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Facing Logistical and Tactical Challenges Maintaining and Protecting Horses and Mules during the Crossing of the Alps (218 BC)

by Annelies Koolen

Abstract. This article researches the circumstances, planning and the logistics of an expedition through enemy territory. It considers to what extent the safeguarding and management of cavalry horses and baggage mules influenced the logistical arrangements and tactical decisions of an army on a march. The protection and sustenance of cavalry horses and supply-carrying mules constituted a central element of military expeditions and marches. These animals were a valuable asset to marching armies. Mules carried the food supplies necessary to feed the infantry. Schooled cavalry horses were valuable, as they were difficult to replace during marches. It was therefore key to any army to keep their cavalry horses and mules in the best condition possible and to keep them as safe as they possibly could. Focal point of this study is the Crossing of the Alps, one of the best known marches through enemy territory in ancient history. Hannibal serves as an example because his expedition and its struggles is well described by Polybius and Livy.

Keywords: Cavalry; cavalry horses; baggage animals; mules; logistics.

Introduction

The starting point for most modern discussions is Jonathan Roth, whose *The Logistics of the Roman Army at War (264 BC–AD 235)* remains the most systematic study of Roman supply. Roth argues that pack animals—especially mules—were indispensable to Roman campaigning. He reconstructs the logistical requirements of armies in the field and emphasises that grain transport could not have relied solely on soldier self-carrying or opportunistic foraging. A mule could carry roughly 100 kilograms, dramatically increasing transport capacity. However, Roth also highlights a critical constraint: animals themselves consume significant quantities of fodder. This creates what might be called a logistical multiplier problem—every additional animal increases car-

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rying power but simultaneously increases daily consumption requirements. For Roth, Roman logistics were therefore structured and carefully organised, with pack animals integrated into planned supply systems rather than serving as ad hoc additions[1].

The economic dimension of animal logistics has been further developed by Paul Erdkamp in *Hunger and the Sword*. Erdkamp shifts the focus from transport capacity to food systems. He emphasises that the real constraint was not merely how much a mule could carry, but whether fodder and grain could be reliably sourced from provincial economies. Pack animals were embedded within wider agricultural networks; their sustainability depended on grazing access, surplus production, and market integration. In fertile regions, reliance on animals was feasible. In arid or mountainous zones, fodder scarcity could sharply limit the number of animals deployed[2].

In *Alexander the Great and the Logistics of the Macedonian Army*, Donald Engels identifies pack animals as the most critical logistical variable in Alexander's campaigns, as they require significant grain and water, limiting their effective range to roughly 8–10 days without forage. Engels highlights that Alexander minimised this "logistical footprint" by preferring mules for speed, restricting baggage carts in mountainous terrain, utilising camels in arid regions, and compelling soldiers to carry their own gear to reduce animal dependence. [3]

Ann Hyland has looked into the logistical demands of maintaining horses. In *Equus: The Horse in the Roman World* she emphasises that feeding horses was the main constraint. Roman cavalry horses were relatively small (around 13–14 hands), which reduced fodder needs and improved endurance. However, they still required careful management, including rest and veterinary care. Hyland also stresses the importance of remount systems, since horses were frequently lost through exhaustion, illness, or injury during campaigns. [4]

A particularly stimulating contribution is that of John F. Shean, in his article "Hannibal's Mules: The Logistical Limitations of Hannibal's Army and the Battle

1 P. Roth., 1999.
2 Erdkamp, 1998.
3 Engels, 1978.
4 Hyland, 1990.

of Cannae, 216 B.C." In this study, Shean attempts to quantify the logistical requirements of Hannibal Barca's army during its crossing of the Alps, calculating the quantities of food and fodder necessary to sustain both cavalry mounts and infantry. He further suggests that Hannibal was well informed about conditions in the Alpine region and was aware that suitable locations existed along the route where fodder for the animals could be obtained[5].

Several scholars have calculated the quantities of fodder required to sustain horses and mules on campaign. The present article focuses in particular on the case of Paul Erdkamp's reconstruction of the logistics of Hannibal Barca. His calculations provide a useful case study demonstrating how the use of inaccurate data—arising from problematic assumptions regarding the feeding requirements of horses—can lead to distorted logistical estimates. Secondly, this article examines the calculations proposed by John F. Shean concerning the number of pack animals required to transport supplies during the crossing of the Alps. These estimates similarly illustrate that when the underlying assumptions regarding horses and mules are flawed, the resulting logistical figures are correspondingly unreliable.

Scholarship on ancient military logistics has thus far concentrated predominantly on the concept of "living off the land," with particular emphasis on practices such as frumentatio and pabulatio, as well as on calculations concerning the quantities of grain required to sustain mules and horses. These studies also tend to foreground the protection of soldiers during foraging operations as their primary analytical concern[6].

Ancient and medieval military and veterinary treatises such as the Roman *Mulomedicina* and *De Re Militari epitoma*; the Byzantine *Strategiko*n; and later the medieval Marescalcie literature acknowledge the importance of pack animals, but they mainly focus on cavalry horses. These works discuss their care and logistical significance, yet they do not address the tactical decisions required to transport such animals safely during military operations[7]. The *Strategikon*, for

5 Shean, 1996, pp. 159 - 187.

6 Erdkamp, cit., pp. 122 - 123; 127 - 128; 156 - 187; Armstrong, 2023, p. 136.

7 The *Mulomedicina* of Vegetius (approx. 400 AD) treats horse and mule care, remedies, and diseases; it incorporates the work of the Mulomedicina Chironis; Vegetius, *De Re Militari* offers Roman military organization, training, and tactics; The *Strategikon* of Maurice (late 6th c.) provides Byzantine battlefield strategy, troop management, and enemy-specific tactics; The medieval Marescalcia (13th c. - 15th c.) texts focus on horse breeding, shoeing,

example, mentions that the baggage train should be kept apart from the infantry and never mixed with soldiers on a march. It also recommends the baggage train to be kept safe, not for the sake of the animals, but because it will otherwise distract the soldiers too much in battle [8]. Anna Comnena wrote a detailed history of the reign of her father, Alexius I Comnenus, who ruled the Byzantine Empire from 1081 to 1118. In the *Alexias* she described cavalry tactics, however the comments on logistics and marches are scarce.

Furthermore, this study uses the expertise of nineteenth-century military handbooks. These books provide a useful comparative perspective, as the armies of this period maintained large cavalry formations and developed highly systematic approaches to cavalry training and tactics. In this respect the work of North Ludlow Beamish is particularly valuable. Beamish combined practical experience as a cavalry officer with a sustained interest in the historical development of cavalry warfare. In his studies he frequently engaged with classical sources and interpreted them from the perspective of a professional soldier. His observations therefore offer a useful analytical framework for understanding cavalry operations in antiquity.

When terrain is considered as a factor influencing logistics and tactics, discussion is generally confined to the ways in which environmental conditions affected the weight of the loads that pack animals could carry, but not on the effect of the suitability of the route for the animals themselves and the effect that this would have on their survival or coping[9].

For instance, scholar Emma Louise Herbert-Davies in her book *The Warhorse in England. 1272-1372* comments ‘Information on the physical care of horses on the march is scarce but there are indications that they were well looked after.’ After which she provides some examples of saddle cloths and stabling being provided on the march. She does not offer anything on terrain and how this influenced the decisions on a march, however she did find that ’There were no major

and treatment, blending classical and medieval knowledge. The works of Giordanus Ruffus (1256 AD) and Lorenzo Rusio (1347 AD) are the best know. Together, these works reveal a trajectory from Roman logistical and tactical manuals to Byzantine operational guidance and medieval equestrian expertise, showing the continuity and adaptation of military and veterinary science across centuries.

8 Dennis, 1984, p. 58; p. 61.

9 Roth, cit., pp. 78 - 79.

battles in this campaign so many of the horses that were recorded as lost appeared to have suffered the effects of the march - most of the losses occurred during the winter months when difficult conditions and inclement weather appeared to have taken a heavy toll on horses'. [10]

On the troubles that can occur on a march, therefore, however common they may have been, sources are scarce. Not much attention has been paid to the extent to which terrain itself constrained operational planning by compelling armies to identify routes capable of accommodating pack animals and cavalry horses in order to keep them safe and, in the case of warhorses, deployable. This study indicates that facilitating the movement of animals across difficult landscapes was not merely an auxiliary concern, but a central strategic consideration shaping military decision-making.

In fact, the protection and sustenance of cavalry horses and supply-carrying mules constituted a central element of military expeditions and marches. These animals were a valuable asset to armies. Mules carried the food supplies necessary to feed the infantry and were expensive to buy[11].Cavalry horses were highly valuable, as only a limited number of horses possessed the necessary character, physical build, age, and breed for service in warfare[12]. It was therefore key to any army to keep their cavalry horses and mules in the best condition possible and to keep them as safe as they possibly could. Cavalry has always been a difficult part of the army to manage, as horses can only function when they are properly fed and taken care of[13].

This study, therefore, focuses on the influence of safeguarding cavalry horses and baggage mules on the logistical organisation and tactical decision-making of an army. It provides a detailed examination of the challenges faced during a march, particularly through enemy territory. The sources examined here are therefore notable for explicitly describing the decisions by which commanders sought to guide their animals along viable routes. Such logistical considerations are rarely treated in detail in military treatises, yet they were clearly central to the practical conduct of long-distance campaigns.

10 Herbert - Davies, 2025, p. 212.
11 Roth, cit., p. 206.
12 Koolen, 2012, pp. 33 - 36.
13 Beamish, 2010, pp. 58 - 59.

The descriptions of the campaigns of Hannibal by Polybius and Livy, and to a certain extent the March of the Ten Thousand (Xenophon), however, provide a clear example. The sources suggest that Hannibal recognised the necessity of preserving both cavalry horses and pack animals, understanding that the survival of the baggage train was essential to the success of his expedition. His choice of routes was therefore shaped not only by strategic considerations but also by the need to safeguard these animals.

The focal point of this study, therefore, is the Crossing of the Alps into Italy by the Carthaginian army under Hannibal in 218 BC, one of the most renowned military marches in ancient history, distinguished not only by its passage through hostile territory but also by the extreme and unforgiving terrain that confronted the army. This event has long captured the attention of historians because it represents a convergence of strategic audacity, environmental challenge, and logistical complexity. The Alps were not merely a physical barrier; they constituted a formidable natural obstacle characterised by steep passes, unpredictable weather, narrow pathways, and limited access to provisions.

Unlike conventional campaigns fought across relatively navigable landscapes, this march required the movement of thousands of soldiers—along with animals, equipment, and supplies—through mountainous regions that were scarcely mapped and often controlled by hostile tribes. The difficulties posed by snow, rockslides, altitude, and ambushes compounded the strain on morale and organisation. The expedition took place at the setting of the Pleiads[14], which would mean at the end of autumn, a time when snow had already been falling on the mountain tops. The snow made it difficult for the infantry to find foot, but it was a huge problem for the pack mules and cavalry horses. The soldiers, unable to penetrate the hardened lower layer of snow, repeatedly fell and slid further down the steep slope when they tried to rise. The animals, heavier and burdened with packs, broke through the surface but became trapped in the frozen layer beneath, immobilised by their weight and the icy crust[15].

14 Polyb. 3.54.1: As it was now close on the setting of the Pleiads snow had already gathered on the summit.

15 Polyb. 3.55.4-5: As for the men, when, unable to pierce the lower layer of snow, they fell and then tried to help themselves to rise by the support of their knees and hands, they slid along still more rapidly on these, the slope being exceedingly steep. But the animals, when they fell, broke through the lower layer of snow in their efforts to rise, and remained there

Centrones, a Celtic tribus, treacherously ambushed the Carthaginian Army during its crossing of the Alps. Colored woodcut *Die Karthager – Hannibals Übergang über die Alpen* von Heinrich Leutemann (1824-1905), published in *Münchner Bilderbogen* (Blatt 13 der „Bilder aus dem Alterthume"; Nr. 438, 1866). Wikimedia Commons.

For his battles, Hannibal relied heavily on his cavalry. Trained and reliable warhorses were hard to replace on a march and were certainly not found around every corner in the Alps. Not every horse was suited for cavalry service, for instance, from medieval sources can be learned that discarding horses due to poor behaviour was even featured in the rules drawn up for the Knight Templars: if a knight had "a restive or jibbing horse, or one that bucks or throws him," he was allowed to exchange it for another[16].

Especially the Numidian cavalry horses could not easily be replaced[17]. The Numidian cavalry performed not only hit-and-run tactics that were entirely unique to them and their horses, they also rode their horses bitless with a rope around their necks or a muzzle[18]. Due to their specific breed and the way that they were trained and ridden in battle, these horses were so valuable, that Hannibal seems to have decided that he would rather slaughter them than sell them off and let the Romans get their hands on them, when he could not transport them back to Africa in 203 BC[19]. The Numidian cavalry could not afford to lose too many of their horses during the Crossing of the Alps, because they were hard to replace. As such, they provide an exemplary case for detailed study.

