Hyeok Hweon Kang

Difference in an Age of Parity: Technology and Global Military History

Introduction

A recondite subject of military history has mattered on an order of world-historical magnitude. The musketry volley tactic – a technique for rotating the ranks to fire in turns – figures at the crux of the military revolution. As first conceived by Michael Roberts, military revolution theory posited that in sixteenth-century Europe, tactical innovations around the use of matchlock muskets led to revolutionary changes in military organization and the state at large.[1] The musket, as argued, was a marginally useful weapon that required gargantuan military, fiscal, and administrative efforts to deploy. It did not just pressure Europeans to invent drill, adopt standing armies, and grow centrally governed nation-states, but, as Geoffrey Parker further argued, the cascading changes around the gun even enabled the rise of the West in global warfare, allowing countries in Europe to control nearly 35 percent of it by 1800.[2]

This ambitious paradigm of world history has faced many criticisms, inviting *inter alia* charges of technological determinism by other Europeanists in the field of the history of technology.[3] The most transformative critique, however, emerged from the ranks of global historians and specialists of non-Europe, especially East Asia. Namely, works by Tonio Andrade, Sun Laichen, Kenneth Swope, Peter Lorge, and others have shown that East Asians were similarly innovative in their use of gun technology.[4] With regards to muskets, for instance, which remains central to the literature, they evinced that the Japanese employed volley-firing by

1 Roberts, "The Military Revolution, 1560 1660," 13 35. I thank Mark Fissel, Wayne E. Lee, Kenneth Swope, Peter Lorge, James O'Neill, Keith Roberts and Philip Tom for their generous source suggestions and insightful feedback on this paper.

2 Parker, *The Military Revolution*; Rogers, ed., *The Military Revolution Debate*; Yerxa, ed., *Re cent Themes in Military History*, 11 48. For the most comprehensive bibliography on the mili tary revolution, see Fissel, "Military Revolutions."

3 Hall and DeVries, "The 'Military Revolution' Revisited," 500 507. Also see Raudzens, "War Winning Weapons," 403 434.

4 For an overview, see Andrade, *The Gunpowder Age*, and Lorge, *The Asian Military Revolu tion*. Also see Laichen, "Military Technology Transfers from Ming China and the Emergence of Northern Mainland Southeast Asia (c. 1390 1527)," 495 517; Swope, *A Dragon's Head and a Serpent's Tail*; and Chase, *Firearms*. Also relevant are works on South Asia and Southeast Asia: Gommans, *Mughal Warfare*; and Charney, *Southeast Asian Warfare, 1300 1900*.

https://doi.org/10.1515/9783110661415 002

the 1590s,[5] and the Chinese held the world's "first unequivocal" record – i.e., codified in the form of a manual – from 1560.[6] In seventeenth century Korea, where both Chinese and Japanese influences coalesced with the local practices, a new musketry corps also formed that could not only volley fire but also aim with precision.[7]

This new scholarship has interwoven a global military history that emphasizes not so much European exceptionalism as a world of connections and parallels that generated similarities across Eurasia. Importantly, Tonio Andrade, doyen of said scholarship, employed the term "Age of Parity" (1550–1700) to capture this new understanding. As shown in his seminal *Gunpowder Age*, many innovations emerged in early modern Europe, to be sure, but China, Japan, and Korea kept up comparable levels of military developments vis-à-vis Europe well into the eighteenth century.[8] Andrade summarizes: "Europeans did have advantages in deep-water naval warfare and fortress architecture, but East Asians fielded dynamic and effective forces, defeating European troops not just by superior numbers but also by means of excellent guns, effective logistics, strong leadership and better (or at least equivalent) drill and cohesion."[9]

The global turn in military history is commendable, but it is not with its flaws. Historians Frank Jacob and Gilmar Visoni-Alonzo criticize recent works for abusing the concept of military revolutions to "find similarities with regard to military progress" between Europe and East Asia.[10] This, they argue, ends up reintroducing West-centrism through the back door. In a review of *Gunpowder Age*, economic historian Roy B. Wong also weighs in, stressing that the problem, rather, is in conflating two terms – parity and similarity. Wong argues that a state of parity does not preclude the existence of differences, and he puts it in concrete terms by comparing muskets to mechanical clocks. China adopted both from Europe – thus achieving parity; but this did not mean that its military or

5 Stravos, "Military Revolution in Early Modern Japan," 250. For more information on Japanese musketry and the Japanese military revolution, see Brown, "The Impact of Firearms on Japanese Warfare, 1543–98," 236–253; Varley, "Oda Nobunaga, Guns, and Early Modern Warfare," 105–125; Morillo, "Guns and Government," 95–100. There is also evidence of Ottoman volley fire by 1605. Börekçi, "A Contribution to the Military Revolution Debate," 407–438. For more on Ottoman firearms, see Ágoston, "Firearms and Military Adaptation," 85–124.

6 Andrade, *The Gunpowder Age*, 166.

7 Andrade, *The Gunpowder Age*, 185. For more on Korean musketry, see Kang, "Big Heads and Buddhist Demons," 127–189; Andrade, Kang, and Cooper, "A Korean Military Revolution?," 51–84.

8 Andrade, *The Gunpowder Age*, 5, 125, 135–236, 299.

9 Andrade, *The Gunpowder Age*, 5.

10 Jacob and Visoni Alonzo, *The Military Revolution in Early Modern Europe*, 18.

economy was "changing to become more like Europe's in any consequential manner."[11] In comparing technologies between two regions, then, it is important to situate them in their respective contexts and reflect on broader differences in society, political economy, and institutions among others.

Better understanding difference is key to move forward, and I herewith address technological difference – i.e., in the manner of producing and employing muskets – between the two world regions. Albeit in passing, disparities in the use of muskets between Europe and Asia have been noted by historians, including Geoffrey Parker.[12] To date, however, only works in Japanese and Korean language have addressed them squarely, and with proper attention to the rich troves of data found in their respective archives. In a 2008 study, Japanese historian Kubota Masashi argued for a military divergence between Japan and Europe, based on a comparison of musket use: Japanese gunners, he showed, focused on accuracy, while their European peers trained instead to increase rate of fire.[13] At the heart of Kubota's notion of divergence was technological difference: in Japan, accurate yet slow-firing muskets – known as fowling pieces – found military use; in Europe, fast-firing yet inaccurate muskets – or shoulder arms – did. This difference, in turn, led to other wide-ranging consequences: a strong preference developed in Japan for marksmanship and individual skills training; and in Europe, for mass firing and drill (collective training).[14] Korean historian Kim Yŏngchung furthered Kubota's work with the case of Chosŏn Korea (1392–1910). Not unlike their Japanese counterparts, Korean musketeers also diverged from Europeans in their use of sporting guns as infantry weapons; as a result, they, too, emphasized accuracy at the expense of volley fire, and individual training in lieu of drill.[15]

These works divulge an unresolved point of debate in the globalist discourse on the Military Revolution. Just as the debate in Western academe was undergoing

11 Wong, "Tonio Andrade. The Gunpowder Age," 466.

12 Andrade, "The Arquebus Volley Technique in China, c. 1560," 122, n. 24.

13 Kubota refuted Parker's assertion that the Japanese under Oda Nobunaga had developed their own method of volley fire analogous to the Dutch invention. Kubota, *Nippon no gunji kakumei*.

14 Kubota, *Nippon no gunji kakumei*. 38 56. Kubota also mentions other differences, such as the prolonged peace in Japan and the lack of a strong cavalry as stimulus for musketry. Regarding the latter, warhorses in Japan were apparently the size of contemporary ponies, and this rendered the Japanese cavalry weak. Musketeers there thus had less incentive to mass fire against their mounted counterparts. Kubota, *Nippon no gunji kakumei*, 48, 250.

15 Kim, "17 segi Chosŏn ŭi p'osu hullyŏn pangsik kwa kunyŭl" 17C 조선의 포수 훈련방식과 군율, 167 97. Also see Chang, "17 segi chŏnban Chosŏn ŭi p'osu yangsŏng kwa unyŏng" 17세기 전반 朝鮮의 砲手 養成과 運用.

transformation by globalists and Asianists, a separate strain of scholarship emerged, ironically, in Japanese and Korean language, in response to the original theses by Roberts and Parker.[16] To be sure, written without the benefit of the recent Anglophone scholarship, Kubota and Kim show a certain parochiality with their understanding of the Military Revolution literature: Kubota uses a strictly Europe-based definition of concepts, concluding that the Japanese military revolution "terminated at the minimum level necessary"; Kim also misunderstands the nature of Korean musketry when he calls it a form of ("Eastern") "martial art" rather than ("Western") "drill."[17]

These conclusions notwithstanding, the possibility of a "military technological divergence" merits a close investigation: did important differences indeed exist between Europe and East Asia? If so, how do we reconcile them – and their implications about divergence – with the notion of parity, as proposed by global military historians?

The following analysis answers by focusing on musket (in)accuracy. It outlines, first, the differences in musket production and usage between Europe and East Asia, one by one, and then cross-examines both to understand the implications of said differences. By using new comparative data and a balanced evaluation of both sides, it will show that important differences – akin to those laid out by Kubota and Kim – did occur, but they stemmed not from a fundamental disparity in military or technological aptitude, as suggested, but from variances in the manner of employing effective firepower in an age of parity.

Europe and the De-accurizing of Muskets

Let us begin with an extreme yet illustrative example: Prussian musketeers under Frederick the Great (1712–1786). The Prussian way of deploying the musket was far from efficient in the sense of killing with the least ammunition, or in achieving any sense of accuracy. In terms of rate of fire, however, it was unparalleled in Europe and probably the early modern world. The Prussians adapted every aspect of their musket use – including gun design, training, and

16 See notes 13 15 above. Also see Kuba, *Higashi Ajia no heiki kakumei* 東アジアの兵器革命; No, "16 17 segi choch'ong ŭi toip kwa Chŏson ŭi kunsajŏk pyŏnhwa" 16 17 세기 조총의 도입과 조선의 군사적 변화; No, "Kihoek nonmun chŏnjaeng ŭi sidaejŏk yangsang" 기획논문 전쟁의 시대적 양상; Chŏng, "Hwasŏng kongsimdon ŭi yurae wa kinŭng" 화성 공심돈의 유래와 기능, 1 35; Chŏng, "Hwasŏng uĭ pangŏ sisŏl kwa ch'ongpo" 화성의 방어시설과 총포, 133 161.
17 Kubota, *Nippon no gunji kakumei*, 243, 255; Kim, "17 segi Chosŏn ŭi p'osu hullyŏn pangsik kwa kunyŭl," 178.

tactics – for speed and convenience. They not only drilled relentlessly, to fire and load their pieces like automatons. But various expedients accumulated over time, such as knocking their muskets on the ground instead of ramming the charge home, exploiting double-ended ramrods for quick-loading, and firing away hastily with no aim.[18] As a result, Prussians purportedly fired up to three to four rounds per minute in battle, and as many as six rounds blank in drill.[19] "This rapidity," as Frederick liked to boast, "made a Prussian equal to three adversaries," capable of firing "three shots per minute more than their enemies."[20]

Speed came at a great cost of accuracy, however. By one metric from 1742, it was reported that Frederick's men would use as many as 540 balls (or 33 pounds of lead) per enemy death at the Battle of Chotusice.[21] The statistic may be exaggerated. Still, the Prussians were such that many contemporaries ridiculed their obsession with quick-firing: French general Comte de Guibert (1743–1790), for one, likened their musketry to "burning powder at the birds."[22] Yet, as the critics themselves admitted, there was no denying that the Prussians were widely admired and imitated throughout Europe.[23] Their way, in fact, was the very culmination of a European emphasis on mass firing, which – as argued here – traded speed for accuracy.

