horse sacrifices, where some horses were displayed as if in motion. Funerary vessels continued to be the predominant method of displaying wealth and social status, as well as showing the association horses had with the deceased in funerary motifs.

In the Classical period, status and prestige were displayed through the simple presence of a horse on grave stele. While the predominant association with horses was through their function, grave stelai depicted particular moments of training and riding. It also showed the investment the individual had made in the development of their horse. The horse on the Dexileos grave stele showed a moment in the horse's riding career within a military context. On the Horse and Groom Relief, a groom used a lead and whip to control a well-muscled stallion. The training and riding scenes presented on the grave stelai correspond with Xenophon's manual, which will be explored in greater detail in Chapter Two.

CHAPTER TWO: CARE AND MANAGEMENT OF THE ANCIENT GREEK HORSE

The connection drawn between the elite and horses in ancient Greek funerary evidence showed the high value of horses. The burial evidence also hinted at substantial training, as indicated by the inclusion of bits, whips, harnesses, grooms, and scenes of equine use on funerary markers, suggesting significant care and training was undertaken with the employment of horses in elite culture. The importance of equine care can be seen through literary and visual evidence indicating the roles and responsibilities of the equine caregivers, as well as the quality of care provided. These elements of care, which are integral to the health of the horse, include grooming, feeding, and training, resemble modern day practices. Xenophon's recommendations also reveal forethought in the management of horses and speak to a preventative care mindset in the training of horses. This is visible in the grammar and syntax of his manual as well.¹⁰⁵ The ability for these care tasks to be executed can be seen in the longevity of select horses, of which a few examples exist. Whether the horse was used for athletic or military pursuits, such as hunting, racing, and cavalry service in parade or war, the consideration for the care of horses can be seen across Greek horsemanship. Ultimately, the investment of time and money in the care, utilization, and development of a training rationale warrants an examination of sound and unsound biomechanical health in horses.

¹⁰⁵ Please note that a single word or phrase, given as a dictionary gloss, will keep the form that is used in the ancient passage rather than adhering to academic conventions of providing nominative or first-person singular forms. This is done in order to ensure that those who do not read ancient Greek can locate the word in the Ancient Greek passages given and follow it into the English translation. In the appendices, the academic conventions of dictionary entries are followed.

I. PROVISION OF CARE

In the manual, *The Art of Horsemanship*, Xenophon details a grooming process that is remarkably similar to modern practices. Grooming is integral to the health of the horse as it not only allows the caregiver to check the horse for injuries, but it also prevents sores from developing under equipment.¹⁰⁶ Grooming also helps condition the horse's coat and improves circulation.¹⁰⁷ Caution must be taken when brushing, however, as the horse's skin is embedded with various levels of nerves, muscle, and blood and lymph vessels, making it incredibly sensitive.¹⁰⁸ Xenophon express awareness for the sensitivity of the horse in his grooming recommendations.

The most significant aspect that Xenophon addresses is the care that is to be taken when brushing over the bony areas of the horse, which include the head, spine, and legs.¹⁰⁹ These are sensitive areas for the horse as the bone lies just beneath the surface of the skin and can be easily injured. The spine and legs received different treatment than the horse's head, which is also indicative of familiarity and care of the horse, as the horse's head is one of the most sensitive areas to touch and handle. Xenophon recommended rubbing down the spine and legs with hands, and cleaning the horse's head with water.¹¹⁰ His reasoning, which reflects sound judgment and a means of preventing injury and agitation to the horse, was that in all instances, the bony areas of the horse were not injured by the grooming instruments.¹¹¹ To reduce injury, Xenophon explains that the tools were only to be used on the fleshy parts of the horse, such as those areas covered

¹⁰⁶ Harris 1994, 168.

¹⁰⁷ Harris 1994, 168.

¹⁰⁸ Green 2006, 3; Kainer 1998, Plate 5.

¹⁰⁹ Xen. *Eq.* 5. 5-6.

¹¹⁰ Xen. *Eq.* 5. 5-6, 10.

¹¹¹ Xen. *Eq.* 5. 5-6.

by muscle and fat.¹¹² Xenophon's recommendations show familiarity with the anatomy and physiology of the horse and the horse's skeletal system. Such an awareness is developed when interacting with a horse and shows Xenophon's long exposure to the care and training of horses, but also that he inherits a long tradition of knowledge through practice.

Depictions of horses being brushed in the manner Xenophon describes can be seen on Attic black and red-figured pottery, which predate the manual by approximately 150 years.¹¹³ The few depictions of grooming scenes that remain are typically set in stables as indicated by decorations of columns and other motifs.¹¹⁴ The horses are all shown tied to a wall or column, and the grooms, holding grooming instruments, stand beside them. On an unattributed Attic black-figure cup dating to *ca.* 520-500 BCE, two grooms are each caring for a horse in a stable (figure 6). The groom on the right is brushing his horse's flank, and unique to this piece, the groom on the left is cleaning that horse's left, front hoof.¹¹⁵ Another grooming scene on an Attic red-figured cup dating to *ca.* 490 BCE, shows an African groom blowing the collected hair and dust off a brush during the horse's daily cleaning (figure 7).¹¹⁶ These scenes bear a striking similarity to Xenophon's recommendations on how to groom a horse, as neither groom is using the brush on the horse's bony areas and resemble modern practices for a well-cared for horse. Xenophon provides additional details on how to groom a horse as part of its daily regimen, which will be discussed in further detail later in this Chapter.

¹¹² Xen. *Eq.* 5. 5-6.

¹¹³ Xenophon wrote the *Art of Horsemanship* between 365-360 BCE (Stoll 2012, 251.)

¹¹⁴ Moore 2004, 51. For more information on the representation of stables in Archaic and Classical pottery, see Moore 2004, 37-42.

¹¹⁵ The flank is the area between the ribs and the hip on the side of the horse, see figure 5.

¹¹⁶ Metropolitan Museum of Art, 1989.281.71. See also Moore 2004, 52, fig. 32.

The provision of such diligent horse care can also be seen on a black-figured hydria attributed to the Antimenes Painter from *ca.* 520 BCE (figure 8).¹¹⁷ The panel can be divided into three parts, with a horse and groom on both the left and right side of the panel. The horse on the left is calmly held by the groom, and the horse on the right is being brushed while tied to a column. In the center are two men, a youth newly returned from hunting who is standing and gesturing to the older, bearded man who may be his father. The bearded man is seated on a campstool in the middle of the stable, which is richly decorated.¹¹⁸ This scene “probably belongs to the realm of daily life.”¹¹⁹ Is the man seated in the middle of the stable the aristocratic horse owner overseeing the care and management of his horses? Such an interpretation would be consistent with Xenophon’s note that it was an important aspect of horsemanship to know not only how to care for a horse, but also to instruct the groom on how to do so as well.

At the beginning of the section on grooming Xenophon writes, *[ἰ]ππικοῦ δὲ ἀνδρὸς ἡμῶν δοκεῖ εἶναι καὶ τὸν ἵπποκόμον πεπαιδεῦσθαι ἃ δεῖ περὶ τὸν ἵππον πράττειν.*¹²⁰ E.C Marchant translates this, “[it] is a mark of a good horseman, in our opinion, to see that his groom, like himself, is instructed in the way in which he should treat the horse.”¹²¹ A second translation by M. Morgan omits the explicit expectation that the horseman should be knowledgeable in the proper way to treat the horse, but it is perhaps implied through context as the horseman would presumably not be able to instruct the groom without being knowledgeable himself. Morgan translates Xenophon’s recommendation to be, “[it] is also a horseman’s duty, I think, to see that his groom is taught the proper way to treat the horse.”¹²² Both translations provide sufficient

¹¹⁷ Additional grooming scenes can be found in Moore 2004, 50-52.

¹¹⁸ Moore 2004, 40.

¹¹⁹ Moore 2004, 40.

¹²⁰ Xen. *Eq.* 5.1.

¹²¹ Xen. *Eq.* 5.1. All translations are by E.C. Marchant (1968), unless otherwise stated.

¹²² Morgan 1962, 30.

understanding of the Greek for any individual, with the first translation by E.C. Marchant being preferred for the clarity it provides in the expectation of the horseman as well.

Xenophon's Greek text, however, is far more nuanced in its meaning than can be understood through the translations alone. The sentence "*ἵππικοῦ δὲ ἀνδρὸς ἡμῶν δοκεῖ εἶναι καὶ τὸν ἵπποκόμον πεπαιδεῦσθαι ᾧ δεῖ περὶ τὸν ἵππον πράττειν*" can be divided into two clauses for a closer interpretation. In the first clause (*ἵππικοῦ δὲ ἀνδρὸς ἡμῶν δοκεῖ εἶναι καὶ τὸν ἵπποκόμον πεπαιδεῦσθαι*), the use of the impersonal verb *δοκεῖ* suggests that Xenophon recommended (*δοκεῖ*) a horseman to be knowledgeable on horses (*ἵππικοῦ*) and to train, teach, or educate (*πεπαιδεῦσθαι*) the groom (*ἵπποκόμον*). By using the plural *ἡμῶν*, the audience is also more fully drawn into the sphere of expertise expressed by him, the expert, and potentially with the experts who came before him (such as Simon of Athens who Xenophon references in the opening of his manual). A further examination of *δοκεῖ* reveals that the verb can also mean to think, imagine, and suppose; to think to do, or propose to do; and lastly, to be an established, current opinion.¹²³ It is clear from the use of *δοκεῖ* that it was expected and recommended that horsemen should know how to care for their horse and perhaps more importantly, be able to instruct (*πεπαιδεῦσθαι*) the groom as well.

The standard of horse care is perhaps most visible through the second clause of the phrase introducing the section on grooming. Introduced by a relative pronoun (*ᾧ*), the second clause states that the instructions must be on the proper way to treat the horse (*...ᾧ δεῖ περὶ τὸν ἵππον πράττειν*).¹²⁴ Governed by the impersonal verb *δεῖ*, the second clause has a much stronger sense of necessity than the first. The possible translations of the verb include: to be in want or need; require, or stand in need of, with a genitive; and lastly, to imply that one must do

¹²³ LSJ 1996, 441. I.

¹²⁴ Morgan 1962, 30.

something.¹²⁵ The strong sense of mandatory action suggests that the way the horse was treated (*πράττειν*) was standardized and fixed. The weaker, first impersonal verb, *δοκεῖ* suggests that it was a good idea for the horseman to be knowledgeable and instruct his groom, where the stronger sense of the second impersonal verb, *δεῖ*, provides a sense of necessity or obligation in the manner in which the horse is trained and maintained. This shows that the individual caring for the horse was less important than the horse receiving proper care.

In the second clause, the horse is the recipient of the action and the object of concern in the sentence. The typical translations of the second clause, *ἃ δεῖ περὶ τὸν ἵππον πράττειν*, translates the infinitive, *πράττειν*, as “to treat”, rendering the translation: “the proper way to treat the horse.” The verb *πράττειν*, however, has far greater implications than the typical translation provides. In English, the verb “to treat” typically implies a method of conduct and does not distinguish the quality of treatment, whether that be fair or abusive. The verb *πράττειν* can also mean: to accomplish (in relation to a journey); to achieve, bring about, or accomplish; and, more generally, to transact, negotiate, or manage.¹²⁶ It can also mean: to make; to have to do, or be busy with; to practice; and to “do something to one.”¹²⁷ Any individual familiar with training and caring for horses would appreciate the distinction these definitions of *πράττειν* provide, as it incorporates the planning and negotiating that is required when training an animal. The verb also provides the sense of negotiation that can come from working with a living animal with a mind of its own. The Greek meaning of *πράττειν* therefore provides a sense that is far more long term in its implication and speaks to achieving an overarching goal, rather than conduct which is

¹²⁵ LSJ 1996, 383, B. II. 1. a, b.

¹²⁶ LSJ 1996, 1460, III.1, 5, 6.

¹²⁷ LSJ 1996, 1460. III.4, IV, V.

implied with the English verb “to treat.” A better translation of *πράττειν* is perhaps “to train” as it encompasses the management, treatment, and objective of reaching a goal over time.

A possible translation of the sentence that introduces the section on grooming and stable management in Xenophon’s manual, which emphasizes the nuance of the impersonal verbs and incorporates equine training principles, is: *it is a good idea, in our opinion, that a horseman is to teach the groom, like himself, on the necessary way to train the horse.* A close reading of the sentence, *ἵππικοῦ δὲ ἀνδρὸς ἡμῶν δοκεῖ εἶναι καὶ τὸν ἵπποκόμον πεπαιδευκένας ἃ δεῖ περὶ τὸν ἵππον πράττειν*, therefore shows that the need to train the horse properly was a stronger objective than the person who did it, whether that was the horseman (*ἀνδρὸς ἵππικοῦ*) or the groom (*τὸν ἵπποκόμον*), as indicated by the impersonal verbs.

There are many instances in Xenophon’s manual where he recommends the horse-owner have the groom perform the duties of equine care and stable management. Most of the daily care, maintenance, and early handling of horses was performed by the enslaved grooms at home, while the initial training of the horse for riding was done by an employed, off-property horse-breaker.¹²⁸ The elite horseman was responsible for overseeing the correct completion of the care and training done by others, while they focused on their ability to ride and duties to the state.¹²⁹ Similarities exist between these ancient care practices and the management of modern horses providing a foundation for the evaluation of biomechanically sound training principles in Chapter Three, as they are found in Xenophon’s manual. The following section of this chapter examines the preventative manner in which horses were cared for, as well as the effects of this care through the longevity of horses in antiquity. The focus is on sustained care and practice, an important element of biomechanically sound training. Although Xenophon does not use these

¹²⁸ Xen. *Eq.* 2. 2-5.

¹²⁹ Xen. *Eq.* 2. 1.

terms, his manual consistently demonstrates that he acknowledges long-term goals, and consistent long-lasting practices.

II. ASPECTS OF CARE

Having examined the roles and responsibility for the caretakers of the horse, the owner, the horse-breaker, and the groom, additional modes of caring for the horse will show the extent to which ancient practices were developed to support the prolonged well-being of the horse. Xenophon's manual provides an overview of the daily regimen that should be enacted to provide ideal care for the horse, and includes elements such as grooming, feeding, stable orientation and maintenance, and training. The following section of this chapter examines the preventative manner in which horses were cared for as well as the effects of this care through the longevity of horses in antiquity. The focus is on sustained care and practice, an important element of biomechanical soundness training. Although Xenophon does not use these terms, his manual consistently demonstrates that he acknowledges long-term goals, and consistent, long-lasting practices.

GROOMING

In *The Art of Horsemanship*, Xenophon outlines a specific daily routine to care for the horses, as well as recommendations to help prevent diseases and illness in the horse. As part of the horse's daily routine, Xenophon recommends that the horse should be brushed, fed twice daily, and released from the manger between meals.¹³⁰ These tasks, largely performed by the groom, are detailed in their instruction and would be sufficient to educate someone unfamiliar

¹³⁰ Xen. *Eq.* 4.4.

with horsemanship to care for their horse in a preventative manner. These practices are consistent with modern treatment and maintenance of stabled horses.¹³¹

Grooming is an important part of caring for a horse and serves many purposes. It cleans the horse's coat so that they look shiny, healthy, and beautiful, and it helps them feel more comfortable.¹³² It also helps to condition the skin and promotes circulation of the blood.¹³³ Perhaps most important, it provides the human with the opportunity to look closely over the horse for any injuries or skin problems, and it prevents dirt from building up and creating sores underneath equipment.¹³⁴ While a free-roaming horse may roll to provide some of these benefits for itself, stabled horses require daily grooming from their human caregivers, and this is something Xenophon recommends.¹³⁵

Brushes then, as now, were first used to raise the hairs of the horse's coat to dislodge dust and dirt, and then were used to remove the dust and dirt by brushing the hairs flat again.¹³⁶ In addition to ensuring that the bony areas of the horse were not injured by grooming instruments, which were often made of iron or wood, Xenophon describes the best way to groom the horse so that it is both clean and the discomfort to the horse is minimized.¹³⁷ He recommends,

¹³¹ Henschel 1985, 184-185.

¹³² Harris 1994, 168.

¹³³ Harris 1994, 168.

¹³⁴ Harris 1994, 168.

¹³⁵ Xen. *Eq.* 4.4; Henschel 1977, 185.

¹³⁶ Xen. *Eq.* 5.5. For an English translation of the names and function of ancient horse brushes listed by Pollux (1.185), see Morgan 1979, 133, n27. For information on modern brushes and grooming practices, see Harris 1994, 168-174. The methods described are more elaborate than those provided by Xenophon, but they are similar.

¹³⁷ Xen. *Eq.* 5. 5-6. Xenophon's grooming recommendations are similar to modern practices, with the exception that they are more conservative in their care owing likely to the harder grooming instruments used in antiquity. Modern brushes come in a variety of shapes, sizes, and materials, such that softly bristled brushes are specifically designed for use on the bony parts of the horse. This is done to reduce injury and agitation to these sensitive areas of the body, including the head, spine, and limbs below the knee and hock.

καὶ τὴν ὑπὸ γαστέρα δὲ ἄγαν κάθαρσιν μειοῦν χρή· αὕτη γὰρ λυπεῖ μὲν
μάλιστα τὸν ἵππον, ὅσῳ δ' ἂν καθαρώτερα ταῦτα γένηται, τοσούτῳ πλείονα τὰ
λυποῦντα ἀθροίζει ὑπὸ τὴν γαστέρα· ἦν δὲ καὶ πάνυ διαπονήσῃται τις ταῦτα,
οὐ φθάνει τε ἐξαγόμενος ὁ ἵππος καὶ εὐθὺς ὁμοίως ἐστὶ τοῖς ἀκαθάρτοις.
[Xen. *Eq.* 5. 9-10.]

Excessive cleaning under the belly also should be diminished; for this worries the horse very much, and the cleaner these parts are, the more they collect under the belly things offensive to it; and notwithstanding all the pains that may be taken with these parts, the horse is no sooner led out than he looks much the same as an unwashed animal.

His grooming instructions are practical in that he recognizes that certain parts of the horse will immediately become dirty again when exposed to nature, but he also recognizes that some horses find it uncomfortable being brushed under the belly. He optimizes the care of horses by recommending that dirt be left on this sensitive area of the horse which is prone to being bitten by insects. Not having access to fly sprays, Xenophon uses what was available to him to keep the horse as comfortable as possible. By recommending which areas should and should not be brushed, and the reasoning behind these recommendations, Xenophon instructs his readers on how to care for a horse in a manner that is conducive to the well-being of the horse.

He also describes handling techniques that aim to prevent injury to the horse. In addition to recommending that grooming tools not be used on the bony areas of the horse lest they cause injury, Xenophon also provides information on the best practice to tie a horse's halter and on how to tie the horse to be groomed. According to him, a horse's halter should be knotted loosely about the ears to prevent sores from developing as a consequence of the horse rubbing its head against the manger.¹³⁸ This is also to decrease any chance that the horse should feel discomfort

¹³⁸ Xen. *Eq.* 5. 1.

when bridled as the halter and bridle sit on the same part of the horse's head (the poll), which can be an especially sensitive area.

In many regards, Xenophon's grooming recommendations serve as practical tips to prevent injury to the horse's body and to work with the nature of the horse. This can be seen in his recommendation on how a horse should be tied so that it may be groomed, he writes:

Καὶ μὴν δεσμεύειν τὸν ἵππον ἄνωθεν τῆς κεφαλῆς δεῖ. πάντα γὰρ ὅποσα ἂν δύσκολ' ἦ περι τὸ πρόσωπον ὁ ἵππος ἐκνεύειν πέφυκεν ἄνω. ἐκνεύων γε μὴν οὕτω δεδεμένος χαλᾷ μᾶλλον ἢ διασπᾷ τὰ δεσμά.

[Xen. Eq. 5. 4]

He should tie up the horse at a place above the head, because when anything irritates his face, the horse instinctively tries to get rid of it by tossing his head upwards; and if he is tied thus he loosens the halter instead of breaking it by tossing up his head.

Tying a horse above the head would prevent the lead and halter (*τὰ δεσμά*) from breaking and it would also prevent injury to the top of the horse's head if the horse would panic. This can occur quite often depending on the surrounding circumstances, such as insects bothering the horse, the horse's sensitivity to being groomed, environmental stimulants, and whether the horse has been trained to tie. While Xenophon emphasizes his concern for the equipment breaking, he also mentions that, when irritated, a horse tosses its head upwards (*ὁ ἵππος ἐκνεύειν πέφυκεν ἄνω*).¹³⁹ His reasoning would not only prevent the equipment from breaking if the horse were to pull on the lead, but it would also prevent injury to the horse and human.¹⁴⁰ In most instances,

¹³⁹ Xen. Eq. 5. 4.

¹⁴⁰ Anderson 2020.

horses tend to pull against pressure, so following Xenophon's recommendations would reduce harm to the horse as the horse would not meet resistance in its attempt to momentarily flee.¹⁴¹

The importance of properly tying a horse can best be relayed through this quote from a modern, prominent horse trainer, Clinton Anderson. In an online horsemanship article, he wrote: "Horses that won't tie are a pain. At the slightest provocation, they [will] pull back, struggling violently against the pressure the halter exerts on their polls. In the worst case, they can injure themselves or their handlers. In the least, they ruin good equipment."¹⁴² This issue is a considerable problem for anyone handling horses. They are tied to groom and tack-up, and a horse's ability to stand while tied drastically impacts the relationship one has with the horse and its ability to perform. If a horse cannot tie to be prepared for use, whether that is riding or driving, now or 2500 years ago, the horse is either deemed behaviorally unsound and abandoned, or much time is spent to re-train it. In ancient Greece, it is likely that more stringent measures would be taken to control the horse, or the horse would be removed from use.

As noted in an equine behavior book, the tendency for the horse to pull against the tie can be even more dangerous when multiple horses are tied near each other as "a wave of socially facilitated hysteria crashes over them" if one horse panics, the others follow suit.¹⁴³ There are other management and tying techniques which can correct the behavior of pulling when tied, but Xenophon exhibits forethought in preventing these ill-effects by recommending that the horse be tied above its head so that the pressure of the lead is reduced as the horse moves its head in a motion that is natural in its initial moment of resistance.

¹⁴¹ McGreevy 2012, 310-311. For an image of a horse injured due to an improper tying technique, see McGreevy 2012, 311, fig. 14.3.

¹⁴² Anderson 2020.

¹⁴³ McGreevy 2012, 311.

In contrast to this extreme tied position, the horse on an Attic red-figured cup dating to 520-510 BCE is tied at the height of its withers with a rope that is long enough to allow the horse to turn its head and watch the youth working at its back.¹⁴⁴ According to modern best practices, this is the ideal height of the lead to be tied as it allows the horse to hold its head in a neutral position, and “normal head movement can be maximized within the limits set by the length of the rope.”¹⁴⁵ The neutral position and normal head movement does not cause over-development or exertion of the muscles as when the head is tied tightly in an upward position, as is seen with the horses being groomed on the unattributed black-figured cup (figure 6) and the horse being groomed on the right side of the black-figured hydria attributed to the Antimenes painter (figure 8).

Images of horses tied also exist on funerary kraters, though these scenes are not as complex as those represented on black and red-figure pottery of the 6th century BCE. The scenes on geometric pottery, dating to the 7th and 8th centuries BCE, show only a horse tied to a tripod at a level below the horse’s head and nose. The lead is represented by a thick line that connects the horse’s nose to either a manger or a tripod and is shown as a curved or wavy line. While the wave in the lead could be for stylistic purposes, it could also represent that a longer length of lead was used in the 8th century BCE which would afford the horse a greater ability to move its head, neck, and body to relax and alter its stance. This would help reduce muscle fatigue as the horse would not be required to hold its body in an unnaturally, high-headed position for any

¹⁴⁴ Moore 2004, fig. 31. Tondo, Museo Archeologico Regionale “Paolo Orsi,” Syracuse. The description states that the youth is grooming the horse, although it is possible the horse is being massaged. Although there is no documentation that horses were massaged in ancient Greece, the Roman author, Columella (2nd cent. CE), describes how to massage a horse’s back. He writes, “The bodies of horses require a daily rubbing down just as much as those of human beings, and often to massage a horse’s back with the pressure of the hand does more good than if you were to provide it most generously with food” (Columella. *Rust.* 6.30.1.)

¹⁴⁵ McGreevy 2012, 311.

length of time. According to modern sources and horsemanship practices, an experienced groom can spend up to three-quarters of an hour to clean a horse.¹⁴⁶ The length of time the horse would have to hold the position to be groomed is substantially long, as most modern horses are ridden for that amount of time as well.

A closer reading of Xenophon's recommendation reveals that he did not suggest the horse to be tied tightly, only that the rope should be tied above the level of the head so that the equipment would not break if the horse tossed its head upward. From this example of how a horse should be tied to be groomed and prepared for use, it is clear there was a discrepancy between Xenophon's recommendations and what was practiced. Xenophon's solution focuses on the preservation of the equipment, while preserving the safety of the horse and human. His recommendation seeks to prevent the horse from harming itself by reducing the opportunity for injury, as a horse can panic even more when it meets resistance mid-flight. Although Xenophon's practical solution may not meet the standard of current best practices, tying the lead above the horse's head would prevent the equipment from breaking should the horse toss its head upwards, as well as prevent unnecessary injury to the horse's poll.

FEEDING AND STABLE MANAGEMENT

The Athenians did not have access to large pasture lands like the Spartans and Thessalians did, but they were able to keep their individual horses on their private lots and supplemented their feeding with purchased grain rather than pastureland of alfalfa.¹⁴⁷ With the

¹⁴⁶ Hadfield 1989, 127.

¹⁴⁷ Howe 2008, 57. Horses raised and pastured in Messenia and Thessaly could have been grazed on alfalfa up until they were removed from the pastureland for training or sold to other regions in Greece, based on the evidence that individuals from across Greece purchased horses from Thessaly, and possibly from the Spartans as well (Howe 2008, 66-67, 70-71.)

daily subsidy for grain provided by the state for active cavalry members to feed their horses in 4th century BCE Athens, the horsemen were able to feed their horses to ensure they were healthy and able to perform as needed.¹⁴⁸ Regardless of the quantity of drachmas supplied, it is evident that the Athenians provided their horses with grain.

The types of grains used to feed the horses according to ancient sources could be varied. While Aristotle provides clear directions that horses should be fed alfalfa as it makes them strong and sleek, Xenophon specifies only that the horses should be given grain and focuses the majority of his recommendations on providing a specific feeding regimen to ensure that horses were well fed.¹⁴⁹ The horse, according to Xenophon, should be fed breakfast (*τὸ ἄριστον*) in the morning and given dinner (*τὸ δεῖπνον*) in the evening.¹⁵⁰ Between meals, the horse should be let free from the manger (*μεταδετέον... ἀπὸ τῆς φάτνης*) so that the horse may return to its evening feed with a greater appetite.¹⁵¹ The regimen suggests that the feeds were essential in supplementing the horses diet as there would be minimal grasses for the horse to eat during its daily turnout.

This is consistent with the need for a grain subsidy in 4th century BCE Athens, enabling the expansion of the cavalry within the pasture-poor environment of the polis. The active cavalry members “were required to maintain their horses on their own land,” and the grain supplement

¹⁴⁸ Howe 2008, 64; Spence 1993, 272. For the cost of cavalry service in classical Athens, see Spence 1993, 272-286. The *katastasis*, a subsidy, included the cost of the horse up to 1,200 drachmas, which would have been the cost of an expensive racehorse and the equivalent of four years of standard labour (Bugh 1988, 57.)

¹⁴⁹ Ars. *Hist.An.*596b.23-29; Xen. *Eq.* 4.1-2, 4.4. The word used by Xenophon to describe the feed, *σίτον*, can be used to imply food made from corn for humans, but also comprehends corn, barley, wheat, rice-wheat, and lentils (LSJ 1996, 1602.) It is also used to mean fodder for animals, although rarely, and is the same term used for the allowance that was provided to the Athenian cavalry in the 4th century BCE (LSJ 1996, 1602, II.3.)

¹⁵⁰ Xen. *Eq.* 4.4.

¹⁵¹ Xen. *Eq.* 4.4.

allowed them to do so while maintaining a healthy horse.¹⁵² This was such an important aspect of horse care that Xenophon recommended situating the stall so that the grain could not be stolen from the manger.¹⁵³ The feeding of the horse and protection of the grain from theft was so important to Xenophon that he states, “[h]e who neglects this seems to me to neglect himself; for it is plain that in danger the master entrusts his life to his horse” (ὁ δὲ τούτου ἀμελῶν ἐμοὶ μὲν ἑαυτοῦ δοκεῖ ἀμελεῖν’ δῆλον γὰρ ὅτι ἐν τοῖς κινδύνοις τὸ αὐτοῦ σῶμα τῷ ἵππῳ ὁ δεσπότης παρακατατίθεται.)¹⁵⁴

The location of the stall also imparted a second outcome: it allowed the owner to see whether the horse was spilling its food. For this, as Xenophon explains, could either indicate a sick horse needing treatment or a horse needing rest from being over-worked.¹⁵⁵ The observation of the horse’s location and daily feeding regimen was therefore an important aspect of horse care that provided fundamental nutritional value, but also a means for preventing illness. On this point Xenophon is clear for he says:

¹⁵² Howe 2011, 15; Howe 2008, 64-65. Xenophon expresses great concern for the cavalry horses being well fed, see Xen. *Eq.mag.* 1.13, 8.4.

¹⁵³ Xen. *Eq.* 4.1.

¹⁵⁴ Xen. *Eq.* 4.1. This quote has been used by modern equestrian authors to show that Xenophon cared for his horse in all aspects, however, this quote is very specifically situated in the section of the manual concerning the feeding of the horse.

¹⁵⁵ Xen. *Eq.* 4.2. Horse maladies known in the 4th century BCE include: “foot-ill”, possibly laminitis, (ποδάγρας) (Ars. *Hist.An.* 604a.24); colic (εἰλεός) (Ars. *Hist.An.* 604b.1); abscesses (ἔμπνοι) (Ars. *Hist.An.* 604b.7); tetanus (τέτανος) (Ars. *Hist.An.* 604b.5); “barley-surfeit”, perhaps mild colic, (κριθίασις) (Xen. *Eq.* 4.2; Ars. *Hist.An.* 604b.8); and possibly, bowed tendons (as described in, Xen. *Eq.* 1.5). According to Aristotle, stabled horses experienced more diseases than pastured horses, who only suffered from “foot-ill” (ποδάγρας) (Ars. *Hist.An.* 604a20-25.) The translation of Aristotle was taken from Balme 1991, 185-187.

ἔστι δ' ὥσπερ ἀνθρώπῳ οὕτω καὶ ἵπῳ ἀρχόμενα πάντα εὐιατότερα ἢ ἐπειδὰν ἐνσκιρρωθῆ τε καὶ ἐξάμαρτηθῆ τὰ νοσήματα.

[Xen. *Eq.* 4.2]

It is the same with horses as with men: all distempers in the early stage are more easily cured than when they have become chronic and have been wrongly treated.

In understanding this mindset that Xenophon both exhibits and instills in his readers, it is plausible that attention would have been paid to the handling of the horse to prevent long-term disease, illness, or lameness.¹⁵⁶ This is also visible in his recommendations on riding and training horses, and so would have contributed to the desire for biomechanically sound riding and training as this optimizes the longevity and useful, functional life of the horse.

III. THE AGEDNESS OF HORSES

The preventive care of horses can be seen in the evidence of the age of horses in the Bronze Age, and the Archaic and Classical periods. The Greeks provided care to ensure the longevity of their horse. Many factors lead to this, including the overall maintenance of horses, their hooves, diet, and training. To show that the Greeks did in fact care for their horses, the

¹⁵⁶ Human ‘rational medicine’ was developed by Hippocrates in the fifth century BCE, but its theory of “one medicine” meant that it could apply to “animal healing” as well (Curth 2013, 26.) Prior to this, it is largely unknown what medical practices were applied to horses as veterinary medicine. Xenophon and Simon of Athens discuss equine medical care “in a non-veterinary context” (Curth 2013, 22-23.) Later Roman authors on agriculture of the 1st-2nd cent. BCE, such as Columella and Varro, are generally considered the earliest authors on veterinary texts (Curth 2013, 19.) A new assessment of ancient veterinary practice traces the tradition of horse healing to Chiron of early Greek mythology (Curth 2013, 19-20.) Curth (2013) argues that the compilations of horse healing from Late Antiquity, such as the *Mulomedicina Chironis* (4th cent. CE) and the *Hippiatrica* (5th-6th cent. CE), may refer to an ancient Greek human (or humans) from the 14th cent. BCE or possibly the 7th cent. BCE (Curth 2013, 23-26; McCabe 2007, 1.) For information on the prevention of diseases in horses as a response to their environment in accordance with Greek literature, see Curth 2013, 27.

evidence surrounding the age of horses will show that they were being actively used for competition and war into the horse's teen years, and possibly even longer.

The age of horses can be determined through their teeth and ancient sources were aware of this. Simon of Athens, an author on horsemanship from the late 5th century BCE, wrote on the anatomy and ideal conformation of the horse much as Xenophon did in his first chapter.¹⁵⁷ Both Simon of Athens and Aristotle wrote on the correlation of the horse's age with their teeth, and include references to the horse's training level.¹⁵⁸ Modern equine dentistry also uses a horse's teeth to determine its age.¹⁵⁹ It is possible to determine the age of a horse accurately in the early years of a horse's life and the writings of Aristotle and Simon are the same as modern scientific findings. Through this information, the age of horses can be used to corroborate the age of horses with ancient authors and compare it with modern veterinary and training practices. The age of horses can be accurately determined in their skeletal remains through osteological indicators. Therefore, it is possible to show that horses were actively used into their teen years and that mature horses were depicted in sculpture. Through this information, it can also be determined that horses were well cared for, and often in a preventative manner as described by Xenophon, so that horses had a long functional life through the preservation of the physical form.