To compare the circumstances that Hannibal experienced in the Alps two other expeditions through extreme terrain and weather conditions have been researched. The first example is Xenophon on the March of the Ten Thousand, in which Greek mercenaries navigated hostile Persian territory and rugged mountains. The second example of horses in extreme conditions is the Trakehner Trek of World War II, when East Prussian civilians and their horses endured harsh winter conditions while fleeing Soviet forces. The comparison with other expeditions highlights the importance of terrain and circumstance in shaping these decisions. In the Trakehner trek, the route was largely dictated by necessity. By contrast, Xenophon describes how reconnaissance, intelligence gathering, and consultation with local populations influenced the route selection of the Greek forces.

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with their packs as if frozen into it, owing to their weight and the congealed condition of this old snow.

16 *The Rule of the Templars: The French Text of the Rule of the Order of the Knights Templar*, trans. J. M. Upton-Ward, rule 154.

17 Polyb. 3.101.

18 Koolen, *Journal of Roman Military Equipment Studies*, 22 (2021), pp. 71 - 80.

19 App. *Hann.* 59.

F2 Stylised Berber Cavalry under Lusius Quietus, fighting against the Dacians. From the Column of Trajan (https://en.wikipedia.org/)

Hannibal likewise adjusted his path through the Alps to ensure that his horses and pack animals could survive the crossing. Since the environmental conditions are extreme and the animals that faced them have not changed, these case studies can fill the gap in sources regarding the difficulties of crossing the Alps.

Xenophon guided the Greek mercenaries, also known as the Ten Thousand, when they tried to get back to the Black Sea from Cunaxa in Mesopotamia. Through Mesopotamia there were constant threats from Persian cavalry, scarcity of provisions, and the challenge of moving through hostile territory. The retreat became particularly arduous in the Carduchian mountains (modern Kurdistan), where they faced narrow passes, steep slopes, and guerrilla attacks from local tribes. The terrain itself became a formidable enemy, and the Greeks had to adapt continuously, seizing high ground and maintaining shield formations on treacherous inclines. Later, as they entered Armenian territory, extreme winter conditions added a new layer of difficulty: deep snow, freezing temperatures, frostbite, and the death of many pack animals tested both soldiers and leaders alike. The conditions and circumstances were like those in the Alps.

With a leap of over two thousands years, in January 1945, with East Prussia effectively cut off and Germans facing destruction or occupation, thousands of East Prussians and their Trakehner horses fled in order to save the precious horses from the Soviets. This journey, hundreds of miles long in the depths of winter, became known among survivors and historians as "The Trek." The conditions were brutal: deep snow, frozen rivers and lagoons, scarce food, and relentless pursuit by Soviet troops. At times refugees had to cross the frozen Vistula Lagoon (Frisches Haff), where thin ice gave way under human and equine weight, and Soviet aircraft strafed those attempting to flee across the ice. Many horses and people died when the ice broke or under bombardment, and supplies were exhausted along the route. Of course, the military circumstances are not comparable to the circumstances in the Punic Wars, but the extreme conditions and their impact on the horses can be used to get a better understanding of what happened on the highest mountains of the Alps.

The expedition under study, the Crossing of the Alps, similarly highlights how difficult terrain, climate, and logistical planning could determine the outcome of a campaign, making it a compelling case study of the enduring challenges armies face when moving through hostile landscapes. To what extent did the safeguarding and management of cavalry horses and baggage mules influence the logistical arrangements and tactical decisions of an army on a march through enemy territory?

Energy Consumption and Maintenance Requirements for a Horse

First, the research will zoom in on the idea that the principal cause of horse and pack animal losses during the Alpine campaign was starvation. At first glance it may seem very probable that the Alpine environment would have provided insufficient fodder for horses and mules, thereby necessitating the transport of substantial quantities of grain. For example, Erdkamp, in his case study of the expedition of Hannibal, estimates that each horse would have required at least five kilograms of grain per day, in addition to several kilograms of hay.[20] However, it is unlikely that starvation constituted either the primary or the decisive cause of the losses reported by Polybius and Livy.[21]

20 Erdkamp, cit., p. 160 - 161.

21 Polyb. 3.60.1-5; Polyb. 3.56.3-4: He had spent fifteen days in crossing the Alps, and now,

It is most logical to begin by determining the amount of fodder required for horses and mules in normal situations.[22] Although no records exist for the rations of Carthaginian cavalry, comparable calculations can be made based on Roman cavalry data. According to Polybius, the daily rations of the Roman cavalry were seven *medimni* of barley and two of wheat. The allies received five *medimn*i of barley and one and a third of wheat.[23] A *medimnus* is six *modii* and a *modius* is set at 8.62 litres. An average weight of 0,722 kg has been set for a liter of wheat. Cavalry men would have to feed their horses and mules from this amount.[24]

Erdkamp contends that the figures provided by Polybius concerning the grain rations for horses in the Roman army are likely inaccurate. These calculations can be used as an example of why the assumption that each horse is 'just a horse as any other' can lead to wrong outcomes and interpretations. He asserts that barley possesses a higher nutritional value than oats, and therefore a smaller quantity is required to meet a horse's energy needs[25]. Following this, he compares the daily rations of barley with those of oats provided to British cavalry horses during the American War, as well as to horses in French regiments, which could receive as much as 8 to 10 kilograms per day[26].

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when he thus boldly descended into the plain of the Po and the territory of the Insubres, his surviving forces numbered twelve thousand African and eight thousand Iberian foot, and not more than six thousand horse in all, as he himself states in the inscription on the column at Lacinium relating to the number of his forces.; Liv. 21.38.2-4.

22 Mules will be left out of the calculations as they required little or no grain. Mules are, like horses, equids. Equids are grazing animals whose digestive systems have evolved to support a continuous intake of high-fiber roughage. However, some forages will be too nutrient-dense for mules. Mules should eat approximately 1.5 to 2% of their body weight in forage daily. High-fibre, low-sugar grass hay will ensure enough volume without adding too much energy to the diet. Mules in heavy work need more. Straw is commonly used as a low-calorie alternative to satisfy forage requirements in donkeys and mules, who are more efficient than horses at digesting this fibrous forage. Unrestricted access to lush pastures or nutrient dense forages can contribute to obesity and laminitis in these equids. High-quality grass hays are usually not suitable for mules. Mules in light work should not be fed grains. Even in small amounts, cereal grains can provide more energy than most mules require, and their high starch content can heighten the risk of digestive and metabolic issues. (*madbarn.com mule-management-guide* online)

23 Polyb. 6.39.

24 Erdkamp, cit., pp. 27 - 28.

25 Erdkamp, cit., p. 38: 'The ratio practiced in the German army between oats and barley indicates that barley was slightly less nutritious.'

26 Erdkamp, cit., pp. 37-41; p. 44.

This comparison presents three significant issues. First, it equates barley with oats, despite the fact that these grains differ in their nutritional composition. Second, the comparison involves two distinct categories of horses, each of which has differing dietary requirements. Third, when evaluating the quantities of oats provided to modern cavalry horses, it is important to consider that the operational pace and activity levels of these units differ markedly from those of horses in the ancient period.

It should be noted that crossings of the Alps were most likely conducted at a slow, walking pace. In antiquity, marches were typically performed at a walk—occasionally interspersed with short canters—with riders frequently dismounting due to muscular fatigue and soreness.

> ἔν γε μὴν ταῖς πορείαις ἀεὶ δεῖ τὸν ἵππαρχον προνοεῖν ὅπως ἀναπαύῃ μὲν τῶν ἵππων τὰς ἕδρας, ἀναπαύῃ δὲ τοὺς ἱππέας τῷ βαδίζειν, μέτριον μὲν ὀχοῦντα, μέτριον δὲ πεζοποροῦντα. τοῦ δὲ μετρίου ἐννοῶν οὐκ ἂν ἁμαρτάνοις: αὐτὸς γὰρ μέτρον ἕκαστος τοῦ μὴ λαθεῖν ὑπερπονοῦντας.
>
> During a march the cavalry commander must always think ahead, in order that he may rest the horses' backs and relieve the men by walking, giving moderate spells of alternate riding and marching. You cannot misjudge what is a moderate spell, since every man is himself the measure that will show you when they are getting tired[27].

Xenophon, apparently, used the trot only to transition from walk to canter and Arrian makes no comment on trotting at all[28]. In contrast, modern cavalry primarily employed the trot as the principal pace for marches. Only the introduction of the stirrup, and later the German army saddle—modeled after the English saddle—enabled sustained trotting over long distances[29]. Trotting allowed units to cover greater distances more efficiently, and the development of the rising trot in

27 Xen. *Cav.* 4.1.

28 Xen. *Horse*. 7.10 - 12; Arrian does not mention trot at all.

29 Gustav Steinbrecht, *Gymnasium des Pferdes 1884*, FN Verlag, Warendorf 2004, pp. 18 - 19. Wenn jedoch der Bocksattel durch einen sich mehr der Form des englischen nähernden Sattel aus der Armee verdrängt sein wird, wird man den jetzigen Normalsitz augeben müssen un dadurch für das Reiten im Gebrauch, noch mehr aber für die Bearbeitung der Pferde groβe Vorteile gewinnen. Für jede Einwirkung auf das Pferd ist der Bocksattel höchst unvorteilhaft, da er nu den Spaltsitz zulässt, also die feineren Hilfen der Balance und Gewichtsverteilung mehr oder weniger hindert. Note from the author: der Spaltsitz is also typical for riders who ride without saddles. Xenophon described this position of the rider Xen. Horse. 7.6-7.

the eighteenth century further enhanced rider comfort[30]. Larger horses, with their longer strides, not only provided a smoother ride but also facilitated the covering of greater distances with less effort compared to smaller horses[31].

From Table 1 it can be concluded how much more energy intake a trotting horse would require instead of a horse that is only required to walk[32].

Tab 1. Energy Consumption And Maintenance Requirements for a Horse

Situation	Velocity (m/mn)	Energy expenditure (Kcal/mn)	Times of maintenance (maintenance = 1)
Waiting without a rider	0	11,5	1,1
Waiting with a rider	0	12	1,2
Walk	110	50	2,5
Slow trot	200	110	10
Normal trot	300	160	15
Fast trot	500	350	35
Canter	350	210	20
Fast galop	600	420	40
Maximum velocity		600	60

Consideration should now also be given to the breeds of horses in use. The armies of the Prussians, British and French used horsebreeds such as the English Thoroughbred, Trakehner, Hannoverian, Oldenburger, Holsteiner or French saddle horse 'Selle Français', which all have a height of approximately 160 - 170 centimeters and a weight of approximately 500 kilograms and up[33].

30 Rising trot, also known as posting trot, is a horse riding technique where the rider rises out of the saddle with every other stride of the horse's trot. This is achieved by a rhythmic motion originating from the rider's hips, which allows them to rise and sit in time with the horse's diagonal leg movements. It's the opposite of the sitting trot, where the rider remains seated throughout the gait. (author's note)

31 Charles De Warnery, *Remarks on Cavalry; by the Prussian Major General of Hussars, Warnery, 1798*, Gale ECCO Print Editions, Farmington Hills, 2018, p. 14: Formerly when two squadrons charged sword in hand, the most rapid pace was the trot only, here the largest horses afforded the greatest advantage over small ones.(..) The charge at the walk or trot, is at this time called the ancient attack of cavalry.

32 See Table 1. Based on: William Martin-Rosset, <<*Feeding Standards for Energy and Protein for Horses in France*>> in J.D. Pagan, *Advances in Equine Nutrition* II, 2001, pp. 245-305.

33 *horseandcountry.tv horse-height-and-weight-guide* online. See Table 2.

Tab 2 Horse Breeds and their Heights and Weights

Horse breed	Average weight (kg)	Average height (meters)
American Warmblood	550 - 600	1.52 - 1.73
Arabian Horse	360 - 450	1.45 - 1.55
Ardennes Horse	700 - 1000	1.60 - 1.65
Cleveland Bay Horse	550 - 700	1.63 - 1.68
Connemara Pony	290 - 390	1.27 - 1.47
Dales Pony	400 - 500	1.32 - 1.42
Dutch Warmblood	550 - 600	1.52 - 1.73
Hanoverian Horse	550 - 650	1.60 - 1.78
Holsteiner Horse	450 - 700	1.63 - 1.73
Shetland Pony	180 - 200	0.71 - 1.07
Swedish Warmblood	400 - 550	1.63 - 1.73
Thoroughbred Horse	450 - 500	1.57 - 1.78
Westphalian Horse	450 - 600	1.57 - 1.78

Especially the Ostpreus or what we now call a Trakehner was a well sought-after cavalry horse.