Military historians and historians of technology have long recognized that small arms in Europe emphasized volume of fire, not accuracy. Historian Bert Hall put it clearly: the European gun was designed "not to minimize its limitations of accuracy, but to maximize its advantages as a quick-firing weapon."[24] When it came to speed, indeed, various innovations came to accelerate fire in Europe; if anything, the oft-repeated chronology of firearms inventions shows this much: the musket, first fired with a smoldering match in the seventeenth century, grew faster and more convenient with the flintlock mechanism, and eventually, paper cartridges and the percussion cap.[25] The resulting uptick in "efficiency" was, apparently, revolutionary. As Philip Hoffman explains in his *Why did Europe Conquer the World*, it translates to a "labor productivity growth of 1.5 percent per year which rivals overall labor productivity growth rates in

18 Quimby, *The Background of Napoleonic Warfare*, 114 115, 118 120.
19 Rothenberg, *The Art of Warfare in the Age of Napoleon*, 17 19.
20 Jomini, *The Art of War*, 279; Grant, *The Cavaliers of Fortune*, 121.
21 Hall, *Weapons and Warfare in Renaissance Europe*, 136.
22 Quimby, *The Background of Napoleonic Warfare*, 119.
23 Quimby, *The Background of Napoleonic Warfare*, 118.
24 Hall, *Weapons and Warfare in Renaissance Europe*, 140.
25 Carmen, *A History of Firearms*, 101 104; Hughes, *Firepower*, 27.

modern economies and far exceeds what one would expect even at the onset of the Industrial Revolution."[26]

So much for speed. But how did this spirit of haste impinge on accuracy? The question has gone ignored because so far, musket marksmanship has been considered impossible in Europe and by extension, the rest.[27] This section shows, however, that the former's preference for speed did foreclose possibilities of pursuing higher accuracy. The musket in Europe, as we will see, divested from accuracy in three main ways: first, they adapted the material aspects of the gun to accelerate, not accurize, fire; they also adopted distinctive ways of usage – namely, shortcuts to loading, and an emphasis on indiscriminate fire – to trade quality for quantity of shot.

Take first the case of musket manufacture. It takes no ballistic science to figure that a firearm, shot at a distance with any sense of accuracy, would meet such basic standards as having a straight bore, tightly fitting bullets, and a pair of gun sights. Surprisingly however, military muskets in Europe rarely met these standards. Regarding the bore, George Hanger (1751–1824) – an officer in the British army who was a vocal advocate of musket accuracy – lamented that military pieces in service were "bored with a most shameful and scandalous neglect." In fact, Hanger would go so far to suggest that these guns "are all crooked, and if, per chance, a few be tolerably straight bored, they are bent in folding the loops on"; and that as such, "a soldier . . . may with *just as much hopes of hitting*, fire at the moon as at the body of a man at the distance of two hundred yards."[28]

Other militaries in Europe may have commissioned better barrels. But what was surely widespread was the large windage – or gap between the bullet and the barrel – which allowed even "crooked" muskets to be loaded and fired. As early as 1590, soldier and military writer Sir John Smythe (1534–1607) explained the issue of windage in English muskets and its effect on accuracy.

> [H]ow truly soever they take their sights at point and blank, the air doth work very great effect with their bullets, which are lower by four or five bores than the height of their pieces, to carry them from the mark or marks that they are shot at. Moreover, by proof they may find that in giving their volleys of musket shot but only twelve scores at either horsemen or footmen that are in motion, they shall work no great annoyance, by reason

26 Hoffman, *Why Did Europe Conquer the World?* 57 58.

27 Hall, *Weapons and Warfare in Renaissance Europe*, 140. Also see Krenn, Kalaus and Hall, "Material Culture and Military History," 101 109.

28 Hanger, *Reflections on the menaced invasion*, 196, 201 202.

> that the bullets, beings so much lower than the height of their pieces, as is aforesaid, do naturally mount and fly uncertainly.[29]

Smythe wrote that English guns in late sixteenth century were made with large windage – to the extent that their bullets were smaller by "four or five bores than the height of their pieces." The large gap meant that even with careful aim at close range, English muskets could not give accurate fire, whose bullets would "mount and fly uncertainly" and wide from "the mark or marks that they are shot at."[30]

Designing guns with greater tolerances was a widespread practice, and an intentional one: the aforementioned Prussians also preferred it, and on average, windage on a late eighteenth-century European flintlock was as much as .05 inches.[31] To be sure, large windage conferred an advantage for rapid firing: it let the ammunition roll down the barrel with ease, which saved time in reloading. As Smythe noted, however, loose-fitting bullets harmed accuracy. This is an amply proven point in historical and modern ballistic experiments. In the early eighteenth century, mathematician Benjamin Robins (1707–1751) showed that bullets fired from a loose barrel were prone to rub against a side of the muzzle and deviate wildly from their intended path upon fire. Modern firing experiments conducted by David Miller and others also corroborate that windage diminishes accuracy, not the least when combined with bent barrels.[32]

What is perhaps most surprising about European muskets, however, is their lack of gun sights. Before the age of modern telescopes, all aiming was done with the naked eye, and a surer shot attained by matching the front bead sight with a standing back sight. This technology was commonplace and old, tracing back to as early as 1450 in Europe. But curiously, while Europeans kept furnishing sporting guns with sighting devices, they did not for military equipment.[33] In 1855, General Sir Howard Douglas reflected: "Till within the last

29 Smythe, *Certain Discourses Military*, 66.

30 Smythe, *Certain Discourses Military*, 66.

31 Stephenson, *The Last Full Measure*, 91.

32 Robins and Curtis, *New Principles of Gunnery*, 210 217. For a general discussion of smooth bore ballistics, see Hall, *Weapons and Warfare*, 142 143. Hanger uses Robins' experiments as "proofs" to argue in favor of smoothbores. An expert marksman and colonel, he argued that a smoothbore musket in general use when straightened and better bored could "shoot as true and correct as the best rifle gun in the kingdom" within the range of 60 yards to 200 yards. For his discussion of straightening smoothbores, see Hanger, *Reflections on the men aced invasion*, 159, 167, 197; for his use of Robins' experiments as "proofs" for his argument, see 202 203. For modern experiments, see Miller, "Ballistics of 17th century muskets."

33 Peterson, *Encyclopedia of Firearms*, 297 299.

twenty years, no *sight* was considered necessary for common musket – the stud at the muzzle being sufficient for the purpose of taking aim."[34] Indeed, some military muskets continued to feature front sights, but these no longer provided an aiming function per se: as historian William Wells also noted, they were shaped in a rectangular form, and served merely to "indicate the direction where the muzzle was pointing rather than providing accurate aim."[35]

How could Europe, where matchlock muskets were first invented, become so resigned on accuracy? It bears mentioning here that European gunmakers could certainly make exquisite matchlocks with upright barrels, tightly fitting bullets, and accurized sights. This is more than amply evidenced by the still existing specimens made for the nobility and stored in the various museums and private collections. Among these fine guns, too, were rifled pieces that greatly enhanced accuracy by imparting a beneficial spin on the bullet.[36]

Rather than technological deficiency, then, I argue that a series of "choices" – wittingly or not – had been made that rendered European military matchlocks to be crude machines for rapid firing. The reasons behind the curious development require a separate investigation,[37] but it suffices here to understand this: the European musket had a lopsided development towards speed and convenience, and whatever accuracy had been possible or achieved – for military, strategic purposes – was eventually forgone or lost.[38]

With guns that were designed against accuracy, it certainly made sense for their users to maximize their potential for a higher rate of fire instead. Many techniques developed, for instance, in shortcutting the loading action. It is well known that after the seventeenth century, new recruits in Western nations

34 Douglas, *A Treatise on Naval Gunnery*, 528.

35 Douglas, *A Treatise on Naval Gunnery*, 528; Wells, *Shots That Hit*, 5.

36 Wilson, "Some Important Snap Matchlock Guns," 3 10.

37 Perhaps this was because early modern Europe was engaged in constant warfare, and the pressing demand for military firearms outstripped the state's ability to impose quality control on its burgeoning and frequently engaged armies. Or perhaps it had to do with industrial limi tations, problems of logistics, and governmental funding.