EVIDENCE OF LONGEVITY

The archaeological remains of horses found in Mycenaean tombs at Dendra confirm the age of four horses which had been used as chariot horses when they died. Both pairs of horses found at Dendra were male horses of the same height and are thought to have come from the

¹⁵⁷ For more information on the technical treatises of Simon and Xenophon, see Dillery 2017, 212.

¹⁵⁸ Easley 2005, 12.

¹⁵⁹ Muylle 2005, 85.

same lineage.¹⁶⁰ They were also all a similar age.¹⁶¹ The first horse (Horse 1) from Tumulus B is the oldest of the pair and was 15-17 years old at the time of death. The second horse (Horse 2) was 13-15 years old. The second pair of horses from Tumulus C are of similar ages to the first pair; the first horse (Horse 3) is the younger of the pair and was 13-15 years old, and the second horse (Horse 4) was 15-17 years old.¹⁶² These horses were being used at the time of their death, and were “military draft animals...yoked to the chariot of the chieftain whom they followed to the grave.”¹⁶³ While the horses were elderly, they were “not unfit for service” showing that even in the 16th century BCE, horses were cared for in a manner that enabled them to be actively used for a significant length of their life.¹⁶⁴ As the horses were sacrificed, they would likely have lived longer than 13-17 years had the chieftain not died, thereby precipitating their death and resulting in their inclusion in his grave.

It is possible that elderly horses were selected for sacrifice at Dendra as younger horses may have been too valuable to sacrifice in the Mycenaean period.¹⁶⁵ Recent finds of horses from the Phaleron necropolis in Athens indicates that those horses were four to six years old at the time of death.¹⁶⁶ The differences in the ages of the horses from the Mycenaean tombs to the Phaleron necropolis may be due to a changed burial practice, where the symbolism of the horse reflected slightly different values in society. The Mycenaean horses could have been the personal horses of the warrior who died, and their joint burial conserved their relationship in death. The Phaleron horses could instead be indicative of the value of youth and dying in one’s prime.¹⁶⁷

¹⁶⁰ Protonotariou-Deilaki 1990, 102.

¹⁶¹ The ages of the Dendra horses are taken from Protonotariou-Deilaki 1990, 102.

¹⁶² A fifth horse was discovered at Dendra and has been aged to 16 years or older (Pappi 2015, 474.)

¹⁶³ Protonotariou-Deilaki 1990, 102.

¹⁶⁴ Protonotariou-Deilaki 1990, 102.

¹⁶⁵ Payne 1990, 106.

¹⁶⁶ Dibble 2022a (Hippus Lecture Series).

¹⁶⁷ The context for these burials has yet to be published.

Both Simon and Aristotle indicate that the horse reached their prime after they had shed all their teeth from the age of four and a half to six years old, and this coincides with the age of the horses from the Phaleron necropolis.¹⁶⁸ Additionally, these horses would not have received as much training as older horses, so it may have been practical to sacrifice horses that were less valuable than a fully trained and experienced horse.¹⁶⁹

From literary sources, it is possible to ascertain age at death and range of active use of horses from the Archaic and Classical periods. According to Herodotus and Plutarch, the three-time Olympic winning mares of Cimon were buried near him and the family's tombs.¹⁷⁰ The active years of the team of horses can be calculated through the dates of their victories. They won three consecutive Olympic Games in 536, 532, and 528 BCE, indicating that they were successfully active for eight years.¹⁷¹ The horses would have been adequately trained by the time they won their first Olympic victory in 536 BCE and were likely between four and six years old at this time, as indicated by other literary sources on the early developmental and training stages of a horse. They would then have been approximately 12-14 years old in 528 BCE when they won their final Olympic victory and were sacrificed shortly thereafter.¹⁷² The horses could have been older when they were sacrificed as it is not clearly stated how long after Cimon's death, they were buried with him.¹⁷³ The most accurate date to determine their length life and active use is therefore 528 BCE, which is when they won their third consecutive Olympic victory. If the

¹⁶⁸ Simon, 11; Ars. *Hist.An.* 576b13, 576a12-13. All subsequent translations of Aristotle are by Peck (1970), unless otherwise stated.

¹⁶⁹ Xenophon speaks to this as he says that a man can make a horse more valuable than when he bought it by providing it with adequate training, and military and parade experiences (*Xen. Eq.* 11. 13.)

¹⁷⁰ Hdt. 6.103.3; Plut. *Vit.Cat.Mai.* 5.4.

¹⁷¹ Papakonstantinou 2013, 99-100.

¹⁷² In an oral presentation at the annual conference by the Classical Association of Canada, C. Willekes also concluded that the mares were approximately this age when they died (Willekes 2022b, University of Western Ontario.)

¹⁷³ Nicholson 2005, 38.

accounts of Plutarch and Herodotus can be trusted, these horses would therefore have been in their teens when they died and would have been actively used for 10-12 years including their training. The horses were sacrificed when they were still physically able to perform and shows that horses were cared for in a manner that allowed them to be successfully used for at least a decade.

The age horses began their training can be roughly determined through ancient literary sources on the early years of a horse's life. These accounts include the stages of equine dentistry according to age, as well as the early physiological development and training timelines of horses. Simon of Athens (i.e., Xenophon's main literary source) writes that horses began to be driven two years after their birth.¹⁷⁴ They would then have required training and exercise to be strong and build stamina to win races. According to Simon, horses reached their prime of strength and fierceness at the age of six, so this may be the oldest age of their introduction to a sporting event.¹⁷⁵ Aristotle provides more detailed information on when a horse reaches their prime, for he says that horses and mules reach their prime (ἀκμάζει) after they lose all their baby teeth when they are four and half years old.¹⁷⁶ He also notes:

ἡ μὲν οὖν θήλεια πέντ' ἐτῶν τέλος λαμβάνει μήκους καὶ ὕψους, ὁ δ' ἄρρην ἐξ ἐτῶν· μετὰ δὲ ταῦτα ἐν ἄλλοις ἐξ ἔτεσι τὸ πλῆθος λαμβάνει τοῦ σώματος, καὶ ἐπιδίδωσι μέχρι ἐτῶν εἴκοσιν.

[Ars. *Hist.An.* 576b.4-7]

The mare reaches her full length and height in five years, the stallion in six; after that, during the next six years they attain their full physical bulk, and go on improving until they are twenty.

¹⁷⁴ Simon, 11. Simon wrote, “[ἐ]λκεται δὲ πᾶλος ἐκ τῶν πολίων διέτης.” All translations of Simon are by Morgan (1979) unless otherwise stated.

¹⁷⁵ Simon, 11. Simon wrote, “ἀκμαῖος <δ’> αὐτὸς ἑαυτοῦ γίγνεται εἰς τε ποδώκειαν καὶ ἰταμότητα ἔργων ἐξέτης γερονός.”

¹⁷⁶ Ars. *Hist.An.* 576b.13, 576a.12-13.

While Aristotle does show a bias based on gender, the ages he provides give an overall accurate representation of when horses reached maturity, congruent with other ancient authors. In addition to this, Aristotle provides a limit for the upper age of horses. In breeding horses, he mentions that they live longer than 20 years, but still, this provides an upper age limit that is near the age of horses found in burials and recorded in literary sources.¹⁷⁷

From this information, it can therefore be determined that Cimon the Elder's mares would have been approximately four to six years old when they won their first Olympic victory in 536 BCE. Under certain conditions, it is possible that the horses could have been three when they started, but their long-term success is also indicative of a later start as horses that are pushed hard at the beginning of their career tend to wear out faster, especially in the lower legs. In addition to this, four-horse chariot races dedicated to young horses were not introduced into Olympic events until 384 BCE.¹⁷⁸ Cimon's horses would therefore have been approximately 12-14 years old when they won their last race in 528 BCE, which is also the approximate year they were sacrificed. The age and circumstances of these horses' deaths are consistent with the Mycenaean horses found in Dendra speaking to the consistency of care that was given to horses.

Aside from Cimon's team, only one other team has been recorded of having won three consecutive Olympic victories in the four-horse chariot race (*tethrippon*). The four horses belonged to Eugoras of Sparta, and the victories have been dated to 548, 544, and 540 BCE.¹⁷⁹

¹⁷⁷ Aristotle says that a well-cared for breeding stallion can live until fifty years old, but the maximum age for most stallions is thirty (Ars. *Hist.An.* 576a.27-31.)

¹⁷⁸ Miller 1991, 203; Willekes 2019, 467. Willekes notes that it is not until the Hellenistic period that the exact age of a horse when they started racing is known and posits that Cimon's horses would have been quite young when they started. Even if the mares started as two-year-olds, the horses would have been ten years old when they won their third Olympic event. If they started as two-year-olds, they would have had to have been maintained even better than horses that started as four- to six-year-olds to have raced for so long and so successfully. Roman chariot horses started as five-year-olds and could continue racing for 10-15 years (Meijor 2010, 59-60; Willekes 2019, 467.)

¹⁷⁹ Papakonstantinou 2013, 101, n7.

These horses would have been of a similar age to Cimon's mares and would have been approximately 12 or more years old when they won their last Olympic victory in 540 BCE. The date of their death is unknown, but their victories help corroborate the effectiveness of a training regimen in the 6th century BCE, even if these horses were exceptional. It may have been rare for the same team to win three consecutive victories as these two four-horse chariot teams did, but it does show that it was possible for multiple teams of horses to have long and successful careers.

Another horse to have a successful, but controversial, career on record was a racehorse named Lycus. Pausanias records an inscription on a statue base dedicated by the winners, the sons of Pheidolas, saying that the horse supposedly won three victories in the Panhellenic game series, one Isthmian and two Olympic.¹⁸⁰ He won a single victory at the Isthmian games and possibly won two victories in the Olympian games; the first victory occurred in 508 BCE, and the second possible victory was in 504 BCE.¹⁸¹ Unfortunately, not enough is definitively known of Lycus' victories to determine an accurate age. If he won two Olympic races, he could have been between eight and ten in 504 BCE. If he won the Isthmian games between 508 and 504 BCE, eight to ten would be his maximum age in 504 BCE. If he won the Isthmian games before 508 BCE or after 504 BCE, he would be older than the suggested age range. This is complete conjecture as it is not known whether Lycus won both victories, or if the family won both victories with two separate horses. No indication of when or how he died is given, and so it is only Lycus's active life that can be determined.

¹⁸⁰ Paus. 6.13.10.

¹⁸¹ There is debate surrounding the years Lycus won the Olympic games as Pausanias explains that the Elean records confirmed only that he won the sixty-eighth festival, which corresponds to 508 BCE (Paus. 6.13.10; Jones 1933, 81.) Ebert (1972) prefers the real account of the inscription, which claims that Lycus won in 508 and 504 BCE, saying that the Elean records could have been incorrect due to their late age in the 6th century (Ebert 1972, 48-49.) For further discussion, see Papakonstantinou 2013, 110; Ebert 1972, no. 7, with commentary.

The final example of a horse with a long and successful career is the most well-known horse of antiquity. Alexander the Great's horse, Bucephalus, was supposedly thirty years old when he died after the Battle of Hydaspes in 326 BCE.¹⁸² According to Plutarch, Bucephalus possibly died from wounds acquired in battle, but he states it is more likely he died from heat exposure and old age.¹⁸³ There is some debate as to Bucephalus's true age at the time of death and it has been posited that he was twenty years old when he died as he and Alexander the Great rode together for 13-16 years.¹⁸⁴ The average fourth century cavalry horse by contrast was likely serviceable up until they were 15 years old, but "probably some years less than that."¹⁸⁵ Even though Bucephalus may have lived exceptionally long for a cavalry horse, he does show that horses who were well treated and trained could live extensively while having a successful career.

CONCLUSION

The average active use of horses for 10-12 years speaks to the successful implementation of a regimen of grooming and care that Xenophon described in his manual in the middle of the fourth century BCE. The manual contained more detail and instruction than was available through images on pottery alone. According to Xenophon, this regimen included the daily grooming, feeding, stabling, and training of horses that likely continued through a horse's life. Horses were treated in a manner that prevented injury, disease, and illness in the horse. In large part, Xenophon's recommendations worked with the natural tendencies of the horse, even if they

¹⁸² Plut. *Vit. Alex.* 61.1; Arr. *Anab.* 5.19.4-5.

¹⁸³ Plut. *Vit. Alex.* 61.1.

¹⁸⁴ For further discussions on the credulity of Plutarch's writings that Bucephalus was thirty when he died, see Anderson 1930, 10-11; Charles 2007, 126-129.

¹⁸⁵ Bugh 1988, 70.

were not always consistent with modern standards which have the advantage of scientific and technological advancement.

From this standpoint, it is now possible to launch into a deeper understanding of what horses were experiencing from a biomechanical perspective. Xenophon's training recommendations for biomechanically sound riding remain largely consistent with the preventative handling methods he describes in the manual and shown throughout this chapter. In the next chapter, the correlation between ancient and modern anatomical vocabulary on locations on the horse will provide the foundation for assessing Xenophon's recommendations as they pertain to the biomechanically sound and unsound posturing of the horse. A biomechanical assessment of the posturing of horses in Xenophon's manual will help determine whether he recommended physiologically correct training practices.

CHAPTER THREE: XENOPHON'S STANCE ON BIOMECHANICAL SOUNDNESS

In *The Art of Horsemanship* (*Περὶ Ἱππικῆς*), a manual on training cavalry horses, Xenophon outlines the ideal shape of a colt (*πῶλος*) and how to train it into a suitable and serviceable warhorse.¹⁸⁶ Xenophon's manual, dated to between 365-360 BCE, was composed against the backdrop of the historical rise of the Athenian cavalry.¹⁸⁷ Beginning in the first half of the fifth century, Athens developed a state cavalry that consisted of elite citizens who were now expected to serve in the cavalry year-round rather than in emergencies.¹⁸⁸ The state cavalry developed into a structured force of 300 horsemen by *ca.* 450 BCE; and more specifically, this restructuring likely occurred between the end of the Persian Wars (480/79 BCE) and before (or around) the battles of Tanagra (458/7 BCE) and Oinophyta (457 BCE).¹⁸⁹ The state cavalry of 300 men was comprised of three squadrons of 100 men, probably volunteers, and each squadron was led by a *hipparch*.¹⁹⁰ The state cavalry was restructured a second time by 439/8 BCE when it grew into a force of 1000 cavalrymen.¹⁹¹ They were subdivided into ten squadrons of 100 men, and each squadron was led by an annually elected *phylarch* from each of the ten tribes.¹⁹² The entire corps was under the command of two *hipparchs*, and between them, the cavalry was

¹⁸⁶ Xen. *Eq.* 1.1-2.

¹⁸⁷ Stoll 2012, 251.

¹⁸⁸ Bugh 1988, 53.

¹⁸⁹ Bugh 1988, 41-49; Spence 1993, 11-14; Anderson 1961, 130.

¹⁹⁰ Anderson 1961, 131; Spence 1993, 14.

¹⁹¹ Spence 1993, 15-16. The latest plausible (and most cautious) date for the increase to 1000 cavalry members is 431 BCE (Bugh 1988, 49; Spence 1993, 15.) There were an additional 200 mounted bowman, which are largely considered to have been in addition to the 1000 cavalrymen (Anderson 1961, 131; Spence 1993, 16.) It has been argued, however, that they were included within the count of the 1000 horsemen (Bugh 1988, 39-40.) The size of cavalry was maintained (at least artificially) until the beginning of the Hellenistic period around *ca.* 320 BCE, at which time it was reduced to 200-300 cavalrymen due to Macedonian influence (Bugh 1988, 50; Spence 1993, 17.)

¹⁹² Anderson 1961, 131; Spence 1993, 16.

divided into two groups of 500 cavalymen to flank each side of the army in battle.¹⁹³ To accommodate the increased need of individuals for service in the cavalry, the Athenians created a loan (*katastasis*) and grain allowance (*sitos*) to cover the cost of the cavalryman's horse and its daily feed.¹⁹⁴ In its early phase, the recruitment for the state cavalry drew from the wealthy and horse-experienced families of the two upper classes of Athenian society, the *pentakosiomedimnoi* and the *hippeis*, but it was now open to those with the money to own, train, and equip a good horse.¹⁹⁵ As this capsule history of the cavalry shows, the cavalry became highly regimented with respect to membership, corps numbers, combat position, battle tactics and allowances.

Xenophon's own cavalry experiences were gained from his service in the Athenian state cavalry at the end of the Peloponnesian War (404/3 BCE), his military activity while in exile (402/1-369 BCE), and his renewed connection to the Athenian state cavalry after his return from exile and through his sons' enrolment in *ca.* 369 BCE.¹⁹⁶ It was toward the latter end of this decade that he wrote the manual, in approximately 365-360 BCE.¹⁹⁷ Xenophon's manual was timely as the fourth century cavalry needed consistency in terms of assessing a horse, and training and equipping it. The time was also right for a manual given the growth of the cavalry.

The cavalymen and their horses were subject to specific expectations. They were required to pass annual inspections held by the Council of Five Hundred, which assessed the horses based on their level of fitness and ability to perform with the unit.¹⁹⁸ The squadrons were

¹⁹³ Anderson 1961, 131. For information on the election of the *hipparchs*, see Bugh 1988, 53-54.

¹⁹⁴ Bugh 1988, 53.

¹⁹⁵ Bugh 1988, 52-53, 70; Spence 1993, 16, 198; Anderson 1961, 133. For more information on the wealth of the cavalymen, see Anderson 1961, 134-139. For more information on the state's support, see Bugh 1988, 56ff.

¹⁹⁶ Spence 1993, xxii, 179, 290; Stoll 2012, 251.

¹⁹⁷ Stoll 2012, 251. He died shortly thereafter in *ca.* 355 BCE (Stoll 2012, 251.)

¹⁹⁸ Horse and rider had to undergo several examinations, *dokimasiai*, which were "overseen by the Council of Five Hundred" (Bugh 1988, 58-59.) Horses could be rejected if they were not well cared for or

expected to move as a single tactical unit, which could be very challenging owing to the discrepancies in talent, experience, and differences in the quality of horses and their training. The development of technical manuals would have been able to provide instruction to the new recruits who lacked experience riding, training, and caring for horses, as well as standardizing the care and training of horses for the Athenian cavalry. Xenophon's recommendations provide a regimen of horse training and riding that would have provided consistency and standardized horsemanship for the Athenian cavalry in the fourth century BCE.

Xenophon's manual is divided into 12 chapters instructing horse owners on how best to acquire a young horse and ready it for military service. The chapters cover topics ranging from the ideal conformation of a colt (I) to the correct management of stabled horses (V-VI), training high and low-spirited horses (IX), and closes with a review of military equipment for horse and rider (XII). Interwoven throughout are instructions on how to ride and train the horse, particularly in chapters 7, 8, 10, and 11. In these chapters, Xenophon makes assertions as to the posture he desired horses to assume and often contrasted them to objectionable poses. Strong similarities exist between ancient Greek and contemporary training practices such that a comparison of their biomechanical posturing can be undertaken. There is a significant overlapping of vocabulary between the past and present anatomical parts of the horse, which can then be physiologically mapped and compared to contemporary biomechanical models of soundness. A close reading of Xenophon's treatment of each part of the horse as ideally postured will show that his manual serves as the foundational text for modern practices of biomechanically sound training and contemporary equitation scholarship.

able to keep pace with the unit (Bugh 1988, 59.) It was therefore "in the cavalryman's own interests to feed and train his mount properly" (Bugh 1988, 59.)

I. ANATOMICAL VOCABULARY

Before launching into a comparison of ancient Greek and contemporary anatomy and comportment, and how the ancient and modern ideals of biomechanically sound and unsound training are linked, a brief comment on horse breeds is warranted. Physiologically, the form and function of the horse has not changed in the years since Xenophon wrote his manual in 365-360 BCE.¹⁹⁹ Modern horse breeds have especially evolved in the last 200-300 years as horses have been bred for their size, strength, and movement.²⁰⁰ While each modern breed has their own distinct conformational attributes, the underlying anatomy of every horse is the same with the exception of the individual variations in conformation.²⁰¹ Despite individual variances, anatomical principles can be consistently applied to develop and understand correct physiological training and movement, which are relatively uniform across the species, *equus caballus*.²⁰² It is this overarching principle of consistent anatomical and physiological development and its application to sound and unsound biomechanical principles that are addressed in this chapter.

Correct physiological training, from a classical dressage standpoint, takes into consideration the development of the horse's own natural talents and abilities regardless of breed.²⁰³ When “put into a ‘position’ or ‘frame’” correctly, a “horse will be able to withstand the

¹⁹⁹ Willekes 2016, 19-20. For more information on the characteristics of ancient horse types and how they differ in classification from modern horse breeds, see Willekes (2016). It is particularly important to note that ancient horse types resemble modern horses more than they resemble modern ponies, which are of a distinct zoological type (Willekes 2016, 6-7.) Biomechanical principles can be applied to horses and ponies.

²⁰⁰ For an overview of some modern horse breeds and their dating, see Draper 1985, 42-71; Baker 1985, 72-87. For an overview of the influential Arabian horse breed, see Greely 1985, 36-41.

²⁰¹ Bennett 2012, vol. I, 5-6.

²⁰² For information on the adaptation of modern horse breeds and their suitability to different terrain, see Bennett, 2012, vol. 1, 24.

²⁰³ While I have mainly referenced sources from the tradition of classical dressage, which is typically considered an “English” discipline, these principles can be applied to all disciplines. For an example of

strains of service life for a long time.”²⁰⁴ The correct position referred to here is that of the horse trained in a biomechanically sound manner in the tradition of classical dressage, which is philosophically based on incorporating the horse’s “fundamental anatomical, physiological and psychological characteristics.”²⁰⁵ The principles of modern anatomy and training can therefore be applied to compare ancient and modern horse physiology as found in Xenophon’s manual, the *Art of Horsemanship*.

CONFORMATION (*Εἰδος*)

The unique composition of a horse’s anatomical features is known as the horse’s conformation, and this can be defined as the “shape or contour of the body structures,” and more specifically as the “overall structure of the horse and alignment of the body parts.”²⁰⁶ There are a variety of ways in which a horse’s anatomy can appear in the body as conformation, with some characteristics being more detrimental to the horse’s health, ability to perform, and functional life.²⁰⁷ While some horses may exhibit less than ideal conformation, they can still be trained in a physiologically correct manner which aims to enhance and optimize the horse’s natural movement.²⁰⁸ For strenuous careers (i.e., as a war horse), it is important for horses to have a

physiologically correct training in the “Western” discipline, see “Rider's Guide to Real Collection” by L. Palm (2010), and the sub-discipline known as “Western Dressage.”

²⁰⁴ According to a German cavalry training manual developed in 1912, the *HDV 12* (as translated in Heuschmann 2009, 38.)

²⁰⁵ Heuschmann 2009, 38.

²⁰⁶ Thomas 2005, 367.

²⁰⁷ For example, all horses have a shoulder blade (scapula), but the scapula’s relative size, angle, shape, and depth from the surface of the skin will vary depending on the horse’s unique body shape, breed, training, age, equipment, etc (Schleese 2017, 62-63.) For additional information and a broad overview on the modern understanding of horse conformation, see Thomas (2005). For a detailed anatomical understanding and assessment of conformation as it impacts the performance of the horse, see Bennett (2012).

²⁰⁸ In the book “Tug of War: Classical versus Modern Dressage”, Dr. Heuschmann emphasizes that correct physiological training according to the principles of “classical” dressage takes into consideration

good underlying form (i.e., conformation) as it would improve their likelihood of having an effective and longer period of service.²⁰⁹ Xenophon shows an awareness for the importance of a well-conformed horse when purchasing a young horse as he provides guidelines on how the horse should appear. Sometimes Xenophon's descriptions of the horse's ideal conformation are cryptic, but they always refer to specific parts of the horse using anatomical vocabulary.²¹⁰ The parts of the horse as Xenophon understood them can be found in *Appendix 1: Parts of the Ancient Greek Horse (Greek-English)* where a full list of his anatomical vocabulary has been defined adjacent to their modern English anatomical equivalents. This compilation has been done with one explicit goal in mind: to show that both periods focus on the same muscles, bones, and/or body parts. To underscore this connection between past and present biomechanical training, each time I use a contemporary term the corresponding ancient Greek term will also be given. This is a significant part of the evidence for the assertion of this thesis; namely, Xenophon is a foundational author in the development of the school of biomechanically sound training.

Xenophon specifies the ideal features and conformation of the horse to be purchased, both as an unbroken colt and trained horse, explaining that the features of the foal are carried into adulthood.²¹¹ Xenophon indicates that the horse should have a bony head (*κεφαλή*) with small cheeks (*σιαγών*).²¹² The neck (*αὐχὴν*) should rise straight to the crown (*κορυφή*) like a rooster and not protrude forward like a boar's, and it should be flexible at the poll (*συγκαμπή*).²¹³ The horse should have a well-muscled, "double" spine (*ῥάχις*), and not a "single" protruding

the horse's unique physiology and anatomy (Heuschmann 2009, 38.) This enables the rider to train the horse in a healthy manner and maintain its well-being (Heuschmann 2009, 38-39.)

²⁰⁹ For more information on Xenophon's recommendations on conformation and the correlation with the horse's ability to perform as a warhorse, see Willekes 2016, 34-55.

²¹⁰ For example, the horse's neck (*αὐχὴν*) is to be upright like a rooster and not like a boar (Xen. *Eq.* 1.8.)

²¹¹ Xen. *Eq.* 1.17.

²¹² Xen. *Eq.* 1.8.

²¹³ Xen. *Eq.* 1.8.

backbone (ῥάχις).²¹⁴ To provide the rider with a more secure seat (ἔδρα), the withers (ἀκρωμία) should be high and the ribcage (πλευρά) should be deep and swell toward the belly (γαστήρ).²¹⁵ A wider chest (στέρνον) is preferred as it makes the horse stronger, look better, and provides more distance between the front legs (σκέλη) so they do not hit each other.²¹⁶ The horse's loin (ὀσφῦς) should be short and broad as this will enable the horse to easily lift its forehead (πρόσθεν), and bring its hind end (ὄπισθεν) underneath itself.²¹⁷ The flank (κενεών) would appear slimmest with this loin conformation, which is important to Xenophon as he indicates that a large flank (κενεών) disfigures the horse, and makes it “to some extent both weaker and clumsier”.²¹⁸ The haunches (ἰσχία; see ἰσχίον) should be proportionate to the chest (στέρνον) and ribcage (πλευρά), and be broad and well-fleshed.²¹⁹ The area between the thighs (μηρός) under the tail (οὐρά) should be broad so that the horse can reach its hind legs (τὰ ὄπισθεν σκέλη) well underneath himself.²²⁰ The front and hind legs should have little flesh below the knee (γόνυ) and hock (ἀστράγαλος), and have mid-angled pasterns (see ὀστέον).²²¹ Lastly, the hooves (ὀπλή, ὄνυξ)

²¹⁴ Xen. *Eq.* 1.11.

²¹⁵ Xen. *Eq.* 1.11-12.

²¹⁶ Xen. *Eq.* 1.7.

²¹⁷ Xen. *Eq.* 1.12.

²¹⁸ Xen. *Eq.* 1.12; Marchant 1968, 303. (The summary of the Xenophon's conformational points is based on my own reading with the support of the LSJ (1996), Marchant (1968), Morgan (1979), and Delebecque (1978).)

²¹⁹ Xen. *Eq.* 1.13.

²²⁰ Xen. *Eq.* 1.14. The specific reference point of the thighs is less anatomically clear here and has been translated in a variety of ways. Xenophon specifies the area and its conformation as, “[μ]ηρούς γε μήν τοὺς ὑπὸ τῆ οὐρᾷ ἦν ἅμα πλατεία τῆ γραμμῆ διωρισμένους ἔχει” (Xen. *Eq.* 1.14.) This phrase is typically translated as the line from the point of the buttock to the hock, and it is interpreted to mean that the horse was to have straight hind legs when viewed from behind (Marchant 1968, 305, n.1; Morgan 1979, 18.) Delebecque uniquely interprets this sentence to mean the “poverty line” of the thigh (which is the very visible line between two muscles of the thigh, the *biceps femoris* and the *semi-tendinosus*) (Delebecque 1968, fig. 1, 19; Grönberg 2016, 146, n3, n4.)

²²¹ Xen. *Eq.* 1.4. The knee (γόνυ) corresponds to the front leg, and the hock (ἀστράγαλος) is the corresponding joint of the hindlimb. For the location of the pasterns, see fig. 5, 21; Appendix 2, 3.16.

should be high and the hoof wall (*ὄνυξ*) should be hard.²²² This is not a complete list of all the conformational features Xenophon idealizes, nor does it represent the full scope of his vocabulary, but it does provide an overview of the relevant features for the discussion on the posture he desires for horses.²²³ It is also these body parts that contemporary equitation experts focus on when determining the best horse to purchase for their intended training program.²²⁴ A focus on the horse's idealized features, or conformation, is therefore the first step in correlating ancient and contemporary practices of sound and unsound biomechanical training.

Both ancient and modern equitation specialists recognize that there are a set of ideal features that enables a horse to fulfill its designated role. When discussing these ideal features, Xenophon does not use the term “conformation”. This is a modern term that is typically applied when interpreting these features, but Xenophon does include terminology when discussing the assemblage of a horse's body parts.²²⁵ After discussing the ideal colt in the first chapter, Xenophon uses the term *εἶδος* when referring to the shape of the horse they should purchase.²²⁶ When translated, *εἶδος* is defined as “that which is seen: form, shape,” and also as “form or

²²² Xen. *Eq.* 1. 2-3. Xenophon recommended examining the hoofs first (Xen. *Eq.* 1.2.) I have ordered the parts of the horse in this manner to facilitate a biomechanical assessment more clearly. The ancient Greeks did not use horseshoes, whether they were nailed or tied on as is typical of ancient horseshoes, and this practice is probably why Xenophon recommended buying a horse that had hard, balanced hooves (Xen. *Eq.* 1. 2-3; Anderson 1961, 91-92.) From a conformational and biomechanical perspective, it is more important for the horse to have balanced and healthy hooves than for them to be shod (Bennett 2012, vol. III, 92-93.) For a discussion on hoof characteristics in relation to Xenophon's manual and other ancient authors, see Willekes 2016, 34-39.)

²²³ Some of the idealized features are likely related to cultural ideals rather than having a physiological benefit to either horse or rider, such as the recommendation that the colt have small testicles (*ὄρχις*) (Xen. *Eq.* 1.15.)

²²⁴ In contemporary practices, a pre-purchase exam assesses the horse's anatomy and conformation for the intended training objective and often includes an assessment by a veterinarian (NFACC 2013, 12.)

²²⁵ For a comparison of Xenophon's conformational recommendations with other ancient authors and a discussion of the importance of anatomical features for the function of the horse, see Willekes 2016, 34-55.

²²⁶ Xen. *Eq.* 1.17.

figure” in reference to humans.²²⁷ The medical connotations of εἶδος include “physique, habit of body, [and] constitution.”²²⁸ The terms *conformation* and εἶδος are very similar in their meaning as they both indicate a composition of parts, showing an additional similarity between ancient Greek and modern terminology.

POSTURE (ΣΧΗΜΑΤΟΠΟΙΕῖΣΘΑΙ)

My thesis focuses on the chapters in Xenophon’s manual where he describes the ideal posture and movement of ridden horses. In the tenth and eleventh chapters, Xenophon describes to the reader how to ride and train their horse using physiological and anatomical indicators. Xenophon explains how they can get their horse to “look more stately and showy when ridden,” and in some instances, includes the best and worst practices to achieve the desired exercises.²²⁹ The tasks Xenophon instructs the rider to have their horse perform range from serviceable skills (walk, trot, canter, circles, etc.) to more “showy” (περιβλεπτοτέρῳ) moves, such as the “rear” (τὸ σῶμα αἴρειν).²³⁰ For determining Xenophon’s recommendations on biomechanically sound training, the focus is not on assessing the means in which these exercises were achieved, but

²²⁷ Xen. *Eq.* 1.17; LSJ 1996, 482, I.

²²⁸ LSJ 1996, 482, I.c. There is no direct reference to medicinal practices in this section of the manual, but Xenophon details lameness that can result from a horse not having the ideal form as he has described in relation to the tendons (περόνη) (Xen. *Eq.* 1.5; see also Appendix 1, “περόνη”).

²²⁹ Xen. *Eq.* 10.1. For an example of Xenophon describing best and worst training practices, see the passage on achieving the “rear” (Xen. *Eq.* 11.3-6.) At the beginning of Chapter 7, Xenophon states that those who want to be the most serviceable (ὠφελιμώτατος) should follow his recommendations (Xen. *Eq.* 7.1; LSJ 1996, 2041 (ὠφέλεια))

²³⁰ Xen. *Eq.* 11.2. For serviceable skills in Xenophon’s manual, see chapters 7-8; and, for “showy” exercises, see chapters 10-11. I have elected to name the sections based on Xenophon’s terminology when transitioning from his description of training a war horse to enabling it to be more “showy” for parades. He writes, “[if] a man wants to make a useful war-horse look more stately and showy when ridden...” ([ἦν] δέ τις ποτε βουληθῆι χρησθαι τῷ χρησίμῳ εἰς πόλεμον ἵππῳ μεγαλοπρεπεστέρῳ τε καὶ περιβλεπτοτέρῳ ἵππάζεσθαι...) (Xen. *Eq.* 10.1; Marchant 1968, 345-347.) Anderson (1961) divides the content in a similar manner naming the serviceable skills as “schooling and ordinary equitation”, and the “showy” exercises as “Advanced equitation” (Anderson 1961, 98ff, 117ff.)

rather the focus of this chapter is on the posture (or anatomical position) of the horse as it is performing these tasks. This is possible because Xenophon describes the position of the horse with reference to their anatomy, which can then be mapped onto biomechanical models.