> Ein zählbarer Fortschritt in der Entwicklung der Kavallerie war in der Remontierung erreicht worden, nachdem man ab 1787 in Ostpreußen mit der landeseigenen Pferdezucht begonnen hatte. Bisher war für die Kürassiere schwere deutsche Remonte charakteristisch, worunter groβe Holsteinische Halbblüter zu verstehen sind - gute Reit-und Springpferde, dabei aber wenig ausdauernd und leicht überzüchtet. (…) Alle Husarenregimenter verfügten bereits über die leichte ostpreuβische Remonte.
>
> A significant advance in the development of the cavalry had been achieved in remounting after the introduction of domestic horse breeding in East Prussia in 1787. Until then, heavy German remounts, primarily large Holstein half-bloods, had been characteristic of the cuirassiers – good riding and jumping horses, but lacking in stamina and somewhat overbred. (…) All hussar regiments already possessed the light East Prussian remounts[34].

This means that the larger modern horses had to be fed much more grains than the smaller horses in the Roman age, which makes the comparison between Roman cavalry and French or Prussian cavalry difficult. This can easily be calcu-

34 Gottberg, 1998, pp. 122 - 124.

lated. A horse requires a specific daily energy intake, which can be calculated: for the maintenance of a 400 kgs horse this would be 56.1 MJ Digestive Energy; for 500 kgs 68.6 MJ; for 600 kgs 81.2 MJ[35].

Attention should now be directed to the nutritional value of barley and oats. In contemporary horse husbandry, barley is typically used as the reference point for calculating a horse's net energy requirements due to its relatively consistent nutritional composition[36].

The horses used by Roman cavalry resembled small horse breeds such as the Camargue horse, Celtic forest pony or the British Dales pony, with a height of around 140 cm and a weight of approximately 350 - 450 kgs[37]. For example, remains of a robust, or forest, type pony and the Celtic type were found in the Newstead Roman camp[38]. Assuming that horses in Roman times had an average body weight around 450 kgs, as derived from the tables above, the following calculations can be made.

Barley provides approximately 13 MJ of energy per kilogram. Consequently, a 400-kg horse would require 56.1 MJ per day, corresponding to roughly 4.3 kg of barley. For a 500-kg horse, the daily energy requirement would be 68.6 MJ, equating to approximately 5.3 kg of barley.

Oats, which supply 12 MJ of energy per kilogram, would necessitate slightly higher quantities. A 400-kg horse would require 4.7 kg of oats per day to meet its energy needs, while a 500-kg horse would require 5.7 kg per day.

In periods of abundant pasture, grazing could provide a significant portion of a horse's energy requirements, as grass contains between 8 and 14 MJ per kilogram. Under such conditions, a horse would need approximately 5 kg of grass per day to sustain basic energy requirements. When grazing was limited or unavailable, the previously calculated barley or oat rations would suffice, preferably supplemented with hay. Hay offers a lower nutritional value, averaging 4.91 MJ per kilogram.

35 Martin-Rosset, cit., pp. 245-305.

36 Calculations based on the amounts given on *agriculture.vic.gov.au feed-requirements-of-horses* online; these can also be found in the *Veevoedertabel 2022 cvbdiervoeding.nl.* online.

37 Junkelmann, 1990, pp. 32 - 34.

38 Ewart, 1911, p. 362.

A Roman cavalryman had to his disposal about 226 kg of barley per month or 7 kg per day. As stated above, hat would be too much for a horse used in Roman times, despite Erdkamp claiming that even for a small horse it would be too little[39].

According to these calculations, there would be enough left from the 7 kgs a Roman cavalryman received daily to feed an additional mule: 4.3 or 4.7 kgs for a horse and 2.7 or 2.3 kgs for a mule. If enough grazing was available, even two mules could easily be fed from these 2.3 kgs. In times of abundance of grass and hay the 7 kgs could be saved for times when battle was imminent and the horse needed more energy. There is, therefore, no reason to doubt the figures given by Polybius[40]. These figures can now also be used to understand how much fodder would be needed for the Numidian cavalry.

The Carthaginian army consisted of Libyphoenicians, Numidians, Moors and Ilergetes[41]. These peoples had horses that were the forebears of West African horse breeds such as the West African Barb horse. This horse breed is indigenous to the North African regions of Mauretania, Libya, and what used to be called Numidia. Barb horses belong to the Libyan type of horses[42]. The Libyan horse type distinguished itself from other breeds by the typical construction of the head and its fine body. Excavations at the Roman camp of Newstead showed that not only the forest and steppe type of horses were used by the Romans, but that also the Libyan type had established itself in the Roman cavalry in later times[43]. The Libyan horse type was also used to refine the heavier and sturdier forest and steppe type ponies[44].

Horses that descend from the Libyan horsetype are able to live on very little feed. They are comparable to mules in this respect. When overfed they likewise become fat and develop all kinds of diseases[45]. The modern day Arab horse is

39 Erdkamp, cit., p. 38.

40 Erdkamp, cit., pp. 38 - 39. Other studies mention 10 lbs of grain per day (Donald W. Engels, *Alexander the Great and the Logistics of the Macedonian Army*, University of California Press, Berkeley, 1978, p. 34); 2,5 kgs (Roth, cit., p. 79).

41 Liv. 21.22.3: Libyphoenicians came from a mixed Punic and African heritage; Numidians came from Numidia; Moors from Mauretania and Ilergetes from Spain.

42 Ridgeway, 1905, pp. 425 - 477.

43 Ewart, cit., p. 362.

44 Veg. *Epitome Rei Militaris* 3.26.

45 An example of a description of the modern Barb horse: Spanish Barbs have an average height of 13.3 to 15 hands. These horses have a distinct type with Spanish characteristics

a descendant of the Libyan horse type. Their physique makes it possible to go large distances without much feed or water, which makes them nowadays highly sought-after horses for long-distance endurance races[46]. From Table 2 can be deduced that they have a light physique, weighing approximately 350 - 450 kgs with a height of 145 - 155 cm, where as the sturdier Celtic type that the Romans used, weighed around 400 kgs at a height of 140 cm. Horses with lighter bodies typically exhibit superior stamina compared with heavier types.

In the medieval period, notable contrasts were observed between Arabian and Frankish warhorses. The hippologist Abu Bekr ibn Badr was particularly critical of Frankish horses when comparing them with their oriental counterparts. According to his observations, Frankish warhorses demonstrated inferior endurance and possessed a less dense bone structure than Oriental breeds. They were also considered more susceptible to lameness. Furthermore, Frankish horses tended to be heavier in flesh. While this physical build made them effective for massed cavalry charges, it also meant that they fatigued more quickly and were unable to sustain momentum over extended periods. In addition, they required greater quantities of feed. This higher nutritional demand was attributed not only to differences in body size but also to variations in equine metabolic rates and to the European practice of overfeeding warhorses. By contrast, the Arabian horse was regarded as a "good doer," capable of maintaining condition on relatively modest rations. When properly exercised, it was also less prone to excessive fat accumulation—a condition that was frequently observed among the heavier European horse types[47].

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that produce a balanced overall impression.Their heads are refined with a broad forehead, tapering nose, large eyes, and small to medium curved ears. Profiles are often slightly convex. Their necks tie in low to deep bodies with medium-wide chests, well-sprung ribs, and deep heart girths. Round hindquarters with long muscling, short backs, well-angled shoulders, and flexible pasterns produce smooth but active gaits. Their legs are proportionate to their body, with large bones and joints. Hooves should be well-shaped and hard. Like other breeds originating from regions with sparse vegetation, Barb horses are susceptible to metabolic disorders and weight gain if not provided with appropriate nutrition. Most Barb horses are easy keepers, which means they have little difficulty maintaining body condition and are prone to obesity. Overweight horses face a range of health issues, from joint stress to heat stress. Horses that become overweight easily because of metabolic syndrome are prone to laminitis; *madbarn.com barb-horse-breed-profile* online.

46 *fei.org endurance* online.

47 Ann Hyland, *The Medieval Horse, From Byzantium to the Crusades*, Grange Books,

While less fertile terrain typically posed a considerable disadvantage for maintaining cavalry, the Numidian horsemen therefore probably benefited from their mounts that were capable of thriving on minimal sustenance and, according to legend, requiring little water.

> καὶ Φαμέας ὁ ἵππαρχος ὁ τῶν Λιβύων καὶ ἵπποις χρώμενος μικροῖς καὶ ταχέσι, καὶ ποηφαγοῦσιν ὅτε μηδὲν εἴη, καὶ φέρουσι δίψος, εἰ δεήσειε, καὶ λιμόν.
>
> Then there were the horses of Phameas, the captain of the African cavalry, who had small, swift horses that could live on grass if necessary and could endure hunger and thirst[48].
>
> ἴσασι δὲ καὶ λιμὸν φέρειν οἱ Νομάδες οἵδε, καὶ πόᾳ χρῆσθαι πολλάκις ἀντὶ σίτου: καὶ τὸ πάμπαν ὑδροποτοῦσιν. ὅ τε ἵππος αὐτοῖς κριθῆς μὲν οὐδ᾽ ὅλως γεύεται, ποηφαγῶν ἀεί, πίνει δὲ διὰ πολλοῦ.
>
> The Numidians know how to endure hunger. Sometimes they only eat herbs instead of bread and they only drink water. Their horses never taste grain, but only eat grass and hardly drink[49].

The analysis now turns to the water supply, a critical element normally requiring careful advance planning. A horse needs an average of five litres of water per day per 100 kgs of body weight. A horse therefore needs approximately 20 - 25 litres of water every day and after battle probably even more. A horse can recover from a lack of water after 19 hours with an increased water intake, but after 36 hours it cannot do so anymore. Lack of water can therefore quickly become fatal[50]. However, with the abundance of snow in the higher mountains and the many rivers they crossed during their expedition, lack of water seems not to have particularly been a problem for the Carthagian army.

Regarding the Carthaginian army, the Numidian and African horses, as noted above, could subsist on significantly less feed than the average horse and may have relied solely on grass and other forage rather than grain. This provided Hannibal with a significant advantage during the Alpine crossing. The African and

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London, 1994, p. 140; Abu Bekr, *Nâçerî* is a famous treatise of hippology drafted about the year 1333, by Abou Bakr Ibn Badr Eddîn Ibn It Moundir The Baïtar, ordered by the Mamluk sultan An-Nasir Muhammad, also called sultan Ennâcer (victorious), whence the name of Naceri (relative to Nacer).

48 App. *Pun*. 14.100.

49 App. *Pun*. 2.11.

50 *Mogelijke dierenwelzijnproblemen in de paardenhouderij*', Raad van Dierenaangelegenheden (RDA), Lelystad, March 2003, p. 31.

Numidian horses—similar to modern Arabian breeds—could withstand hunger and thirst, travel greater distances, and perform reliably under extreme conditions. Therefore, the feeding standards established by the Romans for their cavalry horses were not directly applicable to the horses used by the Carthaginian army.

African and Numidian horses, accustomed to harsher climates in their native regions, were likely capable of enduring longer periods with less food and water than the heavier Roman horses. Such endurance would have been a critical logistical advantage during Hannibal's Alpine crossing, allowing the army to traverse difficult terrain. It is, therefore, quite safe to say that Hannibal did not primarily lose horses and mules because of starvation.

Logistics and Planning

Hannibal had planned the expedition knowing that the Alps could sustain at least a large part of his army. He had ascertained by careful inquiry the richness of the country into which he proposed to descend, and he had gained the help of natives whom he employed as guides and pioneers to assess the difficulties of the route. Such is the claim of Polybius, who had asked witnesses about the circumstances under which the crossing had taken place[51].

The army thus travelled across terrain that could provide them with enough fodder and food to complete the trip. Hannibal must have had knowledge of the geography of Spain, France, and Italy before he took on his expedition. Speaking of geostrategy in a modern sense of this word would be taking it too far, but in a looser sense he definitely had done logistical planning and made preparations[52]. For instance, before he crossed the Alps he had aimed for a region called the 'Island', which produced an abundance of corn[53]. He was also convinced that the Alps, and later Italy itself, would provide enough food for the army and its animals.

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51 Polyb. 3.48.11-12: Polybius also traveled the route and inspected the countryside.

52 Fronda, 2011, p. 255; Livy shows that it was normal to plan ahead for supplies when moving through enemy country, when he writes that Hannibal one time did not arrange supplies: Hannibal, too, went into camp not far away. Elated as he was at the victory of his horse, he was no less worried by the dearth of food, which increased from day to day, as he advanced through hostile territory without having anywhere arranged beforehand for supplies. (Liv. 21.48.8).

53 Polyb. 3.49.5-6.

> Quid Alpes aliud esse credentes quam montium altitudines? Fingerent altiores Pyrenaei iugis: nullas profecto terras caelum contingere nec inexsuperabiles humano generi esse. Alpes quidem habitari, coli, gignere atque alere animantes; pervias paucis esse, esse et exercitibus.
>
> What else did they think that the Alps were but high mountains? They might fancy them higher than the ranges of the Pyrenees; but surely no lands touched the skies or were impassable to man. The Alps indeed were inhabited, were tilled, produced and supported living beings; their defiles were practicable for armies[54] .