38 European muskets actually retrogressed in accuracy during the course of the seventeenth century. Fine barrels, for instance, were available yet unused in the manufacture of military muskets. Hanger thus quipped, that ill bored barrels could easily be set "straight and fresh[ly] bored by a skillful gunsmith" and with a meager "five or six shillings per piece." Hanger, *Reflections on the menaced invasion*, 159, 167, 197. Gun sights were allegedly furnished on early military muskets but had disappeared by the late seventeenth century. Small arms in Eu rope also lost their resting fork and became shorter barreled during the seventeenth century a transformation that dovetailed with the term "musket" overtaking the "arquebus." Firth, *Cromwell's Army*, 79 80; Hall, *Weapons and Warfare*, 176 179.

underwent intensive training in the handling of their muskets, as argued by the original proponents of the military revolution. Through this so-called 'manual exercise,' said recruits trained in as many as 42 postures for musketry, as shown in *The Exercise of Arms* by Count John de Nassau.[39] It is important to note, however, that the European manual exercise was only for initial repetitive training, and that in actual drill and battle, "much of the fancy rigmarole was dropped in favor of shortcuts."[40]

The shortcuts included forgoing the use of paper wads and ramrods. The importance of wadding was amply understood by contemporaries, but it was often overlooked in practice, to the detriment of accuracy. When properly done, wadding seals the gas that leaks around the shot, and thereby increases the powder's efficiency. But as Roger Boyle, 1st Earl of Orrery (1621–1679) wrote in 1667, "soldiers seldom put in any paper, tow or grass to ram the bullet in." This, he emphasized, led to "the little execution . . . musketeers do in time of fight, though they fired at great battalions, and those also reasonable near."[41]

Overlooking ramming was also injurious and not just for accuracy. Ramming was a crucial step in musketry loading, which by lowering the bullet through the barrel, fitted it tightly against the rear and tamped the powder; this strengthened the power of the shot and prevented misfires. This method was sure, but it was slow, and it became "custom of the day" by the late seventeenth century to simply 'seat' the bullet by slamming the butt of the musket on the ground.[42] The practice allowed musketeers to fire an extra round or two a minute. It was a dangerous shortcut, however: it not only sabotaged accuracy but reduced the effective range (by as much as 75 percent by one account), and caused frequent misfires, or the notorious "flash in the pan."[43] The latter refers to a type of misfire where the trigger goes off with its attendant flash, but leaves the main charge unignited and the bullet still in the barrel. This was not uncommon in the European battlefield, and it could spell catastrophe for soldiers who unwittingly loaded their pieces more than once (sometimes as many as

39 Yerxa, ed., *Recent Themes in Military History*, 14.

40 Stephenson, *The Last Full Measure*, 90. Nafziger also notes that by the late eighteenth century, the number of steps in the standard musketry sequence was about seventeen, which was considered more practical. Nafziger, *Imperial Bayonets*, 30.

41 Firth, *Cromwell's Army*, 82.

42 Firth, *Cromwell's Army*, 82.

43 There were other shortcuts such as not reversing the ramrods while loading. For more details, see Nafziger, *Imperial Bayonets*, 30. In another example, the Prussians in the late eighteenth century "did not ram the charge home" after firing their first salvo, which reduced both accuracy and effective range the latter by as much as 75 percent. See Quimby, 118.

seven times or more); if ever fired in earnest, these barrels would ensure terrible explosions.[44]

So far we have seen that muskets in Europe were both designed and loaded for rapid firing, but surely they were still fired with some measure of "aim"? Certainly so, but the emphasis in European militaries – unlike in East Asian armies, as we will see – was not to hit the space of a human but to set the general direction – and importantly, height – of fire. The average musketeer in early modern Europe simply leveled his gun and pointed it towards the whole façade of an enemy battalion. As shown in Table 1, musketry trials in Europe were conducted almost always with targets that represented the entire width of the enemy battalion. In 1790 Hanover, for instance, targets as wide as 45.7 m (50 yards) were used, showing an indifference to the lateral dispersion of the shot. Care was taken, however, to use a taller target for cavalry, which was 2.6 m in height as opposed to 1.8 m for an infantry target.[45]

This practice of leveling was the European way of "aiming," and in fact, the British infantry would use "level" rather than "aim" as the word of command, as late as the Battle of Waterloo in 1815. Remarkably, even when the word "aim" was explicitly used, it was not what it seemed. Consider, for instance, the instructions for firing by Prussian and American officer Friedrich Wilhelm von Steuben (1730–1794).

> Take Aim! One motion "Step back about six inches with the right foot, bringing the left toe to the front; at the same time drop the muzzle, and bring up the butt end of the fire lock against your right shoulder; place the left hand forward on the swell of the stock, and the forefinger of the right hand before the trigger; sinking the muzzle a little below a level, and with the right eye looking along the barrel."[46]

This instruction occurs in von Steuben's famed manual that became the standard drill guide for the American military until 1812. As shown, taking aim

44 Nafziger, *Imperial Bayonets*, 31; Elting, *Swords Around a Throne*, 480; Grossman, *On Killing*, 19.

45 All measurements used in Table 1 were converted into the metric system, and the original units marked in parentheses. Data was taken from the following: von Pivka, *Armies of the Napoleonic Era*, 60; Müller, *The Elements of the Science of War*, 187; Hanger, *Reflections on the menaced invasion*, 147 148; Picard and Azan, *La campagne de 1800 en Allemagne*; von Scharnhorst, *Results of Artillery and Infantry Gun Trials*, 63 64.

46 von Friedrich Wilhelm Ludolf Gerhard Augustin Steuben, *Regulations for the Order and Discipline of the Troops of the United States*, 9.

meant merely to look along the barrel with the right eye and sink the muzzle a "little below level."[47]

How far back might we trace this peculiar practice of aiming? More research is imperative, but we learn that as early as the late sixteenth century – when matchlock muskets were first spreading across Europe – said practice was already in place. Take for instance the prescriptions of Welsh muster-master Maurice Kyffin, who defined what it meant to be a "trained shot" in his day.

> And as I would not have a soldier in the plain field bound to stay so long as to find his perfect mark or enemy in his fight, before he discharge; so do I hold him utterly unworthy of pay, or bear the name of trained shot, that shall not . . . be sure to bestow his bullet between head and foot although it be ten or twelve score [feet] off [horizontally] . . . and find the breast high mark before he deliver his bullet. Such a one as thus can find his mark most readily, deserves great praise.[48]

As shown, leveling of the gun – when properly done – was enough to merit the title of a "trained shot." Specifically, Kyffin clarifies that the Irish gunner was expected to level his piece to the "breast high mark" and "bestow his bullet between head and foot" of the enemy, up to as much as 240 feet was tolerated in the lateral dispersion of his shot.[49] This is characteristic of the tactical limitations of leveling without aim: while ensuring a well-directed fire (and restraining the soldiers' common habit of firing too high), it left much to be desired in terms of horizontal accuracy.

One concrete way to understand European practices of aiming is target practice. While working with a different set of standards for aiming, musketeers in Europe did practice at the target, however infrequently. The likely chance that soldiers had to practice their "aim" was during the initial training of new recruits. In 1804, Hanger described as follows the standard instruction given to a "raw countryman, or a mechanic from Birmingham" in musketry:

> [H]e is consigned to the superintendence of the drill sergeant; he is first taught to walk, next to march, and hold himself tolerably erect; then a firelock is placed in his hands, which he handles at first as awkwardly as a bear would a plumb cake. When he is taught the manual exercise, and fit to do regimental duty, they then take him to fire powder; whilst the drill sergeant is teaching him to fire either by files or by platoons, the sergeant

47 von Friedrich Wilhelm Ludolf Gerhard Augustin Steuben, *Regulations for the Order and Dis cipline of the Troops of the United States*, 9.

48 Maurice Kyffin, "How shot may be well trained with least charge and waste of powder," as cited in O'Neill, *Irish Sword*, 8 14.

49 O'Neill, *Irish Sword*, 8 14.

> says to him, laying his cane along the barrels of the firelocks, "Lower the muzzles of your pieces, my lads, otherwise, when you come into action, you will fire over the enemy." After this, the recruit is taken to fire ball at a target; how is he taught? Thus he is spoken to: "Take steady aim, my lad, at the bull's eye of the target; hold your piece fast to the shoulder, that it may not hurt you in the recoil; when you get your fight, pull smartly.[50]

As shown, after learning to march and handle the musket, a new recruit first practiced firing en masse with just powder. The recruit then coordinated with his peers and took care not to fire too high, as consistent with the emphasis in Europe for leveling. After this came target practice where the soldiers used real ammunition for the first time and trained to take "steady aim" at the bull's eye.[51] Yet, as we discussed above with Table 1 – and Hanger also clarifies, the target used in these practices were "infinitely smaller" than the proverbial modern one (i.e., representing the space of a man).[52]

Target practice in Europe was also infrequent. Exact data is elusive from the early modern period, probably because they were so sparsely conducted, but we know that even during the Napoleonic times, new conscripts underwent basic instruction for just two or three weeks, and after that, were left to their own devices without any further mastery of their weapons.[53] To be sure, a "quick musketry refresher course" was held in times of war, with twenty rounds per man for target practice.[54] Annual estimates, however, were as low as "two musket shots per year in practice"[55] or "three or four rounds."[56] Perhaps the best endowed around this time were British soldiers who received each "thirty rounds ball and seventy blank" for annual practice,[57] but others had much less: Austrians in 1805 had

---

50 Hanger, *Reflections on the menaced invasion*, 152 153. Similar records of musketry training are also included in the aforementioned writing by Kyffin, where he outlined a three step re gime: 1) practice by false fires in the pan, 2) learn to fire with powder at the target, and 3) fire in groups of different configurations.

51 Hanger, *Reflections on the menaced invasion*, 152 153.

52 Hanger, *Reflections on the menaced invasion*, 148. Another problem Hanger highlights is the inadequacy of training officers. As Hanger notes, the drill sergeant was often "no marks man himself." While fit to "discipline the soldier, and form him for parade and actual service in the line," he quipped that "the sergeant is just as capable of teaching him how to solve one of Sir Isaac Newton's problems as to teach him to be a marksman" (153). It seems that the Rus sian army in 1810 also suffered a similar problem, as an order from the Minister of War "in sisted that the officers, who would train soldiers, had to be themselves trained in aimed fire." Zhmodikov and Zhmodikov, *Tactics of the Russian Army in the Napoleonic Wars*, 12.

53 Chandler, *Dictionary of the Napoleonic War*s, 208.

54 Elting, *Swords Around a Throne*, 483.

55 Chandler, *Dictionary of the Napoleonic War*s, 208.

56 Nafziger, *Imperial Bayonets*, 30.

57 Haythornthwaite, *Weapons and Equipment of the Napoleonic Wars*, 21.

"six live rounds per man," and Russians practiced "at a rate of three per man per year."[58] Target practice was thus infrequent in early modern Europe, and it must be noted that even when conducted, they served not to pursue high rates of marksmanship but merely to "know which eye to use in aiming," or to not stagger at the tremendous recoil of his musket.[59]

This is not to say that all European muskets were inaccurate: as mentioned above, some were rifled and exquisitely made, like those made for the nobility to hunt. Also, as we will later revisit, these fowling pieces saw limited use by the military, and though rare, these episodes caution against sweeping generalizations. Still, for our purposes here, it seems safe to say that at least in the realm of regular military usage, the musket in Europe was made, loaded, and fired for speed, rather than accuracy. But what about East Asia?