Xenophon further clarifies that the rider (who is the reader) should “induce [the horse] to carry himself in the attitudes he naturally assumes when he is most anxious to display his beauty...” (... τις αὐτὸν εἰς ταῦτα προάγη, ἅπερ αὐτὸς σχηματοποιεῖται, ὅταν μάλιστα καλλωπίζηται...).²³¹ A closer examination of this recommendation reveals that the term he uses when referring to the shape that the rider should have the horse take can be translated as “posture” (*σχηματοποιεῖται*).²³² In the middle/passive tense, this verb means “to take a certain shape or posture”, which is remarkably similar to modern descriptive terminology.²³³ The verb *σχηματοποιεῖται* has been translated in French as “*se pavaner*”, meaning “to strut about”, but this is not fully correct.²³⁴ Other modern translations have similarly translated the verb as “to show off” and “to assume an attitude” (“*assumere un contegno*”).²³⁵ All three of these translations, “*se pavaner*”, “to show off”, and “*assumere un contegno*”, describe the quality of the action or motion of the horse when it is in this posture, rather than providing a direct translation of the term itself. This interpretation of the verb most likely comes from the action of a real stallion, as they do appear as if they are strutting or showing off before other horses when moving in the manner Xenophon describes (see fig. 9).²³⁶ More important, however, is the description that

²³¹ Xen. *Eq.* 10.5. Translation by E.C Marchant (1968).

²³² Xen. *Eq.* 10.5; LSJ 1996, 1746.

²³³ LSJ 1996, 1746.

²³⁴ Delebecque 1978, 121; Corr ard 2013, 317.

²³⁵ LSJ 1996, 1746; Marchant 1968, 347; Delebecque 1978, 121; Corr ard 2013, 317; Sestili 2012, 95. “*Assumere*: assume, take on” and “*contegno*: behavior, attitude”, were translated using an Italian online dictionary, edited by Bulhosen (2012).

²³⁶ This horse is in a particular stance phase of the trot, and the modern breed, the Lipizzaner, has accentuated movement as compared to what may have been possible for ancient horse types. For information on ancient horse types, see Willekes 2016, 93ff.

Xenophon provides of such a horse in the preceding passage of his manual where he describes the ideal posture.

Xenophon wrote that the ridden horse should appear as the stallion does when posturing for a mare, as this is when a horse raises (*αἶρει*) his neck highest and arches (*κυρτοῖ*) the head most; he lifts (*μετεωρίζει*) his legs supplely (*ὕγρὰ*) and extends (*ἀνατείνει*) his tail upwards.²³⁷

The description of this ideal horse is introduced by the infinitive of the verb for *posture*, *σχηματοποιεῖσθαι*, and reads as follows:

ὅταν γὰρ σχηματοποιεῖσθαι θέλη παρ' ἵππους, μάλιστα δὲ ὅταν παρὰ θηλείας,
τότε αἶρει τε τὸν ἀυχένα ἀνωτάτω καὶ κυρτοῖ μάλιστα τὴν κεφαλὴν
γοργούμενος καὶ τὰ μὲν σκέλη ὕγρὰ μετεωρίζει, τὴν δὲ οὐρὰν ἄνω ἀνατείνει.
[Xen. *Eq.* 10.4]

“A proof that he delights in them is that whenever he himself chooses to show off before horses, and especially before mares, he raises his neck highest and arches his head most, looking fierce; he lifts his legs freely off the ground and tosses his tail up.” (Trans. Marchant 1968)

In many ways, the horse’s action in this passage very much resembles the motion of a strut when a stallion displays himself naturally before a mare or another horse as can be seen in the image of a modern stallion who is expressing himself in such a manner (see figure 9), but Xenophon has supplied this detailed account of the horse’s posture to clarify what he means. The description is not a replacement of the verb, *σχηματοποιεῖσθαι*, which translates more accurately as “to take a shape or posture,” rather than the more liberal translations which include an interpretation of the horse’s attitude or bearing. In this regard, the translation of the verb’s infinitive by Morgan (1979) as “to hold” is perhaps the most accurate, but “to hold” has a static

²³⁷ Xen. *Eq.* 10.4. Based on my own translation of the phrases that reference anatomy to illuminate the action of the horse while staying as close to the Greek definitions as they are found in the LSJ (1996).

connotation that is not fully reflective of the dynamic motion of the horse as it would be moving within this posture.²³⁸

In most translations, the verb is consistently translated between the infinitive (as it first appears in the manual) and its use in the third person (the second manifestation), but this is not always the case.²³⁹ This indicates that the translators had difficulty consistently applying their translation of the verb to the context of the horse in both passages. The verb appears in the 3rd person following the passage of the description of the horse where Xenophon indicated that the rider should “induce [the horse] to carry himself in the attitudes he naturally assumes” (...τις αὐτὸν εἰς ταῦτα προάγει, ἅπερ αὐτὸς σχηματοποιεῖται...).²⁴⁰ This is the translation provided by E.C. Marchant, and the verb *σχηματοποιεῖται* has been interpreted as “to carry himself.” This translation includes the reflexive aspect of the middle/passive verb, but “to carry himself” has its own modern English connotations with riding, as a horse ridden in a biomechanically sound manner is considered to be carrying themselves “in self-carriage.”²⁴¹ It is possible that the translator’s bias or own knowledge of horsemanship may be coming through in the translation, and while I believe this passage indicates Xenophon’s knowledge and awareness of biomechanically sound training, it is important to separate modern terminology that contains this bias as much as possible. The modern term “posture” has no indication of being biomechanically sound or unsound, and so it allows for an unbiased interpretation of Xenophon’s original text.

²³⁸ Morgan 1979, 56.

²³⁹ The verb appears in Xen. *Eq.* 10.4, 10.5, respectively.

²⁴⁰ Xen. *Eq.* 10.5. Translation by Marchant (1968).

²⁴¹ Marchant 1968, 347; Blignault 2009, 116, where “self-carriage” is implicitly stated with a description of biomechanically sound training practices. See also, Loch 2000, 60; Palm 2010, 65-66, which are passages in modern riding manuals that reference the role of the rider in training the horse to develop self-carriage.

Another English rendition of Xenophon’s manual by Morgan (1979), translates the verb *σχηματοποιεῖται*, as “... he puts on of himself...”, which includes the reflexive sense of the verb and the change in posture that comes from the horse going from a relaxed motion to one where they posture themselves before another horse.²⁴² This change in posture can be seen in the different stances of the two horses in figure 9, where the horse in the background is walking with a slightly convex neck and flicked tail, and the grey stallion is fully trotting with a raised neck, arched head, and lifted tail. An alternative translation of Xenophon’s phrase, “*ἄπερ αὐτὸς σχηματοποιεῖται*”, which includes the dynamic motion of the horse and parallels the original Greek as closely as possible, is therefore, “as he himself takes shape” or “as he postures himself.”

From a biomechanical perspective, the terminology Xenophon uses, along with the descriptions of the horse, are important components as they indicate that Xenophon used terminology to differentiate between the form of the horse, *εἶδος*, and the shape that form could take, *σχηματοποιεῖσθαι*. Xenophon also wrote that the rider should “induce” or “persuade” (*προάγη*) the horse to take the shape he described, revealing that the rider had a direct influence on the horse’s posture.²⁴³ Throughout the manual, Xenophon describes how to train a horse for war, but he also provides descriptions of how to alter a horse’s posture (such as by raising or lowering the head) and its movement (by queuing certain gaits).²⁴⁴ The effects of the rider on the horse’s posture is one of the reasons for the modern study of correct physiological training.²⁴⁵

²⁴² Morgan 1979, 56.

²⁴³ Xen. *Eq.* 10.5; LSJ 1996, 1466, 4.

²⁴⁴ Xen. *Eq.* 7.10-12.

²⁴⁵ Hence the creation of the following books for riders: “Tug of War: Classical Versus Modern Dressage” by G. Heuschmann (2009); “Equine Biomechanics for Riders” by K. Blignault (2009); “The Rider’s Guide to Real Collection” by L. Palm (2010); “Biomechanical Riding & Dressage: A Rider’s Atlas” by N. Nicholson (2006); “The Dressage Horse Optimized with the Masterson Method” by J. Masterson and C. Hughes (2015); “Dressage in Lightness: Speaking the Horse’s Language” by S. Loch

While the focus of this chapter is on the posture of the horse itself, references to the rider are included when relevant to understanding the posture that was induced.

Made in reference to the position and features of the horse's anatomy, Xenophon's descriptions of how to ride and train horses allows us to ask if he was aware of physiologically correct training (i.e., biomechanically sound training). Xenophon does not employ exact ancient Greek equivalents for "biomechanics", or "sound" and "unsound", but he does use terminology of shape or posture (*σχηματοποιεῖσθαι*) and form (*εἶδος*), much like modern trainers and scholars of biomechanical soundness do. He also uses anatomical vocabulary to explain to his reader the posture he desires the horse to have, with many of the descriptions corresponding to anatomical parts of the horse relatable to modern terminology. Even though there are slight variations between ancient and modern parts of the horse, far more similarities exist between the past and present understanding of the horse's body than differences, as will be shown in the following section of this chapter. From here, it is possible to determine whether Xenophon recommended riding a horse in a posture that aligns with modern practices of sound or unsound biomechanical training.

II. ANATOMICAL MAPPING

Just as the vocabulary links Xenophon's text with current practices of sound and unsound biomechanical training, so too does anatomical mapping. In its most basic form, an anatomy map is a diagram or chart of the body's anatomy, either human or animal. Anatomical mapping is

(2000); "Suffering in Silence: The Saddle-Fit Link to Physical and Psychological Trauma in Horses" by J. Schleese (2017); "The Circle of Trust" by W. Zettl (2007); "Dressage Solutions: A Rider's Guide" by A. Kottas-Heldenberg (2014); "Collection or Contortion" by G. Heuschmann (2016); and much more, also in a variety of medias. See also the foreword on the development of biomechanics in relation to equitation by Eric Barrey, DVM, PhD, in Bignault 2009, vii-viii.

locating the bones, muscles, tendons, and joints of a horse, often with the use of bony landmarks, for a systemized and consistent approach to assessing a horse's anatomy and physiology. I have applied it in my thesis as a method of comparing the past and present parts of the horse by locating the Greek parts of the horse on a diagram according to the unchanging anatomy and physiology of a horse. As a relatively dependable process, anatomical mapping provides the connection point in determining any similarities or differences in training techniques affecting the biomechanical position of the horse, whether past or present. Within current scholarship, two diagrams of the Greek parts of the horse already exist, but they are not as anatomically clear and accurate as needed to thoroughly assess Xenophon's recommendations on riding and training a horse in a physiologically correct manner. It was therefore necessary to construct new diagrams reflecting Xenophon's understanding of the parts of the horse with a corresponding equine structure that is anatomically and physiologically accurate. This new diagram allows for a consistent approach to reading and assessing Xenophon's manual from a biomechanical perspective and is fundamental to understanding whether Xenophon recommended sound or unsound training practices.

The standard illustrations of horse anatomy that correlate Xenophon's text to parts of the horse can be found in Widdra (1964) and Delebecque (1978), both of whom are editors of *The Art of Horsemanship*.²⁴⁶ The diagrams are a useful addition, but certain stylistic and linguistic features make them difficult to use for an accurate biomechanical assessment. Stylistically, the diagrams found in Widdra and Delebecque are slightly different, but both utilize an artistically

²⁴⁶ Widdra (1964) is the editor of the Teubner edition, which includes a manuscript of the fragments on horsemanship by Simon of Athens. The volume by Delebecque (1978) includes a French translation of the manuscript along with notes and a critical apparatus of the manuscript. Delebecque's original work from 1950 was re-printed and updated in 1978 with the assistance of Lucien Pernée (Delebecque 1978, 34.)

drawn line diagram of a horse with simple lines connecting the term to the relatively correct areas.²⁴⁷ The diagram by Widdra has the more realistically depicted horse, but it does not provide boundaries for the regions of the horse. All the terms appear in the original Greek, which is of benefit when translating Xenophon’s manual, but they are not as differentiated or as holistic as they appear in the text.²⁴⁸ For example, Xenophon uses a single term, *ὄσφῶς*, to refer to two different areas of the horse. He predominantly uses it to refer to the area equivalent to the modern loin, but he also indicates that *ὄσφῶς* can refer to the area of the modern croup.²⁴⁹ The diagram included in the critical apparatus by Widdra indicates that *ὄσφῶς* refers only to the region equivalent to the modern loin. Perhaps more significantly still, the line depicting the region of the horse for *ἰσχίον* is unclear as it either broadly shows the word to mean the hind end, or it is pointing incorrectly to a specific anatomical part. The line indicates that the *ἰσχίον* is the location of the most dorsal aspect of the pelvis, the *iliac tuberosity*, when it is instead either the hip joint or haunches.²⁵⁰ When *ἰσχίον* appears in the singular, it means the hip-joint, which is palpable on the horse’s body through the *greater trochanter*, and is centrally located in the thigh where the hind limb attaches to the pelvis.²⁵¹ According to the LSJ (1996), when *ἰσχίον* appears in the plural (*ἰσχία*), it means haunches (*ἰσχία*).²⁵² The term haunches, however, is a problematic term. From modern sources, there are three different anatomical components used to define the

²⁴⁷ Widdra 1964, 5; Delebecque 1978, 86, fig. 1.

²⁴⁸ See Appendix 1 for a complete compilation of the terms used by Xenophon, which was corroborated with the list by Sestili 2012, 28-29, and the “Lexique Technique” by Delebecque 1978, 93-127.

²⁴⁹ See Appendix 1, *ὄσφῶς*. Xenophon uses *ὄσφῶς* to refer to the area of the modern loin in two passages (Xen. *Eq.* 1.12, 11.2.) In the second passage, he specifies that he is referring to the anatomical area equivalent to the modern loin, and not to the area of the modern croup (Xen. *Eq.* 11.2.) For the location of the loin and croup on the modern horse, see fig. 5, 29, 30. For the locations of *ὄσφῶς* according to Xenophon, see Appendix 2, 3.23, 24.

²⁵⁰ See Appendix 1, *ἰσχίον*. See Appendix 4, 24 for the location of the *iliac tuberosity*.

²⁵¹ See Appendix 2, 3.26. See Appendix 4, 27, for the location of the *greater trochanter*.

²⁵² LSJ 1996, 843, II. 1-2.

term. The oldest modern term defines the haunches as including the hips and buttocks of the horse; the second, defines the haunches as the hind-quarters, which includes the entire hind end of the horse (croup, buttocks, and hind-legs); the third, defines the haunches as the large joints of the hind-limb, which includes the hip joints, the stifles, and the hocks.²⁵³ The different modern definitions for the term haunches can make it difficult to understand the specific anatomical location Xenophon intended, especially as the LSJ (1996) does not provide any greater anatomical clarity. From the perspective of a horse's functional anatomy, the third definition is likely the most anatomically accurate as the stifle and hock joints bend synchronistically, but it is not clear whether these were the areas of the horse Xenophon meant when referring to the hip-joint in the plural (*ἰσχία*). In my diagram of the Greek horse, I have taken a more literal approach and delineated the "haunches" (*ἰσχία*) to encompass the area between the hip-joints on either side of the horse. This incorporates the entire pelvic region of the horse, which coincides with the older modern definition of haunches.²⁵⁴ Knowing the accurate location of the loin (*ὀσφύς*) and the hip-joints (*ἰσχία*) is of particular importance as Xenophon makes reference to the loin when describing the movement of the horse in his text, and these parts of the horse also play a large role in the physiologically correct training of the horse. It is therefore important to understand and map the terms according to Xenophon's description as found in his manual, but also in accordance with a horse's physiology and shape.

²⁵³ Stratton 1985, 246; Thomas 2005, 369; Heuschmann 2009, 108. There are also a variety of ridden exercises, such as the "haunches-in" (also known as "travers"), which use the term "hind quarters" to describe the relevant horse anatomy (Zettl 2013, 104.) Walter Zettl (1929-2018) was a prominent classical dressage rider and trainer, and "is considered to be one of the world's most accomplished masters of classical dressage training" (as per his biography on the back cover of Zettl (2013).) I had the fortune of riding under his instruction a few times in 2017-2018.

²⁵⁴ Appendix 2, 3.26; Appendix 3, 26.

The diagram by Delebecque (1978) is equally problematic for an accurate assessment of Xenophon's recommendations for biomechanically sound training. The figure shows the exterior parts of the horse using a stylized horse from Greek art with a French translation of the terminology mapped with lines indicating the parts of the horse.²⁵⁵ While the list is incomplete, it does provide margins for the parts of the horse's back as indicated by two lines for each region. They are correctly indicated in their correct physiological order from withers to croup, but their proportion in relation to a horse's real body is inaccurate, possibly due to the stylized version of the horse which itself has a shortened back and enlarged hindquarters.²⁵⁶ The most problematic example of this as it appears in the diagram, is the location of the withers and the parts of the spine in relation to the rest of the horse's anatomy, and especially to the size and orientation of the hind end, rib cage, and point of hip.²⁵⁷ The diagram marks the withers of the horse as the length of the back from the base of the mane's hairline, until just ahead of the point of the hip along the back.²⁵⁸ This is a relatively accurate starting point for the withers, but realistically, the withers are the front "half" of the ribcage and not the entire length of the back upon which the rider would sit. Rather, the withers are in front of the rider when sitting on a horse's back, both then and now.²⁵⁹ In his manual, Xenophon notes this position of the withers in relation to the location of the rider as well. He says that a rider will have a safer seat/back (*ἔδρα*) and a stronger attachment (*πρόσφυσιν*) to the horse's shoulders (*ῶμος*) if the withers (*ἀκρωμία*) are high.²⁶⁰

²⁵⁵ Delebecque 1978, 86.

²⁵⁶ Delebecque 1978, 86, fig.1, 14-17. The horse appears to replicate a stylized horse from Greek art, possibly black or red-figure pottery from the 5th century BCE.

²⁵⁷ Delebecque 1978, 86, fig. 1. The point of the hip is indicated by the small, curved line in the middle of the horse's body, and has been used to indicate the most forward (*cranial*) aspect of the hind limb.

²⁵⁸ Delebecque 1978, fig. 1, 14, "garrot".

²⁵⁹ See Appendix 2, 3.8 (*ἀκρωμία*).

²⁶⁰ Xen. *Eq.* 1.11. The English word choice for the grip on the horse's shoulders has been taken from the translation by Marchant (1968). A better translation may be "attachment" rather than "grip" as the ancient Greek word, *πρόσφυσις*, means "growing to, clinging to; ongrowth, attachment, or point of attachment"

While the term *ἔδρα* can refer to the rider's bottom, it also refers to the area of the horse on which the rider sits and is equivalent to the location of the modern "back."²⁶¹ In the diagram by Delebecque, the area of the back ("*dos*") is depicted closer to the location of the anatomical loin (i.e., lumbar spine), and the loin ("*rein*") is depicted closer to the anatomical location of the croup (i.e., sacrum).²⁶² The spacing of the regions of the horse's topline appear to be mostly correct, even if they do not correspond to the physiologically correct locations. This is likely due to the shortened and disproportionate length of the horse's ribcage with the rest of its body, as there is not enough space to adequately portray the length of the withers and back within the length of the ribcage. This is problematic when attempting to map Xenophon's recommendations of a horse's ideal conformation and training with this diagram, as the parts of the horse do not align with a horse's anatomy and physiology. More importantly, it does not align with the locations that correspond to Xenophon's anatomical and physiological understanding, which are relatively comparable to modern concepts.

One of the key stylistic issues addressed in the creation of the new diagram was detailing the surface area that corresponds to the various parts of the horse, rather than relying upon indicator lines to provide a general location for the parts of the horse. This increases the accuracy of understanding the corresponding anatomical and physiological parts of the horse that are mentioned in both Xenophon's manual and with modern English terminology. This is possible as the external parts of the horse have corresponding anatomical components, such as the withers,

(LSJ 1996, 1531, I, II.) Grip implies a certain amount of active participation from the rider; however, the original Greek word does not necessarily imply an active role of the rider, but rather a passive security afforded by the high withers.

²⁶¹ Delebecque 1978, 101 (*ἔδρα*). See Appendix 1, *ἔδρα*; Appendix 2, 3.22; Appendix 3, 22. For the location of the modern anatomical equivalents, see fig. 5, 11 (withers), 28 (back).

²⁶² In French, *dos* is the horse's back, and *rein* is the horse's loin (Corréard 2013, 140, 374.) For the location of the back and loin according to Delebecque (1978), see fig. 1, 15, 16.

which are located at the base of the hairline along the top of the horse's neck and back.²⁶³ In modern anatomical understanding, the withers correspond to the spinous processes of specific vertebrae of the thoracic spine, which can be felt through the skin of the horse.²⁶⁴ By applying my knowledge of equine anatomy and physiology, and cross-referencing Xenophon's remarks on the anatomy of a horse with the location of bony landmarks which are externally visible and palpable, I created a diagram to accurately reflect Xenophon's text with the anatomy of a horse.²⁶⁵ This process was also developed through the theory demonstrated by scholars, that the Greeks were able to realistically reproduce horses as they appeared in daily life from the exterior of the horse, but that they also had an understanding of the internal anatomy of animals through the constant sacrificing and butchering of animals, including horses.²⁶⁶ Additionally, the two diagrams, and especially the diagram found in Widdra (1964), were consulted to ensure accuracy with already mapped locations of Xenophon's anatomical terminology.²⁶⁷ This terminology had already been compared and contrasted to modern equine anatomical terminology for the creation of *Appendix 1: Parts of the Ancient Greek Horse (Greek-English)*, and so the parts of the Greek horse could be reasonably mapped onto a realistically stylized anatomical diagram of a horse.

²⁶³ For the location of the withers, see fig. 5, 11.

²⁶⁴ Heuschmann 2009, 49. For the location of the withers as felt through the skin, see Appendix 4, 22(a). The withers are formed from the extra height of the spinous process from the second to tenth thoracic vertebrae (Heuschmann 2009, 49.) On the diagram, I have indicated anatomically exact locations as much as possible.

²⁶⁵ Simon of Athens sometimes uses different terminology for the parts of the horse than is found in Xenophon's manual. Xenophon tends toward more militaristic terminology whereas Simon tends toward terminology used for all animals. This is especially evident in the difference of word choice for the horse's tail. Xenophon uses οὐρά, which can also be used for the rear flank of a marching army (Xen. *Eq.* 11.2; LSJ 1996, 1272, II.) Simon uses the term κέρκος, which is a term used for the tail "of all sorts of beasts" (Simon, 9; LSJ 1996, 943.)

²⁶⁶ Willekes 2022a (Hippus Lecture Series); Dibble 2022b (Northwestern University) (not recorded). See Dibble 2022a (Hippus Lecture Series) for a brief and recorded presentation on the horses from the Phaleron necropolis, including information on the discovery of strategic cut marks on the fore and hind limbs of some horses so that they could be positioned in the grave as desired. Further research from this necropolis is forthcoming.

²⁶⁷ Widdra 1964, 5; Delebecque 1978, 86, fig. 1.

Due to the many similarities between ancient and modern anatomical language and regions of the horse, Xenophon's training recommendations can be mapped onto modern templates of biomechanical postures of soundness.

To complete a biomechanical assessment of the ancient Greek horse, I created three original diagrams that correspond to the anatomical vocabulary used by Xenophon, as well as a fourth diagram that integrates only the most relevant parts of the ancient Greek horse for a biomechanical assessment. The first diagram, *General Features of the Ancient Greek Horse*, depicts the most general anatomical features that are most easily recognizable, such as the eye (ὄφθαλμός, ὄμμα), ear (οὖς), nostril (μυκτήρ), mouth (στόμα), forelock (προκόμιον), mane (χαίτη), tail (οὐρά), etc. The second diagram, *Regional Parts of the Ancient Greek Horse*, consists of the terms used for the more broadly encompassing external parts of the ancient Greek horse, such as the head (κεφαλή), the forehead (πρόσθεν), the hindquarters (ὀπισθεν), the backbone (ράχις), the shoulder (ὤμος), and the foot (πούς), etc. The third diagram, *Anatomical Parts of the Ancient Greek Horse*, shows the parts of the horse in accordance with the horse's underlying anatomy and physiology, such as the poll (συγκαμπή), the withers (ἀκρωμία), the loin (ὄσφῦς), and the hock (ἀστράγαλος), etc. This diagram can be directly compared to the modern parts of the horse as found in figure 5. There are a couple of terms which are applied in both the second and third diagram, such as the neck (ἀχίην, τράχηλος) and the jaw (γνάθος, σιαγών), as they are terms that are used interchangeably with one another in a regional context, but they are also applied to specific anatomical locations (see Appendix 1.) The three original diagrams and their corresponding legends can be found in Appendix 2. The Greek terms can also be cross-referenced with their definitions in *Appendix 1: Parts of the Ancient Greek Horse (Greek-*

English) as the same terms have been consistently applied across the Appendices and within this thesis.

In addition to the three diagrams of Appendix 2, a fourth diagram was created to integrate the most relevant parts of the ancient Greek horse for a biomechanical assessment. As not all the parts from the three diagrams are needed for a biomechanical assessment, only the most important parts of the ancient Greek horse were included for understanding the relevant passages in the manual. The fourth diagram, *Significant Parts of the Ancient Greek Horse*, and the associated legend can be found in Appendix 3. To further clarify the similarities between the ancient Greek horse and the modern horse, there is a diagram of the bony landmarks of a horse and an associated legend in Appendix 4. The legend has the common English terms for the relevant parts of the horse, as well as modern veterinary anatomical terminology when needed for greater specificity. If desired, these can be cross-referenced with the English terms found adjacent to the parts of the ancient Greek horse in Appendices 1-3. These diagrams show that the parts of the horse that were understood by Xenophon in the fourth century BCE are not dissimilar from contemporary anatomical vocabulary and locations. The consistencies between ancient and modern horse anatomy can therefore be used to determine whether the postures Xenophon recommended were of a sound or unsound biomechanical model. Non-equine experts can use the anatomical vocabulary and mapping, and especially the fourth diagram, to engage visually and linguistically with Xenophon's manual on horsemanship.

III. BIOMECHANICAL SOUNDNESS

A strong correlation between ancient and modern anatomical vocabulary and mapping exists which is evident in the terminology of the manual and the corresponding diagrams of the

ancient Greek horse. The correlation between the vocabulary and the locations of the body parts creates the foundation from which the horse's posture as described by Xenophon can be assessed from a biomechanical perspective. Two models of biomechanical soundness will be used to compare the description of the horse's body. Physiologically, the ancient horse's body can be mapped onto these two models, the model of the sound posture (fig. 1) and the model of the unsound posture (fig. 2), because Xenophon indicates the posturing of relevant anatomical features. The first component of assessing the biomechanical postures of the horse as they appear in the manual is to assess to the position of the rider as their balance, posture, and location on the horse affects the horse's movement and balance. If the rider is not sitting properly, the horse has a significantly reduced capacity to be postured in a sound manner. From here, it is possible to assess the horse's biomechanical stance starting with the horse's midsection and headset, through to their tail and legs.

THE RIDER'S SEAT OF INFLUENCE

Before continuing with an assessment of the biomechanical training principles as found in the manual, it is important to clarify the location and position of the rider as these factors impact the horse's ability to balance itself and move in a physiologically correct manner, regardless of Xenophon's other recommendations. As noted above, Xenophon states that high withers provide the rider with the safest seat and attachment (*πρόσφυσιν*) to the horse's shoulders.²⁶⁸ But this passage also provides indicators as to where the rider would sit. For the rider to have a grip on the horse's shoulders, presumably with their legs (although this is not explicitly stated), the rider would have to be sitting on the area labelled as the back in the modern

²⁶⁸ Xen. *Eq.* 1.11.

diagram and the seat (*ἔδρα*) in the diagram of the Greek horse. As with the modern rider, the ancient rider following Xenophon's recommendations would be sitting on the horse's ribcage (*πλευρά*). If they were sitting further back along the spine toward the loin, as is typically assumed with the rider being in the chair-seat position, the rider would not be able to securely "grip" (*πρόσφυσιν*) the horse near the area of the withers (*ἀκρωμία*).²⁶⁹ When describing how to mount the horse, Xenophon explains that the rider should not touch the horse's backbone/back-line (*ρόχις*) with his knee, and having thrown his leg over the side of the ribcage (*πλευρά*), he should let his buttocks down on the horse.²⁷⁰ The anatomical references to the horse indicate that the rider was to sit on the ribcage, even if they may have slid into a different location during the course of their ride.

There is considerable debate and evidence that the majority of ancient Greek riders sat in a chair seat position, but Xenophon does not recommend riding in such a manner.²⁷¹ Instead, he indicates that the rider should sit "as though he were standing upright with his legs astride."²⁷² This is the same position that the modern rider assumes when riding in a biomechanically correct manner, as the balance and posture of the human impacts the balance and posture of the horse.²⁷³ The correct position of the rider is essential to being able to ride the horse in a biomechanically

²⁶⁹ The chair-seat position is named from the appearance of the human, as they look like they could be sitting on a chair.

²⁷⁰ Xen. *Eq.* 7.2.

²⁷¹ See Willekes 2022a (Hippus Lecture series); Spence 1993, xxiii; Anderson 1961, 103.

²⁷² Xen. *Eq.* 7.5. For an example in art, see the Leontis Victory monument.

²⁷³ Loch 2000, 26. Loch (2002) credits Xenophon with founding of the modern rider's upright position and the "classical seat", which is essential to riding a horse in a biomechanically sound manner (Loch 2002, 10-13.) For a deeper understanding of the horse's gravity line and the necessary cohesion between horse and rider, see Blignault 2009, 9-21. For further information on the biomechanics of the rider and their influence upon the horse see Nicholson (2006), and especially p. 25-27 which shows diagrams of the anatomical correlation between the horse's movement and the rider's position. Nicholson does not assess the chair-seat position as it has been largely excluded as a proper seat in modern dressage.

sound manner.²⁷⁴ By indicating that the rider should sit on the horse's ribcage behind the withers in a standing posture, Xenophon facilitates the horse being able to move in a biomechanically sound manner.

THE HORSE'S POSTURE

The assessment of the horse's posture comes from two main passages as well as smaller phrases throughout the manual. The two passages that are primarily used for understanding the positioning of the horse's body are found in the tenth chapter of Xenophon's manual, where he indicates an ideal posture and an unwanted posture. Xenophon describes the ideal posture as the one that resembles a stallion showing off before other horses, especially for mares. Within this description, he includes the position of the head (*κεφαλή*) and neck (*αύχην*), and the movement of the legs (*σκέλη*) and the tail (*ούρά*).²⁷⁵ In contrast to this ideal posture, Xenophon provides the description of a horse that is "vexed" or "in pain" (*λνπῶνται*).²⁷⁶ Here too, Xenophon includes relevant anatomical and postural information of the chest (*στέρνον*) and legs (*σκέλη*), and to some extent, the position of the horse's mouth (*στόμα*) through the action of the rider's hands on the

²⁷⁴ The ancient Greeks did not use stirrups, but in some instances, they did have cloths and padding (Anderson 1961, 81-82.) The Scythians had early saddle-types, but Xenophon recommends using a quilted cloth (Xen. *Eq.* 12.8-9; Anderson 1961, 82.) A rider's ability to maintain a standing posture would not be hindered by a lack of stirrups or a modern saddle construction, as modern saddles and the relative position of the stirrups can hinder the rider in achieving a balanced posture (Schleese 2017, 32, 170.) It may therefore have been easier for the ancient rider to achieve a standing posture (i.e., balanced posture), as they would not be "fighting the saddle to maintain position" (Schleese 2017, 32.) For a comprehensive examination of saddle fit for the horse and rider, and one which takes into consideration the biomechanics of both partners, see Schleese (2017). For an example of an ancient rider in a standing posture without stirrups or a saddle, see the rider on the far-left horse of the Leontis Victory Monument, ca. 400 BCE (Shear 2003, 171.)

²⁷⁵ Xen. *Eq.* 10.16.

²⁷⁶ LSJ 1996, 1065-1066 (see *λνπέω*). The definition includes a mental and physical component, and it is typically translated as the horse being "uncomfortable" and "hurt" (Marchant 1968, 353; Morgan 1979, 59.) In the middle/passive tense, it means to have "pain of body", a "sad plight or condition", and "pain of mind; grief" (LSJ 1996, 1065, II.)

bit.²⁷⁷ These are the two main passages from which the posture of the whole horse is assessed and compared with the modern models of biomechanically sound and unsound posture.

Elsewhere in the manual, Xenophon provides short descriptions that provide additional indicators of a horse's posture that correspond to an unsound or sound biomechanical model. These are especially relevant for the anatomical parts that are not described in the ideally postured stallion or in the posture of the vexed horse. These short passages are useful to assess the corresponding posture or physiological development of the regions of the poll (*συγκαμπή*), backbone (*ράχις*), loin (*όσφῶς*), flank (*κενεών*), and angle of the horse's nose. As the passages indicating Xenophon's awareness of biomechanically sound or unsound posture are taken from several sections in the manual, the assessment of the horse's positioning has been organized according to the biomechanical function of the parts. This means that rather than following the path of the static horse from head to hoof as was done with the horse's ideal conformation, the biomechanical assessment of the horse will conform to the dynamic motion of the horse and their physiological movement within the biomechanical models.