In order to make the most out of these plunderings and foragings, Hannibal had prepared himself well and had thoroughly informed himself on the physical geography of northern Italy[55]. He also had knowledge of the terrain and roads in Etruria[56]. He seems to have targeted specific Latin colonies[57]. With a closer look it becomes clear that he specifically targeted areas rich in corn and other supplies, so he could continuously keep his army fed[58]. He made this one of the priorities

54 Liv. 21.30.7.

55 Polyb. 3.34; 3.48.

56 Polyb. 3.78 - 79; Liv. 22.2.

57 Polyb. 3.88; 3.90; Liv. 25.22.

58 Hannibal now shifting his camp from time to time continued to remain in the country near the Adriatic, and by bathing his horses with old wine, of which there was abundance, he thoroughly set right their mangy condition. In like manner he completely cured his wounded, and made the rest of his men sound in body and ready to perform cheerfully the services that would be required of them. Polybius 3.88.1 - 6.; The Carthaginians, after ravaging the country I mentioned, crossed the Apennines and descended into the territory of the Samnites, which was very fertile and had not for long been visited by war, so that they had such abundance of provisions that they could not succeed either in using or in destroying all their booty. They also overran the territory of Beneventum, a Roman colony, and took the city of Telesia, which was unwalled and full of all manner of property. Polybius 3.90.7-8.;Hannibal, having thus done his best to provoke the Romans by laying the whole plain waste, found himself in possession of a huge amount of booty and decided to withdraw, as he wished not to waste the booty, but to secure it in a place suitable for his winter quarters, so that his army should not only fare sumptuously for the present, but continue to have abundance of provisions. Polybius 3.92.8-9.;but after some days he was compelled to tell off a portion to pasture the animals, and send others to forage for corn, as he was anxious, according to his original plan, to avoid loss in the live stock he had captured and to collect as much corn as possible, so that for the whole winter there should be plenty of everything both for his men and also for the horses and pack-animals; for it was on his cavalry above all that he placed reliance. Polybius 3.101; All through the winter and spring the two armies remained encamped opposite each other, and it was not until the season was advanced enough for them to get supplies from the year's crops that Hannibal moved his forces out of the camp near Geronium. Judging that it was in his interest to compel the en-

of his conquests in Italy.

> σχεδόν που τὴν ἡμίσειαν τῆς δυνάμεως, καθάπερ ἐπάνω προεῖπον, ἐν ταῖς ὑπερβολαῖς διέφθειρεν. οἵ γε μὴν σωθέντες καὶ ταῖς ἐπιφανείαις καὶ τῇ λοιπῇ διαθέσει διὰ τὴν συνέχειαν τῶν προειρημένων πόνων οἷον ἀποτεθηριωμένοι πάντες ἦσαν.πολλὴν οὖν ποιούμενος πρόνοιαν Ἀννίβας τῆς ἐπιμελείας αὐτῶν ἀνεκτᾶτο καὶ τὰς ψυχὰς ἅμα καὶ τὰ σώματα τῶν ἀνδρῶν, ὁμοίως δὲ καὶ τῶν ἵππων.
>
> I said above, about half his whole force, while the survivors, owing to the continued hardships they had suffered, had become in their external appearance and general condition more like beasts than men. Hannibal, therefore, made every provision for carefully attending to the men and the horses likewise until they were restored in body and spirit[59] .

In camp, horses could graze during the day, but they would rapidly consume all available vegetation in the immediate vicinity of the campsite. Moreover, pasturelands needed to be reserved for hay production, as horses cannot be sustained solely on grain or fresh grass; hay or other roughage is essential for maintaining intestinal health[60]. Since hay could only be produced during a limited period of the year, careful advance planning was necessary at all times, including or maybe especially during encampments.

> ὑπάρχον αὐτῷ μῖσος ἔμφυτον πρὸς Ῥωμαίους. ἐν ᾧ καιρῷ καταστρατοπεδεύσας παρὰ τὸν Ἀδρίαν ἐν χώρᾳ πρὸς πάντα τὰ γεννήματα διαφερούσῃ μεγάλην ἐποιεῖτο σπουδὴν ὑπὲρ τῆς ἀναλήψεως καὶ θεραπείας τῶν ἀνδρῶν, οὐχ ἧττον δὲ καὶ τῶν ἵππων.ὡς ἂν γὰρ ὑπαίθρου τῆς παραχειμασίας γεγενημένης ἐν τοῖς κατὰ Γαλατίαν τόποις, ὑπό τε τοῦ ψύχους καὶ τῆς ἀνηλειψίας, ἔτι δὲ τῆς μετὰ ταῦτα διὰ τῶν ἑλῶν πορείας καὶ ταλαιπωρίας ἐπεγεγόνει σχεδὸν ἅπασι τοῖς ἵπποις, ὁμοίως δὲ καὶ τοῖς ἀνδράσιν ὁ λεγόμενος λιμόψωρος καὶ τοιαύτη καχεξία.διὸ γενόμενος ἐγκρατὴς χώρας εὐδαίμονος ἐσωματοποίησε μὲν τοὺς ἵππους, ἀνεκτήσατο δὲ τά τε σώματα καὶ τὰς ψυχὰς τῶν στρατιωτῶν.
>
> He now encamped near the Adriatic in a country abounding in all kinds of produce, and paid great attention to recruiting the health of his men as well as his horses by proper treatment. In consequence of the cold from which they had sufficient while wintering in the open land of Gaul, com-

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emy to fight by every means in his power, he seized on the citadel of a town called Cannae, in which the Romans had collected the corn and other supplies from the country round Canusium, conveying hence to their camp from time to time enough to supply their wants. Polybius 3.107.1-3.

59 Polybius 3.60.5-7.

60 Junkelmann, 1991, pp. 110 - 111.

> bined with their being unable to get the friction with oil to which they were accustomed, and owing also to the hardships of the subsequent march through the marshes, nearly all the horses as well as the men had been attacked by so-called "hunger-mange" and its evil results. So that, now he was in occupation of such a rich country, he built up his horses and restored the physical and mental condition of his men[61].

The army could sustain itself only by securing access to areas where horses and pack animals could be adequately fed. While soldiers could, in extremis, subsist on meat, herbivores have no such alternatives. It is therefore unsurprising that Xenophon warned against traversing barren terrain. For instance, Cyrus reportedly marched thirteen stages through desert regions, during which many pack animals perished from starvation due to the complete absence of fodder or vegetation[62].

In contrast, Hannibal was well prepared for the challenges of the higher Alps, reaching the summit after nine days[63]. The army's animals only approached starvation when confronted with a difficult landslide. In this specific instance, the elephants nearly perished, having to wait for three days with minimal access to food[64]. Horses and pack animals, by contrast, were able to traverse the obstacle more easily, waiting only a single day before being sent to fertile lower valleys to graze[65].

> τοῖς μὲν οὖν ὑποζυγίοις καὶ τοῖς ἵπποις ἱκανὴν ἐποίησε πάροδον ἐν ἡμέρᾳ μιᾷ. διὸ καὶ ταῦτα μὲν εὐθέως διαγαγὼν καὶ καταστρατοπεδεύσας περὶ τοὺς ἐκφεύγοντας ἤδη τὴν χιόνα τόπους διαφῆκε πρὸς τὰς νομάς,τοὺς δὲ Νομάδας ἀνὰ μέρος προῆγε πρὸς τὴν οἰκοδομίαν καὶ μόλις ἐν ἡμέραις τρισὶ κακοπαθήσας διήγαγε τὰ θηρία. καὶ τάδε συνέβαινε κακῶς ὑπὸ τοῦ λιμοῦ διατεθεῖσθαι·τῶν γὰρ Ἄλπεων τὰ μὲν ἄκρα καὶ τὰ πρὸς τὰς ὑπερβολὰς ἀνήκοντα τελέως ἄδενδρα καὶ ψιλὰ πάντ' ἔστι διὰ τὸ συνεχῶς ἐπιμένειν τὴν χιόνα καὶ θέρους καὶ χειμῶνος, τὰ δ' ὑπὸ μέσην τὴν παρώρειαν ἐξ ἀμφοῖν τοῖν μεροῖν ὑλοφόρα καὶ δενδροφόρα καὶ τὸ ὅλον οἰκήσιμ' ἔστιν.
>
> In one day he had made a passage sufficiently wide for the pack-train and horses; so he at once took these across and encamping on ground free of snow, sent them out to pasture, and then took the Numidians in relays to work at building up the path, so that with great difficulty in three days he

61 Polybius 3.87.1-3.
62 Xen. *Anab.* 1.5.5.
63 Liv. 21.35.4.
64 Liv. 21.37.3.
65 Polyb. 3.4.7.

> managed to get the elephants across, but in a wretched condition from hunger; for the summits of the Alps and the parts near the tops of the passes are all quite treeless and bare owing to the snow lying there continuously both winter and summer, but the slopes half-way up on both sides are grassy and wooded and on the whole inhabitable[66].

On the basis of this passage, it can be concluded, that Hannibal indeed mainly depended on the grazing possibilities in the Alps. If that plan had failed, it would have meant starvation as well for the infantry, since the loss of pack animals would mean an eventual loss of supplies and food.

> οὐ γὰρ μόνον ὑπὸ τῶν ἀναβάσεων καὶ καταβάσεων, ἔτι δὲ τραχυτήτων τῶν κατὰ τὰς ὑπερβολάς, δεινῶς τεταλαιπωρήκει τὸ σύμπαν αὐτῷ στρατόπεδον, ἀλλὰ καὶ τῇ τῶν ἐπιτηδείων σπάνει καὶ ταῖς τῶν σωμάτων ἀθεραπευσίαις κακῶς ἀπήλλαττε.πολλοὶ δὲ καὶ καθυφεῖνθ' ἑαυτοὺς ὁλοσχερῶς διὰ τὴν ἔνδειαν καὶ συνέχειαν τῶν πόνων. οὔτε γὰρ διακομίζειν εἰς τοσαύτας μυριάδας διὰ τοιούτων τόπων δαψιλῆ τὰ πρὸς τὴν τροφὴν οἷοί τ' ἦσαν, ἅ τε καὶ παρεκόμιζον, ἅμα τῇ τῶν ὑποζυγίων καταφθορᾷ καὶ τούτων τὰ πλεῖστα συναπώλλυτο.διόπερ ὁρμήσας ἀπὸ τῆς τοῦ Ῥοδανοῦ διαβάσεως, πεζοὺς μὲν εἰς ὀκτακισχιλίους καὶ τρισμυρίους ἔχων ἱππεῖς δὲ πλείους ὀκτακισχιλίων, σχεδόν που τὴν ἡμίσειαν τῆς δυνάμεως.
>
> For his men had not only suffered terribly from the toil of ascent and descent of the passes and the roughness of the road but they were also in wretched condition owing to the scarcity of provisions and neglect of their persons, many having fallen into a state of utter despondency from prolonged toil and want of food. For it had been impossible to transport over such ground a plentiful supply of provisions for so many thousand men, and with the loss of the pack-animals the greater part of what they were carrying perished. So that while Hannibal started from the passage of the Rhone with thirty-eight thousand foot and more than eight thousand horse he lost nearly half in crossing the passes. Polyb. 3.56.3-4: He had spent fifteen days in crossing the Alps, and now, when he thus boldly descended into the plain of the Po and the territory of the Insubres, his surviving forces numbered twelve thousand African and eight thousand Iberian foot, and not more than six thousand horse in all, as he himself states in the inscription on the column at Lacinium relating to the number of his forces[67].

One may, therefore, safely conclude, that Hannibal relied on the possibility of pasturing horses and pack-animals during a campaign[68]. This would also mean, that Hannibal did not have to use mules to carry grain for either themselves or

66 Polyb. 3.55.7-9.

67 Polyb. 3.60.3-5.

68 Polyb. 3.101.

On the Following Page: Fig. 3. Hannibals Crossing the Alps according to Johannes Kromayer und Georg Veith, *Schlachten-Atlas zur antiken Kriegsgeschichte*: 120 Karten auf 34 Tafeln; mit begleitendem Text (1. Lieferung, *Römische Abteilung* 1): *Älteste Zeit und Punische Kriege bis Cannae* (*Röm. Abt* 3, 1). Universitätsbibliothek Heidelberg, DFG).

for the horses of the cavalry. Consequently, the size and logistical burden of his baggage train may have been considerably smaller than previously assumed.

Therefore, the calculations of John F. Shean concerning the number of pack animals required during Hannibal Barca's crossing of the Alps cannot be correct. Building on estimates proposed by Donald W. Engels, Shean attempts to reconstruct the potential size of the baggage train[69]. However, they presuppose that horses and mules depended primarily on transported grain. Yet, as discussed above, the accounts of Polybius and Livy indicate that pack animals and cavalry mounts were frequently sent out to graze and that the supplies they carried were primarily intended for the infantry. Consideration of the dietary requirements of North African horses and mules further suggests that these animals could largely subsist on forage encountered along the route. If so, the need to transport large quantities of fodder would have been significantly reduced, and the number of pack animals required correspondingly smaller than Shean's reconstruction implies.