East Asia and Musket Marksmanship

Since its first introduction in the sixteenth century, the musket in East Asia was known for accuracy. In 1545, the year when most scholars date its debut in Japan, a Portuguese marksman supposedly "shot twenty-six ducks in quick succession" and shocked the Japanese locals into reproducing his gun.[60] The veracity of this tale is questioned. Yet, there is little doubt that in the next decades the Japanese started to produce high-quality muskets and began to unleash their potential for marksmanship. In Ming China (1368–1644) and Chosŏn Korea, where these guns were used to wreak havoc, the defenders noted their unusual ability for precise shooting and named them "bird gun" (鳥銃; Ch. *niaochong*; K. *choch'ong*).

> [The bird gun] is unlike any of the other types of fire weapons . . .. In accuracy, it can strike the center of targets as if hitting the eye of a coin and not just for expert marksmen . . .. [It] hits the mark eight out of ten times, and can bring down birds flying amidst the trees, hence its name.[61]

If fanciful, the passage above occurs in a military manual by Qi Jiguang (戚繼光, 1528–1588), a Ming general who was known for his hard-nosed practicality. In the 1550s, when China's southeastern coast was raided by musket-toting pirates (some hailing from Japan), Qi had many encounters with the gun and eventually incorporated it into his own army. To the skeptics of his day, the

58 Zhmodikov and Zhmodikov, *Tactics of the Russian Army in the Napoleonic Wars*, 12.
59 Nafziger, *Imperial Bayonets*, 30; Elting, *Swords Around a Throne*, 322.
60 Andrade, *The Gunpowder Age*, 169.
61 Qi, *Ji xiao xin shu*, 56. Also see Andrade, "The Arquebus Volley," 122.

Table 1: Musketry Trials in Western Europe.

	Year	Target size	Target Score according to Distance						Source
			76 m (100 paces)	91 m (100 yds)	110 m (120 yds)	150–152 m (200 paces)	182 m (200 yds)	225–228 m (300 paces)	274 m (300 yds)	
Hanover	1790	1.8 m x 45.7 m (6 ft x 50 yds; Infantry Target)	3/4	75%		37.5% (152 m)		1/3 (228 m)	33.3%	Otto von Pivka
		2.6 m x 45.7 m (8 ft 6 in x 50 yds; Cavalry Target)	5/6	83.3%		50% (")		3/8 (")	37.5%	
Britain	1814	Target representing a line of cavalry		53% ("Well exercised men")			30% ("Well . . . ")		23% ("Well . . . ")	Müller
				40% ("Ordinary soldiers")			18% ("Ordinary . . . ")		15% ("Ordinary . . . ")	
Britain	1804	Unknown; likely frontage of infantry battalion		60% (3/5)	60%					Hanger
		1.8 m x 0.5 m (6 ft x 20 in; "figure of a man")			62%					

France	1800	1.8 m x 3 m	60%		40% (”)	25% (225 m)	Picard
					Mean error of 75 cm x 60 cm (150 m)		Picard
Prussia	1810	1.8 m x 30.5 m (6 ft x 100 ft)	66.7–75%	50%		25% (228 m)	Scharnhorst

general qualified that musket accuracy was often spoiled by soldiers who were improperly trained; as he liked to retort, if the musketeers neglect to "hold their guns level, hold them to the side of their cheek, or use the sights, how can one hit the enemy, to say nothing of being able to hit a bird?" Conversely, then, Qi contended that with the right equipment and training the musket could indeed hit the mark and live up to its name.

Such optimism was widespread across East Asia, and the question is how – in practical terms – accuracy was pursued. Adducing new data from all three countries, this section shows that East Asians, unlike their European peers, maximized the potential of smoothbore marksmanship: they accurized gun manufacture, trained for discriminate fire, and emphasized target practice.

Let us begin with gun manufacture. Contrary to Europe, where quality guns were reserved for sporting, the expectation in Korea, Japan, and China was that artisans would deliver similarly well-made pieces (albeit not ornately decorated) for general use in the army. Again, elements such as boring, windage, and sights were crucial. In recent years, we have come to understand gun boring of this region in detail, and what seems consistent throughout is a deep concern with quality control. The aforementioned Qi, for one, was a stickler for meticulous boring, and he commissioned local smiths to bore a mere 3 cm (1 Chinese *cun* 寸) per day for as long as a month or until the inside gives off a shine. Ensuring the supply of such quality barrels was difficult – and Qi complained about some negligent workshops. Yet, the general was adamant and he specified how to tell good barrels from bad, such as inspecting that the product is of equal thickness throughout – or in the parlance of the gunsmith, "perfectly upright."[62]

A similar attitude prevailed in Chosŏn, where both texts and practices emphasized high standards for boring. Taking after Qi's works, which were widely read in Korea, military practitioners in Chosŏn upheld this job as an important determinant of barrel quality and importantly for us, accuracy. Consider, for instance, a 1813 production manual entitled *Essentials of Military Affairs* (*Yungwŏn p'ilbi* 戎垣必備), compiled at the Special Manufactory of the Military Training Agency (*Hullyŏn togam* 訓鍊都監) – one of Korea's central armies.

> The accuracy that hits the center of targets lies in the straight muzzle [of the musket]. If the muzzle is straight, loading the powder is convenient, and with an unwavering igni tion unwavering, eight or nine shots out of ten can hit the mark . . .. [D]uring manufac ture, forge the iron to be refined of impurities, and bore the barrel straight. The bullet

62 Qi, *Ji xiao xin shu*, 56; Pye, *The Sportsman's Dictionary*, 424. For more on historical techni ques of boring, see Kang, "Crafting Knowledge," 257 262.

> must twist and turn unimpeded (*wanjŏn muae* 宛轉無礙), and only then could it be called a good [musket].[63]

This manual equates a good musket with one whose barrel is immaculately bored. As described, after forging the barrel, its inside was reamed to a high polish, such that the bullet, when fired, would "twist and turn unimpeded" and make as straight an exit as possible out of the muzzle.[64] This was, of course, easier said than done, but in Korea, strict regulations were in place for borers working in military workshops, such as the one at the Military Training Agency. In a typical musket shop from the eighteenth-century, military borers comprised the most numerous group (up to 41 percent of the whole), followed only by filers (23 percent) and blacksmiths (10 percent). By 1714, said borers were required by law to write their names on every barrel crafted, so that negligent ones can be tracked down, punished, and made to re-deliver better barrels.[65]

Windage and sights, too, were important. Returning to the Ming military, Qi specified that only tightly-fitting, polished lead balls (11.25g) should be used, and that they should be pushed into the muzzle with subtle force before being rammed with strength and paper wadding down to the bottom of the barrel. This careful charging of the musket ensured greater accuracy, as well as preventing misfires, increasing the musket's effective range, and allowing it to be fired downwards from higher ground. To prevent malpractices and expedients, Qi had these loading procedures tested in drill, and exhorted against harming accuracy by "trying for speed and convenience."[66] Regarding gun sights, military muskets throughout East Asia were expected to have a pair. But the best examples are found in Japan, where thousands of historical guns have survived in great condition. As summarized by arms historian and collector Sugawa Shigeo, these objects show "five styles of front and rear sights respectively," supplemented by a middle sight in either round or square shapes.[67]

---

63 *Yungwŏn p'ilbi*, 17.

64 *Yungwŏn p'ilbi*, 17.

65 Consider the full text of the said law to inscribe names: "Muskets should be bored accord ing to the old precedent i.e., to allow only lead bullets of 3 *chŏn* in weight. If this size bullet does not enter the muzzle, then the gun is useless. The borer shall be punished with 30 beat ings if 10 barrels or fewer [reported issue] and 50 beatings if 20 barrels or more. After that, they are to make the [same number of] barrels again." Kang, "Crafting Knowledge," 261.

66 Andrade, "The Arquebus Volley," 129.

67 Sugawa Shigeo, *The Japanese Matchlock*. There were also attachable sights as the "sighting ladder" that adjusted for shooting at distances of 100 paces, 150 paces, 250 paces and allegedly 1,500 paces. Rogers, "The Development of the Military Profession in Tokugawa Japan," 189.

More needs to be said on manufacture, but this suffices to show that East Asians pursued a high standard, and higher than Europeans – at least in the seventeenth and eighteenth centuries, and when it came to military muskets. But the question still lingers: could a marginally more accurate gun – as used by East Asians – actually lead to high rates of marksmanship? In 1804, when the aforementioned George Hanger wrote in favor of training musketeers at the target – in a way that is, as we will see, reminiscent of East Asian practices – he argued that a smoothbore musket, in the right hands, did not pale against the "best rifle gun in the kingdom" within 200 yards. Could this have been true?[68]

Accuracy is subjective and we must first define distance. The laws of physics prevent a smoothbore gun, regardless of how immaculately forged and bored, to deliver a straight bullet beyond 150 m or so. This limitation was certainly noted by East Asians. In China, for instance, the musket was known to be effective under 150 m (100 Chinese paces): as explained in a 1636 encyclopedia, the shot can "shatter birds into pieces within a distance of 30 paces, kill them without tearing their bodies at more than 50 paces, and was extremely weak at 100 paces."[69] Within this range, however, accuracy could vary significantly, and practitioners in East Asia believed that the right attitudes towards aiming and target practice could make a difference.

When compared to the European notion of aiming, the East Asian counterpart strikes us as starkly different: the unit of musketry aiming in East Asia was not the whole frontage of an enemy battalion but the space of a single man. This meant that shooting was discriminate, and both vertical and lateral dispersion of the shot was controlled through human effort. First, evidence of selective aiming by the average soldier abounds in all three countries of East Asia. In China and Korea, draconian measures were taken squad-by-squad to ensure that the musketeer in the line aimed at a single enemy while volley firing.[70] "If the enemy approaches en masse," Qi warned his soldiers, "each person should designate only one out of the enemy ranks and fire."[71] Interestingly, in Korea, similar yet more detailed instructions were given, along with an emphasis on countering cavalry. A manual from 1693 has it that the Korean musketeer should "aim the muzzle at the chest of the enemy," and "if the enemy is mounted, at the head of the horse, or if the enemy comes in flocks, at one out of the

68 Hanger, *Reflections on the menaced invasion*, 197, 200.
69 Sung Ying Hsing, *T'ien kung K'ai wu*, 276.
70 Qi, *Ji xiao xin shu*, 199 200. For Korea, see *Pyŏnghak chinam chuhae*, 38 39.
71 Qi, *Ji xiao xin shu*, 199 200.

crowd."[72] Similarly, in Japan, instructions had it that while firing in unison, "a single musketeer should aim and fire towards a single enemy."[73]