The postural assessments will start with the line of the horse's backbone (*ράχις*). This corresponds to the region where the rider sits on the horse's back (*ἔδρα*), and it is also the area associated with an important muscle for locomotion, the *longissimus dorsi*. This muscle follows the length of horse's spine from pelvis to poll, and its development is an indicator of biomechanical soundness in the horse. The loin (*όσφῶς*) is the region of the lumbar spine and is strongly influential to the correct physiological movement of the horse, which Xenophon also describes. The horse's back (*ἔδρα*) and loin (*όσφῶς*) move synchronistically with the flank (*κενεών*) to engage the hind. The position of the flank (*κενεών*) and backbone (*ράχις*) correlate to

²⁷⁷ Xen. *Eq.* 10.15.

the posture of the chest (*στέρνον*), which Xenophon describes in his example of the vexed horse. As the four regions are extremely influential to the posturing of the horse, they will be assessed in the order described above: the backbone (*ράχις*) and back (*ἔδρα*), the loin (*ὄσφῦς*), the flank (*κενεών*), and the chest (*στέρνον*). The posture of the horse's midsection influences the other parts of the horse, especially the dynamic posture of the chest and headset, and the spine with the tail and legs. By assessing the midsection first, it is possible to determine whether Xenophon recommended the horse's midsection to assume a posture congruent with a sound or unsound biomechanical model. This information can then be used to determine the posture of the remaining features, which will assist in determining Xenophon's training practices for the whole horse.

As the posture of the chest influences the mobility of the horse's neck, Xenophon's recommendations on the posture of the horse's headset will follow the assessment of the midsection. The assessment of a horse's headset includes an analysis of three anatomical features, the neck (*ἀρχήν*), head (*κεφαλή*), and the angle of the nose through references to the mouth (*στόμα*). The posture of the headset can be assessed by the relative positioning of these three features with each other, and especially through the position of the neck in relation to the head, the bend of the head as determined by the flexion in the poll, and through the angle of the nose which shows the degree of flexion in the head and neck. Due to the increased mobility of the neck as compared to the rest of the spine, more than two models of biomechanical soundness need to be discussed to assess Xenophon's descriptions. From eight possible headsets representing biomechanical soundness, four of these can be compared with select passages from Xenophon's manual.²⁷⁸ Of the four relevant headsets of the horse, two possible combinations fall

²⁷⁸ ISES 2015, 1, fig. 1a-d.

within the category of an unsound biomechanical posture and two headsets correspond to a biomechanically sound model. Xenophon provides indicators for each of these five possible headsets, and they will be explained in more detail in the second section of the assessment of biomechanical soundness. The third and final segment of the biomechanical assessment will examine the posture of the horse's appendages, the tail (*οὐρά*) and the legs (*σκέλη*). There are few references in the manual to indicate the ideal posture of the tail and legs, but when taken into consideration with the whole of the horse, they can be assessed based on the models of biomechanical soundness. By assessing the posture of these important anatomical features as Xenophon discusses them with horse physiology and modern models biomechanical of soundness, it is possible to determine Xenophon's idealized and unwanted posture of the ancient Greek horse according to the *Art of Horsemanship*.

A. The Horse's Midsection

The posture of the midsection is important for understanding whether Xenophon's recommendation conform to a biomechanically sound model. The physiological development of the backbone (*ράχις*) and area of the rider's seat (*ἔδρα*), as well as the development and function of the loin (*ὄσφῦς*), will show whether a full assessment of the horse is warranted and consistent throughout Xenophon's descriptions of the horse. If these features do not conform to a biomechanically sound posture, it can be determined relatively quickly whether Xenophon was aware of physiologically correct training as a horse cannot move in a biomechanically sound manner if the long back muscle is not functioning properly. Following the assessment of the horse's back line (the area from the withers to the croup), Xenophon's recommendations for the physiology of the flank (*κενέων*) and chest (*στέρνον*) will show that he was consistent in his

recommendations of a horse's posture, and this gives the framework for assessing the headset and the appendages.

The Backbone (ῥάχις)

Physiologically, the horse's back from the withers to the croup is one of the most significant areas of locomotion, and this is the area upon which the rider sits.²⁷⁹ In addition to the standing posture of the rider and the position of their seat behind the withers (*ἀκρωμία*), Xenophon wrote that the rider would be more comfortable if the spine (*ῥάχις*) were double rather than single (*[ῥ]άχις γε μὴν ἢ διπλῆ τῆς ἀπλῆς...*).²⁸⁰ Xenophon's text is generally interpreted here to mean that the horse's back muscles are to be sufficiently developed behind the withers so that the backbone (*ῥάχις*) is not steepled along the horse's back-line, but rather that the long back muscles, the *longissimus dorsi*, are well developed.²⁸¹ As noted by Morgan and Willekes, this is indicative of physiologically correct training (i.e., biomechanically sound training).²⁸² In some regards, certain modern horse breeds and ancient horse types are more likely to have this double back feature as the spinous processes are short. The *longissimus dorsi* runs the length of the horse's back, with the attachments beginning in the pelvis, and along the top of the spine to the lower cervical vertebrae at the base of the neck, with an additional segment that goes from the base of the neck to the poll.²⁸³ The muscle lies on either side of the spine and fills the space between the spinous processes and the transverse processes (or wings) of the thoracic and lumbar vertebrae, as well as connecting to the tops of the ribs.²⁸⁴ If the horse had a poorly developed or

²⁷⁹ Bennett 2012, vol. II, 5.

²⁸⁰ Xen. *Eq.* 1.11.

²⁸¹ Morgan 1979, 125, n.13; Willekes 2016, 47-48.

²⁸² Heuschmann 2009, 55-60; BIGNAULT 2009, 123-125; Willekes 2016, 47-48.

²⁸³ Masterson 2015, 23; Grönberg 2016, 96, 98, 99.

²⁸⁴ Heuschmann 2009, 55.

damaged *longissimus dorsi* muscle, or if it was conformationally designed with tall spinous processes (as seen in the modern Thoroughbred), the horse would not have the “double back” feature that Xenophon describes.²⁸⁵ The smaller horse types that Xenophon rode would be predisposed to having a “double-back” feature due to their smaller stature, but this predisposition does not mean that Xenophon’s description was not indicative of biomechanically sound training.²⁸⁶ This is especially important as he very clearly indicates that the rider should not select a horse with a “single-back”, which could be an inherited conformational feature, but could more likely be the result from incorrect physiological training.²⁸⁷ The description of the back-line from withers to croup as needing to be “double” indicates that Xenophon preferred a well-developed *longissimus dorsi* muscle which can only maintain its tone if the horse is being ridden in a sound manner, as the *longissimus dorsi* muscle is physiologically responsible for transferring the movement from the horse’s hindquarters to the forehand.²⁸⁸ If this muscle were poorly developed as in the physiologically “single-back” horse, the horse would likely not be moving in a biomechanically sound manner for this muscle to strengthen and maintain its ideal “double-back” shape. The “double-back” feature is only possible in a biomechanically sound model as the muscle develops in this healthy manner when the horse is ridden with a lifted back, which comes from relaxed *longissimus dorsi* muscles and an active, engaged abdomen.²⁸⁹ When the *longissimus dorsi* muscle is tight and contracted, the back drops as in the biomechanically

²⁸⁵ To illustrate the differences in modern horse breed conformation, compare the anatomical formation of a Clydesdale, Thoroughbred, Arabian horse, and Shetland pony. Ancient horses would also have the physiological advantage of not being ridden in a modern saddle, which can impede proper development of the *longissimus dorsi* muscle (Schleese 2017, 94-95.)

²⁸⁶ For a comparison of modern horse breeds with ancient horse types, see Willekes (2016).

²⁸⁷ It must be said that nutrition also plays a role in the physiological development of the horse, but such an assessment is beyond the current scope of this paper.

²⁸⁸ Heuschmann 2009, 55-60. For additional information on the function of the *longissimus dorsi* muscle, see Masterson 2015, 23-24.

²⁸⁹ Heuschmann 2016, 24.

unsound model. Thereby potentially creating the steeped effect of the “single-spine” horse that Xenophon describes as less desirable. Xenophon’s preference for the double-backed horse is therefore indicative that he tended toward selecting and training horses that were postured in alignment with a biomechanically sound model.

The Loin (ὄσφυς)

In his manual, Xenophon notes the ideal size of the loin. He writes that “[the] broader and shorter the loins, the more easily the horse lifts his [forehand] and the more easily he brings up his hind quarters” (*[ὄ]σφυς γε μὴν ὄσω ἂν πλατυτέρα καὶ βραχυτέρα ἦ, τοσοῦτω ῥᾶον μὲν ὁ ἵππος τὰ πρόσθεν αἴρεται, ῥᾶον δὲ τὰ ὀπίσθεν προσάγεται*).²⁹⁰ Xenophon shows an awareness of the function of the horse’s back, especially the loin, in the lifting of the forehand as well as the physiological development of the loin. Xenophon repeats the function and importance of the loin when he describes how a horse should “rear” its body. He wrote,

“οὐ μέντοι ὃ γε οἴονται τινες, τὸν τὰ σκέλη ὑγρὰ ἔχοντα καὶ τὸ σῶμα αἴρειν δυνήσεσθαι, οὐχ οὕτως ἔχει· ἀλλὰ μᾶλλον ὃς ἂν τὴν ὄσφυν ὑγρὰν τε καὶ βραχεῖαν καὶ ἰσχυρὰν ἔχη, καὶ οὐ τὴν κατ’ οὐρὰν λέγομεν, ἀλλ’ ἢ πέφυκε μεταξὺ τῶν τε πλευρῶν καὶ τῶν ἰσχυῶν κατὰ τὸν κενεῶνα, οὗτος δυνήσεται πόρρω ὑποτιθέναι τὰ ὀπίσθια σκέλη ὑπὸ τὰ ἐμπρόσθια.”

[Xen. Eq. 11.2]

“Many suppose that an animal that has supple legs will also be capable of rearing his body. That, however, is not the case: rather it is the horse with supple, short, strong loins that will be able to extend his hind-legs well under the forelegs. By “loins” we do not mean the parts about the tail, but those between the flanks and haunches about the belly.”

²⁹⁰ Xen. Eq. 1.12. All subsequent translations are by E.C Marchant (1968) unless otherwise stated. When necessary, the correct anatomical term has been corrected in the translated passages. These changes are indicated by square brackets and reflect the ancient and modern anatomical vocabulary as found in Appendix 1.

Xenophon is very specific about the region of the horse he is describing as being responsible for the horse reaching its hind-legs well underneath the forehead: it is the loin that is between the ribcage (*πλευρά*) and the haunches (*ἰσχίον*), and above the flank (*κενεών*) that is responsible for the motion (i.e., the loin of the lumbar spine), and not the loin (*ὄσφῦς*) that is around the tail (*οὐτήν [ὄσφῦν] κατ' οὐράν*) (i.e., the croup). The musculature of the loin does indeed provide the back its strength and aids in the transmission of power from the hind end to the front, as well as assisting in engaging the hind quarters. Part of this musculature comes from the strongest segment of the *longissimus dorsi* muscle, which is along the lumbar vertebrae of the loin.²⁹¹ The lumbar region of the spine is also supported by the *psoas* muscle group, which runs along the underside of the spine from the transition of the thoracic-lumbar vertebrae and inserts along the inside of the wing of the pelvis and the upper hind leg.²⁹² Both of these muscle segments, the *longissimus dorsi* muscle and the *psoas* muscle group, provide the horse with the ability to surge forward as they push off with the hind leg and round the back to lift the fore hand.²⁹³ Additionally, the *psoas* muscle group is also responsible for the horse being able to engage its hind-end in collection by tilting the pelvis so that the angle of the pelvis raises toward the front, and the lumbar spine arches as in a biomechanically sound model.²⁹⁴ Xenophon recognizes the importance of the strength and motion of the loin to train a horse in a correct physiological manner and repeats the loins importance to his readers every time he references the area.

The importance of this area for the physiological training of the horse in achieving the rear is recognized by Xenophon. The contraction of the *longissimus dorsi* muscle facilitates the

²⁹¹ Heuschmann 2009, 50; Grönberg 2016, 9, n.6.

²⁹² Grönberg 2016, 147, 148.

²⁹³ Masterson 2015, 24.

²⁹⁴ For the images of the horse's body and skeleton in three degrees of increased collection, see Heuschmann 2016, 53.

levade, which is a modern term for a similar lifting of the body (*τὸ σῶμα αἴρειν*) that Xenophon describes in this passage.²⁹⁵ Elsewhere in this paper, I have implied the horse Xenophon describes in this passage to be in a “rear,” such as in the description of the Dexileos Stele. The quotation marks were intentionally used to suggest that it was not a rear in the sense of a spontaneous action by the horse (as in Plato’s *Phaedrus*, when the black horse is misbehaving and the charioteer pulls his horses onto their haunches, *τὰ ἰσχία*), but instead as an intentional action requested of the horse and described here by Xenophon to show that the horse uses their loin to lift the body, and not their legs.²⁹⁶ The musculature of the back, including the region of the loin, is indeed what allows the horse to raise the fore hand off the ground as in the modern *levade*, and in Xenophon’s case, to lift the body (*τὸ σῶμα αἴρειν*). Xenophon was therefore able to correlate the conformation of the ideal loin in a horse, one that is short, supple, and strong, with the physiologically correct movement of a horse performing the “rear,” and this further corresponds to biomechanically sound training as it is known today.

While Xenophon may or may not have been aware of the musculature of the loin, he does indicate that he was aware of its importance to the physiological function of the horse. Within his manual he identifies and recommends the training of horses that align the three functions of the loin as Xenophon describes them with sound modern practices. He identifies that the loin should be strong and that it is the area responsible for the horse being able to lift its forehand and for bringing the hindquarters underneath the body. He also identifies that it is the area physiologically responsible and needed to intentionally raise the forehand in a “rear”. All three of these correlations to the function of the loin are correct physiological functions of the lumbar region according to modern principles of movement and equine biomechanics. Xenophon has

²⁹⁵ Xen. *Eq.* 11.2; Heuschmann 2009, 58.

²⁹⁶ Pl. *Phaed.* 254b-c.

therefore identified a key region for sound biomechanical training that facilitates the continued assessment of his recommendations for sound and unsound practices.

The Flank (*κενεών*)

The abdominal muscles play a key role in supporting the horse to move in physiologically correct manner. They help the horse bring its hind legs toward the body, and help raise the back by arching the thoracic and lumbar spine.²⁹⁷ For a horse to be ridden in a healthy manner, the *longissimus dorsi* muscle must be able to sufficiently relax so that the line of the back is able to round when the abdominal muscles contract.²⁹⁸ When the back muscles are contracted and the abdominal muscles are relaxed, the horse looks shorter along the line of the back, which can be seen in the biomechanically unsound posture in figure 2, and the horse develops the appearance of what is typically called a “hay belly.”²⁹⁹ This term comes from the appearance of a horse that is usually overweight from eating too much hay, as the belly in the area of the flank looks rotund and slack, rather than taut and slender. If this area is too large, it can make it more difficult for the horse to bring the hind legs under itself and bascule (round) the back as in the biomechanically sound model (fig. 1). When discussing the ideal shape of the horse, Xenophon notes that the appearance of the flank is affected by the loin, and that a large flank can affect the mobility of the horse. In relation a short and strong loin, he says,

²⁹⁷ Heuschmann 2009, 63.

²⁹⁸ Masterson 2015, 24.

²⁹⁹ Masterson 2015, 24.

καὶ ὁ κενεὸν δὲ οὕτω μικρότατος φαίνεται, ὅσπερ μέγας ὄν μέρος μὲν τι καὶ αἰσχύνηι, μέρος δέ τι καὶ ἀσθενέστερον καὶ δυσφορώτερον αὐτὸν τὸν ἵππον παρέχεται.

[Xen. *Eq.* 1.12.]

And, apart from that, the [flank] looks smallest so, and if it is big it disfigures the horse to some extent, and also makes him to some extent both weaker and clumsier.

If the musculature of the horse's abdomen is not strongly developed, it can make it more difficult for the horse to perform in a biomechanically sound manner. Xenophon's correlation with the conformation of the horse's flank and its relationship to the back shows that he was aware of this physiological connection in the horse. He was also able to apply this link in physiology to the biomechanically sound position and function of the horse. Xenophon's ideal description of the back muscles and the loin, along with his description of the disadvantageous function of a large belly, indicates that he was describing a horse that tended toward a biomechanically sound posture.

The Chest (*στέρνον*)

To understand the significance anatomical descriptions for the assessment of the biomechanical posture of the horse, it is important to understand the physiology of the horse's midsection and body as it relates to the "ring of muscles". The "ring of muscles" is responsible for the physiologically correct movement of the horse, and it is described by Dr. Bennett as being comprised of 17 anatomical components of the horse, which include a variety of muscles, tendons, ligaments, and bones.³⁰⁰ Of those components, three muscles are most relevant for this discussion. The first muscle of importance, the *longissimus dorsi* muscle of the neck and back,

³⁰⁰ Bennett, 2012, vol. I, 53.

has been discussed already.³⁰¹ The second muscle, the *scalenus* muscle, connects the first rib to the neck and is responsible for the lifting the root of the neck and connects the posture of the chest (*στέρνον*) with the posture of the neck (*ἀρχήν*).³⁰² And lastly, the *rectus abdominus* muscle, which connects the sternum to the pelvic bones on the underside of the horse's abdomen, draws the pelvis closer to the sternum when the muscle is contracted allowing the back to round.³⁰³ Through the musculature of the back and stomach, the line of the horse's back moves synchronistically with the abdomen and the function of the horse's hind end influences the movement of the fore hand. The forehand and hindquarters of the horse do not act or move independently of one another, nor do they move independently of the midsection, and so the action and position of one part of the horse provides indicators as to what is occurring in other regions of the horse. The ring of muscles in the horse therefore connects the biomechanical posture of the entire horse and can be used to assess its physiological posture based on detailed descriptions of specific anatomical features, as is the case for the posture of the horse's chest (*στέρνον*) in Xenophon's manual.

The interconnectedness of the horse's body is important to understand from a physiological basis as Xenophon's descriptions do not explicitly state whether a horse's motion is sound or unsound. Instead, he describes the parts of the horse with terminology that indicates their characteristics. When describing the motion of the horse that he advises against, Xenophon describes the horse as being vexed (*λυπῶνται*) and provides an account of the horse's posture with reference to anatomical terminology. He says,

³⁰¹ Bennett, 2012, vol. I, 53, fig. 24, 13.

³⁰² Bennett, 2012, vol. I, 53, fig. 24, 15.

³⁰³ Bennett, 2012, vol. I, 53, fig. 24, 12; Bennett 2012, vol. I, 55.

...ὕπὸ δὲ τοῦ ὀρμᾶν σημανθῆναι ἐγερθεὶς προβάλλεται μὲν τὰ στέρνα, αἶρει δὲ ἄνω τὰ σκέλη ὀργιζόμενος, οὐ μέντοι ὑγρὰ γε· οὐ γὰρ μάλα, ὅταν λυπῶνται, ὑγροῖς τοῖς σκέλεσιν ἵπποι χρῶνται.

[Xen. Eq. 10.15.]

...he throws his chest out and lifts his legs from the ground impatiently, but not with a supple motion; for when horses feel uncomfortable, the action of their legs is not at all supple.

The thrown-out chest is indicative of an unsound biomechanical posture. It implies that the horse's chest and sternum are pressing forwards, rather than lifting up toward the horse's back through the withers.³⁰⁴ The relative position and motion of the sternum is a function of the thoracic sling, which is the musculature that connects the forelimbs with the ribcage.³⁰⁵ As the horse has no collarbone connecting the forelimbs with the ribcage, the thoracic sling provides the stability that can also change according to the manner in which the horse is ridden and the posture they assume through the orientation of the muscles.³⁰⁶ The withers connect to the sternum through the ribs, and this area forms the region of the chest (*στέρνον*).³⁰⁷ Xenophon's description of the horse that is ridden in an unsound manner with a chest thrown forward (*προβάλλεται*) potentially indicates a horse that is pushing forwards with its chest and has a correspondingly dropped root of the neck. In the middle/passive tense, *προβάλλεται* can mean: "throw or toss before oneself (as in throw away or expose); set before or in front; set before oneself, propose to oneself ...; hold before oneself".³⁰⁸ The horse's chest is therefore in a posture where it is pressing forward rather than being in a more neutral or balanced position. As the chest is pressing forward, the back would be dropped and tense as the horse's whole body moves

³⁰⁴ See the contrast in the relative position of the horse's chest and back between figure 1 and figure 2.

³⁰⁵ Masterson 2015, 22; Heuschmann 2016, 29, 50.

³⁰⁶ For information on the thoracic sling, see Masterson 2015, 22.

³⁰⁷ See Appendix 1, *στέρνον*.

³⁰⁸ LSJ 1996, 1470, I, 2, III.

together. Following the hollow in the line of the back and the pressed forward chest, the flank (*κενεών*) would also be dropped making the horse appear to have a “hay-belly” rather than the slender flank that Xenophon recommended for the conformationally ideal horse.³⁰⁹ This “hollow-backed” posture can be seen in the biomechanically unsound model of the horse in figure 2. In this model, the horse would need to compensate for the lack of spinal movement that comes from a hollow-backed position by overcompensating with its legs, as Xenophon indicates through the description of the horse’s legs being lifted impatiently. The legs will receive additional treatment in the third segment of this analysis on the appendages of the horse, as the descriptions of the legs provide additional indicators for biomechanical soundness that are reflective of the entire motion and physiological training of the horse.

The description of the vexed (*λνπῶνται*) horse fits the model of a horse trained in an unsound manner as seen in figure 2, and it is this posture Xenophon recommends his readers avoid when training and riding their horse.³¹⁰ Instead, he recommends that his readers should ride their horse in a manner that resembles the stallion’s posture (*σχηματοποιεῖσθαι*) when he displays himself before a mare and other horses.³¹¹ The contrast between the description of horses moving in an unsound or vexed (*λνπῶνται*) manner with their chest thrown forward, and the description of the horse that should move in the posture of a stallion, provides a contrast between the posture Xenophon did not recommend and the posture he desired.

These two horse postures form the core descriptions upon which a biomechanical assessment can be made as they also include descriptions of multiple features within the same horse. From these passages, it is possible to determine that Xenophon preferred the stallion that

³⁰⁹ Xen. *Eq.* 1.12; Masterson 2015, 24.

³¹⁰ Xen. *Eq.* 10.15; Heuschmann 2009, 59-60.

³¹¹ Xen. *Eq.* 10.16-17.

moved in the physiologically correct manner, rather than the unsound posture of the vexed horse. Through the description of the horse's backbone (*ῥάχις*), loin (*ὄσφῦς*), and flank (*κενεών*), and chest (*στέρνον*), it was shown that not only was Xenophon aware of biomechanically sound posture, but he also connected the proper development of musculature with physiologically correct training. From here, the remainder of the horse's body can be assessed from a biomechanical perspective.

B. The Horse's Headset

The headset of the horse can be divided into three anatomical sections, the neck, the head, and the angle of the nose. All three of these parts are important for understanding the biomechanical model that Xenophon desired the horses conform to. The physiology of the horse's head and neck allows for a greater range of motion than the rest of its body, and so a multitude of postures can reflect sound and unsound practices. In total, there are eight possible headsets, but based on Xenophon's preferences for a high neck carriage, only four of these models will be used to compare Xenophon's recommendations on the horse's headset. They have been grouped into three main models, which are the inverted headset, the hyperflexed headset, and the ideal headset.

Of these models, two headsets reflect unsound practices. The first model is the inverted headset, where the horse is postured with the head and neck raised, and the angle of the nose is almost horizontal (fig. 10.) The second unsound model is that of the hyperflexed headset, where the neck is raised, and the head is strongly flexed so that the angle of the nose is either mildly or deeply behind the vertical (fig. 11). These two headsets will be examined first as Xenophon recommended against riding the horse with such headsets. Following these assessments, the

posture Xenophon desired the horse to assume will be examined in relation to the anatomy of the neck (*ἀύχην*), head (*κεφαλή*), crown (*κορυφή*), and poll (*συγκαμπή*). With the assessment of the head and neck, it is therefore possible to determine that Xenophon recommended posturing the horse's headset in a manner that is both congruent with biomechanically sound models, but also in a manner that corresponds to the sound positioning of the horse's midsection.

The Inverted Headset

In the section on the conformation of the horse, Xenophon notes that the horse should have its head raised like a rooster so that it may see what lies ahead of its feet. In the section regarding the ideal placement of the head and neck when ridden, Xenophon notes that the rider should not drag the mouth upwards as it blinds the horse. He wrote that "...by dragging the mouth up they blind their horses instead of letting them see ahead..." (*τά τε γὰρ στόματα ἔλκοντες ἄνω ἀντὶ τοῦ προορᾶν ἐκτυφλοῦσι τοὺς ἵππους...*).³¹² At first glance, this passage shows that Xenophon was concerned for the horse being able to see where it was going, and also, that he had a notion that the angle of the horse's head impacted its ability to see.³¹³ While Xenophon may be primarily expressing his concern for the horse's line of sight being impaired by the rider pulling the mouth upwards, this style of riding would result in the horse's nose being positioned parallel to the ground. This posture would place the horse's head and neck in an inverted position, which is one of the head and neck postures of an unsound biomechanical model.³¹⁴ His

³¹² Xen. *Eq.* 10.2.

³¹³ Xenophon discusses the horse's line of sight elsewhere, see Xen. *Eq.* 1.8. Horses can see directly ahead of themselves to a limited degree and more extensively along the sides of their body (Reece 2009, 150-153.) It is not clear whether Xenophon was aware of the horse being able to see on either side of its body, as he only refers to the impact of the line of sight ahead of the horse (Xen. *Eq.* 1.8, 10.2.) For an image of the horse's line of sight as it is known today, see Reece 2009, 153, fig. 5-27.

³¹⁴ ISES 2015, 1, fig. 1d.

motivation in recommending against this head posture is, foremost, to allow the horse to see properly, but a secondary effect of recommending against the horse being ridden in such a manner is that the horse would move in a more natural and physiologically correct manner. While horses may spontaneously produce this headset when they are annoyed by something around their face, as Xenophon notes in the fifth chapter of his manual, it is the prolonged maintenance and repeated positioning of this headset by the rider that causes physiological defects and is associated with an unsound biomechanical posture.³¹⁵ Xenophon, therefore, clearly recommends against the unsound biomechanical posture of an inverted headset.

The Hyperflexed Headset

Further examinations of Xenophon's manual indicate that he also recommended against the horse being ridden in a hyperflexed headset. When the horse is ridden in hyperflexion, the angle of the horse's nose goes behind the vertical, sometimes to such extent that the chin touches the horse's chest.³¹⁶ This is an extreme headset of the unsound biomechanical model (see fig. 11) as the horse cannot use its back and body in a physiologically correct manner. Horses that have been ridden in this manner exhibit several physiological characteristics, such as an overextended back that lacks musculature and a "break" in the line of the neck between the second and third cervical vertebrae of the neck.³¹⁷ This is approximately one to two hand-spans behind the area of the poll.³¹⁸ The hyperflexed headset is typically created by the rider's rein tension and this can

³¹⁵ Xen. *Eq.* 5.4. See *Chapter Two: Grooming* of this thesis for a discussion on the horse's headset while grooming.

³¹⁶ See the images found in Heuschmann 2009, 89; ISES 2015, 1, fig. 1c. This is the diagram used in this thesis and can be found in the list of figures as fig. 11. For a definition of hyperflexion and its consequences on the physiology of the horse, see ISES 2015, 5ff.

³¹⁷ Heuschmann 2009, 88-90, 93.

³¹⁸ Heuschmann 2009, 92.

happen with any type of bit.³¹⁹ Due to the physiology of the horse, the poll acts as a pivot point for the skull when the rider pulls on the reins and mouth, which is especially visible when viewed from the side of the horse.³²⁰ With the understanding of the effects of the rider's hands on the horse's mouth through this pulling action, it is possible to assess Xenophon's ridden instructions and anatomical vocabulary to determine if this headset was achieved.

The passage for analyzing this headset comes from Xenophon's recommendation against riding the horse in a vexed (*λυπῶνται*) manner. In the description of the horse with the pushed forward chest (*στέρνον*), Xenophon indicates that the rider has not released his hold on the reins and the horse's mouth. This holding of the bit in conjunction with the rider queuing the horse go forward is what Xenophon says creates the pushed forward chest and angrily lifted legs.³²¹ If the rider were holding so tightly to the reins with the chest pushed forward in the manner Xenophon describes, then the head would likely be hyperflexed and the horse's mouth would have to be close to the horse's chest. This headset would be similar to one of two unsound headsets depending on the strength of the rider and the horse's individual response. The horse's body in this passage is likely postured similar to the biomechanically unsound model of figure 2, and the headset could range from the nose angle being mildly behind the vertical to a deeply angled nose, as seen in the hyperflexed model (fig. 11).³²² Xenophon recommends against riding in this

³¹⁹ Heuschmann 2009, 102-104. Ancient Greek horsemen used both snaffles and curb bits. Although few bits have been found in the archaeological record, the bits Xenophon describes are likely curb bits (Anderson 1961, 65; Xen. *Eq.* 10.6-12) A curb bit has shanks that fall below the level of the horse's mouth which puts an additional lever effect on the horse's poll (Masterson 2015, 101.) For more information on ancient horse bits, see Anderson (1961). Although I do not agree with all of Anderson's assessments of the horse, its posturing, and its interactions with the rider, equipment, etc, he provides a starting point to interact with the ancient Greek material in a mostly comprehensive manner. Anderson's evidence on horses and horsemanship is also lightly sourced and there have been several advancements in horsemanship since the publication of his book in 1961.

³²⁰ Heuschmann 2009, 104.

³²¹ Xen. *Eq.* 10.15.

³²² For an image of the nose being angled mildly behind the vertical, see ISES 2015, 1, fig.1c.

manner, and so it is possible to determine that Xenophon preferred horses be postured with biomechanically sound headsets.

The Ideal Headset

The description of the horse's head and neck in the passage of the ridden horse being postured like a stallion, and descriptions of the head and neck elsewhere in the manual, indicates that Xenophon recommended practices that can be mapped onto models of biomechanically sound posture. In the passage discussing the natural posturing of a stallion, Xenophon wrote that "the horse raises his neck highest and arches the head most" (*αἴρει τε τὸν ἀχένα ἀνωτάτω καὶ κυρτοῖ μάλιστα τὴν κεφαλὴν*).³²³ When displaying himself for horses, the stallion will spontaneously produce what is known as a "neck telescoping gesture."³²⁴ This gesture is created by the *scalenus* muscle which lifts the root of the neck and simultaneously aids in arching and extending the neck by pushing the forehead away from the chest. This is the neck shape that is associated with a biomechanically sound model.³²⁵ If the horse's chest were thrown forward as Xenophon describes in the improperly ridden horse, the neck would not be able to create the neck telescoping gesture as the chest would be pushing forwards and down, rather than lifting up toward the withers which allows for the head and neck to lift and arch in a biomechanically sound manner. The sound posturing of the horse's chest and body therefore allows for

³²³ Xen. *Eq.* 10.4.

³²⁴ Bennet 2012, vol. I, 57.

³²⁵ Bennet 2012, vol. I, 53, 57; Bennett 2012, vol. II, 40. For a full description of the telescoping neck see, Bennett 2012, vol. II, 39-44, and especially figure 23, which shows three different neck postures corrected for a biomechanically sound posture through the biomechanics of the telescoping neck gesture. See also Bennett (2008), for an overview of the connection between the neck telescoping gesture, the ring of muscles, and the function of the *longissimus dorsi* muscle in biomechanically sound posture.

Xenophon's recommendations on the horse being postured in a biomechanically sound manner throughout the rest of body to be possible as well.

A closer reading of the passage on the ideal posture of the horse's head and neck shows that Xenophon wanted the neck raised or lifted up (*αἴρει τε τὸν ἀχένα ἀνωτάτω*) and the head arched most (*κυρτοῖ μάλιστα τὴν κεφαλὴν*).³²⁶ He repeats the phrasing for the neck lifted highest throughout the manual, using the root word *αἴρει* to describe the position of the neck (*ἀχὴν*). In this section, the description of the neck indicates that the horse "lifts his neck highest".³²⁷ In another section of the manual where Xenophon describes the same ideal posture with slightly different language, he says that the rider can teach the horse "to hold his neck up and to arch it towards the head" (*... ἄνω δὲ τὸν ἀχένα διαίρειν, ἀπὸ δὲ τῆς κεφαλῆς κυρτοῦσθαι...*).³²⁸ The same root verb *αἴρει* was used to indicate the position of the head, with the preposition *δια* adding emphasis to the upward motion and carriage of the head. The posture of the neck is additionally exemplified by the comparison Xenophon provides to the posture of a rooster's neck and a boar's neck in the section on the horse's conformation. Here, he notes that the neck should not protrude from the chest like a boar's neck (*[ἀ]πό γε μὴν τοῦ στέρνου ὁ μὲν ἀχὴν αὐτοῦ μὴ ὥσπερ κάπρου προπετῆς πεφύκοι...*).³²⁹ Instead, the horse's neck should be postured like the rooster's neck and rise straight up to the crown (*... ἀλλ' ὥσπερ ἀλεκτρυόνος ὀρθὸς πρὸς τὴν κορυφὴν ἦκοι...*). The motion and height of the necks between the two animals, the boar and rooster, provide a very clear image of how the horse should carry its neck. To some extent, this description can imply a horse's conformation, but given that all horse necks can be positioned in an upright manner, this passage can be used to determine the biomechanical posture Xenophon

³²⁶ Xen. *Eq.* 10.4.

³²⁷ Xen. *Eq.* 10.4.

³²⁸ Xen. *Eq.* 10.3.

³²⁹ Xen. *Eq.* 1.8.

favoured.³³⁰ The language of the three passages on the neck's upright position indicates that Xenophon consistently thought of the head and neck as raised from the chest to the head. This is consistent with the biomechanically sound model of head carriage and the biomechanics of the telescoping neck gesture as seen in a stallion.