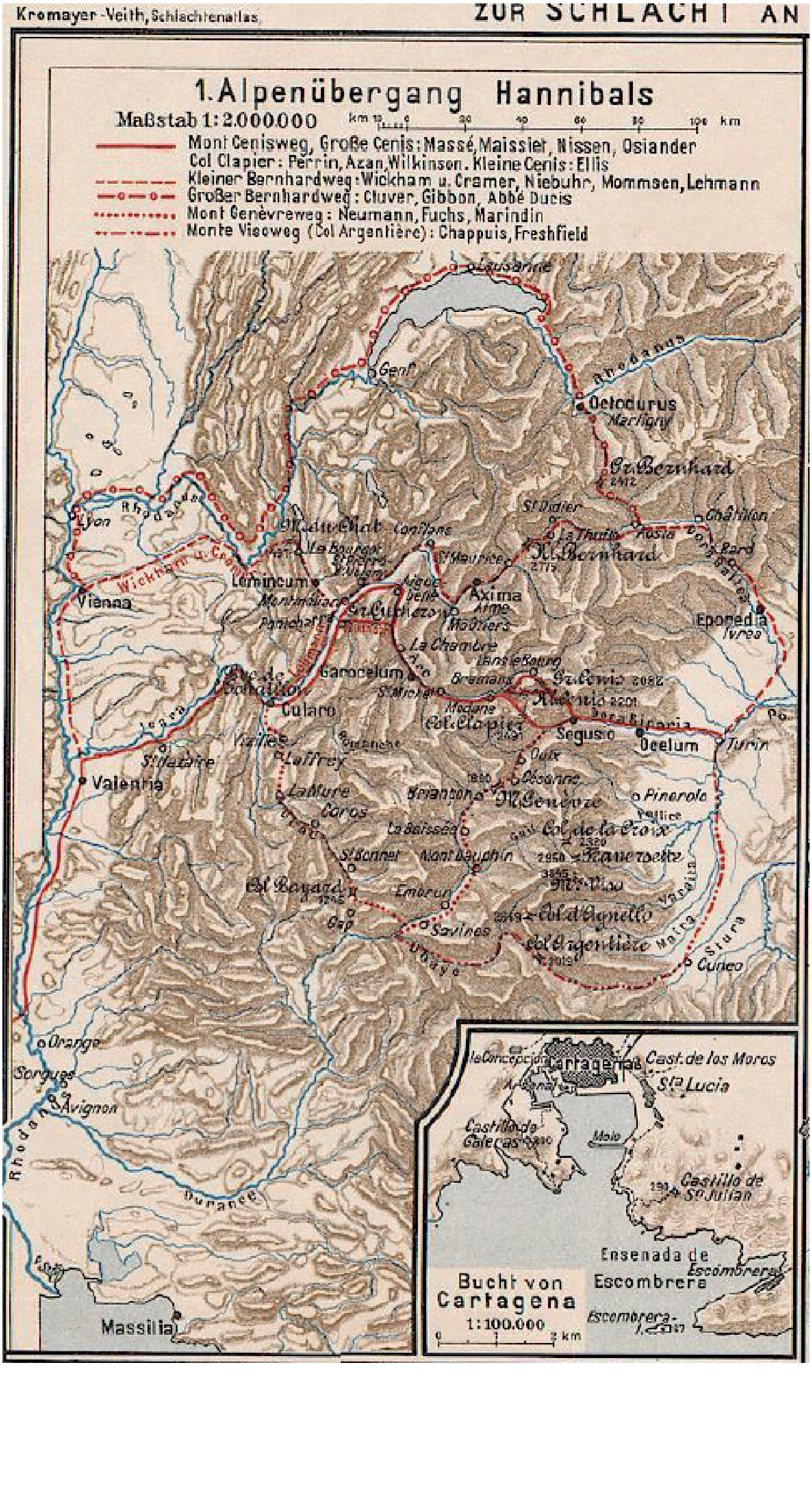
His calculations assume that horses carried their own fodder within the army's supply system. Accordingly, he estimates that horses and pack animals required approximately 10 lbs of grain per day, while infantrymen required about 3 lbs. Adopting that a single pack animal could carry 200 lbs, Shean calculates that an army of 90,000 infantry (plus 34,000 camp followers) and 12,000 cavalry would have required 55,520 pack animals to sustain ten days of supplies. A smaller reconstruction—34,500 infantry (plus 14,700 camp followers) and 9,800 cavalry.[70]. On this basis, Shean concludes that Hannibal could not realistically have maintained more than 20,000 pack animals at any given time[71].

If the calculations are restricted to provisions for the men alone during the

69 Engels, cit., p. 18.

70 Shean, cit., pp. 171 - 173: he has made several calculations.

71 Shean, cit., p. 174.


Kromayer-Veith, Schlachtenatlas.
ZUR SCHLACHT AN
1. Alpenübergang Hannibals
Maßstab 1:2.000.000
Mont Cenisweg, Große Cenis: Massé, Maissiat, Nissen, Osiander
Col Clapier: Perrin, Azan, Wilkinson. Kleine Cenis: Ellis
Kleiner Bernhardweg: Wickham u. Cramer, Niebuhr, Mommsen, Lehmann
Großer Bernhardweg: Cluver, Gibbon, Abbé Ducis
Mont Genèvreweg: Neumann, Fuchs, Marindin
Monte Viesoweg (Col Argentière): Chappuis, Freshfield
Lausanne
Genf
Octodurus
Martigny
Gr. Bernhard
Châtillon
Aosta
Kl. Bernhard
Lyon
Vienna
Lemincum
Axima
Eporedia
Ivrea
Garocelum
Cularo
Segusio
Ocelum
Turin
Valentia
Briançon
Pinerolo
Col Bayard
Gap
Embrun
Savines
Col de la Croix
Col Argentière
Cuneo
Orange
Avignon
Massilia
Buch von Cartagena
1:100.000
Cartagena
Cast. de los Moros
Sta Lucia
Castillo de Galeras
Castillo de Sn Julian
Ensenada de Escombrera
Escombrera

Alpine crossing—estimated here at ten days—an army of 90,000 infantry and 9,800 cavalry (plus 34,000 camp followers) would have required approximately 408,000 lbs of grain, based on the figures given by Shean. A smaller force of 34,500 infantry and 9,000 cavalry (plus 14,700 camp followers) would require roughly 177,000 lbs. Subsequently, the number of mules needed would be significantly less than calculated[72].

It can now be concluded that Hannibal made good use of the opportunity of grazing on the mountain pastures and, as we have seen above, it seems most of the pack animals and horses did not die from famine. How then did the Carthaginian army lose as many pack animals and horses as Polybius claims?

Terrain and Weather Conditions influencing Tactical Decisions

Crossing difficult terrain on enemy territory did not only require logistical planning ahead to keep the infantry fed, but also a clever tactical brain to cope with terrain, enemy attacks, and all unforeseen circumstances that could cause losses of cavalry horses and pack-animals. It necessitated good planning.

> ὅπου δὲ χιλὸς σπάνιος πάνυ εἴη, αὐτὸς δὲ δύναιτο παρασκευάσασθαι διὰ τὸ πολλοὺς ἔχειν ὑπηρέτας καὶ διὰ τὴν ἐπιμέλειαν, διαπέμπων ἐκέλευε τοὺς φίλους τοῖς τὰ ἑαυτῶν σώματα ἄγουσιν ἵπποις ἐμβάλλειν τοῦτον τὸν χιλόν, ὡς μὴ πεινῶντες τοὺς ἑαυτοῦ φίλους ἄγωσιν.
>
> And wherever fodder was exceedingly scarce and he was able to get it for his own use because of the large number of his servants and because of his good planning, he would distribute this fodder among his friends and tell them to give it to the horses that carried their own bodies, that they might not be hungry while carrying his friends[73].

The terrain, for example, could not be suitable for animals to pass. Whether or not pack animals and horses could pass a certain area or terrain would play a decisive role in planning routes which would be passable for them.

> καὶ οὗτοι πρῶτοι συνέμειξαν τοῖς προκαταλαβοῦσι τὸ χωρίον. Ξενοφῶν

72 Furthermore, when doing such calculations, it must be noted that the loss of a horse did not necessarily entail the loss of the cavalryman himself. While in battle the death of a mount effectively removed the rider from combat, on campaign a dismounted cavalryman would nevertheless remain part of the marching force and thus continue to require rations. This distinction further complicates attempts to reconstruct the logistical requirements of Hannibal's army.

73 Xen. *Anab.* 1.9.27.

> δὲ ἔχων τῶν ὀπισθοφυλάκων τοὺς ἡμίσεις ἐπορεύετο ᾗπερ οἱ τὸν ἡγεμόνα ἔχοντες· εὐοδωτάτη γὰρ ἦν τοῖς ὑποζυγίοις· τοὺς δὲ ἡμίσεις ὄπισθεν τῶν ὑποζυγίων ἔταξε. πορευόμενοι δ' ἐντυγχάνουσι λόφῳ ὑπὲρ τῆς ὁδοῦ κατειλημμένῳ ὑπὸ τῶν πολεμίων, οὓς ἢ ἀποκόψαι ἦν ἀνάγκη ἢ διεζεῦχθαι ἀπὸ τῶν ἄλλων Ἑλλήνων. καὶ αὐτοὶ μὲν ἂν ἐπορεύθησαν ᾗπερ οἱ ἄλλοι, τὰ δὲ ὑποζύγια οὐκ ἦν ἄλλῃ ἢ ταύτῃ ἐκβῆναι.
>
> But Xenophon with half the rearguard set out by the same route which the party with the guide had followed, because this was the easiest route for the baggage animals; and behind the baggage animals he posted the other half of the rearguard. As they proceeded they came upon a hill above the road which had been seized by the enemy, and found themselves compelled either to dislodge them or be completely separated from the rest of the Greeks; and while, so far as the troops themselves were concerned, they might have taken the same route that the rest followed, the baggage animals could not get through by any other road than this one by which Xenophon was proceeding[74].

Such examples can also be found in medieval sources such as the Alexias. During the hostilities against Tzachas (1092), Alexios I Komnenos could not ride his horse because the place was hilly, full of gullies, thickly covered and almost impassable.

> Καὶ τὸν ὅλον αὐχένα διαδραμὼν τοῦ οὑτωσί πως ἐγχωρίως καλουμένου Ζυγοῦ, οὐκ ἐποχούμενος (οὐ γὰρ ἐδίδου τοῦτο ἐς ἀεὶ ὁ τόπος ὀχθώδης τε καὶ χαραδρώδης ὢν καὶ συνηρεφὴς καὶ μικροῦ ἄβατος), ἀλλὰ πεζῇ ἅπαντα διερχόμενος
>
> He traversed the whole narrow mountain ridge of what is locally called the 'Zygum' but not on horseback (for the nature of the ground did not allow of this as it was rugged and full of gullies and here and there thickly wooded and almost impassable)[75].

The castle of Anchialus provided problems as well as it is described as having on the right the Pontic Sea and on the left a rough, rugged place, planted with vines, that was almost impassable for horsemen.

> Τὸ δὲ κάστρον ἡ Ἀγχίαλος τοιαύτης ἔτυχε θέσεως. Δεξιόθεν μὲν τὴν Ποντηρὰν εἶχε θάλασσαν, ἐξ εὐωνύμου δὲ τραχύν τινα τόπον καὶ δύσβατον καὶ ὑπάμπελον καὶ τοῖς ἱππόταις εὔοδον τὸν δρόμον μὴ παρέχοντα.
>
> Now the site of the fortress Anchialus was like this, on the right lay the

74 Xen. *Anab*. 4.2.9-10; Xen. Anab. 4.6.17: From these fellows I also learn that the mountain is not impassable, but is pastured with goats and cattle; therefore if we once get possession of any part of the mountain, our pack animals also will find it passable.

75 Anna Comnena, *Alexias* 9.1.1.

> Pontic sea, and on the left the ground was very rough and impassable and overgrown with vines and did not afford any foothold for riders[76].

It is therefore not a surprise that Polybius wrote that the Carthaginians suffered great loss in horses and mules to the circumstances and the ground in the Alps, and not so much, as would rather be expected, from the hands of their enemies.