But how then did East Asians aim? Despite minor differences, soldiers in China, Korea, and Japan were expected to fire from the cheek and use the front and back sights. In Qi's army, for instance, the musketeer was instructed "to rest his cheek on the stock's end, and using one eye, match the back sight with the front sight, and the front sight with the man being shot at."[74] Korea had almost identical instructions but clarified with detail that the soldier should fire also from a kneeling position and without "shaking his head, hands or the front knee."[75] The emphasis on using the gun sights was to decrease the horizontal dispersion of the shot, but leveling the gun – as the Europeans emphasized – was also important, especially for firing at longer distances. In Japan, ample pictorial as well as textual data survive of the Japanese leveling system. For instance, when firing without adjustable sights, Japanese musketeers were advised to aim their pieces at the enemy's mid-section from 109 m (1 Japanese *chō* 町), the chest from 218 m (2 *chō*), base of the head from 327 m (3 *chō*), middle of the forehead from 436 m (4 *chō*), and the crown of the head from 545 m (5 *chō*).[76]

No matter how specific and rigorous the instructions were, aiming was only perfected through practice. Unlike in Europe, target practice was routinized in East Asian armies from as early as the seventeenth century. While its details varied from army to army, the convention throughout the region was to fire ball at a man-sized target, if not smaller, using precise range and lead bullets, and recording hits per individual (Table 2). Regarding ammunition, while European armies were parsimonious, preferring to train by "false fires in the pan," or with clay bullets,[77] East Asians insisted on using lead ammunition to drill as close to battle conditions as possible. Also, target practice, it seems, was quite frequent. While exact data is elusive, in one example, Japanese musketeers in the Hachisuga clan (蜂須賀氏) had practice ammunition of about 375 shots per

72 This manual *Chinpŏp Ŏnhae* 陣法諺解 was published in 1693 by Ch'oe Suk (崔橚, 1646–1708) at Hamkyŏng Provincial Governor's Office 咸鏡監營. For an annotated and translated version, see Yi, *Chinpŏp ŏnhae chuhae*, 79.

73 Ishioka, *Naganumaryu heiho*, 167.

74 Qi, *Ji xiao xin shu*, 59.

75 *Pyŏnghak chinam chuhae*, 22.

76 Anzai, *Hōjutsuka no seikatsu*, 81. More research is needed to compare leveling systems in detail. In Western Europe, "practical knowledge veterans passed to conscripts" during the Napoleonic era was as follows: "[W]hen the enemy was 50 yards away, aim at their knees . . . at 100 yards, aim at the waist; at 140 to 200, at the head." Elting, *Swords Around a Throne*, 483.

77 Zhmodikov and Zhmodikov, *Tactics of the Russian Army in the Napoleonic Wars*, 12.

man per year. If, according to the customs of the day, they shot ten rounds per practice, they could train approximately once every ten days.[78]

The best evidence of target practice occurs in Japan, where there was a wide variety including but not limited to the *funauchi* (船打, "shooting on board"), *chōchi* (町打, "long-range shooting"), and the *kakuchi* (角打 "short-range shooting"). Long-range accuracy was the eventual goal, and the *chōchi* was conducted on large curtain-like targets by increments of 109 m (1 *chō*), up to 1090 m.[79] Yet, the Japanese practiced most rigorously at close distances, presumably to calibrate their aim, and allow the shooter to adjust to the built-in inaccuracies of each musket. To that end, the *kakuchi* used a 24 cm (8 *sun* 寸) square target, with a bull's eye of 6 cm (5 *sun*) in diameter. This small target, or *kaku*, was clasped between bamboo poles, and raised on a firing mound 27 m (15 *ken*) from the shooter, or in some cases, 90 m or 109 m. Scoring sheets from 1795 show that shooters in the Seki-ryu Gunnery School had 87.5 percent accuracy (50 percent at the bull's eye, and 37.5 percent target hits) at the *kaku* from 27 m; there were three shooters, and a total of 24 shots, of which only three missed.[80] Comparable data – at the same target and distance – can be found in the scoring sheets submitted to the Bakufu in 1830 as "proof of the readiness of the musketeers," who achieved 95 percent accuracy (22 percent at the bull's eye, and 73 percent target hits or graze).[81]

We still need to process more data from Japanese target practices, but it is clear that the standards were remarkably high. In the Aizu domain, for instance, qualifying marks to earn the license of a "trained shot" – measured on the *kaku* at the standard 27 m, and from a kneeling position – were as follows: nine hits out of ten with a 11.5 mm caliber (2.3 *momme* 匁), eight hits out of ten with a 18.8 mm caliber (10 *momme*). Further, a "skilled shot" had to perform even better, and on a smaller 18 cm square target: 30 hits out of 50 for 18.8 mm caliber, and 80 hits out of 100 with any smaller caliber.[82]

Target practice was just as important in continental East Asia. In sixteenth-century China, Qi stipulated both archers and musketeers to practice at a 32 cm (1 *chi* 尺) by 1.6 m (5 *chi*) target. While the former shot from 80 paces, or 120 m at most, the latter took it 20 paces further and fired from 150 m. "Target strikes

78 Sasama, *Kakyū bushi ashigaru no seikatsu*, 124 125, as cited in Kubota, *Nippon no gunji ka kumei*, 50.

79 Udagawa, *Edo no hōjutsu*, 22.

80 Udagawa, *Edo no hōjutsu*, 22.

81 *On saki teppo kakucho* [Score Sheets for Bakufu Musketeers]. For more, see Rogers, "The Development of the Military Profession," 196.

82 Anzai, *Hōjutsuka no seikatsu*, 23.

Table 2: Target Practice in East Asia.

	Target Size (width by height)	Distance	Source (Date)
China	32 cm (1 *chǐ*) by 1.6 m (5 *chǐ*)	150 m (100 Ming paces)	*Ji xiao xin shu* (1580)
	32 cm (1 *chǐ*) by 1.6 m (5 *chǐ*); bull's eye: 16 cm (5 *cun*) in diameter.	150 m (100 Ming paces)	*Wu Bei Zhi* (1621)
	32 cm (1 *chǐ*) by 1.6 m (5 *chǐ*)	64 m (41 Qing paces)	*Qin ding Da Qing huidian* (1655)
Korea	9 cm (3 *ch'on*) by 1.6 m (1 *bal*)	72 m (60 Korean paces)	*Pukchŏng ilgi* (1658)
	61 cm (2 *ch'ŏk*) by 2 m (7 *ch'ŏk*)	120 m (100 Korean paces)	*Sokdaechŏn*, f. 4 (1746)
Japan	24 cm (8 *sun*) by 24 cm (8 *sun*); raised by poles; bull's eye: 6 cm (5 *sun*) in diameter	27 m (15 Japanese *ken*)	Udagawa, 22; Anzai, 39.
	24 cm (8 *sun*) by 36 cm (1 *shaku* 2 *sun*)	55–73 m (30–40 Japanese *ken*)	
	24 cm (8 *sun*) by 1.7 m (5 *shaku* 5 *sun*)	109–127 m (60–70 Japanese *ken*)	

were tallied on an abacus," as Andrade explains, "and the results recorded with the name of the soldier" on a "sample assessment forms . . . with blank spaces to be filled in with the names of soldiers and grades for their performance."[83] Often, in such a rigorous manner – with assessment forms and individual grades – musketry was pitted against archery. Speaking from experience, Qi was a clear partisan of the former: "when comparing and vying on the practice field the arquebus [musket] can hit the bull's-eye ten times better than the fast-lance and five times better than the bow and arrow."[84] In 1595, Korean King Sŏnjo (宣祖, 1567–1608) seems to have been inspired by Qi. He carried out an experiment of his own, comparing his brand-new musketry corps against the time-tested archers. At the end of the day, presumably after counting the target

83 Andrade, "The Arquebus Volley," 127 128. Sample assessment forms can be found in Qi, *Ji xiao xin shu*, 144 145.

84 Qi, *Ji xiao xin shu*, 57, as cited in Andrade, "The Arquebus Volley," 130.

Table 3: Target Practice Data from Korean Musketeers, 1658.

Date	Results	Percentage
4/6	51 hits / 200 shots	25.5%
4/21	N/A	N/A
5/17	40 hits / 200 shots	20%
5/18	65 hits / 200 shots	32.5%
5/21	200 people, 3 shots/person, 600 shots total 3/3 accuracy = 5 people (15 hits / 15 shots) 2/3 accuracy = 21 people (42 hits / 63 shots) 1/3 accuracy = 97 people (97 hits / 291 shots) 154 hits / 600 shots	25.67%
Total	**310 hits / 1200 shots**	**25.83%**

Source: Sin, *Pukchŏng ilgi*, 73–5.

hits like Qi, the former was declared severalfold better than the bow, and Sŏnjo exclaimed: "how believable are the words of the late [Qi] that the musket [shoots] five times better than the bow!"[85]

In Korea, there is evidence that musketeers practiced shooting on an extremely narrow target – about 10 cm wide and 1.5 m high – from as far as 72 m (60 Korean paces), and successfully at that (Table 3). These musketeers were Korean auxiliaries sent to the Russo-Qing war in the Amur region, and their commander Sin Yu kept a diary of the entire expedition, including records about musketry tests. At the aforementioned target and distance, 200 Korean musketeers fired a total of 1200 shots, and averaged 25 percent accuracy, with the highest rate being 32.5 percent and the lowest 20 percent.[86] These numbers might not seem impressive at first but they shot at an incredibly narrow target – certainly smaller than the space of a man, and comparable in width only to the bull's eye of the Japanese *kaku* (yet from nearly thrice as far as its standard range of 27 m). Using Probable Errors (PE) to extrapolate on ballistic performance, we may also conjecture that these men would have scored – at a roughly man-sized target (1.6 m tall and 30 cm wide) from the same distance –

85 *Sŏnjo sillok*, 1594/8/2 and 1595/10/8.
86 Sin, *Pukchŏng ilgi*, 73 75.

an average accuracy of 66.2 percent. Under their best conditions (when 32.5 percent was scored), they would have boasted 79.8 percent.[87]

As shown, musketry and marksmanship were synonymous in East Asia. Unlike in Europe, where a trained shot simply leveled his piece and fired indiscriminately into a crowd, the East Asian equivalent aimed at narrow targets, representing the space of a solitary man, if not smaller. In fact, with regard to the lateral alignment of their aim, the best marksmen in seventeenth-century East Asia outmatched European sharpshooters even during the Napoleonic era; the standard French target at the time was 53.34 cm by 1.67 m, significantly larger than most targets used in East Asia.[88]

There was indeed an appreciable difference in musketry between Europe and East Asia during the early modern period. But while a difference is discernible, its exact nature and implications are not clear. Was this difference simply a matter of choice and preference in the style of musketry? Or was it a fundamental divergence in the "culture" of training and aptitude in war-making?