The sound posture is given additional meaning when taking into consideration Xenophon's recommendation on the physiology of the horse's neck. In addition to comparing the horse's neck with a rooster's neck and a boar's neck, Xenophon writes that the neck "should be flexible at the [poll]" (*λαγαρός δὲ εἶη τὰ κατὰ τὴν συγκαμπήν*).³³¹ He does not indicate that the neck (*ἀρχήν*) should be flexible, but rather the anatomical part of the horse that corresponds to the modern poll (*συγκαμπή*). This is further exemplified by the Greek meaning of the word *συγκαμπή*, which is used for a bendable joint, such as a human finger or elbow.³³² An examination of these joints bending shows a doubling of two straighter parts coming together with a pointed, bony apex between them. Opposite to the bony apex is a gathering of soft tissue. This construction of a joint mimics the motion of a horse's poll (fig. 5, 1) and throatlatch (fig. 5, 7) as the horse bends its head in relation to its neck (Appendix 2, 3. 4; Appendix 3, 4.4.) When a horse is ridden in a biomechanically sound manner, the poll is the highest part of the spine regardless of whether the angle of the nose is above or on the vertical (fig. 12). When ridden in an unsound manner with the head bent, the area of the second and third cervical vertebrae develops abnormally and appears as the highest point of the spine.³³³ This area is approximately

³³⁰ For example, horses can have what is conformationally known as a "bull neck", "swan neck", "ewe neck", etc. (Thomas 2005, 42-43.) This describes the attachment of the neck to the chest based on the anatomical composition rather than as a way the horse postures itself. A horse with a bull neck can still be ridden in a physiologically correct manner, and a neck raised like a "rooster." Likewise, a horse that has a perfectly set neck can be ridden with its head down in the position of a "boar."

³³¹ Xen. *Eq.* 1.8.

³³² LSJ 1996, 1662.

³³³ Heuschmann 2009, 48.

two hand-spans behind the poll and would be considered the region of the neck (*ἀρχήν*).³³⁴ In his description of the horse's conformation, Xenophon clearly indicates that the area of the poll should be flexible and that the neck should rise straight to the crown, which is the top of the horse's head. These descriptions provide sufficient anatomically correct relationships with modern biomechanical models to determine that Xenophon was describing horses in a physiologically correct manner.

The angle of the nose within his ideal descriptions provides further evidence that Xenophon idealized a headset that tends toward modern sound practices. Xenophon indicates that the posture mimicking the rooster's neck has the advantage of protecting the rider from attack, and more importantly for a biomechanical assessment, that the horse may see what lies ahead of its feet.³³⁵ From this passage of the horse's line of sight, and compared to the horse that was blinded when its mouth was dragged upwards, it can be relatively determined that the horse's angle of the nose was not inverted and was more likely above the vertical (see fig. 12a). The headset of a rooster may be higher than what a horse can naturally produce in a sound manner, but when compared to the boar's neck, the similes provide an illusion to a range of movement from one extreme to another. They can therefore be used to indicate a preferred upward posture of the head that moves fluidly as a rooster's does when it walks, rather than pushing forward and down with stiff movement, like a boar's motion.

Taking into consideration Xenophon's descriptions on how to properly posture the horse's head and neck when ridden, the ideal headset is made clearer. He indicates that the most beautiful horse has the neck raised upwards and the head arched most (*αἶρει τε τὸν ἀχένα*

³³⁴ Heuschmann 2009, 92.

³³⁵ Xen. *Eq.* 1.8.

ἀνωτάτω καὶ κυρτοῖ μάλλιστα τὴν κεφαλὴν).³³⁶ In the descriptions of the head and neck posture, Xenophon indicates that it is the head that should be “arched” and not the neck. Although it is typically translated as “arch”, *κυρτοῖ* means to “make convex, or hump up”, which provides a clearer image of the bend applied to the horse’s head carriage.³³⁷ The verb is used in the passages referencing the ideal posture of the neck in relation to the horse’s head, but it is not used for the anatomy of the neck as being “arched”. The application of these directional terms with the correct anatomical parts of the horse is synonymous with modern models of biomechanical soundness. The same terminology for the convexity of the horse’s head in relation to the neck has been applied by Dr. Heuschmann’s in his book, “Tug of War”, to indicate the correctly developed neck musculature of a horse. Along with an image of a young horse’s correctly developed neck physique, Dr. Heuschmann describes the horse as having “correctly developed upper neck muscles that produce a long convex-curved line.”³³⁸ When taking into consideration all of Xenophon’s descriptions that pertain to the ideal head and neck posture within the manual, and especially the desiring of a flexible poll (*συγκαμπή*), it is likely that Xenophon recommended a headset that more closely resembles a sound biomechanical model (fig. 12). This is consistent in his descriptions of the ideal headset and in his recommendations on how to ride and train the horse to achieve the desired posture.

Through Xenophon’s anatomically specific descriptions of the horse’s headsets, it was possible to compare his recommendations to three unsound biomechanical models and two sound biomechanical models. From this assessment, it was determined that Xenophon recommended against riding the horse in a manner that results in the inverted headset with the angle of the nose

³³⁶ Xen. *Eq.* 10.4.

³³⁷ LSJ 1996, 1014. Other definitions of the word provide a similar meaning, such as “[b]ulging, swelling; humped, convex” (*κύρτος*), and for the “convexity...of a line” (*κύρτοτης*) (LSJ 1996, 1014.)

³³⁸ Heuschmann 2009, 62.

far above the vertical, and that he also recommended against riding in the hyperflexed model with the nose behind the vertical and pressed into the horse's chest. Instead, he recommends riding the horse that has a head bent with a flexible poll and a neck that is raised from the root as in the stallion posturing himself before a mare. This most closely resembles the two sound biomechanical models where the nose can be slightly ahead of the vertical or on the vertical as it does not place the head and neck in an unnatural position. These recommendations fit with the posturing of the horse's midsection as the back and chest were to be lifted, which would allow for the horse to posture its head and neck as Xenophon desired. From here, it is now possible to assess the two remaining features of the horse that will complete the biomechanical models of the soundly or unsoundly postured horse: the tail and the legs.

C. The Horse's Appendages

The tail and the legs of the horse are the last feature to be examined. While they have the least amount of textual evidence from which to gather indicators of a biomechanically sound or unsound posture, certain key words in the sections describing the two body postures provides a possible clue as to the model they fall under. The tail is composed of the last vertebrae of the spine, and it has muscular connections to the back and neck through the *longissimus dorsi* muscle.³³⁹ The position of the tail is therefore reflective of what is occurring along the spine of the horse. The legs are likewise an indicator of what is occurring in the rest of the horse's body, as their balance and movement are directly dependent upon the movement of the spine and balance of the horse's body. Issues in the spine will appear in the horse's legs, so this feature is addressed last as the interpretation of their movement is dependent on how the rest of the horse's

³³⁹ Heuschmann 2009, 51-52; Bennet 2012, vol 3, 91-92.

body was postured.³⁴⁰ The description of the legs also provide the last anatomical component needed to determine the posture of the horse that Xenophon desired.

The description of the tail's position and the movement of the horse's legs is mainly taken from the description of the stallion's posture that Xenophon idealized in his tenth chapter. Xenophon describes the ideal posture, as "the stallion raises his neck highest and makes the head most convex, looking spirited; he lifts his legs supplely, and extends his tail upwards" (*τότε αἴρει τε τὸν αὐχένα ἀνωτάτω καὶ κυρτοῖ μάλιστα τὴν κεφαλὴν γοργούμενος καὶ τὰ μὲν σκέλη ὑγρὰ μετεωρίζει, τὴν δὲ οὐρὰν ἄνω ἀνατείνει*).³⁴¹ In addition to describing the position of the head and neck, Xenophon notes that the tail should be raised up and the legs should lift fluidly. This is perhaps the only description of the tail's posture, and so the evidence is limited. For the legs, however, the horse moving in a vexed or painful manner provides an alternative description of the legs that Xenophon did not endorse. He indicates that when the horse is positioned so that it becomes vexed, the horse will move its legs "impatiently" (*ὀργιζόμενος*). There are therefore two opposing descriptions of the movement of the horse's legs that relate to the models of biomechanical soundness and Xenophon's recommendations. The descriptions can be used to assess the posture of the legs, and the description of the movement of the legs likewise enhance the assessment of Xenophon's description of the horse's posture.

³⁴⁰ Bennett 2012, vol. II, 5.

³⁴¹ Xen. *Eq.* 10.4. My own translation with support from the LSJ (1996) and the translation by E.C. Marchant (1968). For the translation of *γοργούμενος*, see *γοργός*, which can mean "spirited, vigorous" as well as "grim, fierce, [and] terrible"; and see, *γοργόμαι*, which in the passive, is used for a horse "to be spirited" (LSJ 1996, 357.)

The Tail (*αύχην*)

The position of the tail as it is described in the passage on the ideal horse provides insight into the biomechanical soundness of the horse. In the naturally postured horse, Xenophon details a tail that lifts (or extends) up (*τὴν δὲ οὐρὰν ἄνω ἀνατείνει*).³⁴² The verb governing the movement of the tail, *ἀνατείνει*, has several definitions that assist in understanding the possible posture and movement of the tail. It can be defined as “lift up; stretch forth; lift up, exalt; spread out, expand”, and in the passive as “to be distended upwards; extend”.³⁴³ The direction of the motion is additionally described as being up (*ἄνω*), which is translated as “upwards” with verbs of motion.³⁴⁴ The description of the stallion’s tail, *τὴν δὲ οὐρὰν ἄνω ἀνατείνει*, may therefore be translated as “he extends his tail upwards.” Some scholars have translated the phrase as “[he] tosses his tail up”, however, this indicates a momentary movement of the tail which is indicative of a tense back, rather than as a sustained, relaxed position of the tail as is associated with a biomechanically sound posture.³⁴⁵ This is significant as the horse’s tail serves as a balancing rod and reflects whether the horse has a tense or relaxed back and spine.³⁴⁶ Physiologically, this is possible as there are “complex interconnections between the skeletal, muscular and ligament systems of the horse’s neck and back.”³⁴⁷ Through this interconnection, the position of the tail therefore reveals whether the horse is carrying tension in its back, which is itself impacted by the position of the head and neck. When ridden in a biomechanically sound manner, the horse will extend its tail in a relaxed manner as the spine itself is moving in a relaxed, healthy manner. By contrast, the horse ridden in an unsound manner will move its tail in any manner of positions or

³⁴² Xen. *Eq.* 10.4.

³⁴³ LSJ 1996, 123, I-II.

³⁴⁴ LSJ 1996, 169, I.

³⁴⁵ Marchant 1968, 347. Morgan (1979) translates the phrase as “he raises his tail” (Morgan 1979, 56.)

³⁴⁶ Heuschmann 2009, 51-52.

³⁴⁷ Heuschmann 2009, 52.

directions, such as wringing, tossing (or flicking), clamping it down, or holding it toward one side, the side of pain.³⁴⁸ Xenophon's choice of wording, that the tail extends, lifts, spreads out, or expands upwards, which are all possibly translations of *ἀνατείνει*, is a deliberate choice and shows he was thinking not of a tail that moved as in an unsoundly positioned spine, but rather, belonging to a horse whose back was relaxed allowing the tail to flow and spread out behind the horse and was held gently aloft as is found in biomechanically sound horses. The quality of the biomechanically sound tail can be seen in the image of the modern stallion moving freely in figure 9 and resembles Xenophon's description of the extended tail.

The Legs (*σκέλη*)

Xenophon describes the legs in variety of ways which shows a correlation to biomechanically sound and unsound postures. As the legs reflect the movement of the horse's body, their description can be used in conjunction with the description of the horse's body within the same passages. The biomechanically sound model will be explained first and compared to the motion and description of the legs in the biomechanically unsound model. The terms Xenophon used to describe the motion of the legs reflects the movement of modern horses and provides the point for comparison between his recommendations on the models of biomechanical soundness.

Of the stallion posturing itself before other horses, Xenophon wrote that the stallion lifts his neck highest and arches his head most, looking fierce; the horse lifts (*μετεωρίζει*) his legs supply (*ύγρὰ*) and extends the tail upwards (*τότε αἴρει τε τὸν ἀρχένα ἀνωτάτω καὶ κυρτοῖ μάλιστα τὴν κεφαλὴν γοργοῦμενος καὶ τὰ μὲν σκέλη ύγρὰ μετεωρίζει, τὴν δὲ οὐρὰν ἄνω ἀνατείνει*).³⁴⁹

³⁴⁸ Masterson 2015, 126; Heuschmann 2009, 51. For information on the tail reflecting the tone of musculature throughout the spine, see Bennett 2012, vol. III, 91-92.

³⁴⁹ Xen. *Eq.* 10.4; based on my own translation of the passage. For a similar description of a stallion, see Hom. *Il.* 15.263-268.

Xenophon has used the same word here for the supple (*ύγρᾶ*) legs to contrast the vexed (*λοπῶνται*) horse that lifted their legs angrily (*όργιζόμενος*), giving further indicators for the posture of a horse.³⁵⁰ His definition of supple legs are therefore not just legs that move quickly or in a high manner (i.e., impatiently), but legs that move fluidly (*ύγρᾶ*) and that are lifted high and suspended (*μετεωρίζει*) in harmony with the entire motion of the body.³⁵¹ Within its various forms, the root of *μετεωρίζει* has a quality of airiness and being lifted above a surface. For example, *μετέωρος* can be defined as “hanging (as in an arm without support from a bandage); raised higher than..., above...; running along the ground (used of tree roots above ground); raised from off the ground;” and, as “high-stepping” for horses specifically.³⁵² In the form of *μετεωρέω*, the verb can be defined in the active tense as “[to] raise to a height; lift, or buoys it up;” and in the passive tense, “as to be raised up, to be suspended; to be elevated; [to be] raised from off the ground.”³⁵³ For the context of the horse’s legs, it is therefore possible to discern a motion that is both lifted high with a quality of lightness. For horses, this verb is also typically translated as “prancing” and has been compared to the modern dressage movement, the *passage*.³⁵⁴ To define the quality of the legs, Xenophon uses the term, *ύγρᾶ*, which can be defined as “wet, moist, fluid; soft, pliant, supple (of the limbs and body); smoothly flowing; soft, freely.”³⁵⁵ From these definitions, an image of the horse moving with fluid, supple, pliant, freely lifted, and suspended legs can be mapped onto the image of the stallion (fig. 9). The stallion is trotting with his neck raised from the root of his neck, his head is made convex from the poll

³⁵⁰ LSJ 1996, 1246.

³⁵¹ Xen. *Eq.* 10.4.

³⁵² LSJ 1996, 1120, I-II.

³⁵³ LSJ 1996, 1120, I, II.3.

³⁵⁴ Marchant 1978, 355 (Xen. *Eq.* 11.7); Anderson 1961, 118. The *passage* is “a collected, very suspended and cadenced trot” (Kottas-Heldenberg 2014, 186.) Another form of the word, *μετεωριστής*, has been translated as “*prancer*,” and is specifically in reference to horses (LSJ 1996, 1120, II.)

³⁵⁵ LSJ 1996, 1843, I, II.

making it the highest point of the spine, the tail is lifted up in a relaxed manner showing a balanced spine from head to tail, and the legs are lifted high in suspension, rhythmically, coordinated, and equal to one another. While this is an image of a horse captured from a particular moment of the stallion's movement, it can be used to show the balance of the horse and be compared to Xenophon's description to show how the horse he desired of his readers could be postured, statically and in motion. This is important to provide a biomechanical understanding of the motion of the horse's legs in a sound model, but also as a point of comparison for the unsound model which Xenophon recommended against.

By contrast the legs of the horse moving in the manner Xenophon recommended against are described using different descriptors. In the example of the horse that moved in an unsound manner, with a tightly held mouth and pushed forward chest, the legs were described as moving angrily or impatiently (*ὀργιζόμενος*). As a participle of *ὀργίζω*, the word describes the manner in which the horse is moving its legs, and means to “*make angry, provoke to anger, irritate*”.³⁵⁶ The vexed (*λυπῶνται*) horse “lifts his legs from the ground impatiently” (*αἴρει δὲ ἄνω τὰ σκέλη ὀργιζόμενος*). Xenophon describes the motion of this horse as lifting his legs with the verb *αἴρει*, which means “to lift”, but the verb does not have the same weightless and suspended motion as *μετεωρίζει*, which is the verb he used in the image of the horse moving in a physiologically correct manner. The text itself has a static quality to it with the hard consonants stopping the fluid reading of the text, which is not the case for the motion of the legs in the stallion's text. There, the language is softer and flows between the vowels of the words “... *καὶ τὰ μὲν σκέλη ὑγρὰ μετεωρίζει*”.³⁵⁷ The selection of the verbs therefore supports the rhythm of the horse's

³⁵⁶ LSJ 1996, 1246.

³⁵⁷ Xen. *Eq.* 10.4.

motion and in the text, and even though the unsound horse may be lifting his legs up, they are not fluid and supple legs being lifted in a suspended and high manner.

The description of the legs of the horse postured as a stallion and the vexed horse corresponds also to the movement of the modern horse. When the horse moves in a biomechanically correct manner, the legs are able to lift off the ground as if they are floating, fluidly and rhythmically.³⁵⁸ In Xenophon's unsoundly postured horse, the pushed forward chest is indicative of a hollow back as the back cannot lift if the chest is not also lifted. When the back is hollow, the back muscles are tense as the *longissimus dorsi* muscle is contracted.³⁵⁹ The horse compensates for the tension and lack of mobility in their spine with their legs, and they can be labelled as "leg movers".³⁶⁰ When a horse is moving in this manner, they are not always able to achieve a quality of airiness in their limbs as they need to use their legs to balance and can be quick to place them on the ground again.³⁶¹ Therefore the posture of the horse that Xenophon does not recommend can be closely mapped to the modern unsound model of the horse from figure 2. This can be contrasted to the posture of the stallion moving in a biomechanically sound manner with his neck lifted and head arched, and supple (*ὕψα*) legs lifting high over the ground (*μετεωρίζει*). Xenophon's ideal posture corresponds to a biomechanically sound model, and this is the posture that he advises in the *Art of Horsemanship*.

³⁵⁸ See Heuschmann 2009, 76-84 for a description of the movement of legs in the three basic gaits as they relate to the sound and unsound biomechanical models.

³⁵⁹ Bennett 2012, vol. I, 48-57.

³⁶⁰ Heuschmann 2009, 59; Masterson 2015, 23-24.

³⁶¹ This is especially visible when horses are trotting and performing the piaffe, where the front and hind legs work in diagonal pairs. In the trot, the leg bones of the front and hind limbs should be at equal angles when trained in a biomechanically sound manner (Heuschmann 2009, 81.) In the modern *piaffe*, the horse is tightly gathered on the spot and alternates between lifting the diagonal pairs. When done in a biomechanically sound manner, the horse keeps its legs rhythmically lifted off the ground (Heuschmann 2009, 112.) When done in an unsound manner, the horse is not able to sustain the quality of the gait and so the hind legs drop to touch the ground before completing the sequence of the footfall as in a biomechanically sound model (Heuschmann 2009, 112.) For an image of a correctly and incorrectly executed *piaffe*, see Heuschmann 2009, 112.

CONCLUSION

At the beginning of the chapter, it was determined that Xenophon wrote the *Art of Horsemanship* during the expansion of the Athenian cavalry in approximately 365-360 BCE. In response to the need for a standardized cavalry force, he provides instruction on how to select and train a conformationally sound horse for service. Xenophon's recommendations on the horse's conformation provide insight into the anatomical vocabulary that was used in the fourth century BCE and showed that he had a sense of the form (*εἶδος*) of the horse, as well as how that form could take shape by way of the horse's posture (*σχηματοποιεῖσθαι*). The anatomical vocabulary Xenophon uses has many similarities to modern English vocabulary. These similarities provide the foundation for determining whether Xenophon recommended training practices that correspond with modern models of biomechanical soundness.

To complete this assessment, the similarities and definitions of the ancient Greek and modern anatomical terms are compared in *Appendix 1: Parts of the Ancient Greek Horse (Greek-English)*. The parts of the horse were mapped onto realistic diagrams of a horse with the corresponding anatomical landmarks, and especially the bony landmarks as found in *Appendix 4: Bony Landmarks of the Horse*, to provide an assessment that is as accurate as possible. The three diagrams can be found in Appendix 2 and are labelled as the *General Features of the Ancient Greek Horse*, the *Regional Parts of the Ancient Greek Horse*, and the *Anatomical Parts of the Ancient Greek Horse*. A fourth diagram, *Significant Parts of the Ancient Greek Horse*, can be found in Appendix 3, and it has the most important features from the three diagrams for reading the relevant passages on riding and horse biomechanics in Xenophon's manual.

An assessment of the rider's position showed that the horse could achieve a biomechanically sound posture as the rider would not be interfering with the balance of the

horse. The main passages relating to the physiology of the horse and its posture showed that Xenophon recommended horses have a well-developed *longissimus dorsi* muscle along the backbone (ῥάχις), and the area of the rider's seat, the horse's back (ἔδρα). It was also shown that Xenophon recognized the importance of the loin (ὄσφῦς) to the physiologically correct movement of the horse, and that he recognized three main characteristics of its motion: the collection of the hind quarters, the lifting of the forehand, and the horse's ability to "rear" in a physiologically correct manner. Additionally, Xenophon notes that the flank (κενεών) should not be large as this decreases the horse's mobility. He also recommends against riding the horse in a manner that resulted in the chest (στέρνον) being pushed forward. These recommendations follow modern guidelines of physiologically correct training.

Having examined the recommendations of the horse's midsection, three main types of headsets were assessed to show that Xenophon recommended against practices that encouraged an inverted headset or a hyperflexed headset, both of which correspond to a biomechanically unsound posture. Instead, he wanted the horse's head (κεφαλή) and neck (αὐχίην) to be postured in a biomechanically sound manner that can most accurately be mapped with the posture a stallion assumes when showing off before other horses. This neck position corresponds to the modern "telescoping neck gesture" and it would be possible for the ancient Greek horses to achieve this posture due to Xenophon's recommendations of soundly postured midsection. This model also fits with the description of the stallion's tail (οὐρά) extending upward as the physiology of the tail reflects the development of the neck and back. Lastly, the desired motion of the supple legs moving freely over the ground (τὰ μὲν σκέλη ὑγρὰ μετεωρίζει), rather than the staccato of the impatiently lifted legs (αἴρει δὲ ἄνω τὰ σκέλη ὀργιζόμενος), indicates that Xenophon recognized movement and posture that reflects a biomechanically sound model.

Xenophon's title as the forefather of biomechanically sound training is therefore warranted as he demonstrates knowledge of the posturing of horses that corresponds to biomechanically sound models.

CONCLUSION

From the Bronze Age through to the Classical Period, horses were expensive animals to own, train, and maintain; and were selected by the elite to represent wealth and status in burials and grave monuments. In the Bronze Age (3300-1150BCE) and Iron Age (1150-750 BCE), horses were typically buried with the military elite in displays of elevated social status, wealth, and military prowess. The shared burials, along with the inclusion of equestrian equipment, provided a formulaic expression of status of both the horse and the human, and was a practice that transferred from these early time periods into the changing social-political landscape of the Archaic (750-480 BCE) and Classical (480-323 BCE) Periods.

While the primary association with equine remains and equipment, such as bits, was with male warriors, there were some instances of horses being associated with elite females. This typically occurred with horse figurines on feminine grave goods, such as the 8th century BCE pyxis from the Booties Grave in Athens. In exceptional cases, horses could be associated with women, but equestrian pursuits were primarily in the domain of outdoor, masculine activities, and were therefore associated with men. This is especially evident in the grave monuments from the Classical Period, where depictions of horsemanship that relate to passages in Xenophon's manual, *The Art of Horsemanship*, can be found on the Dexileos Stele (*ca.* 394/3 BCE) and the Horse and Groom Relief (*ca.* 320 BCE). The horse on the Dexileos Stele is displayed in a "rear", an exercise that Xenophon describes in detail to his readers and is one of the primary references for the function of the horse's loin (fig. 3). Likewise, the stallion on the Horse and Groom Relief is depicted mid-gait and is led by a young groom holding the horse's reins in one hand, and a whip in the other (fig. 4). This scene is also remarkably similar to the literary descriptions on horsemanship found in Xenophon's manual (written *ca.* 365-360 BCE) and correlates the visual

depictions of horsemanship with practical skills that needed to be acquired by the cavalry members of the 4th century BCE. There is therefore a long tradition of caring for horses, which correspond to recommendations written by Xenophon in his training manual, *The Art of Horsemanship*.

In the manual, Xenophon details the manner in which the horse should be trained and maintained. Horses require regular upkeep and care to ensure that they reflected the status of the owners, who employed or owned grooms to brush, feed, and clean the stables, but also to ensure that the horses had long, useful lives. A well-kept horse could serve actively up until their 15th-17th year as evidenced by the horses buried with the military elite in the Bronze Age tomb at Dendra.³⁶² In the Archaic period, racehorses served actively until their 14th-16th year as was seen through the three-time Olympic winning mares of Cimon from 536-528 BCE.³⁶³ The mares were not unique in this pattern of victories, even if they may have been exceptional horses who received high-level care, feed, and exercise, as the four-horse chariot team of Eugoras of Sparta also won three consecutive Olympic victories from 548-540 BCE.³⁶⁴ These were not the only horses to reach late maturity within a variety of ancient equestrian “disciplines”/careers.

The age of the horses can be determined through the literary sources of Simon of Athens and Aristotle, who wrote on horse dentition and correlated it to the training levels of horses. Within the first few years of a horse’s life, the patterns of horse teeth can provide relatively accurate evidence for aging, and the information from Simon and Aristotle are consistent with modern research on the growth stages of horse dentition.³⁶⁵ From these similarities and the training practices outlined in Simon’s fragmented manual and Aristotle’s *Historia Animalium*, it

³⁶² Protonotariou-Deilaki 1990, 102.

³⁶³ Hdt. 6.103.3; Plut. *Vit. Cat. Mai.* 5.4; Papakonstantinou 2013, 99-100.

³⁶⁴ Papakonstantinou 2013, 101, n7.

³⁶⁵ Easley 2005, 12; Muylle 2005, 85.

was possible to determine that young horses would not have been used until they were between two-three and up until four-six years old.³⁶⁶ It was therefore possible to determine from the careers of select, known horses, how old they would have been at the end of their lives and careers.

In addition to the two Bronze Age chariot horses and the two four-horse chariot teams of from the Archaic period, the age of ridden horses can also be reasonable determined. The famous racehorse, Lycus, is perhaps the most difficult to age owing to the lack of clear sources, but he could have been approximately 8-10 years old at the end of his racing career.³⁶⁷ By contrast, the military horses of the 4th century BCE likely served up until their 15th year, although possibly a few years less depending on the level of care, feed, maintenance, terrain, and the individual conformation of the horse.³⁶⁸ The most famous warhorse of considerable age is Alexander the Great's horse, Bucephalus, who was supposedly 30 years old at the time of his death and had an active military career for 13-16 years.³⁶⁹ As Aristotle states that horses could have lived up until their 20th year reasonably, and up until they were 30-50 as a well-maintained breeding stallion, it is not unreasonable that most well-cared for, serviceable horses could have lived until their mid-teens.³⁷⁰ The agedness of the horses therefore speaks to the considerable care and attention given to them. As the training technique can affect a horse's health, the longevity of these horses within their select careers shows that there is cause to consider the correct physiological training of ancient Greek horses.

³⁶⁶ Simon, 11; Arist. *Hist.An.* 576b13, 576a12-13.

³⁶⁷ Paus. 6.13.10; Jones 1933, 81; Ebert 1972, 48-49.

³⁶⁸ Bugh 1988, 70.

³⁶⁹ Plut. *Vit.Alex.* 61.1; Arr. *Anab.* 5.19.4-5; Anderson 1930, 10-11; Charles 2007, 126-129.

³⁷⁰ Arist. *Hist.An.* 576a.27-31.

Xenophon's manual, *The Art of Horsemanship*, was written during the height of the Athenian cavalry in the 4th century BCE. The Athenian state cavalry developed into a force first of 300 men between 479-450 BCE, which was divided into three squadrons of 100 men, each lead by a *hipparch*.³⁷¹ By 439/8 BCE, the state cavalry had increased in size to 1000 cavalymen, with 100 men coming from each of the ten tribes.³⁷² Each squadron of 100 men was led by an annually elected phylarch, and the entire force was divided between two *hipparchs*, who led 500 men on either side of the infantry in battle.³⁷³ To fill the increased need of the cavalry, there was an influx of new horse owners and riders from the two upper classes of Athenian society, the *pentakosiomedimnoi* and the *hippeis*, and the state provided financial support to acquire and feed a cavalry horse.³⁷⁴ The development of Xenophon's manual was timely for the standardization of acquiring, training, and maintaining a cavalry horse to successfully fit within the unit.

In *The Art of Horsemanship* (*Περὶ Ἱππικῆς*), Xenophon details the ideal conformation of a horse to make it most suitable for a military career. While Xenophon does not use the term “conformation”, which is a modern term used for the assemblage of the horse's individual parts and the development of its physique, he does describe the horse's form (*εἶδος*). He also indicates that the horse's form can take an ideal shape or posture (*σχηματοποιεῖσθαι*), and he compares this ideal posture to the shape a stallion assumes when displaying himself before other horses (fig. 9). From the description of the horse's ideal conformation and posture, it was possible to compare the ancient Greek parts of the horse with modern parts of the horse (Appendix 1). As Xenophon details the position of the horse in reference to the anatomical locations, it was also possible to create diagrams that reflect the accurate and realistic anatomy and physiology of a horse and

³⁷¹ Bugh 1988, 41-49; Spence 1993, 11-14; Anderson 1961, 130-131.

³⁷² Spence 1993, 15-16; Anderson 1961, 131; Bugh 1988, 49.

³⁷³ Anderson 1961, 131; Spence 1993, 16.

³⁷⁴ Bugh 1988, 52-53, 70; Spence 1993, 16, 198; Anderson 1961, 133.

correlate these areas with Xenophon’s terminology (Appendix 2, 3.) This was largely done through the horse’s bony landmarks, which are consistent in every horse (Appendix 4). By comparing the parts of the ancient Greek horse with modern biomechanical models of soundness, it was possible to map Xenophon’s recommendations onto two main models of a sound and unsound posture (fig. 1, 2).³⁷⁵ To complete the study of the horse’s headsets, it was necessary to include four additional models of biomechanical soundness to incorporate the increased flexibility of the horse’s neck (cervical spine).³⁷⁶ These models were divided into two unsound models, the inverted headset and the hyperflexed headset, and one model of soundness, the ideal headset, which incorporated two biomechanically sound postures as they relate to the angle of the horse’s nose. From the descriptions in Xenophon’s manual, it was possible to determine that the line of the back (*ράχις*), the loin (*όσφῶς*), and the flank (*κενεόν*) were described in a physiologically correct manner. It was also possible to discern that Xenophon recommended against riding techniques that vexed (*λῦπῶνται*) the horse and resemble the unsound posture of the horse in figure 2. He also did not recommend riding practices that resulted in the horse being ridden with biomechanically unsound head postures, such as an inverted or hyperflexed headset (fig. 10, 11). The main model of biomechanical soundness comes from Xenophon’s description of the stallion, which he notes is the ideal shape the horse should take when ridden.³⁷⁷ Xenophon describes the ideal posture of the stallion as, “the horse raises his neck highest and makes the head most convex, looking spirited; he lifts his legs supplely and extends his tail upwards” (*τότε αἴρει τε τὸν ἀνχένα ἀνωτάτω καὶ κυρτοῖ μάλιστα τὴν κεφαλὴν γοργοῦμενος καὶ τὰ μὲν σκέλη ὑγρὰ*

³⁷⁵ Taken from Heuschmann 2009, 85, 87.

³⁷⁶ Taken from ISES 2015, 1, fig. 1a-d.

³⁷⁷ Xen. *Eq.* 10.3.

*μετεωρίζει, τὴν δὲ οὐρὰν ἄνω ἀνατείνει).*³⁷⁸ This posture closely resembles the biomechanically sound stance of the ideal headset, as well as the physiologically correct development and relaxation of the back muscles, which enables the horse to lift its tail and legs in the manner described. A modern example of such a horse can be seen in figure 9, where the stallion is trotting with his neck (*ἀρχήν*) raised highest and his head (*κεφαλή*) bent at the poll (*συγκαμπή*). The legs (*σκέλη*) lift high off the ground and the tail (*οὐρά*) extends upwards, behind the horse. The motion and posture of the stallion Xenophon describes and desired his riders to achieve with their horses most closely resembles a biomechanically sound posture and headset (fig. 1, 12).

Having determined that Xenophon recommended physiologically correct training practices, it would be interesting to compare his recommendations with the sculptural monuments from Classical period. The depiction of the stallion on the Horse and Groom Relief highlights the training similarities, but also the differences (fig. 4). For example, the stallion can be seen a raised neck and arched headset. The horse's nose is above the vertical and not putting harmful stress on the poll (*συγκαμπή*). The legs are caught as if in motion, yet only the left front leg is lifted off the ground. The back (*ράχις*) is slightly dipped, and yet the base of the tail (*οὐρά*) is lifted upwards. The hind legs are planted on the ground and the hocks (*ἀστράγαλος*) are bent, but there is not a great degree of engagement in the hindquarters (*ὀπισθεν*) to lift the forehand (*πρόσθεν*). The musculature of the horse indicates that it may have been ridden in both a sound and unsound manner, as determined through the development of the muscles of the hindquarters, the midsection, and the forehand. Where Xenophon was clear in his description of a horse being postured in a biomechanically sound manner, this brief examination of horse biomechanics in sculptural relief indicates that the artistic depictions may have a completely different tale. Further

³⁷⁸ Xen. *Eq.* 10.4. My own translation with support from the LSJ (1996) and the translation by E.C. Marchant (1968).

study of equine biomechanics in ancient Greece is therefore needed to determine whether the depictions of horsemanship and practices aligned with Xenophon's recommendations.

Letters of Copyright Permissions

Letter of Permission for Diagrams 1-5, Figure 5.