> οὗ συμβάντος καὶ τῆς ἡμέρας ἐπιγενομένης, οἱ βάρβαροι συνθεασάμενοι τὸ γεγονὸς τὰς μὲν ἀρχὰς ἀπέστησαν τῆς ἐπιβολῆς·μετὰ δὲ ταῦτα θεωροῦντες τὸ τῶν ὑποζυγίων πλῆθος καὶ τοὺς ἱππεῖς δυσχερῶς ἐκμηρυομένους καὶ μακρῶς τὰς δυσχωρίας, ἐξεκλήθησαν ὑπὸ τοῦ συμβαίνοντος ἐξάπτεσθαι τῆς πορείας.τούτου δὲ γενομένου, καὶ κατὰ πλείω μέρη προσπεσόντων τῶν βαρβάρων, οὐχ οὕτως ὑπὸ τῶν ἀνδρῶν ὡς ὑπὸ τῶν τόπων πολὺς ἐγίνετο φθόρος τῶν Καρχηδονίων, καὶ μάλιστα τῶν ἵππων καὶ τῶν ὑποζυγίων.οὔσης γὰρ οὐ μόνον στενῆς καὶ τραχείας τῆς προσβολῆς ἀλλὰ καὶ κρημνώδους, ἀπὸ παντὸς κινήματος καὶ πάσης ταραχῆς ἐφέρετο κατὰ τῶν κρημνῶν ὁμόσε τοῖς φορτίοις πολλὰ τῶν ὑποζυγίων.καὶ μάλιστα τὴν τοιαύτην ταραχὴν ἐποίουν οἱ τραυματιζόμενοι τῶν ἵππων· τούτων γὰρ οἱ μὲν ἀντίοι συμπίπτοντες τοῖς ὑποζυγίοις, ὁπότε διαπτοηθεῖεν ἐκ τῆς πληγῆς, οἱ δὲ κατὰ τὴν εἰς τοὔμπροσθεν ὁρμὴν ἐξωθοῦντες πᾶν τὸ παραπῖπτον ἐν ταῖς δυσχωρίαις, μεγάλην ἀπειργάζοντο ταραχήν.
>
> At daylight the enemy observed what had happened and at first desisted from their project, but afterwards on seeing the long string of sumpter-animals and horsemen slowly and with difficulty winding up the narrow path, they were tempted by this to molest their march. On their doing so and attacking at several different points, the Carthaginians suffered great loss chiefly in horses and sumpter-mules, not so much at the hands of the barbarians as owing to the ground. For the road up the pass being not only narrow and uneven but precipitous, the least movement or disturbance caused many of the animals to be pushed over the precipice with their packs. It was chiefly the horses on being wounded which caused the disturbance, some of them, terrified by the pain, turning and meeting the pack-animals and others rushing on ahead and pushing aside in the narrow path everything that came in their way, thus creating a general confusion[77].

Certain types of terrain would ask for a specific way of getting the animals through. Especially in snowy conditions horses and mules would struggle enormously. The accounts of the survivors of the so-called Trakehner Treck in the winter of 1944/1945 give an insight into the problems that heavy snowfall and difficult ground could cause for horses, apart from the lack of fodder. Horses

76 Anna Comnena, *Alexias*, 10.3.3.

77 Polyb. 3.51.1-5.

would get stuck in the snow up to their bellies, would repeatedly fall on the ice and they would panic. The constant enemy attacks also made casualties[78]. Yet, the horses survived and showed what their breed was capable of[79].

The Prussian Trakehner Stud had to evacuate as the Russian army invaded the east of Germany. They had to drive the horses over land without any possible delay and without the possibility of food or drink[80]. The Trakehner horses had been the pride of the German cavalry and its stud was located in Prussia. Of course, the German breeders did not want the Trakehner horses to fall into Russian hands. As a result, horses were put on a 1600-kilometre journey overland through mud, snow and biting cold. There was little or no food available and very little shelter. The mares usually remained in harness during the night. The most terrifying part of the journey was the crossing of the frozen lake Frisches Haff, during which many people and horses were lost beneath the ice[81].

Xenophon, too, encountered snow on his expedition through Persia and learned that the local people had their own way of getting their horses and mules through the snow.

> ἦσαν δ’ οἱ ταύτῃ ἵπποι μείονες μὲν τῶν Περσικῶν, θυμοειδέστεροι δὲ πολύ. ἐνταῦθα δὴ καὶ διδάσκει ὁ κώμαρχος περὶ τοὺς πόδας τῶν ἵππων καὶ τῶν ὑποζυγίων σακία περιειλεῖν, ὅταν διὰ τῆς χιόνος ἄγωσιν· ἄνευ γὰρ τῶν σακίων κατεδύοντο μέχρι τῆς γαστρός.

78 Clough, 2004, p. 144: Einige Wagenführer hatten Metallstollen mitgebracht, die an die Hufe der Pferde geschraubt werden konnten, damit sie einen besseren Halt fanden. Andere Pferde, die lediglich auf ihren eisernen Hufeisen gingen, rutschten ständig aus, fielen auf das Eis, rappelten sich wieder auf und stürzten erneut. Oft wateten Pferde und Menschen knietief im Eiswasser und sahen kaum, wohin sie ihre Füsse setzten.

79 Clough, cit., p. 179: Langsam, mühsam und ausgezehrt durch Futtermangel zogen die Trakehner ramponierte Wagen (…) Die Trecks waren 1000 oder sogar 1500 Kilometer unterwegs gewesen, die Pferde hatten Lasten bis zu vierzig Zentner durch bittere Kälte, Eis und Schnee, durch Feuer, Bombenhagel und Schüsse gezogen. Sie hatten selten ausreichend Futter und Erholungspausen gehabt. Viele der Stuten, die tragend waren, hatten verfohlt. Es war wohl die grösste Leistungsprüfung die Pferden je abverlangt worden war, und die Trakehner hatten überzeugender als je zuvor demonstriert, wozu ihre Rasse fähig war.

80 Clough, cit., p. 123: Da die Russen nur noch drei Kilometer entfernt waren, fuhren sie 24 Stunden ohne Unterbrechung, nicht einmal die Pferden wurden getränkt oder gefüttert.; p. 141: Die Temperatur lag bei minus zwanzig Grad, Schnee peitschte ins Gesicht, un die Sicht war auf wenige Meter beschränkt.

81 Goodall, 1973, pp. 74-76; a similar situation where the animals have difficulties because of the ice is described in Liv. 21.35.12-36.8.

> The horses of this region were smaller than the Persian horses, but very much more spirited. It was here also that the village chief instructed them about wrapping small bags round the feet of their horses and beasts of burden when they were going through the snow; for without these bags the animals would sink in up to their bellies[82].

Not only icy and snowy conditions are a danger to horses and mules. Wet soil and moisture are disastrous for the hardness of the hooves and legs. They produce all kinds of lameness and defects, such as mud fever. The biggest factor that causes horse loss is lameness. This can be caused in several ways. Wetness of the soil causes hoof defects, a misstep can cause a muscle strain or a tendon injury. An example of these circumstances is the three-day journey through the swamps, during which many horses lose their hooves.

> πάντες μὲν οὖν ἐκακοπάθουν καὶ μάλιστα διὰ τὴν ἀγρυπνίαν, ὡς ἂν ἑξῆς ἡμέρας τέτταρας καὶ τρεῖς νύκτας συνεχῶς δι’ ὕδατος ποιούμενοι τὴν πορείαν· διαφερόντως γε μὴν ἐπόνουν καὶ κατεφθείρονθ’ ὑπὲρ τοὺς ἄλλους οἱ Κελτοί.τῶν δ’ ὑποζυγίων αὐτοῦ τὰ πλεῖστα πίπτοντα διὰ τοὺς πηλοὺς ἀπώλλυντο, μίαν παρεχόμενα χρείαν ἐν τῷ πεσεῖν τοῖς ἀνθρώποις·καθεζόμενοι γὰρ ἐπ’ αὐτῶν καὶ τῶν σκευῶν σωρηδὸν ὑπὲρ τὸ ὑγρὸν ὑπερεῖχον καὶ τῷ τοιούτῳ τρόπῳ βραχὺ μέρος τῆς νυκτὸς ἀπεκοιμῶντο.οὐκ ὀλίγοι δὲ καὶ τῶν ἵππων τὰς ὁπλὰς ἀπέβαλον διὰ τὴν συνέχειαν τῆς διὰ τῶν πηλῶν πορείας.
>
> All the army, indeed, suffered much, and chiefly from want of sleep, as they had to march through water for three continuous days and nights, but the Celts were much more worn out and lost more men than the rest. Most of the pack-animals fell and perished in the mud, the only service they rendered being that when they fell the men piled the packs on their bodies and lay upon them, being thus out of the water and enabled to snatch a little sleep during the night. Many of the horses also lost their hooves by the continuous march through the mud[83].

As is also evident from the example of the Trakehner Treck, casualties could result not only from the terrain but also from the panic of the horses themselves. Such situations could neither be anticipated nor mitigated through prior training. Consequently, the challenges posed by the terrain would have significantly influenced the success or failure of the expedition.

> Der Dohna-Sasse-Treck erlebte bange Stunden, als er sich den rutschigen, eisbedeckten Damm im Weichsel-Delta entlangsquälte. Die Menschen

82 Xen. *Anab*. 4.5.36.

83 Polyb. 3.79.8-11.

> gingen neben den Pferden her und hielten sie an den Köpfen, um zu verhindern, dass sie ausrutschten und das Steilufer hinabstürzten. Plötzlich lag ein totes Pferd auf dem Weg. Da Pferde nicht an toten Artgenossen vorbeigehen, rührten sich auch die Tiere nichts mehr von der Stelle.
>
> The Dohna-Sasse trek endured anxious hours as they struggled along the slippery, ice-covered embankment in the Vistula Delta. The people walked beside the horses, holding them by the heads to prevent them from slipping and plunging down the steep bank. Suddenly, a dead horse lay on the path. Since horses do not pass by dead members of their species, the animals remained motionless[84].

Rivers, too, were quite tricky to pass with animals. They could either swim or large transport rafts were built[85]. Nevertheless, there was always the risk of drowning, because horses or mules would panic aboard these rafts and would plunge into the river. Therefore, taking a route that would mean less stress to the animals would be preferable to risky crossings.

> Iam paratas aptatasque habebat pedes lintres, eques fere propter equos naves. Navium agmen ad excipiendum adversi impetum fluminis parte superiore transmittens tranquillitatem infra traicientibus lintribus praebebat; equorum pars magna nantes loris a puppibus trahebantur, praeter eos quos instratos frenatosque ut extemplo egresso in ripam equiti usui essent imposuerant in naves.
>
> The infantry had their skiffs all ready and equipped, while the cavalry had large boats, for the most part, on account of their horses. The large boats were sent across higher up the stream, to take the force of the current, and provided smooth water for the skiffs that crossed below them. A good part of the horses swam and were towed by their halters from the sterns of the boats, except those which they had saddled and bridled and put on board, that their riders might have them ready for instant use on landing[86].

The trickiest part of the Alps, like any other mountains, were the steep paths, ravines and passes that provided trouble for the animals. Ungulate animals, of course, cannot cling to branches, trees or rocks to keep their footing. This is illustrated by one of the most dangerous moments in the Crossing of the Alps, when the cavalry was halted because of a perpendicular cliff and a landslide that was

84 Clough, cit., p. 147.

85 Liv. 21.27.4: The Gauls who had been appointed to be his guides informed him that some five-and-twenty miles upstream the river flowed round a little island, and being wider where it divided, and therefore shallower, afforded a passage. There they quickly felled some trees and constructed rafts to transport the men and horses and other burdens.

86 Liv. 21.27.8-9.

too slippery for the horses and mules. It forced them to make a detour. When it became evident that further down the mountain another slope was again too steep to be passable for the horses and mules, let alone the elephants, they had to lessen its steepness and make it wider. As a result, a route was created for the animals to descend the cliff, probably similar to the meandering roads used today to cross mountain passes[87].

A notable difference between antiquity and the medieval or early modern periods concerns the vulnerability of horses to lameness caused by the loss of a horseshoe. In the ancient world, horses were generally not shod with nailed iron horseshoes. Although various forms of hoof protection existed—such as temporary hoof coverings or hipposandals—the majority of horses worked with their hooves in a natural state. As a result, they could not become suddenly lame through the loss of a shoe, since no such attachment was present. Hoof wear certainly occurred, especially on hard or rocky terrain, but this process was gradual rather than abrupt.

By contrast, in the medieval and later periods the widespread adoption of nailed iron horseshoes significantly altered hoof management. Horseshoes protected the hoof from excessive wear and improved traction on certain surfaces, making them particularly advantageous for heavy cavalry mounts, draft animals, and horses travelling long distances on increasingly developed road networks. However, this technological development also introduced a new vulnerability. If a horseshoe was lost during travel or in the course of military activity, the exposed hoof—accustomed to the protection and altered wear pattern provided by the shoe—could quickly become damaged. Nails that had secured the shoe might leave weakened holes in the hoof wall, and uneven wear between shod and unshod hooves could cause discomfort or lameness.