Difference in an Age of Parity

Kubota and Kim saw the difference in musket use between Europe and East Asia as evidence of a fundamental divergence in capacity and "culture" – one of the reasons why the "military revolution [in Japan and Korea] terminated at the minimum level necessary."[89] Their reasoning is straightforward: because East Asian musketry was fixated on marksmanship and individual skills training, it developed as a form of "martial art" rather than "maneuver," lacking the rigorous drill, discipline, and collective training that is characteristic of European

87 The assumption in this extrapolation was that given the extremely narrow target width and the nature of smoothbores, it was due to the lateral dispersion of the shot that the musketeers had missed their targets. Thus, the height was not taken into consideration.

88 By the early nineteenth century, the standard French target was set as 1.67 m high by 53.34 cm wide at ranges of 97 m (50 toises), 195 m, and 292 m. Another source informs that the mean error of the French musket at 150 m was 75 cm vertically x 60 cm laterally. It appears that no gun sights were used. For more details, see Elting, *Swords Around a Throne*, 482 483; Haythornethwaite, *Weapons and Equipment of the Napoleonic Wars*, 19. Interestingly, there is also data suggesting that in terms of short range accuracy (measured at 27 m at the *kaku*), the Japanese matchlock still performed slightly better than a Dutch military musket at target shooting as late as 1863. See Anzai, *Hōjutsuka no seikatsu*, 23.

89 See notes 13 15 in this essay.

musketry.[90] This section shows, however, that their argument lacks in subtlety: a close examination of both sides reveals that this notion of a divergence does not stand up to evidence. Differences in musketry were not always hard-and-fast, and counterexamples go both ways: just as marksmen in East Asia trained at rapid, mass firing – with plenty of drill and collective training, sharpshooting was not unknown to specialist units in European armies. Importantly, said differences also did not translate to a gap in military capability, as there were both advantages and disadvantages to each style of musketry.

The first qualification: East Asians did not simply surrender speed in pursuit of accuracy. Aimed fire took longer, to be sure, but musketeers still drilled to volley fire for alacrity and consistency. Qi, for instance, not only advocated for precise aiming and target practice, but emphasized the importance of keeping up a constant hail of death. This balance of mass firing and marksmanship was achieved in China as well as Korea, where Qi's legacy was strong. In a Korean manual titled, *Annotations on the Guide to the Military Arts* (*Pyŏnghak chinam chuhae* 兵學指南註解), Qi's instructions are glossed line-by-line with great clarity.[91] Out of nearly 2,000 commentaries, an explanation of "volley fire" goes as follows:

> Those who are empty reload; those who are full fire again (which is to say, fire in five turns). While the ones who have fired are loading, those who are full then fire again (it means to complete a cycle and start all over). The firing of guns will not be lacking (or continuous without ending), and there must be no firing to the point of exhaustion (all day long, without using up [ammunition]) and with no slip ups in shooting (one after another, firing in turns without missing a turn). Bow and arrow. . .is also fired in accor dance with musketry (. . .firing overnight without ending. By nightfall, the enemies are reduced, and each squad would have fired ten volleys per musketeer).[92]

As reassured by each annotation, to "volley fire" meant to divide into a formation five-rank deep, and to cycle through the sequence of firing and loading incessantly without missing a single volley. Further reinforced by bow and arrow, such a technique would have generated a barrage of missiles, not unlike the blanket of fire that Western musketry strove for. Exact data is elusive on how

90 See notes 13 15 in this essay.

91 See note 71 in this essay. Qi Jiguang's manuals were circulated widely, annotated, and re adapted by Koreans. For more, see Siegmund, "Circulation of Military Knowledge and its Lo calization"; Siegmund, "The Adaptation of Chinese military techniques to Chosŏn Korea, their validation, and the social dynamics thereof."

92 *Pyŏnghak chinam chuhae,* 58 59. My translation of the Korean annotations is provided in parentheses. With minor edits, the translation of the original Chinese text was taken from An drade, "The Arquebus Volley," 125.

fast the Chinese and Koreans could fire, but they had various firing systems, each presumably with differing speed and density of volleys. Andrade writes of Qi's musketry drill: "[V]arious configurations of layers could be tested, as the commanders deemed suitable: two layers of five, five layers of two, one line of ten."[93]

Second, despite that individual skill was rewarded, the average musketeer in China and Korea underwent just as much collective training as their European counterparts. In fact, volley firing with aim would have required greater discipline and fire control than volley firing without it. It is scant wonder then that Qi prescribed target practice as a team exercise, training musketeers to hear for the signal of a gong or trumpet before firing gracefully in coordination. In battle, such fire control was enforced with draconian measures. In the event of a violation, the musketeer in question would either be executed summarily or earmarked for punishment after the battle. Any squad leader who failed to enforce this rule was also subject to decapitation.

Perhaps in Japan, where Kubota first conceived his notion of divergence, was different. After all, the island was home to as many as 200 gunnery schools, where musketry was prized as form of martial art, and apprentices spent years practicing gunmanship.[94] In such an environment, ever more fanciful forms of musketry emerged, and some even trained in such virtuosic skills as shooting while crossing a river, or while supine and holding the gun between the toes.[95]

But in any case, the point is still moot. While Kubota acknowledges the existence of volley fire, a closer examination indicates that its speed and discipline deserve more credit. References to musketry drill are commonplace in the Japanese military books throughout the early modern period. In a gunnery manual titled "Thoughts on Musketry Training" (習砲私議, 1823), it was emphasized that musketry drills be "regularly practiced by a method of strict testing and comparison."[96] One such drill placed Japanese musketeers at a distance of 55 m (30 *ken* 間) from a small torso-shaped target of 24 cm (8 *sun*) by 1 (1.2 *shaku* 尺), and instructed them to volley-fire with both alacrity and accuracy while marching forwards. The number of hits at the target, and the time interval between each salvo, was then recorded meticulously in assessment forms.[97] A similar practice occurs in a military manual from Aizu domain, which had an elaborate system of evaluating the speed

93 Andrade, "The Arquebus Volley," 127.
94 Anzai, *Hōjutsuka no seikatsu*, 20 21.
95 Rogers, "The Development of the Military Profession," 189.
96 Anzai, *Hōjutsuka no seikatsu*, 38.
97 Anzai, *Hōjutsuka no seikatsu*, 38.

of volley fire by 9 different grades.[98] While exact records on speed of fire are elusive, a modern trial showed that Japanese matchlocks could be fired eight to nine aimed shots in five minutes, and that with cartridges made for rapid fire (*hayago* 早碁), up to three shots per minute was possible.[99] Rich troves of Japanese materials have yet to be engaged with the Military Revolution debate, and we will likely find better data.

Conversely, in Europe, while the average infantrymen in the line aimed at speed of fire, specialist units did strive for accuracy. Often, skirmishers and other light infantry corps employed their firepower not through mass volley but aimed fire, which they achieved with accurized pieces like their East Asian counterparts, or at times, with rifled sporting guns.

From as early as the seventeenth century, for instance, some sharpshooters were employed to pick off enemy officers. During the English Civil War (1642–1651), a marksman distinguished himself at the siege of Sherborne Castle by sniping away at enemy officers with the careful aim of his "birding-piece."[100] Partaking in the same war, English general George Monck later wrote in support of furnishing each company with six sharpshooters, or "[s]ouldiers that carry the Fowling-pieces," and to use them while skirmishing to "shoot not at any, but the Officers of that Division."[101] By 1808, mutual sniping of officer corps – albeit considered a breach of military etiquette – was not uncommon in the European battlefield.[102]

Until the late eighteenth century, these sharpshooters were volunteers temporarily who were recruited in times of need. Many of them had learnt to shoot by sporting with their fowling pieces, which were akin to the military muskets in East Asia. Or perhaps, they had participated in such civilian shooting contests as the Schuetzen, where expert marksmen competed for prizes with both smoothbores and rifles.[103] In any case, unlike their military peers, the volunteers were generally good marksmen. In one example, German peasants in the Thirty Years' War (1618–1648) proved lethal against "plundering parties" of the Imperialist army.[104] "[B]eing used to kill Crowes and vermin on their own land," these peasants were "very good marksmen (especially, the aim being better, when the

98 Anzai, *Hōjutsuka no seikatsu*, 38.
99 Sugawa Shigeo, *The Japanese Matchlock*.
100 Firth, *Cromwell's Army*, 91.
101 Monck, *Observations upon Military & Political Affairs*, 103.
102 Muir, *Tactics and the Experience of Battle in the Age of Napoleon*, 66 as cited in Stephen son, *The Last Full Measure*, 112.
103 Lugs, *A History of Shooting*, 30 34; Peterson and Elman, *The Great Guns*, 84 85.
104 Firth, *Cromwell's Army*, 87.

mark is alive)," and their fowling pieces were "a great deal surer shooters and fitter for their handling than the warlike musket."[105]

Taken together, these examples show that war-making remained variable in both regions, and that hasty generalizations are ill-advised. This, however, is not to deny that there were advantages that one style of musketry had over the other, or that an actual divergence in gunnery developed eventually – in favor of the Europeans.