Friday, July 29, 2022 at 11:10:56 Eastern Daylight Time

Subject: Re: Request permission for image use
Date: Thursday, July 28, 2022 at 4:53:35 PM Eastern Daylight Time
From: Heather Rigg
To: [REDACTED] Dogwise Customer Service

[REDACTED]
Wonderful!

Thanks so much!

Heather

From: [REDACTED]
Date: Thursday, July 28, 2022 at 4:52 PM
To: Heather Rigg [REDACTED] Dogwise Customer Service <mail@dogwise.com>
Subject: Re: Request permission for image use

Sounds neat. Go for it.
[REDACTED]

From: Heather Rigg [REDACTED]
Sent: Thursday, July 28, 2022 1:50:47 PM
To: [REDACTED] Dogwise Customer Service <mail@dogwise.com>
Subject: Re: Request permission for image use

Hello [REDACTED]

Thank you very much for the permission to reuse Plate 1 from "Horse Anatomy, A Coloring Atlas" by Kainer and McCracken (1998).

In addition, I am hoping you will grant me permission to adapt the image. In my thesis, I use the image as a way to show the similarities (and differences) between modern horse anatomy and ancient Greek horse anatomy. I have drafted five diagrams that have adapted the horse image as there are intricacies in the Greek literature that require visual explanation. I will be sure to cite the original source and indicate the adaptations made in the captions.

Please let me know if you need any further information from me.

Thank you,

Heather Rigg

Page 1 of 2

From: [REDACTED]
Sent: Thursday, July 28, 2022 12:58:13 PM
To: Dogwise Customer Service <mail@dogwise.com>; Heather Rigg [REDACTED]
Subject: Re: Request permission for image use

You have permission.
Thanks,
[REDACTED]

From: Dogwise Customer Service <mail@dogwise.com>
Sent: Thursday, July 28, 2022 9:03:09 AM
To: Heather Rigg [REDACTED]
Cc: [REDACTED]
Subject: Re: Request permission for image use

Hi Heather,

I received your voice message on this and would be happy to direct you to the right person. I have CC'd [REDACTED] on this since he would be the one to answer this for you.

Thanks
[REDACTED]

From: Heather Rigg [REDACTED]
Sent: Thursday, July 28, 2022 8:59 AM
To: Dogwise Customer Service <mail@dogwise.com>
Subject: Request permission for image use

Hello,

I am a graduate student the University of Waterloo, and I am preparing my thesis for deposit in UWSpace, the university's institutional repository. I understand that you are the copyright holder for the figure:

Plate 1: "External Parts of the Horse" by R. Kainer and T. McCracken (1998) in "*Horse Anatomy, A Coloring Atlas*" (2nd ed.). Alpine Publications. Image copyright 1994, 1998 by Robert A. Kainer and Thomas O. McCracken.

I would like permission to include Plate 1 in my thesis which will be made openly available in [UWSpace](#), tentatively titled, *Posturing Horses: Xenophon on Biomechanical Soundness in 'The Art of Horsemanship'*. Proper citation will be included with the reproduction of this figure.

Please let me know what your process is for providing permission, and if you need any further information from me.

If you do not hold the copyright for this material, or the right to grant this type of permission, I would greatly appreciate any information you can provide to me regarding the rights holder(s), including any contact information.

Thank you for considering this request,

Heather Rigg



Letter of Permission for Figures 1-2.

Sent: Thursday, July 28, 2022 11:05 AM

To: [REDACTED]

Subject: Contact Form Submission

Name
Heather Rigg
Email
[REDACTED]
Subject
Other
Message
Hello,
<p>I am a graduate student the University of Waterloo, and I am preparing my thesis for deposit in UWSpace, the university's institutional repository. I understand that you are the copyright holder for the following figures as found:</p>
<ol style="list-style-type: none">1. "A horse like this in 'relative elevation'..." in "Tug of War: Classical vs Modern Dressage" by Dr. G. Heuschmann (2009), page 85. Drawing by Kaja Möbius, Copyright 2006 by Wu Wei Verlag.2. "A horse in 'absolute elevation'..." in "Tug of War: Classical vs Modern Dressage" by Dr. G. Heuschmann (2009), page 87. Drawing by Kaja Möbius, Copyright 2006 by Wu Wei Verlag.
<p>I would like permission to include the figures on page 85 and 87 in my thesis which will be made openly available in UWSpace, tentatively titled, "Posturing Horses: Xenophon on Biomechanical Soundness in 'The Art of Horsemanship'." Proper citation will be included with the reproduction of these figures.</p>
<p>Please let me know what your process is for providing permission, and if you need any further information from me.</p>
<p>If you do not hold the copyright for this material, or the right to grant this type of permission, I would greatly appreciate any information you can provide to me regarding the rights holder(s), including any contact information.</p>
<p>Thank you for considering this request,</p>
Heather Rigg [REDACTED]

Letter of Permission for Figure 8.

Wednesday, August 3, 2022 at 15:24:00 Eastern Daylight Time

Subject: Re: Copyright permission request
Date: Wednesday, August 3, 2022 at 10:34:38 AM Eastern Daylight Time
From: Mary
To: Heather Rigg

Dear Miss Rigg,

I think you should contact the Metropolitan Museum Journal and request permission to include the photograph in your thesis. Include a xerox of the photograph and explain why you need it and that I approve this request, though the final permission will probably have to come from the Met.

I hope you will publish your dissertation - I would look forward to reading it.

Let me know if I may be more helpful to you.

Sincerely yours,

Mary B. Moore
Professor Emerita, Hunter College, CUNY

-----Original Message-----
From: Heather Rigg [REDACTED]
Sent: Aug 2, 2022 12:23 PM
To: [REDACTED]
Subject: Copyright permission request

Dear Dr. Moore,

My name is Heather Rigg and I am a graduate student at the University of Waterloo, in Waterloo, Ontario, Canada. I received this email address from the Art & Art History Department of Hunter College, New York City. I was directed to Hunter College from the *Metropolitan Museum Journal*.

As indicated, I am a graduate student at the University of Waterloo, and I am preparing my thesis for deposit in UWSpace, the university's institutional repository. I understand that you are the copyright holder for the following figure:

Page 1 of 2

"Reconstruction drawing of the panel on the body of an Attic black-figured hydria attributed to the Antimenes Painter showing a stable scene, ca. 520 B.C." Private Collection, New York. Drawing by Mary B. Moore. As found in "Horse Care as Depicted on Greek Vases before 400 B.C." by Mary B. Moore (2004), *Metropolitan Museum Journal*. vol. 39. p.8, 35-67.

I would like permission to include Figure 9 in my thesis which will be made openly available in [UWSpace](#), tentatively titled, *Posturing Horses: Xenophon on Biomechanical Soundness in 'The Art of Horsemanship'*. Proper citation will be included with the reproduction of this figure.

Please let me know what your process is for providing permission, and if you need any further information from me.

If you do not hold the copyright for this material, or the right to grant this type of permission, I would greatly appreciate any information you can provide to me regarding the rights holder(s), including any contact information.

Thank you for considering this request,

Heather Rigg

████████████████████
████████████████████

Wednesday, August 3, 2022 at 15:23:19 Eastern Daylight Time

Subject: RE: [External] - request permission for image use
Date: Thursday, July 28, 2022 at 5:55:35 PM Eastern Daylight Time
From: Image Licensing
To: Heather Rigg

Dear Heather Rigg,

Thank you for your inquiry below. Please note that I think that the author made the drawing and is the rights holder. Her most recent contribution to a Metropolitan Museum of Art Journal was in 2016, and the About the authors tab provides this information about her: Mary B. Moore is Professor of Art History, Emerita, Hunter College of the City University of New York. I would recommend contacting Hunter College and seeing if they can assist you with contact information.

All best,

[REDACTED]

--

[REDACTED]
Senior Manager of Rights and Permissions
Digital
[REDACTED]

The Metropolitan Museum of Art
1000 Fifth Avenue
New York, NY 10028
[@metmuseum](#)
metmuseum.org

From: Heather Rigg [REDACTED]
Sent: Thursday, July 28, 2022 10:33 AM
To: Image Licensing [REDACTED]
Subject: [External] - request permission for image use

Hello,

I am a graduate student the University of Waterloo, and I am preparing my thesis for deposit in UWSpace, the university's institutional repository. I understand that you are the copyright holder for the following image:

"Reconstruction drawing of the panel on the body of an Attic black-figured hydria attributed to the Antimenes Painter showing a stable scene, ca. 520 B.C." Private Collection, New York. (Drawing by Mary B. Moore). As found in "Horse Care as Depicted on Greek Vases before 400 B.C." by Mary B. Moore (2004), *Metropolitan Museum Journal*. vol. 39. p.8, 35-67.

Page 1 of 2

Letter of Permission for Figures 10-12.

Tuesday, August 2, 2022 at 11:47:34 Eastern Daylight Time

Subject: Re: [NOTIFICATION] New Form Submission From 'Contact' 🦋🦋

Date: Tuesday, August 2, 2022 at 11:38:24 AM Eastern Daylight Time

From: Heather Rigg

To: [REDACTED]

Hi [REDACTED]

Thank you for the permission to use the cropped images with proper citation and captioning.

Yes, the images are used in alignment with the notion expressed in the position statement. I use the images to show unsound postures of the head and neck (hyperflexed, inverted), and I use the images from fig. 1a-b (in front of the vertical/on the vertical) to show biomechanically sound head and neck positions. I can assure you that I do not recommend hyperflexion as a physiologically correct training method.

If you would like more information, please let me know.

Thank you,

Heather

From: [REDACTED]

Date: Tuesday, August 2, 2022 at 10:14 AM

To: Heather Rigg [REDACTED]

Subject: Re: [NOTIFICATION] New Form Submission From 'Contact' 🦋🦋

Hi Heather,

Thanks for checking - yes, you can show the cropped images if you note the way in which they have been changed. Please just ensure that any comments made about the images are in line with the notion of the ISES position paper (ie, you are not arguing that a hyper flexed head carriage is a correct way of going). I'm sure you're not - but just to check.

Kind regards

[REDACTED]

From: Heather Rigg [REDACTED]

Sent: Monday, August 1, 2022 10:33 AM

To: [REDACTED]

Subject: Re: [NOTIFICATION] New Form Submission From 'Contact' 🎉🎉

Hello,

Thank you very much for giving me permission to use the images. I will be sure to reference the material properly as indicated in the ISES position statement.

I have an additional question in regards for permission to use the images. In my thesis, I only use the images from figure 1a-d which have the horse's neck in an upright position as these are the headsets that are relevant for my thesis. I have cropped the figures so that I could more succinctly identify the relevant headsets for my readers. I have currently taken the left-hand horses from from fig. 1a and fig. 1b, the middle horse from fig. 1c, and fig. 1d remains as is. Might I have permission to show these images in this manner? In addition to citing the images as they are in the ISES position statement fully, I will be sure to indicate the adaptations made in the captions.

I would be happy to provide more information and answer any questions, or use the original images as depicted in the ISES position statement.

[REDACTED]

Thank you,

Heather Rigg

From: [REDACTED]
Date: Monday, August 1, 2022 at 5:17 AM
To: Heather Rigg [REDACTED]
Cc: [REDACTED]
Subject: Fw: [NOTIFICATION] New Form Submission From 'Contact' 🎉🎉

Dear Heather
Thank you for contacting ISES. I forwarded your question to [REDACTED] the ISEs Student Representative, who've I've also copied into this email so you have her contact details.

█ response is:
Hi Heather,

Welcome to ISES! Your thesis sounds very interesting and we are happy for you to use the images you mention in your email. Please ensure that the images are cited as they are in the ISES position statement.

We hope that you're able to join us for our annual conference, which starts on August 9th. It's being held at Hartpury College in the U.K., but lots of content will also be streamed so you can view from Canada, too.

Kind regards

Many thanks
█
ISES Media Officer

From: █
Sent: 28 July 2022 16:53
To: █
Subject: [NOTIFICATION] New Form Submission From 'Contact' 🎉🎉

█
█

Name: Heather Rigg
Email: █

Your Message: Hello, I am a graduate student the University of Waterloo, and I am preparing my thesis for deposit in UWSpace, the university's institutional repository. I understand that you are the copyright holder for the following figure: "HNP 'inverted'; HNP 'behind the vertical'; HNP 'in front of the vertical'; HNP 'on the vertical'". (2015). Image by Cristina Wilkins, from "ISES position statement on alterations of the horses' head and neck posture in Equitation (2015)" as found online, <https://www.equitation-science.com/posstat-head-position> I would like permission to include Figure 1.a-d in my thesis which will be made openly available in UWSpace, tentatively titled, Posturing Horses: Xenophon on Biomechanical Soundness in 'The Art of Horsemanship'. Proper citation will be included with the reproduction of this figure. Please let me know what your process is for providing permission, and if you need any further information from me. If you do not hold the copyright for this material, or the right to grant this type of permission, I would greatly appreciate any information you can provide to me regarding the rights holder(s), including any contact information. Thank you for considering this request, Heather Rigg █

█

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APPENDICES

APPENDIX 1: PARTS OF THE ANCIENT GREEK HORSE (GREEK-ENGLISH)

Greek Term	Definition	Ref. # (Appendix 2)	English Term	Definition	Ref. # (Figure 5)
αἰδοῖον τό	<p>“<i>privy parts</i>, both of men and women” (LSJ 1996, 36.)</p> <p>See also, ὄρχις.</p>	1.XIV	genitalia	The reproductive organs of the mare and stallion, including the prepuce (sheath).	
ἀκρωμία ἡ	<p>“<i>point of the shoulder, acromion process</i> [in humans],...in a horse, <i>withers</i>” (LSJ 1996, 58.)</p> <p>Anatomically, the withers may have been perceived as the point of the horse’s shoulder, rather than the modern understanding of the withers being part of the spine as the translation may imply.</p> <p>See also, ὄμος.</p>	3.8	withers	The region of the spine at the base of the mane. Anatomically, the height of the spinous processes of the second-tenth thoracic vertebrae (Heuschmann 2009, 49.)	11
ἀστράγαλος ὁ	<p>“<i>ball of the ankle joint</i> (not to be confused with σφυρόν, <i>ankle</i>)” (LSJ 1996, 262, II.)</p> <p><i>hock</i>, in horses. (Marchant 1968, 355; Sestili 2012, 28.)</p>	3.30	hock	This joint of the hindlimb is located between the tibia and the cannon bone. Anatomically, they are called the tarsal bones. This joint corresponds to the knee of the front limb.	37

αὐχὴν ὄ	<p>“<i>neck, throat</i>” (LSJ 1996, 285.)</p> <p>See also, <i>τράχηλος</i>.</p>	2.F, 3.5	neck	General term for the part of the horse that connects the head with the back, encompassing the external and internal anatomy, including the cervical vertebrae and the associated musculature.	9
γαστήρ ἦ	<p>“<i>paunch, belly</i>” (LSJ 1996, 339.)</p>	3.20	abdomen, belly	Externally, includes the underside of the horse.	26
γλῶττα ἦ	<p>“<i>tongue</i>” (LSJ 1996, 353.)</p>	1.XI	tongue	It is in the mouth, and it lies between the teeth of the left and right side.	
γνάθος ἦ	<p>“<i>jaw; cheek, in pl.; point of a wedge</i>” (LSJ 1996, 353, I.1-2, II.)</p> <p>The underside of the jaw comes together in a wedge on the underside of the skull, near the mouth, and so this term may specifically mean the front portion of the jaw toward the mouth, and toward the nose (<i>rostral</i>) from the shape of the cheek (fig. 5, 6.) This would encompass the modern <i>bars</i> of the mouth (as the term is sometimes</p>	2.D, 3.1	jaw, body of mandible	The jaw, in modern terminology, is typically the entire mandible. The “body of the mandible” is the region of the mandible that encompasses the teeth and bars, which is the straighter portion of the mandible (as opposed to the curved portion that is toward the back of the head.)	

	<p>translated), and it is the region where the bit would sit (Delebesque 1978, 99; Sestili 2012, 28; Morgan 1979, 57.)</p> <p>Xenophon uses <i>γνάθος</i> when referring to the area of the body affected by the bit, as does Plato (Xen. <i>Eq.</i> 10.9; Pl. <i>Ph.</i> 254e.) The term <i>γνάθος</i> is typically translated as the <i>bars</i>, which is the part of the jawbone between the horse’s molars and incisors where there are no teeth (except sometimes, the wolf-tooth.) This is where the bit rests (for an image of this location on a cadaver, see Clayton 2005, 24, fig. 2.51.) The <i>bars</i> do not encompass the teeth or the whole “front” portion of the mandible, which is the <i>body of the mandible</i> (Clayton 2005, 8, fig. 2.9, 28.)</p> <p>See also <i>σιαγών</i>.</p> <p>*<i>Rostral</i> is a directional term used for referring to the anatomy of the</p>				
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	horse (see, Kainer 1998, Plate 2.)				
γόνο τό	<p>“<i>knee</i>” (LSJ 1996, 357.)</p> <p>This refers to the front leg, and it is not the stifle of the hind leg (for which I have not found a term.)</p>	3.11	knee	The joint of the front limb that is between the radius and the cannon bone; the carpal bones.	18
δέρμα τό	“ <i>skin, hide</i> ” (LSJ 1996, 379.)	1.IV	skin	Covers the entire body except the hooves; the fur and hairs of the forelock, mane, and tail grows from it.	
ἔδρα ἦ	<p>“<i>sitting-place; seat or place of anything; the back of the horse, on which the rider sits</i>” (LSJ 1996, 478, I.1, 3-4.)</p> <p>Also used in reference to the rider’s bottom which sits on the horse (Delebecque 1978, 101.)</p>	3.22	back	The area where the rider sits, behind the withers and ahead of the loin, on the thoracic spine and ribcage.	28
θρίξ ἦ	“ <i>hair, ...of a horse’s tail; ...of a horse’s mane</i> ” (LSJ 1996, 806, I, II.1.)	[1.II]	hair	The fibres of the forelock, mane, and tail.	
ἰσχίον τό	“ <i>hip-joint, in which the thigh turns; in pl., fleshy parts round the hip-joint, haunches ...of a horse</i> ” (LSJ 1996, 843, II.1-2.)	3.25	hip-joint	Anatomically, this is where the femur connects to the pelvis. The joint can be located externally through the <i>greater trochanter</i> , a bony	

	<p>According to Delebecque (1978), Xenophon did not differentiate between the two regions (Delebecque 1978, 107.) Within the manual, however, the term only appears in the plural (<i>τά ισχία</i>) (Xen. <i>Eq.</i> 1.13, 7.7, 11.2.)</p> <p>The most literal translation of <i>ισχία</i> corresponds to the regions of the pelvis as indicated in my diagram and the first (and oldest) modern definition provided.</p>			landmark (Fritz 2012, 23; Appendix 4, 27.)	
		3.26	haunches	<p>Recent modern terminology defines the anatomical location of haunches in three different ways: (1) The oldest modern definition indicates that the haunches include the region of “the hips and buttocks” (Stratton 1985, 246.) (2) The second definition indicates that “haunches” is interchangeable with the “hindquarters” (Thomas 2005, 369.) The hindquarters can be defined as the area of “the rear end of the horse, including the croup, rump, and hind legs” (Thomas 2005, 369.) (3) The third source defines the haunches as including “the large joints of the hindquarters: the hip joints, the stifles and the hocks” (Heuschmann 2009, 108.) The third definition is</p>	

				<p>probably the most physiologically accurate, but it is not clear whether Xenophon included these parts of the horse in his use of the term.</p> <p>The term “hindquarters” is used when referring to the relevant area of the horse in ridden exercises, such as the “haunches-in” (see, “travers” in Zetl 2013, 104.)</p>	
κενεών ό	<p>“<i>hollow between ribs and hip, flank</i>” (LSJ 1996, 938.)</p>	3.21	flank	<p>The area between the ribcage and the hind-limb, below the loin. It can also be defined as the “area in front of the stifle; back portion of the abdomen just ahead of the hind leg” (Thomas 2005, 368.)</p>	27
κεφαλή ή	<p>“<i>head of man or beast</i>” (LSJ 1996, 945.)</p>	2.C	head	<p>Anatomically, the skull and mandible.</p>	
κνήμη ή	<p>“<i>part between knee and ankle, leg, shank.</i>” (LSJ 1996, 964.)</p> <p>This applies to both the front and hind limb, and it corresponds to the</p>	3.12	forecannon, hindcannon	<p>The region between the fetlock and the knee (or hock in the hindlimb). This region includes the cannon bone (3rd metacarpal, or metatarsal), as well</p>	19, 38

	region between the knee and fetlock in a horse.			as the tendons and ligaments. For a detailed anatomical depiction, see, Kainer 1998, Plate 14, 19.	
κορυφή ἡ	<p>“<i>head, top: hence, crown, top of the head, of a horse</i>” (LSJ 1996, 983,1.)</p> <p>This is separate to the poll (<i>συγκαμπή</i>), and it is perhaps the region between the ears on the head. The top of the crown (“<i>ἄκρην καὶ κορυφήν</i>”) is identified in the Iliad (Hom. <i>Il.</i> 8. 83), and is possibly the nuchal crest (Kainer 1998, Plate 41, 1.) Marchant translates this term as “crest” (Xen. <i>Eq.</i> 1.11; Marchant 1968, 303.)</p>	3.3			
κυνήποδες οἱ	“ <i>fetlocks of a horse</i> ” (LSJ 1996, 1010.)	3.15	fetlocks	The first, largest visible joint above each hoof. The “joint between the cannon bone and the pastern” (Thomas 2005, 368.)	20
κυνόδους ὁ	“ <i>canine tooth</i> ” (LSJ 1996, 1010.)	1.XIII	canine tooth	A rounded tooth that grows between the incisors and molars along the bars of the horse’s mouth and is where the bit rests.	

				This term could also possibly refer to the wolf tooth, which is a smaller tooth and is a premolar (see Kainer 1998, Plate 41.)	
μηρός ό	<p>“<i>thigh; thigh-bone; generally, leg-bones</i>” (LSJ 1996, 1129, 1-3.)</p> <p>The term is also used with prepositions to indicate different parts of the horse other than thigh itself, such as the forearm (...<i>ὕπὸ ταῖς ὠμοπλάταις</i>), the region of the buttocks (... <i>ὕπὸ τῆ ὀυρᾷ</i>), and the region of the gaskin (<i>ὕπὸ τὰς μηριαίας</i>). The leg bones referenced are typically those that are muscled above the knee and hock, and not the limbs below the knee and hock (see <i>κνήμη</i>.)</p> <p>*Please note: the modern English terms do not necessarily refer to the exact regions as they were understood by</p>	3.27	thigh	The upper, hind leg that anatomically includes the femur (and possibly the hip-joint), and the associated superficial and deep muscles.	34
			stifle	A Greek term for the stifle has yet to be found but it was possibly incorporated within the thigh (<i>μηρός</i>). The stifle is the joint between the femur and tibia, and it includes the patella.	35
		3.10	forearm	The limb below the elbow, and above the knee. Anatomically, it is the radius and its associated musculature.	17
		3.28	buttock	The region below the tail, including the seat bone (ischial tuberosity) and parts of the hamstrings as indicated in the diagram.	33

	Xenophon. For example, the modern gaskin includes the front facing portion of the limb, but I cannot ascertain at this point whether that was considered part of the thigh (<i>μηρός</i>) or below it (<i>ὕπὸ τὰς μηριαίας</i>). The Greeks may have considered the musculature and physical appearance of the limb rather than the boundaries of joints and bones, as is more common in modern definitions.	3.29	gaskin	The region between the stifle and the hock. Anatomically, the tibia and the associated soft tissue of the region.	36
μυκτήρ ὀ	“ <i>nostril</i> ,...freq. in pl.” (LSJ 1996, 1152.)	1.VIII	nostrils	On the end of the nose, above the mouth; the openings for breathing.	4
ὀδοῦς ὀ	“ <i>tooth</i> ” (LSJ 1996, 1199.)	1.XII	teeth	The incisors, molars, and wolf tooth.	
ὄμμα τό	“ <i>eye</i> , poet. word, rare in Prose,...look <i>straight</i> ; <i>eye-sight</i> ; <i>face</i> or human <i>form</i> ” (LSJ 1996, 1222, I, IV.) The region between the eyes has been included as a possible interpretation of the horse’s “face” and to incorporate the	1.VII	eye (and possibly, face)	The eye is located on the front and side of the head. The Greek term incorporates the line of sight, and there is no modern English term that incorporates both the anatomical location and biological function of the eye; but possibly, the	

	<p>line of sight between both eyes; also, as a distinction from the anatomical eye (<i>ὀφθαλμός</i>). Anatomically, Xenophon uses this term when discussing the horse's ideal conformation and position of the horse's head and neck, so that the horse may see what lies ahead of its feet (Xen. <i>Eq.</i> 1.8.) See also, <i>ὀφθαλμός</i>.</p>			<p>eyeball (or eyeballs).</p> <p>For the location of the modern horse's face, see fig. 5, 3. The modern "face" includes the area around and between the eyes, and down the length of the nose along the nasal bones to the top of the nostrils. It does not include the horse's line of sight. For information on the horse's line of sight, see Reece 2009, 153.</p>	
ὄνυξ ὄ	<p>"<i>talons, claws; anything like the nail; of horses and oxen, hoof; Arist. (HA 486b20, PA 690a9) speaks of the hoof (< ὀπλή) as homologous to the nail or claw; of human beings, nail.</i>" (LSJ 1996, 1234.)</p> <p>Possibly, hoof wall, as it is the hard part of the hoof, like the talon or claw of the hoof. Xenophon's description and use of the term indicates that it may have signified the hoof wall to him, as he says that it should</p>	3.18	hoof, hoof wall	<p>Modern terminology differentiates between the hoof and its composite parts.</p> <p>The hoof is the entire unit below the hair line on the leg, called the coronet band (fig. 5, 22), where specialized cells "produce the horn that forms the hoof wall" (Fritz 2012, 38.) The hoof wall is hard and grows continuously, and it is worn by use or trimmed by the farrier. It is</p>	23

	<p>be neither too thick nor thin (Xen. <i>Eq.</i> 1.3). This description would not make sense if he were referring to the hoof (<i>ὄπλή</i>) as a whole.</p> <p>Additionally, the thickness of the hoof wall is visible on the underside of the hoof when it is lifted (see Kainer 1998, Plate 24). Xenophon shows familiarity with the underside of the hoof when he describes the frog (<i>χελιδών</i>), but also how the hoof should be cleaned (Xen. <i>Eq.</i> 6. 2.) This part of the hoof may also have created the ringing sound of the horse's hoof as it walks, which Xenophon describes (Xen. <i>Eq.</i> 1.3).</p> <p>See also <i>ὄπλή, πούς</i>.</p>			<p>possible to change the angle of the hoof in relation to the ground and the horse's limb (Thomas 2005, 186.)</p> <p>For an image of the hoof wall, see Kainer 1998, Plate 24. Figure 1 shows an external view as the hoof would be on the ground. Figure 2 shows the view of the underside of the hoof, including a trimmed and untrimmed image of the hoof wall.</p>	
ὄπισθεν τὰ	<p>“adverb of Place: <i>behind, at the back</i>, opp. <i>πρόσθε</i>; the hinder parts, rear, back” (LSJ 1996, 1238, I.)</p> <p>Contextually, the term is used to indicate the whole hind end, but also just the back legs.</p>	2.B	hindquarters	Anatomically, the croup and hind legs (Fritz 2012, 10); the hind end of the horse.	

ὄπλη ἦ	<p>“<i>hoof</i>”; in Hom. always <i>the solid hoof</i> of the horse; after Hom., like <i>χηλή</i>, <i>the cloven hoof</i> of horned cattle” (LSJ 1996, 1239.)</p> <p>For <i>χηλή</i>, a horse’s hoof, see LSJ 1996, 1989.</p> <p>See also <i>ὄνυξ, πούς</i>.</p>	3.17	hoof	The entire structure upon which the horse walks.	23
ὄρχις ὀ	“ <i>testicle</i> , freq. in pl., <i>testicles</i> ” (LSJ 1996, 1258, 1.)	1.XV	testicles	Reproductive organs of the male horse.	
ὀστέον τό	<p>“<i>bone</i>” (LSJ 1996, 1263.)</p> <p>Used with prepositions to describe parts of the horse, such as the pasterns and the cannon bones (the third metacarpal and metatarsal bones). For example, Xenophon describes the pastern as “the bones above the hoof and below the fetlock” (“...τὰ ἀνωτέρω μὲν τῶν ὀπλῶν κατωτέρω δὲ τῶν κυνηπόδων ὀστᾶ,” Xen. Eq. 1.4.) He also describes the cannon bones as “the bones of the forecannon” (“[τ]ῶν γε μὴν κνημῶν τὰ ὀστᾶ...,” Xen. Eq. 1.5.)</p>	3.16	pastern	The area between the fetlock and the hoof.	21
		3.13	cannon bone	<p>The bone of the forecannon and hindcannon; anatomically, the third metacarpal and metatarsal bones. It is located on the front (<i>dorsal</i>) part of the lower limb between the knee/hock and the fetlock.</p> <p>*<i>Dorsal</i> is a directional term used for referring to the anatomy of the horse (see, Kainer 1998, Plate 2.)</p>	19, 38

	See also, <i>κνήμη</i> , <i>περόνη</i> . (Translations are my own.)				
ὄσφῦς ἡ	<p>“<i>loin or loins, lower part of the back</i> [in humans];...of a horse” (LSJ 1996, 1264.)</p> <p>Xenophon describes the location of two different regions associated with the term, ὄσφῦς. The location of the first region is comparable to the modern loin, as it described as being “...between the ribs and the hips, about the flanks” (“...μεταξὺ τῶν τε πλευρῶν καὶ τῶν ἰσχίων κατὰ τὸν κενεῶνα...”, Xen. <i>Eq.</i> 11.2.)</p> <p>The second region is comparable to the modern <i>croup</i>. This region was mentioned in the manual as “the loin about the tail” (“...τὴν κατ’ οὐρᾶν...”, Xen. <i>Eq.</i> 11. 2.) The region of the croup can be identified in Appendix 2, 3.24. The ancient “croup”</p>	3.23	loin	The loin includes the lumbar vertebrae and the associated musculature, especially the strongest part of the <i>longissimus dorsi</i> muscle and <i>psoas</i> muscle group (Heuschmann 2009, 50, 68; Grönberg 2016, 148.)	29
		3.24	croup	Anatomically, the croup is the area associated with the sacrum. More broadly, the musculature of the croup “encompasses between the area between the pelvis/sacrum and the hip joint” (Heuschmann 2009, 68.)	30
			tailhead	The area around the base of the tail.	32

	could anatomically correspond to a region larger than the modern croup. Based on the outward appearance of the horse, the ancient “croup” could have also included the area of the modern tailhead.				
οὐρά ἥ	“ <i>tail</i> ” (LSJ 1996, 1272.) It can also mean the <i>rear</i> flank of a marching army (LSJ 1996, 1272, II.)	1.III	tail	Comprised of the dock of the tail and the hairs. Anatomically, it includes the coccygeal vertebrae.	
οὖς τό	“ <i>ear, of horses</i> ” (LSJ 1996, 1274.)	1.V	ear	Located on the top and side of the head. The apex of the skull and the nuchal crest is located between the ears.	
ὄφθαλμός ὁ	“ <i>eye, used by Hom. and Hes. mostly in pl., ...the pl. continued most common, but the dual also occurs... </i> ” (LSJ 1996, 1278.) See also, <i>ὄμμα</i> .	1.VI	eye	Located on the front and side of the head, the eyeball.	
περόνη ἥ	“ <i>ligament [and tendons*] below the knee of a horse</i> ” (LSJ 1996, 1395, II.2); also, “ <i>splint-bones</i> ” in pl., by Pollux, a Greek author of the 2nd cent. CE (LSJ 1996, 1395, II.4.)	3.14	Tendinous structures (of the lower limb)	This area includes the deep and superficial flexor tendons, as well as the suspensory ligament (Fritz 2012, 40.) The division between the	19, 38

	<p>Xenophon uses <i>περόνη</i> in the singular (Xen. <i>Eq.</i> 1.5), so he is most likely referring to the tendons and ligaments of the lower limbs. This coincides with his description of lameness in the first chapter of his manual, where he explains that the swelling of the legs may cause “the pin (<i>περόνη</i>) ...to give way and lame the horse” (Xen. <i>Eq.</i> 1.5; Marchant 1968, 301.)</p> <p>*The definition from the LSJ (1996) has been corrected from “<i>ligament</i>” (LSJ 1996, 1395, II.2), which is anatomically incorrect. See also Morgan (1979), who translates <i>περόνη</i> as “back sinew”, which includes both the tendons and ligament in its meaning (Morgan 1979, 16.) “Sinew”, however, is a dated term that is not often used in modern anatomical contexts, but rather “tendinous structures” may</p>			<p>cannon bone and the tendinous structures on the lower limb is indicated by the shaded line. This marks the indent that is typically seen and felt in horses. The front (<i>dorsal</i>) portion of the lower limb is the cannon bone, and the back (<i>palmar, plantar</i>) portion is the tendinous structures.</p> <p>*<i>Dorsal, palmar, and plantar</i> are directional terms used for referring to the anatomy of the horse (see, Kainer 1998, Plate 2.)</p>	
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	<p>replace it (Fritz 2012, 40.) Fritz uses this term for the suspensory ligament which runs parallel to the flexor tendons, all of which are on the back (<i>plantar</i>, <i>palmar</i>) side of the cannon bone.</p> <p>Morgan (1979) does not mention the splint-bones in his commentary on the term, <i>περόνη</i>, which can also cause lameness in a horse (Morgan 1979, 122-124, n.7; Thomas 2005, 318.) The splint bone runs parallel to the cannon bone, and “acts as a guide rail for the flexor tendons” (Fritz 2012, 39.)</p> <p>See also, <i>κνήμη</i>.</p>				
πλευρά ή	<p>“<i>rib</i>, rare in sg;... pl., <i>ribs</i>; generally, <i>side</i> of a man or animal,...sg., also, of <i>one side</i>,...; a <i>side</i> of beef” (LSJ 1996, 1416, I.1-2.)</p>	3.19	thorax or barrel, ribcage	Anatomically, the thorax/barrel is the ribcage, and it is delineated by the line of the ribcage. The end (<i>caudal</i> edge) of the ribcage is palpable through the location of the last rib, which is ahead (<i>cranial</i>) of the flank. The line of the ribcage can	24