In military contexts, this problem could have practical consequences. A horse

87 Liv. 21.35.12-36.8; 37.3. They then broke up the heated rocks with crow bars and made the whole slope more manageable by creating a series of gentle S- bends down the hillside. As a result both the baggage animals and the elephants were able to be led down the mountain.; Polyb. 3.54 - 55; Polyb. 3.55.6-8: Hannibal encamped on the ridge, sweeping it clear of snow, and next set the soldiers to work to build up the path along the cliff, a most toilsome task. In one day he had made a passage sufficiently wide for the pack-train and horses; so he at once took these across and encamping on ground free of snow, sent them out to pasture, and then took the Numidians in relays to work at building up the path.

that lost a shoe during a campaign or march might be unable to continue effectively until the shoe was replaced, requiring the presence of a farrier or access to suitable equipment. Thus, while horseshoeing improved the durability and utility of horses in many respects, it also created a dependency on farriery and introduced an additional logistical concern that had been largely absent in antiquity[88].

During a march, a general could expect to face enemy attacks. Such assaults did not solely aim to inflict casualties on the infantry; they also sought to cause maximum disruption. Horses and mules were particularly vulnerable, and from a tactical standpoint, it could be more advantageous for the enemy to target the animals rather than the soldiers themselves. If they could wound or kill the pack-animals that carried the supplies, they would easily hinder the entire army for their supplies could not be transported anymore[89]. Wounded horses, on the other hand, could become a danger to their riders in their panic and fear. Animals that panic or no longer obey can harm their own side even more than the enemy can, because they will turn their force against their riders or leaders[90]. Inflicting injuries on the animals to disrupt enemy ranks proved far more effective than attempting to kill them outright, a tactic well understood by the mountain peoples of the Alps.

> Prima deinde luce castra mota et agmen reliquum incedere coepit. Iam montani signo dato ex castellis ad stationem solitam conveniebant, cum repente conspiciunt alios arce occupata sua super caput imminentes, alios via transire hostes. Utraque simul obiecta res oculis animisque immobiles parumper eos defixit; deinde, ut trepidationem in angustiis suoque ipsum tumultu misceri agmen videre, equis maxime consternatis, quidquid adiecissent ipsi terroris satis ad perniciem fore rati, perversis rupibus iuxta, invia ac devia adsueti decurrunt. Tum vero simul ab hostibus, simul ab iniquitate locorum Poeni oppugnabantur plusque inter ipsos, sibi quoque tendente ut periculo primus evaderet, quam cum hostibus certaminis erat. Et equi maxime infestum agmen faciebant, qui et clamoribus dissonis quos nemora etiam repercussaeque valles augebant territi trepidabant, et icti forte aut volnerati adeo consternabantur, ut stragem ingentem simul hominum ac sarcinarum omnis generis facerent; multosque turba, cum praecipites deruptaeque utrimque angustiae essent, in immensum altitudinis deiecit, quosdam et armatos; et ruinae maxime modo iumenta cum oneribus devoluebantur.

88 Herbert - Davies, cit., p. 187 - 188; Hyland, 1994, p. 97.

89 For example: Liv. 38.40.10-13: Manlius Vulso had his baggage train ambushed in Thrace in 188 B.C.

90 Xen. *Cav.* 1.3.

> With the ensuing dawn the Carthaginians broke camp and the remainder of their army began to move. The natives, on a signal being given, were already coming in from their fastnesses to occupy their customary post, when they suddenly perceived that some of their enemies were in possession of the heights and threatened them from above, and that others were marching through the pass. Both facts presenting themselves at the same time to their eyes and minds kept them for a moment rooted to the spot. Then, when they saw the helter-skelter in the pass and the column becoming embarrassed by its own confusion, the horses especially being frightened and unmanageable, they thought that whatever they could add themselves to the consternation of the troops would be sufficient to destroy them, and rushed down from the cliffs on either side, over trails and trackless ground alike, with all the ease of habit. Then indeed the Phoenicians had to contend at one and the same time against their foes and the difficulties of the ground, and the struggle amongst themselves, as each endeavoured to outstrip the rest in escaping from the danger, was greater than the struggle with the enemy. The horses occasioned the greatest peril to the column. Terrified by the discordant yells, which the woods and ravines redoubled with their echoes, they quaked with fear; and if they happened to be hit or wounded, were so maddened that they made enormous havoc not only of men but of every sort of baggage. Indeed the crowding in the pass, which was steep and precipitous on both sides, caused many —some of them armed men —to be flung down to a great depth; but when beasts of burden with their packs went hurtling down, it was just like the crash of falling walls[91].

In later times, too, such tactics were quite common. Gustavus Adolphus (1631, Sweden) even recommended his cavalry to make cuts at the heads and necks of the enemy's horses in order, by wounding them, to cause confusion in their ranks[92]. According to Charles-Emmanuel de Warnery, Major General of Prussian Hussars, a horse rarely just falls down dead on the battlefield, so wounding them enough to make them panic is more realistic than trying to kill them[93].

In the *Alexias* of Anna Comnena several quite harsh tactics are found. For example, during the second Norman invasion (1107-1008), the emperor recommended his archers to take aim at the horses rather than their riders, so the horses would be destroyed, leaving the men. Dismounting from the horses would make them easy to overcome.

Ἐπεχορήγει δὲ δαψιλῆ τούτοις τὰ βέλη παρακελευόμενος μὴ φείδεσθαι

91 Liv. 21.33.1-11.

92 Beamish, 2010, p. 59.

93 De Warnery, cit., p. 19.

> τούτων ὅλως, ἀλλὰ κατὰ τῶν ἵππων μᾶλλον ἢ τῶν Κελτῶν ἐπιτοξά ζεσθαι, τοῦτο μὲν εἰδὼς ὅτι ὅσον ἐπὶ τοῖς θώραξι καὶ τοῖς σιδηροῖς χιτῶσι δύστρωτοι ἦσαν ἢ καὶ παντάπασιν ἄτρωτοι. Βάλλειν οὖν εἰς μάτην καὶ πάντη ἀνόητον ᾤετο. Ὅπλον γὰρ κελτικὸν χιτών ἐστι σιδηροῦς κρίκος ἐπὶ κρίκῳ περιπεπλεγμένος καὶ τὸ σιδήριον ἀγαθοῦ σιδήρου, ὥστε καὶ βέλος ἀπώσασθαι ἱκανὸν καὶ τὸν χρῶτα φυλάξαι τοῦ στρα τιώτου. Προσθήκη δὲ τῆς φυλακῆς καὶ ἀσπὶς οὐ περι φερής, ἀλλὰ θυρεὸς ἀπὸ πλατυτάτου ἀρξάμενος καὶ εἰς ὀξὺ καταλήγων, καὶ τἄνδον ἠρέμα ὑποκοιλαινόμενος, λεῖος δὲ καὶ στίλβων κατὰ τὴν ἔξωθεν ἐπιφάνειαν καὶ ἐπ› ὀμφαλῷ χαλκοχύτῳ μαρμαίρων. Βέλος τοίνυν, κἂν σκυθικὸν εἴη, κἂν περσικόν, κἂν ἀπὸ βραχιόνων ἀπορριφείη γιγαντικῶν, ἐκεῖθεν ἀποκρουσθὲν παλινδρομήσειε πρὸς τὸν πέμψαντα. Διὰ ταῦτα τοίνυν ἔμπειρος ὢν οἶμαι ὁ βασιλεὺς τῶν κελτικῶν ὅπλων καὶ τῶν ἡμετέρων τοξευμάτων, ἀφεμένους τῶν ἀνδρῶν τοῖς ἵπποις μᾶλλον ἐπιθέσθαι παρεκελεύετο καὶ καταπτεροῦν αὐτοὺς τοῖς τοξεύμασι παρήνει, ἅμα δὲ καὶ ἵνα τῶν ἵππων ἀποβεβηκότες εὐχείρωτοι γένοιντο. Κελτὸς γὰρ ἀνὴρ ἔποχος μὲν ἀκατάσχετος καὶ κἂν τεῖχος διατετρήνειε Βαβυλώνιον, ἀποβεβηκὼς δὲ τοῦ ἵππου ἄθυρμα τοῖς ἐθέλουσι γίνεται.
>
> He furnished them abundantly with arrows and exhorted them not to use them sparingly, but to shoot at the horses rather than at the Franks. For he knew that the Franks were difficult to wound, or rather, practically invulnerable, thanks to their breastplates and coats of mail. Therefore he considered shooting at them useless and quite senseless. For the Frankish weapon of defence is this coat of mail, ring plaited into ring, and the iron fabric is such excellent iron that it repels arrows and keeps the wearer's skin unhurt. An additional weapon of defence is a shield which is not round, but a long shield, very broad at the top and running out to a point, hollowed out slightly inside, but externally smooth and gleaming with a brilliant boss of molten brass. Consequently any arrow, be it Scythian or Persian, or even discharged by the arms of a giant, would glint off such a shield and hark back to the sender. For this reason, as he was cognisant both of the Frankish armour and our archery, the Emperor advised our men to attack the horses chiefly and 'wing' them with their arrows so that when the Franks had dismounted, they could easily be captured. For a Frank on horseback is invincible, and would even make a hole in the walls of Babylon, but directly he gets off his horse, anyone who likes can make sport of him[94].

This text describes another benefit of wounding, and killing horses: riders without their horses are furthermore also useless as infantrymen. The emperor Alexios I Komnenos knew that the Franks were invincible while mounted, they would be useless without their horses. Also in more recent times, therefore, com-

94 Anna Comnena, *Alexias*, 13.8.1-3.

manders of battalions have ordered their men to aim at the horses of the cavalry, adding, as a reason, 'if the horse is down, the rider is no longer formidable'[95].

Beamish, for example, who served in the cavalry of Napoleon, wrote that Napoleon, on retreat from Moscow in 1812, had about ten thousand dismounted cavalry. They were formed into companies, battalions and regiments, and armed like infantry, but after a few days this organisation was destroyed and the men, looking for food along the roads, fell either in the hands of the Kossacks or were killed by inhabitants. He wrote 'cavalry, once dismounted, is no longer formidable'[96]. This did not only apply to the modern-day armies; Xenophon as well, wrote that cavalrymen dismounted with the enemy close at hand would be a bad job[97]. He also commented that riders with bad horses would render themselves useless by lagging behind during attacks[98].

Defending themselves against enemy attacks, cavalry and infantry could use formations. However, 'cavalry must have open ground in order to display its force or employ its energy. This ground should be level and hard, or a gentle declivity. The point which it is to defend must either lie in its front or flank, in order that the whole force of the charge may be directed there when the point is threatened. Infantry, on the contrary, must be placed upon the line which it is intended to defend'[99].

This would prove quite difficult in mountainous terrain on narrow paths, which would lead to new insights in how to put infantry, cavalry, and baggage train in marching order. Xenophon, for example, at first used a hollow square to protect his baggage train[100]. However, Xenophon found out that the square formation did not work out as he intended because of the terrain. When the road would be unusually narrow, or because of mountains or a bridge, the wings would draw together pushing the hoplites out and they would be in confusion and disorder,

95 Beamish, cit., p. 59.

96 Beamish, cit., p. 58. Beamish served in this campaign to Moscow.

97 Xen. *Cav.* 4.2.

98 Xen. *Cav.* 1.15.

99 Beamish, cit., p. 60.

100 Xen. *Anab.* 3.2.36 Hence it will be safer, perhaps, for us to march with the hoplites formed into a hollow square, so that the baggage train and the great crowd of camp followers may be in a safer place. If, then, it should be settled at once who are to lead the square and marshal the van, who are to be on either flank, and who to guard the rear.

putting them out of order. The Greeks then invented companies of one hundred men that could move around and had more flexibility[101]. Xenophon brought this flexibility in practice with his advice on cavalry marches. On narrow roads the cavalry had to form a column; in broad roads the regiment had to extend the front. He also advised to keep some aides-de-camp in front of the regiment so they could find the best way to ride and they would not go astray. Of course, a cavalry commander should always make himself acquainted with the terrain in order to have advantages[102].

Hannibal seems to have struggled continuously with safekeeping his baggage mules and cavalry horses. On several occasions the mountain peoples tried to separate the baggage train from his army or tried to wreak havoc among the animals so they could turn them against their own infantry[103]. The importance of the baggage animals was such that Hannibal risked creating confusion among his own troops by returning with his vanguard to safeguard the baggage train.

> Quae quamquam foeda visu erant, stetit parumper tamen Hannibal ac suos continuit, ne tumultum ac trepidationem augeret; deinde, postquam interrumpi agmen vidit periculumque esse, ne exutum impedimentis exercitum

101 Xen. *Anab.* 3.4.19-23. Then it was that the Greeks found out that a square is a poor formation when an enemy is following. For if the wings draw together, either because a road is unusually narrow or because mountains or a bridge make it necessary, it is inevitable that the hoplites should be squeezed out of line and should march with difficulty, inasmuch as they are crowded together and are likewise in confusion; the result is that, being in disorder, they are of little service. Furthermore, when the wings draw apart again, those who were lately squeezed out are inevitably scattered, the space between the wings is left unoccupied, and the men affected are out of spirits when an enemy is close behind them. Again, as often as the army had to pass over a bridge or make any other crossing, every man would hurry, in the desire to be the first one across, and that gave the enemy a fine chance to make an attack. When the generals came to realize these difficulties, they formed six companies of a hundred men each and put a captain at the head of each company, adding also platoon and squad commanders. Then in case the wings drew together on the march, these companies would drop back, so as not to interfere with the wings, and for the time being would move along behind the wings; and when the flanks of the square drew apart again, they would fill up the space between the wings, by companies in case this space was rather narrow, by platoons in case it was broader, or, if it was very broad, by squads—the idea being, to have the gap filled up in any event. Again, it the army had to make some crossing or to pass over a bridge, there was no confusion, but each company crossed over in its turn; and if any help was needed in any part of the army, these troops would make their way to the spot. In this fashion the Greeks proceeded four stages.