Direct comparisons of military strength are difficult because the sample size of formal battles fought between Europe and East Asian powers is small during the early modern period. We can surmise with some certainty, however, that in some situations, the emphasis on marksmanship did confer an edge. If, for instance, East Asians found themselves firing against European infantrymen from a distance, they could deliver volleys from farther away and without retaliatory fire from Europeans. In this case, the latter's skirmishers could have been obstructive – especially if armed with rifles, but all other things being equal, said advantage would favor East Asians given their general superiority in aimed fire. The advantage of accuracy is even clearer if the target presented a narrow frontage. This was a rare occasion, to be sure, as most battles – in both Europe and East Asia – were fought in line formations to maximize firepower. But in cases like the Battle of Bladensberg in 1814, when the British infantry was crossing a river by a single narrow bridge, Korean musketeers would have fared far better than their American peers, who blazed away – with several hundred muskets within effective range – with no apparent effect. Compare this to the Battle of Kimhwa in 1636, when Korean musketeers lured Manchu cavalry into a narrow valley and volley-fired at close distance, with disastrous effect.[106]

The East Asian advantage was not just in accuracy. From the meticulous ramming and loading of their pieces, musketeers in the region could fire downwards from higher ground unlike their Western counterparts; if you recall, some Japanese even trained in *sageya* ("downward target practice"). Europeans, however, did not load their pieces faithfully, so their bullets were prone to fall out when the guns pointed downward. For this, we have a concrete example from a war fought between the Russians and a coalition of Qing and Korean forces. In 1654, the story goes, a Qing-Korean army found itself in a retreating situation during a riverine combat with a Russian fleet. The day was saved, however, by Korean musketeers who had stationed themselves on a hill overlooking the river, where they fired behind stockades and from higher ground. When annoyed

105 Firth, *Cromwell's Army*, 87.

106 Hughes, *Firepower*, 26. Kang, "Big Heads," 148 156.

by their volleys, the Russians – mostly armed with flintlocks – stormed the hill, but they were beaten back by effective counterfire, leaving behind a trail of death. Had the two switched positions, the outcome would have been drastically different: with Russian musketeers failing to fire downward at the climbing enemy. This happened at least once in European history: in the Battle of Wittstock (1636), the Imperial-Saxon army – ensconced atop a hill – paid a dear price for not loading their pieces correctly; to their detriment, when enemies approached from below, and they presented their pieces, the bullets fell out and left them defenseless.[107]

In other situations, however, European musketry held an edge: the sheer volume and speed of fire in Europe rendered it more efficacious against cavalry charges. In the famous Battle of Pavia (1525), French cavalrymen were shot off their horses by "volleys of deadly lead shot . . . [which] penetrated not only one man-at-arms, but often two, and two horses as well."[108] What is impressive is that the Spanish handgunners fought without field fortifications – unlike their East Asian counterparts – and in a dense fog. Despite the odds, their firepower left the field "covered with the pitiful carnage of dying noble knights as well as with heaps of dying horses."[109] Even after Pavia, many European armies continued to raise mounted troops, but musketry in Europe was such that by the mid-seventeenth century, the traditional head-on cavalry charge was avoided for its own sake.[110]

In contrast, East Asian musketry did not fare so well against cavalry. For every tale of musketry victory in East Asia, there seems to be another testimonial of a brutally effective cavalry charge. For instance, despite the oft-mentioned story of Nobunaga's musketeers at Nagashino (1575), Japanese musketeers, in most cases, could only stand their ground against even light horsemen.[111] Indeed, during the East Asian War of 1592 to 1598, Japanese musketeers were often outmaneuvered by Ming cavalry, who were proficient in Mongol-derived tactics.[112] Likewise, Korean musketeers left an ambivalent legacy against the formidable Manchu cavalry: when left in the open without the support of close-quarter units,

107 Firth, *Cromwell's Army*, 90.
108 Hall, *Weapons and Warfare in Renaissance Europe*, 182.
109 Hall, *Weapons and Warfare in Renaissance Europe*, 182.
110 Hall, *Weapons and Warfare in Renaissance Europe*, 179; Stephenson, *The Last Full Mea sure*, 77 81.
111 Kubota, *Nippon no gunji kakumei*, 48.
112 No, "16 17 segi choch'ong," 121.

they were easy targets.[113] A Korean observer at the Battle of Sarhū (1619) put it as clearly as possible:

> The musket is a craft that allows shooting from a great distance, but it is very slow to reload and fire. Without relying on a fortress or rough geography, its use is never to be tested against cavalry in the open field. Last year, our forces faced cavalry charges with only musketeers and before they could even finish reloading, the enemy cavalry dashed into the heart of our formation.[114]

After Sarhū, Koreans learned their lesson and even scored a few battles against the Manchu cavalry by exploiting terrain and fortifications, by sniping at the officer corps, and through mass firing at close range.[115] By and large, however, it seems that East Asian musketeers still preferred to fire behind defensive structures when countering horsemen, and often found themselves outmatched in a way that their European counterparts would not.

Last but not least, there was an unforeseen advantage in European musketry, which gave way to an actual military divergence eventually – and unexpectedly at that. In East Asia, the same infantrymen who trained in marksmanship were also volley-firers. Therefore, they were on average more lethal, well-rounded, and versatile than the regular European soldier in the line.[116] Yet, while this may have been an East Asian edge through the seventeenth and eighteenth centuries, it was no longer so in the nineteenth century. In Europe, because light infantry remained separate from the line infantry, there was a greater compass for specialization of sharpshooting. Initially, due to the neglect in Europe for marksmanship, this separation rendered a European "backwardness" in terms of accuracy. But as interest in light infantry tactics grew in the late eighteenth century, Europeans benefited from, if you will, an "advantage of backwardness," to borrow the words of Kenneth Pomeranz: when formally systematized in the military, sharpshooting units acquired their own institution of practice ammunition and target shooting – which was more generous than that of their average peers, and reaped windfall gains from the advanced rifling technologies of Europe.[117] This small, unforeseen

113 Kang, "Big Heads," 148 156.

114 Kang, "Big Heads," 149.

115 Kang, "Big Heads," 148 156. Both the Koreans and Japanese increased the proportion of musketeers and drilled them harder after their qualified successes against cavalry. For more, see No, "16 17 segi choch'ong," 121.

116 In a sense, they resembled the well trained light infantry corps of nineteenth century Europe, who operated both as specialist sharpshooting units and as regulars firing volleys in the line.

117 Conversely, early military rifles given their extremely slow reloading process may have rendered them inutile for the East Asian musketeer who not only had to aim carefully but vol ley fire

(dis)advantage in European musketry, then, grew further in the nineteenth century when bouts of warfare brought standards of musketry accuracy in Europe up to those in East Asia and beyond. This moment of Western ascendancy was also the time when the Age of Parity finally gave way to the Great Military Divergence.[118]

Conclusion

This chapter has appreciated, if you will, "difference in an age of parity," a conundrum represented by the disparate ways in which the military musket was used and produced in Europe and East Asia, as well as their nonetheless comparable levels of innovation in bringing this artifact to bear on early modern warfare. As demonstrated, speed took precedence in Europe and accuracy in East Asia. Yet, rather than being mutually exclusive, mass firing and marksmanship were also deployed simultaneously in both regions: European skirmishers aimed, and East Asian sharpshooters volley-fired. The difference in musketry, then, stemmed not from an incommensurable gap (or "divergence") in drill and training – as suggested by Kubota and Kim, but from a certain "interpretation" of technology that shaped (and was being shaped by) its surrounding context, social and cultural as well as political, economic, and aesthetic. In other words, a military and technological parity did prevail between Europe and Asia during the early modern period, but with intriguing differences that we have only begun to understand.

In closing, then, I present two further directions for investigation, with an eye for moving the field towards a truly comparative study of technology between Europe and East Asia. First, military historians should take to heart initial charges by their colleagues in the history of technology and much more. In the early responses to the theses by Roberts and Parker, Bert Hall and Kelly Devries challenged the field to consider the social shaping of technology, but the field of the history of technology has since further flourished, and we have ample sources to draw on. Rather than replacing technological determinism with social constructivism – arguably, two sides of the same coin, historian of military science and technology Antoine Bousquet, for instance, makes a compelling case to use "assemblage theory," which embeds technology in a "network" of relations between society, artifact, culture, politics, and so on.[119] Another voice in the field –

118 Andrade, *The Gunpowder Age*, 5.

119 Bousquet, "A Revolution in Military Affairs?"; Bousquet, "Welcome to the Machine."

and drawing on a case study of guns in Central Africa, Giacomo Macola argues instead for grasping the "interpretive flexibility" of technologies when they move between contexts: he draws attention to changes made in the physical alterations of the hardware, as well as the ideologies and values that shape its use.[120] We can move towards a truly comparative history of technology, only after building on these rich works. For the purposes of this paper, this will also help answer questions that remain unresolved: Why did European militaries give up on accuracy until the nineteenth century? What explains the difference in East Asia?

But historians of technology can also learn from global military historians. The global turn in military history has changed that field with a revisionist force that has yet to be seen in the history of technology. As exemplified by works by Tonio Andrade and others, the former has been broken open by new comparative data, and East Asia, for one, is as central to the study of the Military Revolution as Europe. Of course, this, too, has room to grow: as other global historians quip, we need to move beyond comparative studies that shuttle between the opposite ends of Eurasia and consider the space in between – or to grasp what Ander Gunder Frank has called "The Centrality of Central Asia."[121] A truly comparative history of technology, then, would immerse in globalist discourses and data – even when its main thrust may still be anchored in a particular locale, or a juxtaposition of Eurasian poles – and bring such expansive views to understand the different uses to which machines and techniques are put in different places. Again, rephrased in the context of this paper, we should revise the centrality of European data in the formation of our understanding about early modern firearms, and their technical parameters: if the East Asian data on marksmanship stands, then, what of the histories of technology that quote the laws of physics to deny possibilities of smoothbore accuracy? It is indeed time now to interrogate European history with non-European standards and to generate new comparative insights that change our understanding of both: How, for instance, should we rethink the rise of ballistic science in eighteenth-century Europe, in light of the differences reported in this study concerning East Asia?

120 Macola, *The Gun in Central Africa*.
121 Smith, "Nodes of Convergence," 16.

Bibliography

Andrade, Tonio, Hyeok Hweon Kang, and Kirsten Cooper. "A Korean Military Revolution? Parallel Military Innovations in East Asia and Europe." *Journal of World History* 25.1 (2014): 51–84.

Andrade, Tonio. "The Arquebus Volley Technique in China, c. 1560: Evidence from the Writings of Qi Jiguang." *Journal of Chinese Military History* 4 (2015): 115–141.

Andrade, Tonio. *The Gunpowder Age: China, Military Innovation, and the Rise of the West in World History*. Princeton: Princeton University Press, 2016.

Anzai Minoru安斎實. *Hōjutsuka no seikatsu: zōho Ensei buki zuryaku Seiyō heigaku kunmō* 砲術家の生活: 増補遠西武器図略, 西洋兵学訓蒙. Tokyo: Yūzankaku Shuppan 雄山閣出版, 1989.

Paul Varley. "Oda Nobunaga, Guns, and Early Modern Warfare." In *Writing Histories in Japan: Texts and their Transformations from Ancient Times Through the Meiji Era*, edited by James C. Baxter, and Joshua A. Fogel, 105–125. Kyoto: International Research Center for Japanese Studies, 2007.

Bousquet, Antoine. "A Revolution in Military Affairs? Changing Technologies and Changing Practices of Warfare," In *Technology and World Politics: An Introduction*, edited by Daniel R McCarthy, 165–182. London: Routledge, 2017.

Bousquet, Antoine. "Welcome to the Machine: Rethinking Technology and Society Through Assemblage Theory," In *Reassembling International Theory*, edited by Michele Acuto, and Simon Curtis, 91–97. London: Palgrave Macmillan UK, 2014.

Börekçi, Günhan. "A Contribution to the Military Revolution Debate: The Janissaries Use of Volley Fire during the Long Ottoman-Habsburg War of 1593–1606 and the Problem of Origins." *Acta Orientalia* 59.4 (December 2006): 407–438.