				<p>sometimes be seen in physically fit horses. The ribcage is formed by the ribs, and they are supported by the vertebrae of the thoracic spine (Fritz 2012, 24-25.) Of the 18 pairs of ribs, the first eight pairs of ribs connect with the sternum between the front legs of the horse (Kainer 1998, Plate 8.)</p> <p><i>*Caudal and cranial are directional terms used for referring to the anatomy of the horse (see, Kainer 1998, Plate 2.)</i></p>	
πούς ὁ	<p><i>“foot, both of men and beasts;... properly the foot from the ankle downwards;...but also of the leg with the foot; foot as that with which one runs...or walks; freq. with reference to swiftness” (LSJ 1996, 1456-7, 1-2.)</i></p> <p>Therefore, perhaps encompasses (C): the whole region of the hoof, including the hoof wall and the frog as identified</p>	<p>A: 2.K B: 2.L C: 2.M</p>	<p>“hand”, “foot”</p>	<p>The diagram (Plate 1) shows the “hand” and “foot” of the horse to include the carpal bones to the hoof, which is anatomically equivalent to the region from the wrist to the fingers in a human. In my experience, this is not conventionally used as horse owners and professionals tend to refer to specific parts of the horse,</p>	<p>18-23; 38 -37, 20-23 (of the hind end).</p>

	<p>in the associated passage (Xen. <i>Eq.</i>1.3). It could also possibly include (A): the regions from the knee and hock down (as the modern English version), or (B): include the region from the fetlock to the hoof, which would match the LSJ definition for a human and correspond with select passages in Xenophon’s manual (Xen. <i>Eq.</i> 1. 2-3.) More examination is required to determine to what extent the lower limbs were included in this term, if at all.</p>			<p>such as the hoof, pastern, cannon bone, knee, and hock.</p>	
<p>προκόμιον τὸ</p>	<p>“forelock of a horse” (LSJ 1996, 1486.)</p>	1.I	forelock	<p>The hair that grows between the ears on the horse’s forehead.</p>	
<p>πρόσθεν τὰ</p>	<p>“as Adv. ...of Place or Space: <i>before, in front</i>; the <i>forelegs</i> (of a horse)” (LSJ 1996, 1513, B.I.)</p> <p>Potentially also means “the front” of the horse, as compared to the rear, or hind end, of the horse. Typically used in reference to the function of the hind end (<i>ὄπισθεν</i>).</p>	2.A	forehand	<p>The front part of the horse’s body, including the “head, neck, shoulders, and front legs” (Thomas 2005, 369.)</p> <p>In modern language, this is often used in the phrase, “the horse is on the forehand”, to describe a horse</p>	

	For an example, see Xen. <i>Eq.</i> 11. 3.			that is not engaging, i.e., shifting its weight onto the hind end as made possible when riding in biomechanically sound manner.	
ῥάχις ἦ	<p>“the lower part of the back, the chine; the spine or backbone” (LSJ 1996, 1566, 1-2.)</p> <p>In Xenophon, this is in reference to the horse’s back where the rider sits (ἔδρα) (Xen. <i>Eq.</i> 1.11.) Anatomically, it likely refers to the spinous processes of the thoracic, and possibly, lumbar vertebrae of the back that can be felt just below the skin (Fritz 2012, 23-25.) Here Xenophon also refers to the double back, which is likely the development of the <i>longissimus dorsi</i> muscle. (Xen. <i>Eq.</i> 1.11; Morgan 1979, 125, n13.)</p> <p>It should be noted that the term may not include the withers, which are anatomically the spinous processes of the thoracic vertebrae and are</p>	2.I	backbone, spine	<p>The backbone is considered the part of the spine from the withers to the lumbar spine that can be felt just under the skin (see Appendix 4, 23.) The backbone is the top of the spinous processes from the thoracic and lumbar vertebrae.</p> <p>The spine is generally the entire axial skeleton (skull, cervical, thoracic, lumbar, sacral, and coccygeal vertebrae.) For an anatomical depiction of the axial skeleton, see Kainer 1998, Plate 7.</p>	

	considered part of the modern spine. They may however have been considered part of the shoulder (<i>ᾠμος</i>). See also, <i>ἀκρωμία</i> , <i>ᾠμος</i> .				
σιαγών ἦ	<p>“<i>jaw-bone, jaw</i>; (LSJ 1996, 1595.)</p> <p>More specifically, this is perhaps the area of the cheek and corresponding area of the jawbone (angle of the mandible, or jawbone), owing to the reference made in Xenophon when describing the relative size and shape of the head, neck, and cheek (Xen. Eq. 1.8.)</p> <p>The term can also be compared to <i>γνάθος</i>, which is perhaps the area of the jaw between the cheek and the mouth, where the bit rests.</p> <p>See <i>γνάθος</i> above.</p>	2.E, 3.2	cheek	<p>Anatomically, the <i>masseter</i> muscle.</p> <p>The <i>angle of the mandible</i> is the rounded area of the jawbone (mandible), that is covered by the <i>masseter</i> muscle; and, therefore, the cheek. (Clayton 2005, fig. 2.9, n. 26.)</p>	6
σκέλος τό	<p>“<i>leg</i> from the hip downwards; sg., <i>leg</i> of sacrificial victim.” (LSJ 1996, 1606.)</p> <p>This definition for the hind-leg does not necessarily</p>	2.J	leg	<p>General term which can be applied to both the front and back legs. Anatomically, this would include the appendicular skeleton, including</p>	<p>Forelimb: 12,13,15-23.</p> <p>Hindlimb: 34-38, region 20-23, but of</p>

	<p>include the pelvis, as it does anatomically with the modern definition. Xenophon is possibly referring anatomically to the front leg from the elbow* and below, and for the hind-leg, from the hip-joint (where the femur connects to the pelvis) and below. More investigation is needed to determine whether Xenophon included the shoulder and shoulder blade when referring to the front leg.</p> <p>*Xenophon does not mention the armpit/elbow (fig. 5, 16), but Simon of Athens refers to the elbow (<i>μασχάλη ἡ</i>) (Simon, 6.)</p>			the pelvis for the hind-legs.	the hind leg.
στέρνον τό	<p>“<i>breast, chest</i>; both in sg. and pl.; ...of horses; <i>breastbone</i> [in Gal., of 2nd century CE]” (LSJ 1996, 1640, I, III.)</p> <p>This possibly includes the width of the shoulders, and therefore the point of the shoulders (Marchant, 301, n2.) A closer reading of</p>	3.7	chest	The area between the front legs, as well as the front of the body (Thomas 2005, 367.) Anatomically, includes the pectoral muscles, sternum, and the ribcage.	14

	Xenophon may help distinguish the precise anatomical features.				
στόμα τό	“ <i>mouth...of animals</i> ” (LSJ 1996, 1648.)	1.IX	mouth	The whole mouth region, including the lips, tongue, and teeth.	
συγκαμπή ἢ	“ <i>bight, joint, of the elbow joints,...fingers.</i> ” (LSJ 1996, 1662.) “ <i>poll</i> ” (Morgan 1979, 17.) In translations, this region of the horse has been translated as “the bend” (Marchant 1968, 301.) A variation (<i>συγκάμπτω</i>) is translated as “ <i>bend, τὸ σκέλος</i> ” (LSJ 1996, 1662.)	3.4	poll	The top of the horse’s head where the skull connects to the neck; anatomically, the <i>atlanto-occipital</i> joint (Hesuchmann 2009, 48.)	1
τράχηλος ὁ	“ <i>neck, throat;...distd. fr. ἀρχήν...; τράχηλος being...the whole neck and throat, ἀρχήν the back part of the neck in human beings, the upper part in animals; neck of animals, of the horse; the neck as a joint of meat</i> ” (LSJ 1996, 1811-1812, I, I.2.) <i>underside of the neck</i> (i.e., ventral	2.G, 3.6	Neck, throat	The region between the head and shoulders; anatomically, the cervical vertebrae. English terminology does not have a specific term for the underside (<i>ventral side</i>) of the neck and its composite parts.	9

	<p>area), my own inference:</p> <p>Sestili (2012), defines <i>τράχηλος</i> as the neck with a special reference to the upper neck vertebrae (translated from Italian, p. 29.) However, I believe it may refer to the underside of the neck that is visible from the front of the horse when the head is raised, as that would be the area the enemy sees from a head on approach, and so the <i>τράχηλος</i> would therefore be the part of the horse protecting the rider as Xenophon describes (Xen. <i>Eq.</i> 1. 8.)</p> <p>This would support <i>ἀρχήν</i> being used for the top (<i>dorsal</i>) part of the neck (i.e., the upper half of the neck running parallel to the mane) when not referring to the neck in its entirety.</p> <p>See also, <i>ἀρχήν</i>.</p>				
φλέψ ἢ	<p>“<i>blood-vessel, whether vein or artery</i>” (LSJ 1996, 1944.)</p>		<p>blood-vessels, veins, and arteries</p>	<p>carries blood to and from the heart; visible on the exterior of the</p>	

				horse in various places.	
χαίτη ἥ	“of a horse’s <i>mane</i> ” (LSJ 1996, 1970, 2.)	1.II	mane	The hair growing from the top of the neck, i.e., the region of the crest (fig. 5, 8.)	
χεῖλος τό	“ <i>lip</i> ” (LSJ 1996, 1982.)	1.X	lip	The area around the opening of the mouth; mobile.	5
χελιδών ἥ	“ <i>frog in the hollow of a horse’s foot,...</i> so called from its being forked like the swallow’s tail.” (LSJ 1996, 1987, III.)	[3.18]	frog	The forked, tender part of the underside of the horse’s hoof, surrounded by the sole. (See Kainer 1998, Plate 24, Fig. 2.)	
ὠμοπλάτη ἥ	<p>“<i>shoulder-blade</i>, freq. in pl.; also of animals, as of the horse” (LSJ 1996, 2033.)</p> <p>*This is not to be confused with the modern definition of the shoulder-blade, which is anatomically the scapula. The Greek term potentially refers to the entire shoulder region as seen from the surface, hence the comparison to the shoulder. Except, Xenophon refers to the forearms (<i>μηρός</i>) as being under the shoulder-blade (“<i>[μ]ηροί γε μέντοι οἱ ὑπὸ ταῖς</i></p>	3.9	shoulder	The modern shoulder is anatomically the region above the point of the shoulder, and it is more specifically composed of the scapula.	12
			arm	Anatomically, the region of the humerus; below the point of the shoulder, and above the elbow joint.	15

	<p><i>ὠμοπλάταις</i>,” Xen. Eq. 1.7.) This implies that the <i>ὠμοπλάτη</i> may encompass the entirety of the shoulder region above the elbow (i.e., fig. 5, 12, 15.) Sestili suggests that the term may also include the elbow (Sestili 2012, 28.) The musculature of the shoulder region, especially the <i>brachial triceps</i> muscle (fig. SupM., 17), may correspond visually to this area appearing as a single unit.</p> <p>For further clarification, <i>πλάτη</i> (ῆ), means: “<i>flat or broad object; blade of an oar.</i>” (LSJ 1996, 1413, I, 1.)</p> <p>See also, <i>ᾠμος</i>.</p>				
ᾠμος ὀ	<p>“<i>the shoulder with the upper arm</i> [in humans]; <i>the shoulder...</i> also of animals, as of a horse (LSJ 1996, 2033, a, b, b.2.)</p> <p>Perhaps used more generally or broadly than <i>ὠμοπλάτη</i>. Anatomically, it could include the “<i>shoulder-blade</i>”</p>	2.H	shoulder	The modern shoulder is anatomically the region above the point of the shoulder and is more specifically composed of the scapula.	12

<p>(<i>ὀμοπλάτη</i>) as well as the withers.</p> <p>Xenophon used the term when discussing the shoulder from the rider’s position, indicating that high withers would provide a stronger grip on the shoulders and a more secure seat for the rider (“[<i>ἡ</i>] δ’ αὖ <i>ὕψηλὴ ἀκρωμία</i> τῶ τε ἀναβάτη ἀσφαλεστέραν τὴν ἔδραν καὶ <i>τοῖς ὤμοις</i> ἰσχυροτέραν τὴν πρόσφυσιν παρέχεται”) (Xen. <i>Eq.</i> 1.11.)</p> <p>The withers (<i>ἀκρωμία</i>) were perhaps considered part of the shoulder, as that was the term used for the point of the human shoulder. This understanding would allow for <i>ὀμοπλάτη</i> to be used more specifically for the “shoulder-blade,” understood to include the scapula, humerus, and the <i>brachial triceps</i> muscle. More research is required to determine the anatomical differences between</p>			
	point of shoulder	The bony protuberance of the shoulder joint.	13
	arm	Anatomically, the region of the humerus; below the point of the shoulder, and above the elbow joint.	15
	withers	Spinous processes of the thoracic vertebrae. Visually and anatomically, the scapula overlaps the withers on the side of the horse. See also <i>ἀκρωμία</i> .	11

	<p>the two terms of the shoulder, if any.</p> <p>See also, ὠμοπλάτη, ἀκρωμία.</p>				
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Other reference works on the parts of the ancient Greek horse:

For an Italian vocabulary of Xenophon's anatomical terminology, see Sestili 2012, 28-29. For a full lexicon of technical and anatomical terms as found in Xenophon's *Art of Horsemanship*, see Delebecque 1978, 93-127. The anatomical terms presented by Sestili are generally more anatomically correct and accurate. An *apparatus criticus* of Xenophon's manual and a preliminary diagram of the labelled parts of the horse in Greek can be found in Widdra (1964). Some of the parts are mislabelled or missing on the diagram (Widdra 1964, 5.) See Appendix 2 for the corresponding diagrams associated with this appendix.

For an overview of modern directional terms used for the horse's body, see Kainer 1998, Plate 2.

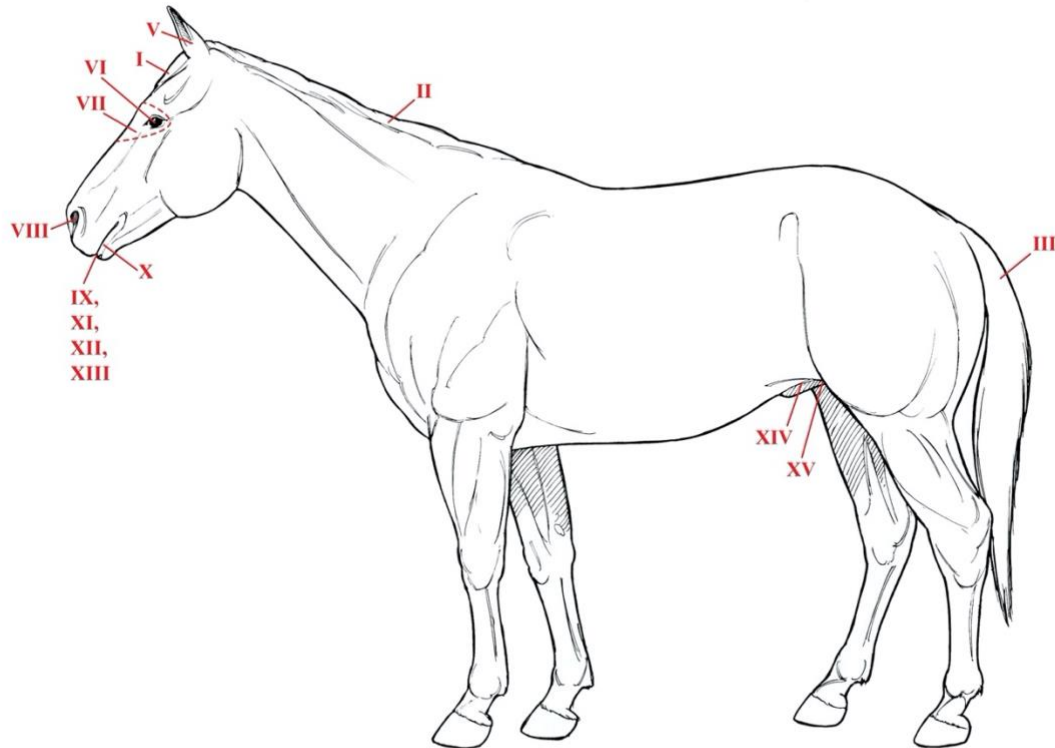
APPENDIX 2: PARTS OF THE ANCIENT GREEK HORSE (DIAGRAMS 1-3)

Ref. #	Greek Term	Modern Term
1. General Features of the Ancient Greek Horse		
Features of the Body		
I	προκόμιον τὸ	forelock
II	χαίτη ἢ [θρίξ ἢ]	mane hair
III	οὐρά ἢ	tail
IV	δέρμα τό	skin, hide
	Please note: This feature is not indicated on the diagram as the skin encompasses the entire body, except the hooves (ὀπλή, ὄνουζ) and the hairs (θρίξ) of the forelock, mane, and tail.	
Features of Head		
V	οὔς τό	ear
VI	ὄφθαλμός ὁ	eye
VII	ὄμμα τό	eye (incl. line of sight, “face”)
VIII	μυκτήρ ὁ	nostril
IX	στόμα τό	mouth
X	χεῖλος τό	lips
XI	γλῶττα ἢ	tongue
XII	ὀδούς ὁ	tooth
XIII	κυνόδους ὁ	canine tooth
Reproductive Organs		
XIV	αἰδοῖον τό	genitals, prepuce
XV	ὄρχις ὁ	testicles
2. Regional Parts of the Ancient Greek Horse		
A	πρόσθεν τὰ	forehand
B	ὀπισθεν τὰ	hindquarters
C	κεφαλή ἢ	head
D	γνάθος ἢ	cheek, jaw
E	σιαγών ἢ	cheek, jaw

F	αὐχὴν ὀ	neck, throat
G	τράχηλος ὀ	neck, throat
H	ῶμος ὀ	“shoulder”
I	ῥάχις ἦ	backbone
J	σκέλος τό	legs (front and hind)
K	πούς ὀ (See Appendix 1, “πούς,” (A))	foot (knee/hock-hoof)
L	πούς ὀ (See Appendix 1, “πούς,” (B))	foot (fetlock-hoof)
M	πούς ὀ (See Appendix 1, “πούς,” (C))	foot (hoof)
3. Anatomical Parts of the Ancient Greek Horse		
1	γνάθος ἦ	body of mandible
2	σιαγών ἦ	angle of mandible
3	κορυφή ἦ	crown
4	συγκαμπή ἦ	poll
5	αὐχὴν ὀ	neck (topside)
6	τράχηλος ὀ	neck (underside)
7	στέρνον τό	chest
8	ἀκρωμία ἦ	withers
9	ῶμοπλάτη ἦ	shoulder-blade
10	μηρός ὀ... (“ὑπὸ ταῖς ὠμοπλάταις”)	forearm
11	γόνυ τό	knee
12	κνήμη ἦ	forecannon/hindcannon
13	ὀστέον τό... (“[τ]ῶν γε μὴν κνημῶν”)	cannon bone
14	περόνη ἦ	tendinous structures
15	κυνήποδες οἱ	fetlocks
16	ὀστέον τό... (“ἀνωτέρω μὲν τῶν ὀπλῶν, κατωτέρω δὲ τῶν κυνηπόδων”)	pastern bones
17	ὀπλή ἦ	hoof
18	ὄνυξ ὀ	hoof, hoof wall
	[χελιδῶν ἦ]	frog
19	πλευρά ἦ	thorax or barrel, ribcage
20	γαστήρ ἦ	belly, abdomen

21	κενεών ό	flank
22	ἔδρα ή	seat, back
23	όσφῦς ή	loin
24	όσφῦς ή... (“τήν κατ’ οὐράν”)	croup
25	ίσχίον τό	hip-joint (sg.)
26	ίσχία τά (see Appendix 1, <i>ίσχίον τό</i>)	haunches (pl.)
27	μηρός ό	thigh
28	μηρός ό... (“ὑπό τῆ οὐρά”)	buttock
29	μηρός ό... (“ὑπό τὰς μηριαίας”)	gaskin
30	ἀστράγαλος ό	hock

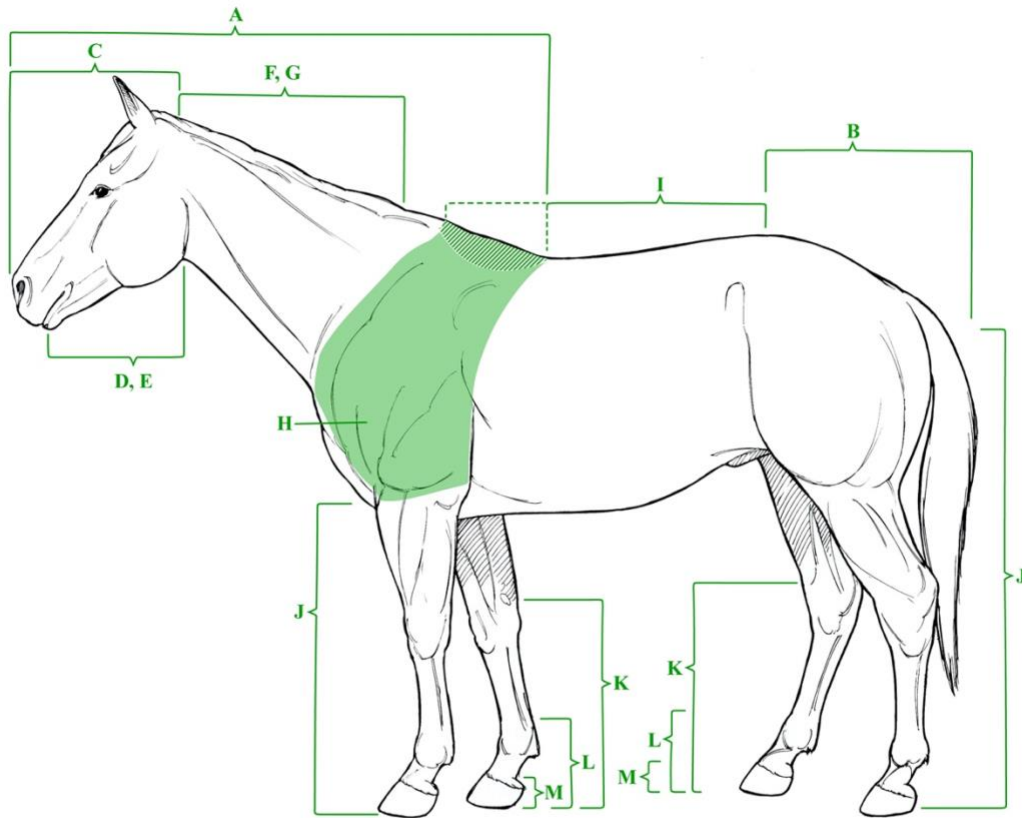
DIAGRAM 1. GENERAL FEATURES OF THE ANCIENT GREEK HORSE



Adapted with permission from “External Parts of the Horse,” by R. Kainer and T. McCracken, 1998, Plate 1. Copyright 1994, 1998 by Robert A. Kainer and Thomas O. McCracken.

Adaptations: The underlying image of the horse was used and the dotted lines that previously indicated the parts of the modern horse were removed. Red lines and Roman numerals (I-XV) were used to indicate the location general features of the horse. The adaptations were made by the author, Heather M. Rigg. The diagram was digitized by Ashley Street.

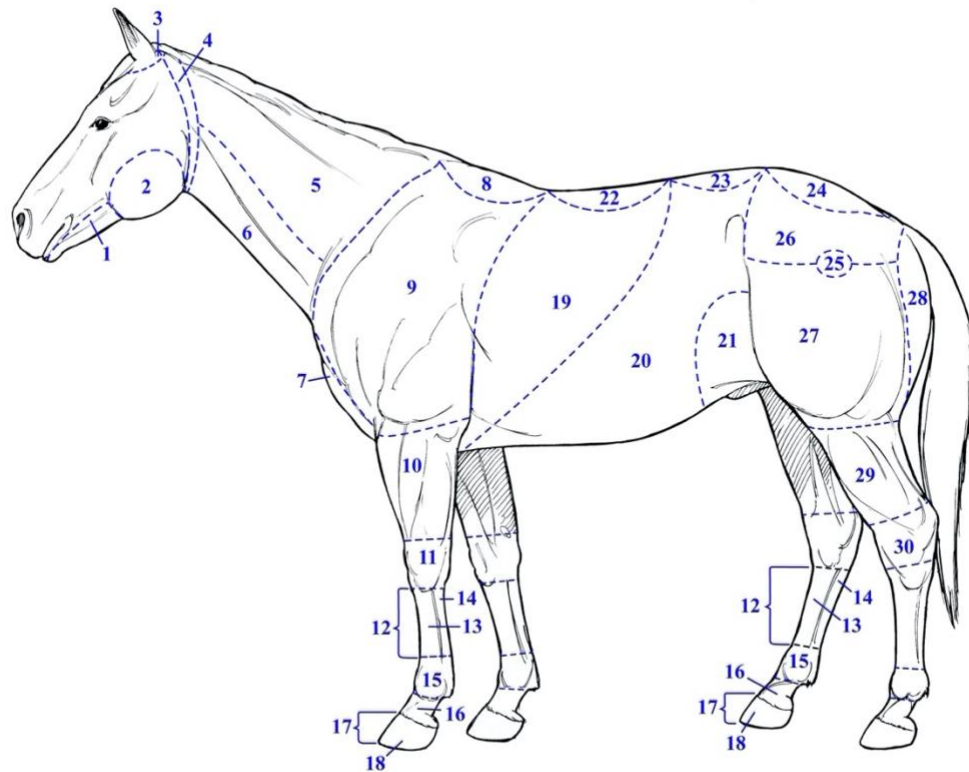
DIAGRAM 2. REGIONAL PARTS OF THE ANCIENT GREEK HORSE



Adapted with permission from “External Parts of the Horse,” by R. Kainer and T. McCracken, 1998, Plate 1. Copyright 1994, 1998 by Robert A. Kainer and Thomas O. McCracken.

Adaptations: The underlying image of the horse was used and the dotted lines that previously indicated the parts of the modern horse were removed. Green lines and capital letters (A-M) were added to show the regional parts of the ancient Greek horse and green shading was added as necessary. The adaptations were made by the author, Heather M. Rigg. The diagram was digitized by Ashley Street.

DIAGRAM 3. ANATOMICAL PARTS OF THE ANCIENT GREEK HORSE



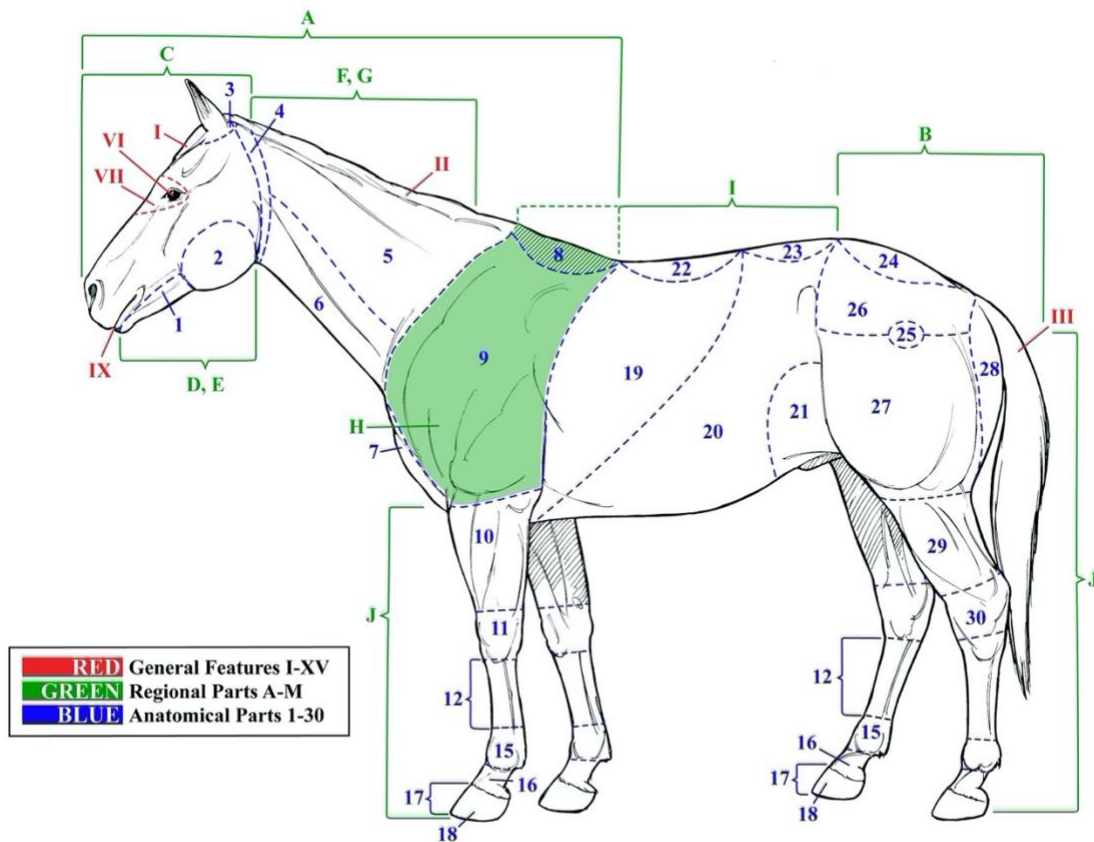
Adapted with permission from “External Parts of the Horse,” by R. Kainer and T. McCracken, 1998, Plate 1. Copyright 1994, 1998 by Robert A. Kainer and Thomas O. McCracken. Adaptations: The underlying image of the horse was used and the dotted lines that previously indicated the parts of the modern horse were adapted as necessary. The original lines of the image were kept when they aligned with the anatomical parts of the ancient Greek horse. In some instances, the lines were removed and/or modified to accommodate the differences in the anatomical parts of the ancient Greek horse, and the numbering was changed from 1-38 to 1-30. The ordering of the parts of the horse was kept consistent with the original image, and it was modified when needed to accommodate the sequence of the anatomical parts of the ancient Greek horse. The colour of the lines was changed from black to dark blue. The adaptations were made by the author, Heather M. Rigg. The diagram was digitized by Ashley Street.