102 Xen. *Cav.* 4.1- 6.

103 For example: Liv. 21.33.1-11; Polyb. 3.51.1-5.

> nequiquam incolumem traduxisset, decurrit ex superiore loco et, cum impetu ipso fudisset hostem, suis quoque tumultum auxit.
>
> Dreadful as these sights were, still Hannibal halted for a little while and held back his men, so as not to augment the terror and confusion. Then, when he saw that the column was being broken in two, and there was danger lest he might have got his army over to no avail, if it were stripped of its baggage, he charged down from the higher ground and routed the enemy by the very impetus of the attack, though he added to the disorder amongst his own troops[104].

The success of the entire expedition depended on the baggage and the mules that carried it. Hannibal ultimately managed to preserve his baggage train, although a considerable number of animals were still lost[105]. Livy emphasizes that safeguarding the baggage mules was as crucial for a general as maintaining the health and readiness of his cavalry. Achieving this required careful planning: the expedition had to account for the safety of roads, rivers, and mountain passes for the animals, determine in advance whether pasturage would be available, and, if not, calculate the necessary quantity of fodder to transport or buy. Measures also had to be taken to protect the animals from enemy attacks, including arranging infantry and cavalry in optimal formations. The survival and operational effectiveness of the army depended on such foresight and logistical management.

Strategic decisions to utilize routes that were less suitable for animals could also serve the purpose of surprising the enemy. After Hannibal reached Italy, his approach to safeguarding the baggage train underwent a notable shift. In his advance toward Etruria, he deliberately guided his army through marshland to catch the Roman consul Gaius Flaminius off guard. Although he had previously ensured that routes were viable for the movement of his troops, on this occasion he showed considerably less concern for the safety of the pack animals. His reasoning appears to have been pragmatic: a defeat in Italy would render the preservation of supplies irrelevant, whereas victory would grant him access to abundant resources[106]. He took the risk of losing his baggage train and went through the

104 Liv. 21.33.8-9.

105 Liv. 21.35.1-2.

106 Polyb. 3.78.6-3.79.3: that the road through the marshes to Etruria was difficult indeed but expeditious and calculated to take Flaminius by surprise. As he was by nature always inclined to such expedients, he decided to march by this road. When the news spread in the camp that the general was going to lead them through marshes, everyone was very reluctant to start, imagining that there would be deep bogs and quagmires. But Hannibal had

marshes, a gamble he did not dare take in the Crossing of the Alps. Following the crossing—during which the preservation of the mules and their loads had been of paramount importance—priority shifted toward maximizing strategic surprise against the Romans, even at the cost of sacrificing the baggage train. The boldness and unconventional nature of this chosen route through the marshes of the river Arno in Tuscany, prior to the Battle of Lake Trasimene in 217 B.C., suggest that it may have been unprecedented for an army to deliberately forgo its own pack animals in pursuit of tactical advantage.

This, in turn, underscores both the usual importance of safeguarding such animals and the central role they played in determining viable routes. The need to protect mules and horses thus exerted a significant influence on military decision-making. Moreover, this episode illustrates Hannibal Barca's capacity for innovative and unconventional thinking, demonstrating a willingness to challenge established norms of warfare.

Conclusions

It may be concluded that the safeguarding and feeding of cavalry horses and baggage mules carrying supplies constituted a crucial element of expedition planning, particularly in enemy territory. Thorough planning and preparations had to be made, challenges on the road or in difficult terrain had to be solved. This required not only tactical but also logistical insight and intelligence.

The protection of cavalry horses and mules has been one of the most important parts of military expeditions which is quite often overlooked. It must have been a challenge far greater than many generals must have been aware of beforehand. Hannibal, however, had made himself acquainted with the geography of Italy before he set out on his expedition. Evidence shows that he made arrangements beforehand with towns for provisions, as Xenophon did as well.

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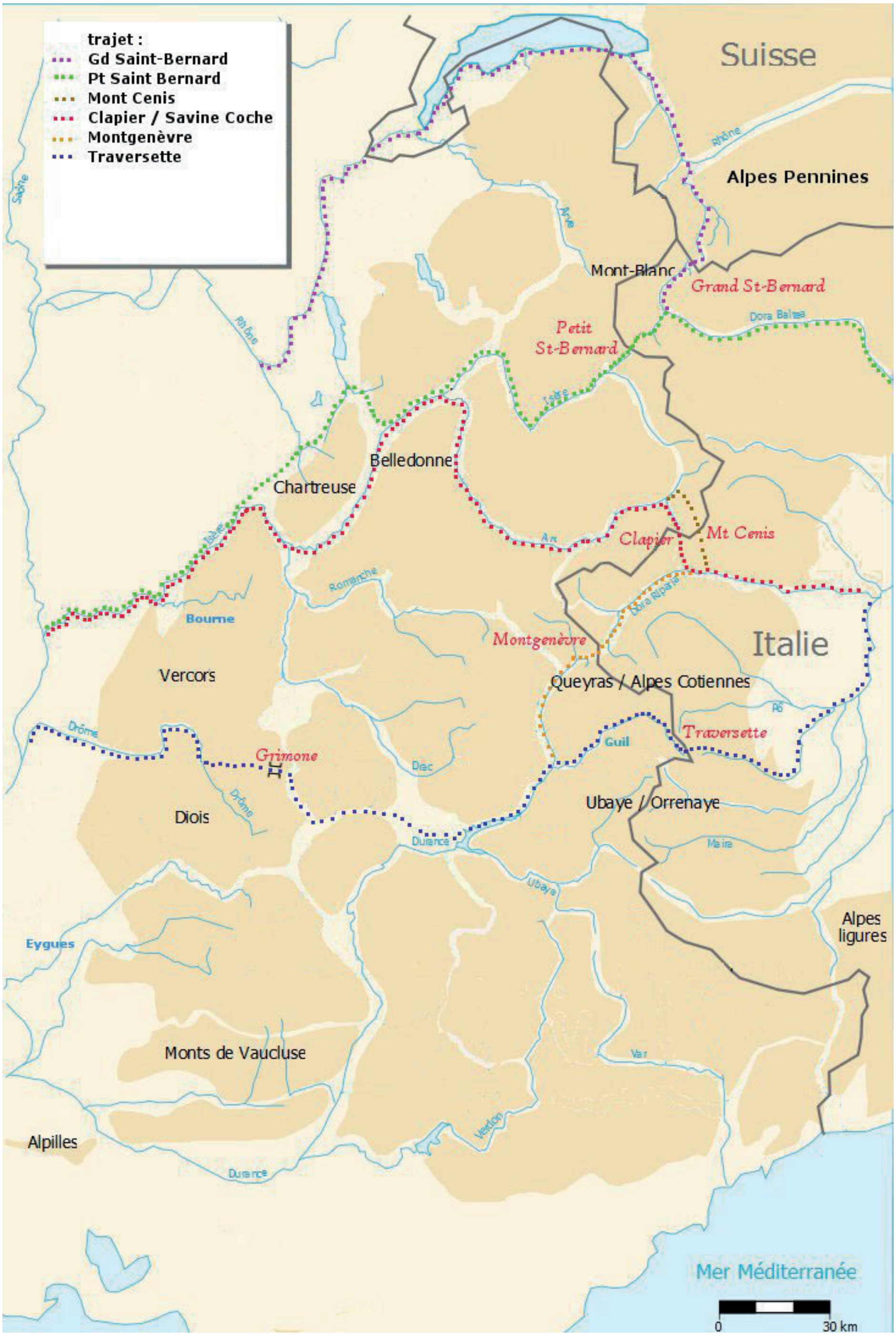
made careful inquiries, and having ascertained that the water on the ground would have to pass over was shallow and the bottom solid, broke up his quarters and started, placing in the van the Africans and Spaniards and all the most serviceable portion of his army, intermingling the baggage train with them, so that for the present they might be kept supplied with food. For as regards the future he did not trouble himself about the pack-animals at all, as he calculated that on reaching the enemy's country he would, if defeated, have no need of provisions, and if he gained command of the open country would be in no want of supplies.

Of course, such arrangements would have primarily been about fodder. In this respect, cavalry has always been a difficult part of the army to manage, while horses can only function when they are properly fed and taken care of. It was therefore key to Hannibal, as to any army general, to keep his cavalry in the best condition possible and to protect as many horses as possible. Scholars have proposed that hunger would have caused Hannibal to lose his horses and mules, however this is not the case. This article shows that there were enough opportunities for the animals to graze along the way.

In addition to this, one should consider that horse breeds that were used in ancient times differ from the modern riding horses. Especially the Numidian horses, which belonged to the Libyan horse type, required less food than the modern horses. In this respect they are more similar to mules. It may even well be that they could survive on grazing alone: not only because they were smaller in size, but because they were so-called robust horse types. The pace at which expeditions took place also played an important role in food requirements. Ancient armies would have travelled at a slower pace, usually a walk, than the Prussian and French armies did, which travelled preferably at a trot. Since Hannibal relied on grazing for them en route as a consequence he could keep the amount of mules necessary to carry the supplies to a minimum.

Secondly, the selection of the route was closely shaped by the needs of horses and mules. Not only was the presence of fodder along the path essential, but adverse terrain and weather could incapacitate the animals, undermining the expedition. Difficult terrain could necessitate halting the infantry in order to adapt the landscape, ensuring that cavalry and baggage mules could traverse it safely. For example, the Carthaginian army had to make a wider and meandering path on the slopes of the Alps that were too steep and narrow for the animals.

Thirdly, an army could also encounter enemy attacks which could harm horses and mules quite severely. Tactically it was probably even more profitable to the enemy to try and harm the animals more than the infantry. Therefore, the likelihood of enemy attacks played a substantial role in choosing a route. Enemies could also easily turn them against their own side, when they were scared or hurt by attacks. Animals that panic can harm their own side even more than the enemy can. In order to protect themselves from such attacks formations had to be formed. From Xenophon can be learnt that this was not an easy feat. He discov-


trajet :
Gd Saint-Bernard
Pt Saint Bernard
Mont Cenis
Clapier / Savine Coche
Montgenèvre
Traversette
Suisse
Alpes Pennines
Mont-Blanc
Grand St-Bernard
Petit St-Bernard
Dora Baltea
Rhône
Arve
Isère
Belledonne
Chartreuse
Clapier
Mt Cenis
Arc
Romanche
Dora Riparia
Bourne
Montgenèvre
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Traversette
Guil
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Diois
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Maira
Ubaye
Alpes ligures
Eygues
Var
Monts de Vaucluse
Verdon
Alpilles
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0
30 km

ered that the traditional square formation was no use when under enemy attack or on narrow roads, so he invented squadrons which were flexible and could easily be moved.

Hannibal, too, struggled to find a useful and safe marching formation. He almost lost all his baggage mules during enemy attacks in the Alps, during which the mountain people came close to separating him from his baggage train, almost forcing him to abandon his expedition to Italy. As may be concluded, separation from the baggage mules rendered an infantry vulnerable to defeat. Furthermore, success in incapacitating the cavalry through the wounding of horses would leave the infantry in a vulnerable and disordered state. Therefore, for an enemy, it would often be preferable - and potentially more advantageous - to target the mules and cavalry horses rather than engage in a pitched battle.

It is therefore particularly noteworthy that Hannibal altered his treatment of the pack animals immediately after completing the Alpine crossing. On his subsequent march toward Etruria, he deliberately chose a route through the marshlands, despite the significant risks this terrain posed to his transport animals. The decision resulted in considerable losses, with many mules perishing in the mud. This shift suggests that he no longer regarded the pack animals as strategically indispensable and, consequently, did not allow their preservation to constrain or shape his operational decision-making.

In conclusion, although the preservation of mules and their loads had initially been of paramount importance during the crossing, this priority was ultimately subordinated in the marshes of the river Arno in Tuscany to the pursuit of strategic surprise against the Romans, even at the expense of the baggage train. The audacity and unconventional character of this decision suggest that deliberately abandoning pack animals for tactical advantage was highly unusual, if not unprecedented. This shift not only reaffirms the typical importance of safeguarding such animals and their decisive role in route selection but also highlights the extent to which their protection shaped military decision-making. Ultimately, this episode exemplifies Hannibal Barca's innovative and unconventional approach to warfare, reflecting a readiness to challenge and transcend established strategic norms.

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Busto di Pirro re dell'Epiro, Ercolano, da un originale del 290 a.C.
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