APPENDIX 3: SIGNIFICANT PARTS OF THE ANCIENT GREEK HORSE (DIAGRAM 4)

Ref. #	Greek Term	Modern Term
1. General Features of the Ancient Greek Horse		
I	προκόμιον τὸ	forelock
II	χαίτη ἡ	mane
III	οὐρά ἡ	tail
VI	ὄφθαλμός ὁ	eye
VII	ὄμμα τό	eye (incl. line of sight, “face”)
IX	στόμα τό	mouth
2. Regional Parts of the Ancient Greek Horse		
A	πρόσθεν τὰ	forehand
B	ὀπισθεν τὰ	hindquarters
C	κεφαλή ἡ	head
D	γνάθος ἡ	cheek, jaw
E	σιαγών ἡ	cheek, jaw
F	αὐχὴν ὁ	neck, throat
G	τράχηλος ὁ	neck, throat
H	ῶμος ὁ	shoulder
I	ῥάχις ἡ	backbone
J	σκέλος τό	leg (front or hind)
3. Anatomical Parts of the Ancient Greek Horse		
1	γνάθος ἡ	body of mandible
2	σιαγών ἡ	angle of mandible
3	κορυφή ἡ	crown
4	συγκαμπή ἡ	poll
5	αὐχὴν ὁ	neck (top)
6	τράχηλος ὁ	neck (underside)
7	στέρνον τό	chest
8	ἀκρωμία ἡ	withers
9	ὠμοπλάτη ἡ	shoulder-blade

10	μηρός ό... (“ <i>ὕπὸ ταῖς ὠμοπλάταις</i> ”)	forearm
11	γόνυ τό	knee
12	κνήμη ή	forecannon/hindcannon
15	κυνήποδες οί	fetlocks
16	όστέον τό... (“ <i>ἀνωτέρω μὲν τῶν ὀπλῶν, κατωτέρω δὲ τῶν κυνηπόδων</i> ”)	pastern bones
17	όπλή ή	hoof
18	ὄνυξ ό	hoof, hoof wall
19	πλευρά ή	ribcage, thorax, barrel
20	γαστήρ ή	belly, abdomen
21	κενεών ό	flank
22	ἔδρα ή	seat, back
23	όσφῦς ή	loin
24	όσφῦς ή... (“ <i>τὴν κατ’ οὐράν</i> ”)	croup
25	ίσχίον τό	hip-joint (sg.)
26	ίσχία τά (see Appendix 1, <i>ίσχίον τό</i>)	haunches (pl.)
27	μηρός ό	thigh
28	μηρός ό... (“ <i>ὕπὸ τῆς οὐρᾶς</i> ”)	buttock
29	μηρός ό... (“ <i>ὕπὸ τὰς μηριαίας</i> ”)	gaskin
30	ἀστράγαλος ό	hock

DIAGRAM 4. SIGNIFICANT PARTS OF THE ANCIENT GREEK HORSE



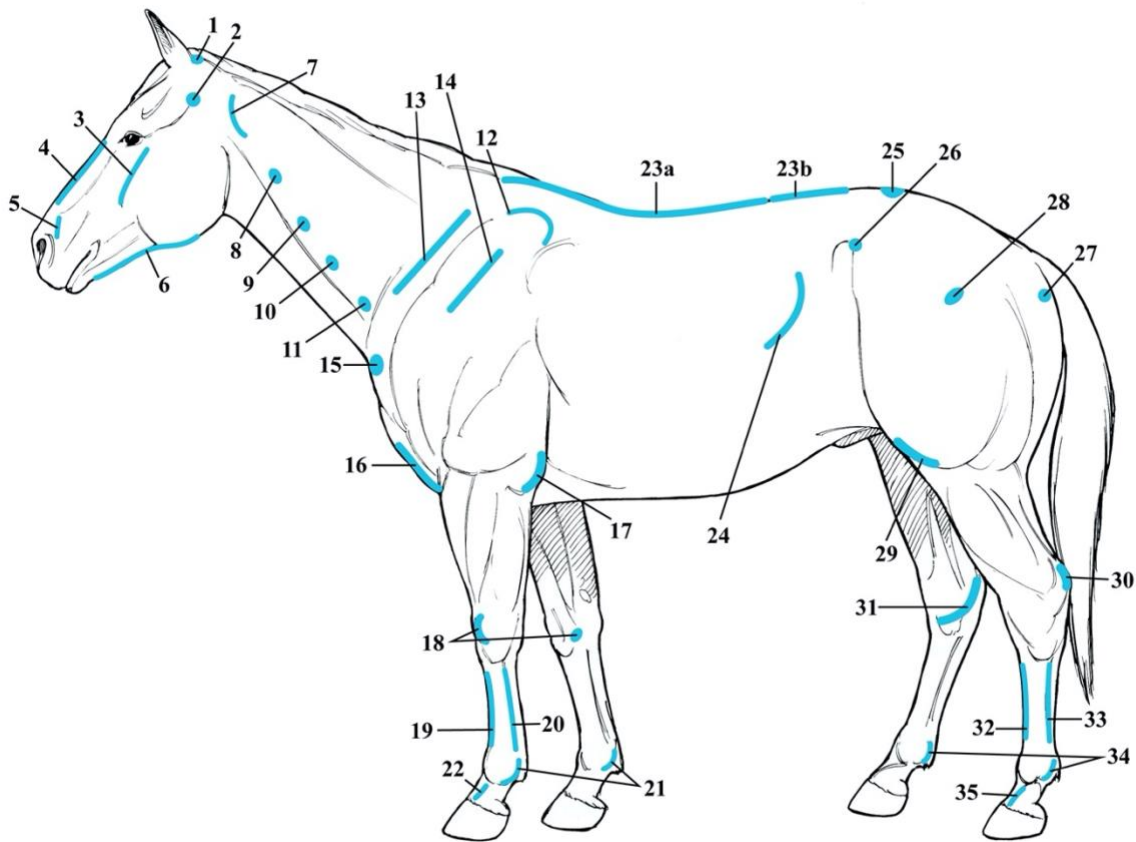
Adapted with permission from “External Parts of the Horse,” by R. Kainer and T. McCracken, 1998, Plate 1. Copyright 1994, 1998 by Robert A. Kainer and Thomas O. McCracken. Adaptations: The underlying image of the horse was used and the dotted lines that previously indicated the parts of the modern horse were adapted as necessary. The original lines of the image were kept when they aligned with the anatomical parts of the ancient Greek horse. In some instances, the lines were removed and/or modified to accommodate the differences in the anatomical parts of the ancient Greek horse. The numbering of the body parts was kept from the original image and modified to include the anatomical parts of the ancient Greek horse when needed. The numbering of the general features and the regionals parts of the horse was added. The general features are indicated in red and in Roman numerals (I-XV); the regional parts are indicated in green and capital letters (A-M), and the lines of the anatomical parts of the ancient Greek horse are drawn in dark blue with numbers (1-30). The individual diagrams can be found in Appendix 2. The adaptations were made by the author, Heather M. Rigg. The diagram was digitized by Ashley Street.

APPENDIX 4: BONY LANDMARKS OF THE HORSE (DIAGRAM 5)

#	English Term (Modern References)
1	Nuchal crest
2	Mandibular joint
3	Cheekbone
4	Nasal bone
5	Incisive bone
6	Lower jaw (mandible)
7	Wing of atlas
8	3rd cervical vertebrae
9	4th cervical vertebrae
10	5th cervical vertebrae
11	6th cervical vertebrae
12	Scapular cartilage
13	Anterior (<i>cranial</i>) edge of shoulder blade
14	Spine of scapula
15	Point of shoulder (shoulder joint)
16	Sternum (between the front legs)
17	Elbow (olecranon process)
18	Knee (carpal bones)
19	Cannon bone, anterior (<i>dorsal</i>) surface
20	Cannon bone, posterior (<i>palmar</i>) surface; splint bone
21	Fetlock joint
22	Pastern bones
23	Spinous processes of the thoracic (a) and lumbar (b) vertebrae*
24	Last rib (caudal edge of the ribcage)
25	Iliac tuberosity (pelvis)
26	Coxal tuberosity (pelvis)
27	Ischial tuberosity (pelvis)
28	Greater trochanter (hip-joint)
29	Stifle (and patella)

30	Protuberance of the hock (calcaneus)
31	Hock (tarsal bones)
32	Cannon bone, anterior (<i>dorsal</i>) surface
33	Cannon bone, posterior (<i>plantar</i>); splint bone
34	Fetlock joint
35	Pastern bones
Notes	<p>Image adapted from Kainer (1998), Plate 1; list adapted from Fritz 2012, 23. The directional terms for the horse are indicated in brackets (i.e., <i>dorsal</i>, <i>palmar</i>, <i>plantar</i>, <i>cranial</i>.) Otherwise, <i>anterior</i> and <i>posterior</i> have been used in this chart for general comprehension.</p> <p>*The spinous processes of T1 and L6 are more difficult to feel from the surface of the skin as they are located deeper within the body.</p>

DIAGRAM 5. BONY LANDMARKS OF THE HORSE

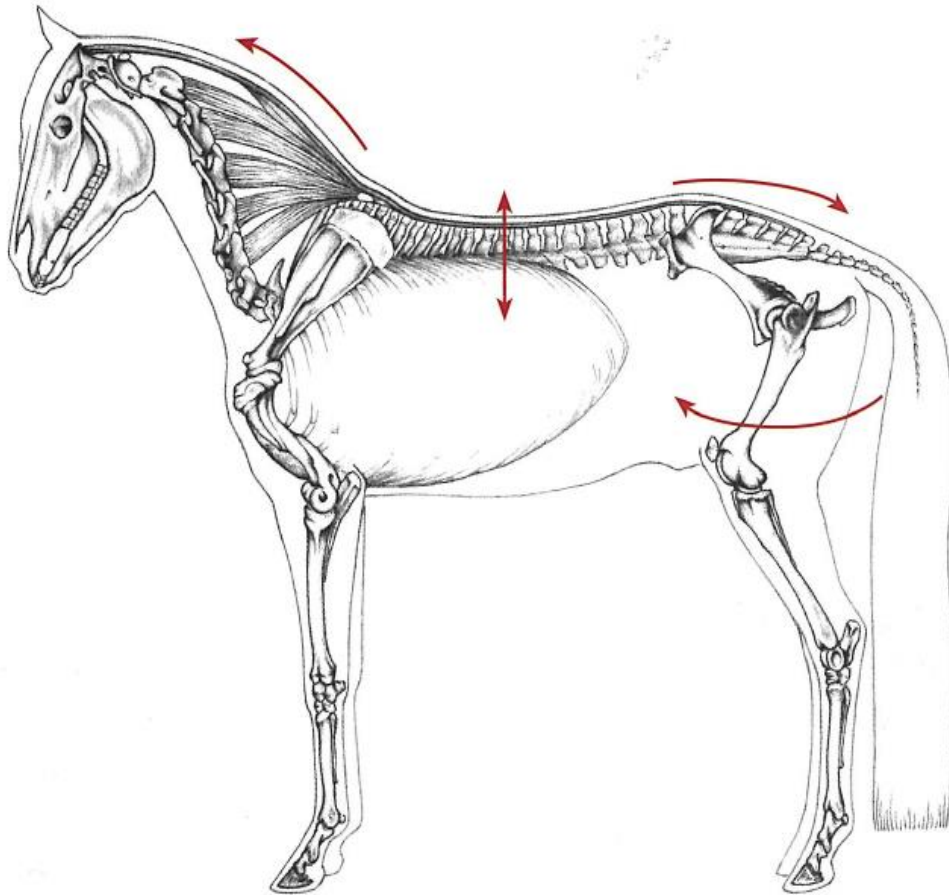


Adapted with permission from “External Parts of the Horse,” by R. Kainer and T. McCracken, 1998, Plate 1. Copyright 1994, 1998 by Robert A. Kainer and Thomas O. McCracken.

Adaptations: The underlying image of the horse was used and the dotted lines that previously indicated the parts of the modern horse were removed. The locations of the bony landmarks were added in light blue by the author, Heather M. Rigg. The diagram was digitized by Ashley Street.

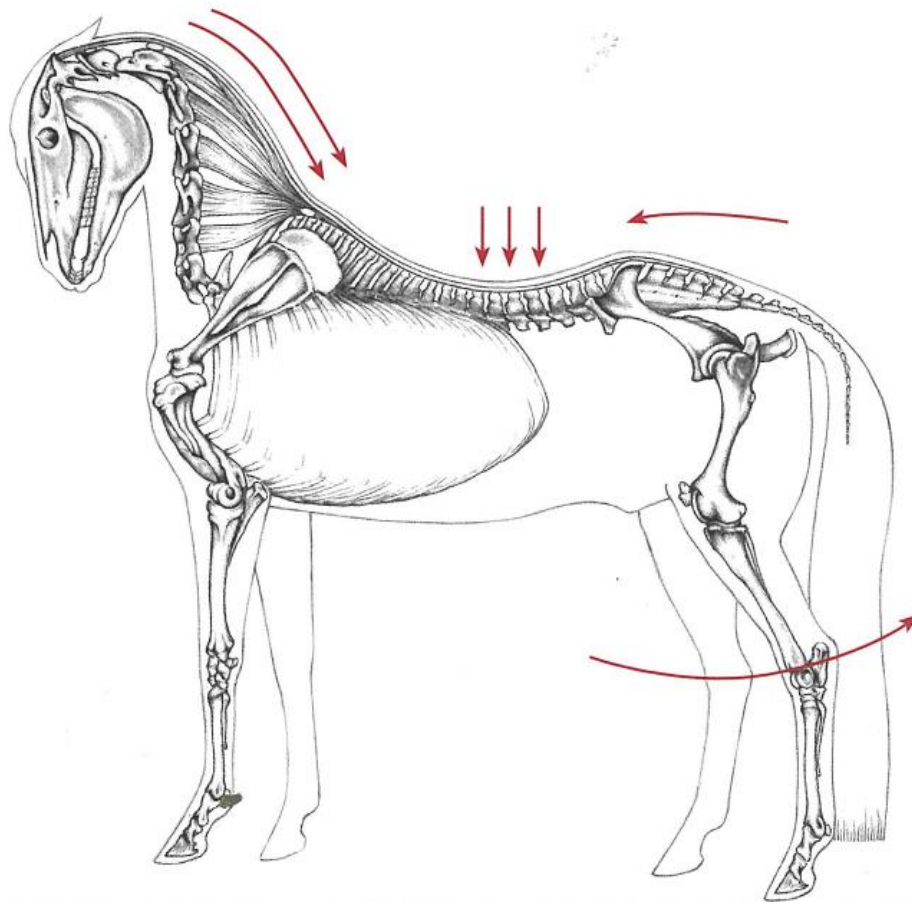
APPENDIX 5: FIGURES

FIGURE 1. BIOMECHANICALLY SOUND POSTURE



From "Relative Elevation," by G. Heuschmann, 2009, page 85. Drawing by Kaja Möbius. Copyright 2006 by Wu Wei Verlag. Used with permission.

FIGURE 2. BIOMECHANICALLY UNSOUND POSTURE



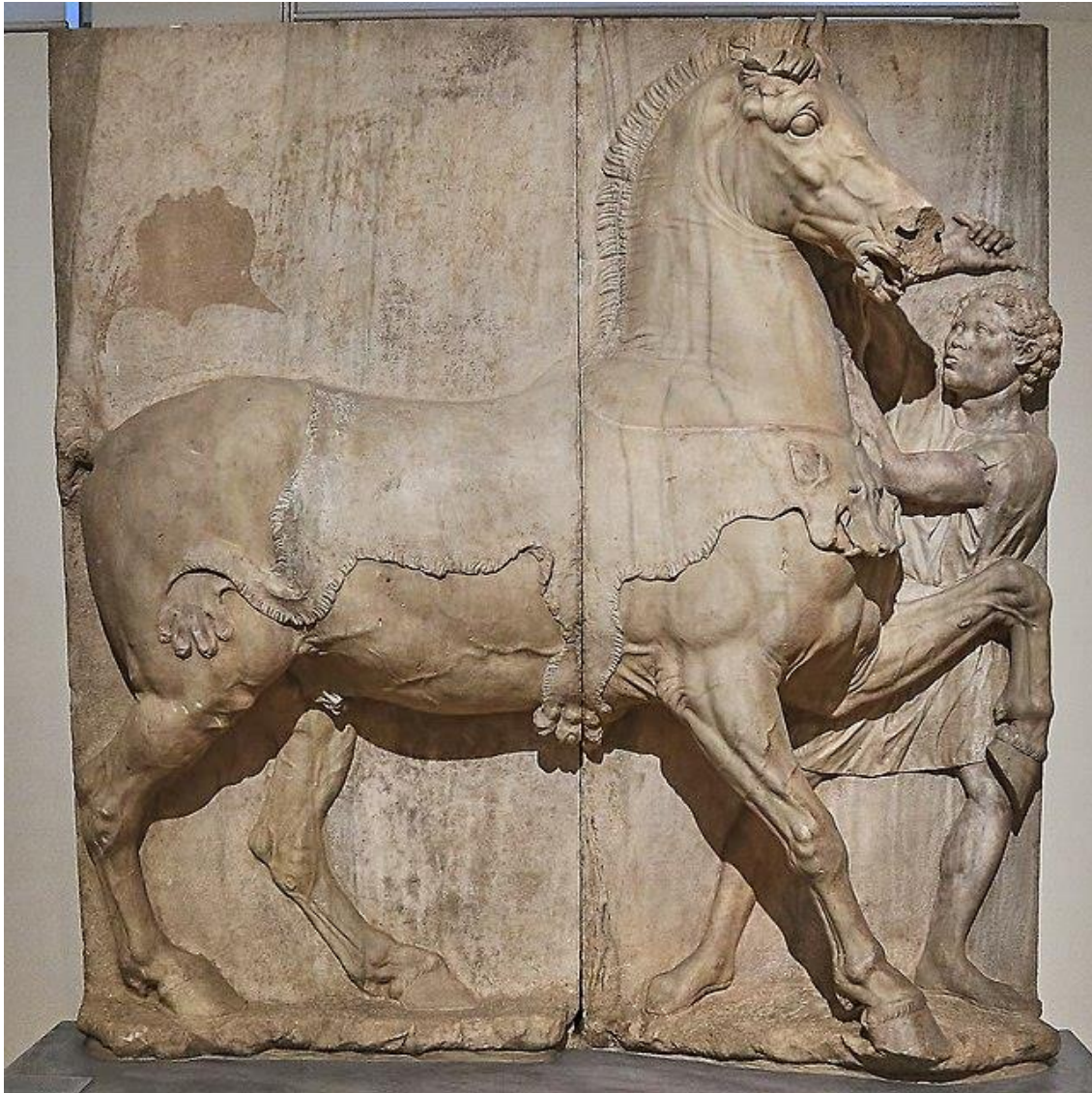
From "Absolute Elevation," by G. Heuschmann, 2009, page 87. Drawing by Kaja Möbius. Copyright 2006 by Wu Wei Verlag. Used with permission.

FIGURE 3. GRAVE STELE OF DEXILEOS, CA. 394/3 BCE



Grave Stele of Dexileos, *ca.* 394/393 BCE. Sculpture, Marble. Attic. Archaeological Museum of Kerameikos, Athens, P 1130 (I 220). Image from “Grave stele of Dexileos – KAMA 01.jpg,” by Jerónimo Roure Pérez, as Dorieo, License CC-BY-SA 4.0. https://commons.wikimedia.org/wiki/File:Grave_stele_of_Dexileos_-_KAMA_01.jpg. Taken from *Wikimedia Commons* on July 28, 2022. Image cropped.

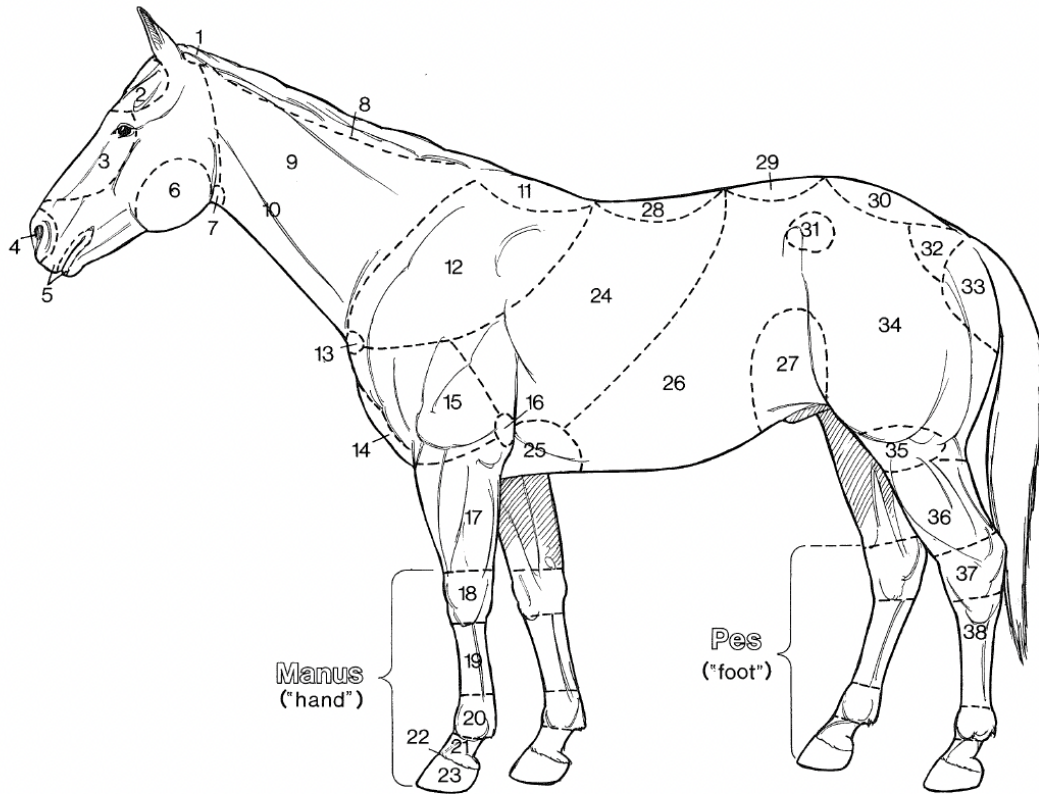
FIGURE 4. HORSE AND GROOM RELIEF, CA. 320 BCE



Horse and Groom Relief, *ca.* 320 BCE. Monumental Relief/Stone Base. Attic. National Archaeological Museum, Athens, 4464. Image from “Grave stele depicting a horse and its Ethiopian groom (4th cent. B.C.) at the National Archaeological Museum of Athens on 7 May 2018.jpg,” by George E. Koronaios.

[https://commons.wikimedia.org/wiki/File:Grave_stele_depicting_a_horse_and_its_Ethiopian_groom_\(4th_cent._B.C.\)_at_the_National_Archaeological_Museum_of_Athens_on_7_May_2018.jpg](https://commons.wikimedia.org/wiki/File:Grave_stele_depicting_a_horse_and_its_Ethiopian_groom_(4th_cent._B.C.)_at_the_National_Archaeological_Museum_of_Athens_on_7_May_2018.jpg). Taken from *Wikimedia Commons* on July 28, 2022.

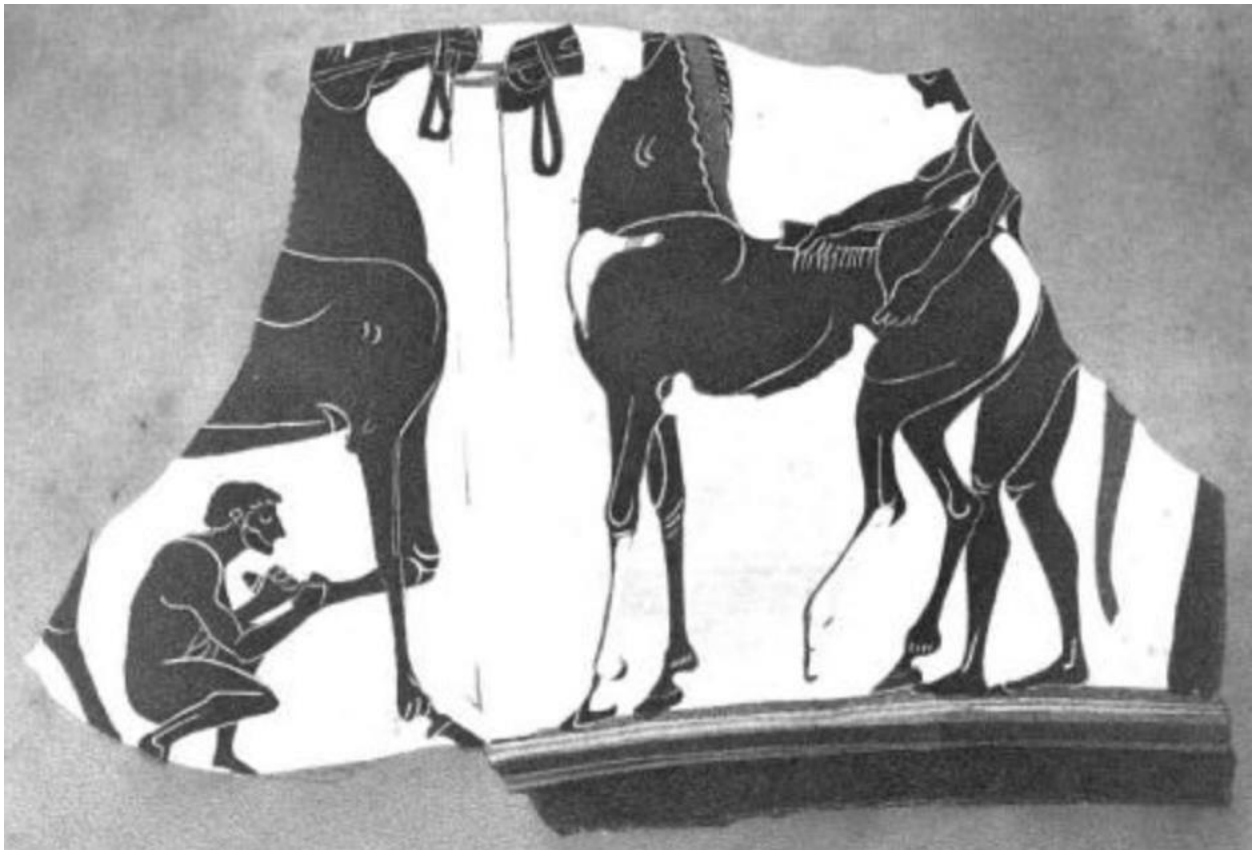
FIGURE 5. ANATOMICAL PARTS OF THE MODERN HORSE



- | | | |
|---|------------------------------|-----------------------------------|
| 1. Poll | 14. Chest | 27. Flank |
| 2. Forehead | 15. Arm | 28. Back |
| 3. Face | 16. Elbow | 29. Loin |
| 4. Nostril | 17. Forearm | 30. Croup |
| 5. Lips | 18. Carpus or knee | 31. Point of hip
(coxal tuber) |
| 6. Jaw | 19. Metacarpus or forecannon | 32. Tailhead |
| 7. Throatlatch | 20. Fetlock or ankle | 33. Buttock |
| 8. Crest | 21. Pastern | 34. Thigh or quarter |
| 9. Neck | 22. Coronet | 35. Stifle |
| 10. Jugular groove | (joins skin of 21 & 23) | 36. Leg or gaskin |
| 11. Withers | 23. Hoof | 37. Tarsus or hock |
| 12. Shoulder | 24. Thorax or barrel | 38. Metatarsus or hindcannon |
| 13. Point of shoulder
(middle of the shoulder joint) | 25. Girth | |
| | 26. Abdomen or belly | |

From "External Parts of the Horse," by R. Kainer and T. McCracken, 1998, Plate 1. Copyright 1994, 1998 by Robert A. Kainer and Thomas O. McCracken. Used with permission.

FIGURE 6. UNATTRIBUTED BLACK-FIGURE CUP, CA. 520-500 BCE



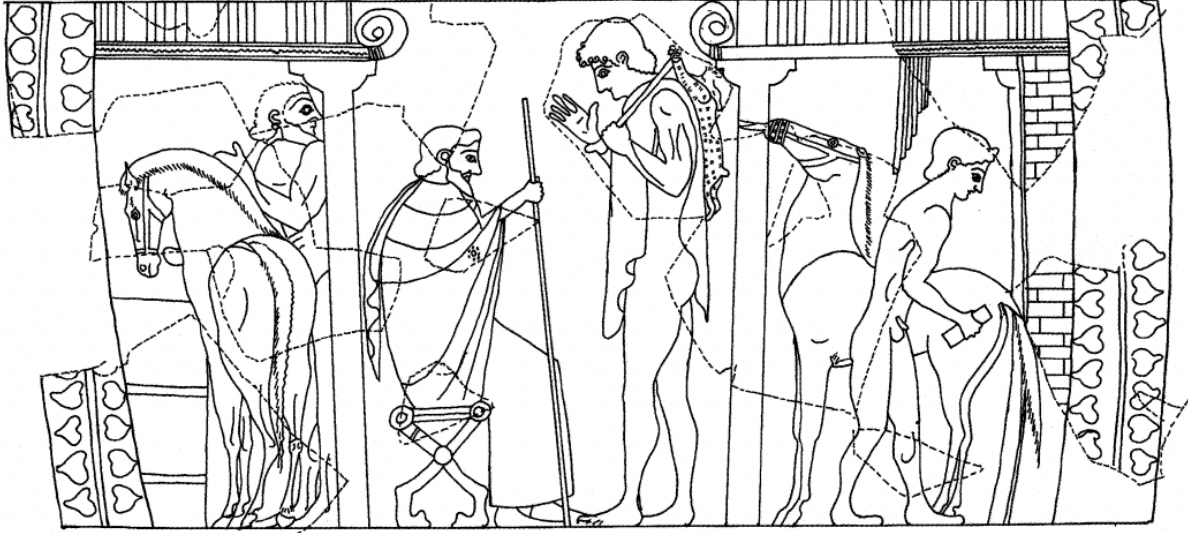
Unattributed black-figure cup, *ca.* 520-500 BCE. Attic. Location unknown. Found in Walpole 1817, 322; Moore 2004, fig. 30.

FIGURE 7. TERRACOTTA KYLIX (DRINKING CUP) ATTRIBUTED TO ONESIMUS, CA. 490 BCE



Terracotta kylix (drinking cup) attributed to Onesimus, *ca.* 490 BCE. Terracotta; red-figure. Attic. Metropolitan Museum of Art, New York, 1989.281.71.

FIGURE 8. BLACK-FIGURE HYDRIA ATTRIBUTED TO THE ANTIMENES PAINTER, CA. 520 BCE



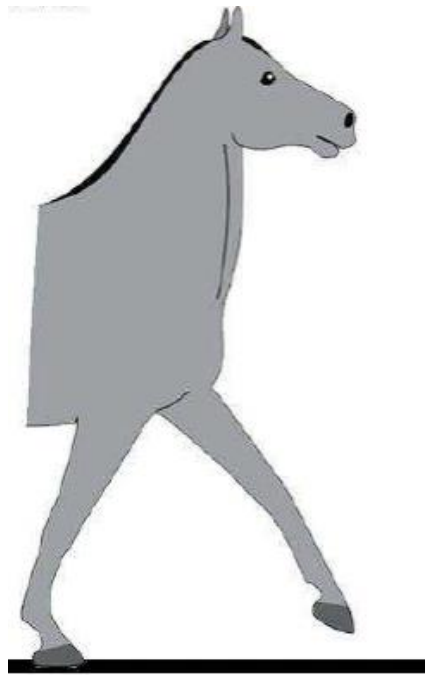
Black-figure hydria attributed to the Antimenes painter, *ca.* 520 BCE. Attic. Private Collection, New York. Drawing by Mary B. Moore. Found in Moore 2004, fig. 9. Used with permission.

FIGURE 9. A STALLION TROTTING



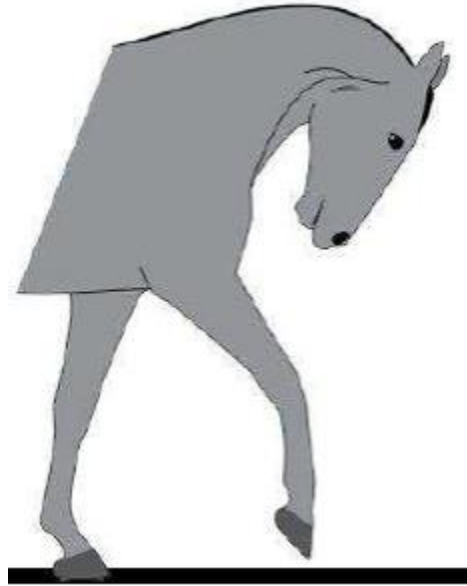
From “Favory Pallavicina, Lipizzan Stallion.jpg,” by Conversano Isabella.https://commons.wikimedia.org/wiki/File:Favory_Pallavicina,_Lipizzan_Stallion.jpg. Taken from *Wikimedia Commons* on May 19, 2022. Image cropped.

FIGURE 10. THE INVERTED HEADSET



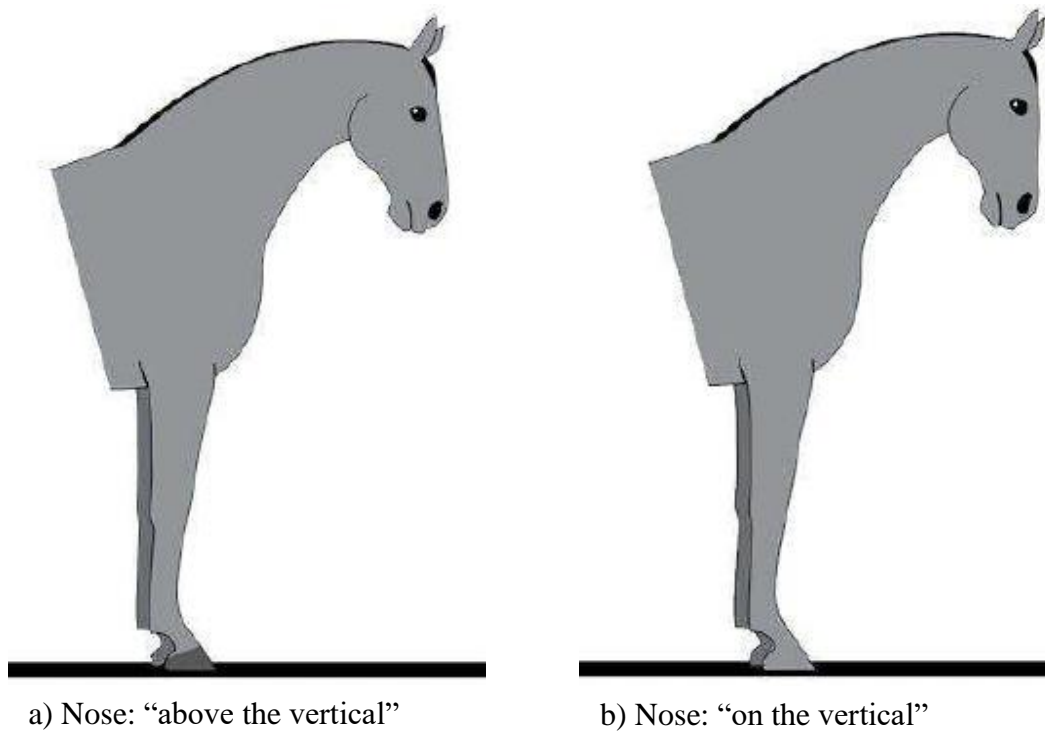
From “Figure 1a-d: Head and neck postures (HNP) with different dorso-ventral flexions”, illustration by Cristina Wilkins, courtesy of ISES. (ISES 2015, fig.1d, “HNP ‘inverted’”). Copyright 2015 by International Society for Equitation Science. Used with permission.

FIGURE 11. THE HYPERFLEXED HEADSET



From “Figure 1a-d: Head and neck postures (HNP) with different dorso-ventral flexions,” illustrations by Cristina Wilkins, courtesy of ISES. (ISES 2015, fig.1c, “HNP ‘behind the vertical’”). Copyright 2015 by International Society for Equitation Science. Used and cropped with permission. The original image had a horse on the left and right side of this figure. The horse on the left had the nose “behind the vertical” with the base of the neck level with the withers and the poll below the withers. The horse on the right had the nose “behind the vertical” with the base of the neck level with the withers, the middle of the neck deeply rounded below the level of the withers, and the chin almost touching the chest between the front legs.

FIGURE 12. THE IDEAL HEADSET



From "Figure 1a-d: Head and neck postures (HNP) with different dorso-ventral flexions," illustrations by Cristina Wilkins, courtesy of ISES (ISES 2015, fig.1a, b, "HNP 'above the vertical'; HNP 'on the vertical'"). Copyright 2015 by International Society for Equitation Science. Used and cropped with permission. The original images had depictions of second horses on the right-hand sides, which showed horses with the same nose angles but with lower necks. The second horse with the nose "above the vertical" had a neck position level with the withers, and the second horse "on the vertical" had a neck position below the withers.