Brown, Delmer M. "The Impact of Firearms on Japanese Warfare, 1543–98," *The Far Eastern Quarterly* 7.3 (May 1948): 236–253.

Carmen, W.Y. *A History of Firearms: From Earliest Times to 1914*. London: Routledge, 2016.

Chandler, David. *Dictionary of the Napoleonic War*s. Hertfordshire: Wordsworth, 1999.

Chang Chŏngsu. "17 segi chŏnban Chosŏn ŭi p'osu yangsŏng kwa unyŏng" 17세기 전반鮮의 砲手 養成과 運用. Ph.D. dissertation, Korea University, 2010.

Charney, Michael. *Southeast Asian Warfare, 1300–1900*. Leiden: Brill, 2004.

Chase, Kenneth. *Firearms: A Global History*. Cambridge: Cambridge University Press, 2003.

Chŏng Yŏnsik 정연식. "Hwasŏng kongsimdon ŭi yurae wa kinŭng" 화성 공심돈의 유래와 기능. Yŏksa Hakpo 歷史學報169 (2001): 1–35.

Chŏng Yŏnsik 정연식. "Hwasŏng uĭ pangŏ sisŏl kwa ch'ongpo" 화성의 방어시설과 총포. *Chindan Hakpo* 震檀學會91 (2001): 133–161.

Douglas, Howard. *A Treatise on Naval Gunnery*. London: J. Murray, 4th ed., 1855.

Elting, John R. *Swords around a throne*. London: Weidenfield & Nicholson, 1999.

Equiluz, Martin de. *Milicia Discurso, y Regla Militar, del Capitan Martin de Eguiluz, Bizcayno*. Antwerp: Casa Pedro Bellero, 1595 [1586].

Firth, Charles H. *Cromwell's army: a history of the English soldier during the civil wars, the commonwealth, and the protectorate*. London: Greenhill Books, 1992 [1902].

Fissel, Mark Charles. "Military Revolutions." In *Oxford Bibliographies in Military History*, edited by Kaushik Roy. New York: Oxford University Press, https://www.oxfordbibliographies.com/view/document/obo-9780199791279/obo-9780199791279-0212.xml.

Gommans, Jos. *Mughal Warfare*. London: Routledge, 2002.
Grant, James. *The Cavaliers of Fortune, or, British Heroes in Foreign Wars*. London: Routledge, Warnes and Routledge, 1859.
Grossman, Dave. *On Killing: The Psychological Cost of Learning to Kill in War and Society*. Boston: Little, Brown, 1996.
Hall, Bert. *Weapons and Warfare in Renaissance Europe: Gunpowder, Technology, and Tactics*. Baltimore: Johns Hopkins University Press, 1997.
Hall, Bert S., and DeVries, Kelly. "The 'Military Revolution' Revisited." *Technology and Culture* 31.3 (July 1990): 500–507.
Hanger, George. *Reflections on the menaced invasion and the means of protecting the capital by preventing the enemy from landing in any part contiguous to it*. London: Printed for John Stockdale, 1804.
Haythornthwaite, Philip J. *Weapons and Equipment of the Napoleonic Wars*. Blandford Press, 1979.
Hŏ Sŏndo. *Chosŏn sidae hwayak pyŏnggisa yŏn'gu* 朝鮮時代火藥兵器史研究. Seoul: Ilchogak, 1994.
Hoffman, Philip T. *Why Did Europe Conquer the World?* Princeton: Princeton University Press, 2015.
Hora Tomio 洞富雄, *Teppo denrai to sono eikyo: Tanegashimaju zohoban* 鉄砲伝来とその影響: 種子島銃増補版. Azekura Shobo 校倉書房, 1959.
Hughes, B.P. *Firepower: Weapons Effectiveness on the Battlefield, 1630–1850*. New York: Sarpedon, 1997.
Ishioka Hisa 石岡久夫. *Naganumaryu heiho* 長沼流兵法. Tokyo: Jinbutsuoraisha 人物往来社, 1967.
Jacob, Frank, and Gilmar Visoni-Alonzo. *The Military Revolution in Early Modern Europe: A Revision*. London: Springer, 2016.
Jomini, Antoine H. *The Art of War: Restored Edition*. Kingston, Ont: Legacy Books Press, 2008.
Kang Hyeok Hweon. "Big Heads and Buddhist Demons: The Korean Musketry Revolution and the Northern Expeditions of 1654 and 1658." *Journal of Chinese Military History* 2 (2013): 127–189.
Kang Seok Hwa. "A Study on the Assimilation of Qing Military Techniques in Chosŏn during the Seventeenth and Eighteenth Centuries." In *Space and Location in the Circulation of Knowledge (1400–1800): Korea and Beyond (Research on Korea)*, edited by Marion Eggert, Felix Siegmund, Dennis Würthner. Peter Lang GmbH, Internationaler Verlag der Wissenschaften, 2014.
Kim Yŏngjung 김영중. "17 segi Chosŏn ŭi p'osu hullyŏn pangsik kwa kunyŭl" 17C 조선의 포수 훈련방식과 군율. *Kunsa* 92 (September 2014): 167–197.
Krenn, Peter, Paul Kalaus, and Bert Hall. "Material Culture and Military History: Test-Firing Early Modern Small Arms." *Material History Review* 42 (1995): 101–109.
Kuba Takashi久芳崇. *Higashi Ajia no heiki kakumei: jūrokuseiki Chūgoku ni watatta Nihon no teppō* 東アジアの兵器革命: 十六世紀中国に渡った日本の鉄砲. Tokyo: Yoshikawa Kōbunkan, 2010.
Kubota Masashi. 久保田正志. *Nippon no gunji kakumei*日本の軍事革命. Tokyo: Kinseisha, 2008.
Lavin, James D. "A Study of Spanish Firearms." Ph.D. diss., The Florida State University, 2017.
Lorge, Peter A. *The Asian Military Revolution: From Gunpowder to the Bomb*. Cambridge: Cambridge University Press, 2008.

Lugs, Jaroslav. *A History of Shooting: The Development of Target Guns, Shooting Ranges and Rifle Associations: A History of Duelling and Exhibiton Shooting: Magic and Superstition*. Feltham: Spring Books, 1968.

Macola, Giacomo. *The Gun in Central Africa: A History of Technology and Politics*. Athens: Ohio University Press, 2016.

Monck, George. *Observations upon Military & Political Affairs*. London: Printed by A.C. for Henry Mortlocke and James Collins, 1671.

Morillo, Stephen. "Guns and Government: A Comparative Study of Europe and Japan." *Journal of World History* 6.1 (1995): 95–100.

Muir, Rory. *Tactics and the Experience of Battle in the Age of Napoleon*. New Haven: Yale University Press, 1998.

Müller, Wilhelm. *The Elements of the Science of War: Containing the Modern, Established, and Approved Principles of the Theory and Practice of the Military Sciences . . . Illustrated by Seventy five Plates, on Artillery, Fortification, &c. and Remarkable Battles Fought since the Year 1675, for the Use of Military Schools and Self instruction*. Longman, Hurst, Rees, Orme and Etc., 1811.

No Yŏnggu 노영구. "Chosŏn hugi pyŏngsŏ wa chŏnbŏp ŭi yŏn'gu" 朝鮮後期兵書와 戰法의 硏究. Ph.D. dissertation, Seoul National University, 2002.

No Yŏnggu 노영구. "16–17 segi choch'ong ŭi toip kwa Chŏson ŭi kunsajŏk pyŏnhwa", 16–7 세기 조총의 도입과 조선의 군사적 변화. *Han'guk munha* 58 (November 2012): 111–137.

No Yŏnggu 노영구. "Kihoek nonmun: chŏnjaeng ŭi sidaejŏk yangsang; 'kunsa hyŏngmyŏngron (Military Revolution)' kwa 17~18 segi Chosŏn ŭi kunsajŏk pyŏnhwa" 기획논문 전쟁의 시대적 양상: '군사혁명론 (Military Revolution)'과 17~18 세기 조선의 군사적 변화. *Sŏyangsa yŏngu* 5.5 (2007): 39–43.

On saki teppo kakucho [Score Sheets for Bakufu Musketeers]. 1849/41/5, 1850/5/10, 1853/ 5/ 19.MSS. H-60-12-88/89, H-60-12-77, H-60-12-227. Honda Family Documents. National Museum of Japanese History, Sakura, Chiba.

Parker, Geoffrey. *The Military Revolution: Military Innovation and the Rise of the West*. Cambridge: Cambridge University Press, 1996.

Peterson, Harold L., and Robert Elman. *The Great Guns*. London: Hamlyn Publishing Group, 1971.

Peterson, Harold L. *Encyclopedia of Firearms*. New York: Dutton, 1967.

Picard, Ernest, and Paul Azan. *La campagne de 1800 en Allemagne*. Paris: Chapelot, 1907.

Pye, Henry James. *The Sportsman's Dictionary; Containing Instructions for Various Methods to be Observed in Riding, Hunting, Fowling, Setting, Fishing. The Management of Dogs, Game. And the Manner of Curing Their Various Diseases and Accidents*. London: J. Stockdale, 1807.

Pyŏnghak chinam chuhae 兵學指南註解 [*Annotations on the Guide to the Military Arts*]. National Library of Korea, Seoul, South Korea.

Qi Jiguang 戚繼光. Ji xiao xin shu: shi si juan ben 紀效新書: 十四卷本. Edited and annotated by Fan Zhongyi 范中義. Beijing: Zhonghua shuju, 2001.

Quimby, Robert. *The Background of Napoleonic Warfare*. New York: Columbia University Press, 1957.

Raudzens, George. "War-Winning Weapons: The Measurement of Technological Determinism in Military History." *The Journal of Military History* 54.4 (Oct. 1990): 403–434.

Roberts, Michael. "The Military Revolution, 1560–1660." Inaugural Lecture Delivered before the Queen's University Belfast. Belfast: M. Bond, 1956, reprinted in *The Military Revolution Debate*, edited by Clifford J. Rogers, 13–35. Boulder: Westview Press, 1995.

Robins, Benjamin, and W.S. Curtis. *New Principles of Gunnery*. Richmond [Surrey]: Richmond Publishing Co. Ltd, 1972; originally published: London: J. Nourse, 1742.

Rogers, Clifford J., ed. *The Military Revolution Debate*. Colorado: Westview Press, 1995.

Rogers, John M. "The Development of the Military Profession in Tokugawa Japan." Ph.D. Diss., Harvard University, 1998.

Rothenberg, Gunther E. *The Art of Warfare in the Age of Napoleon*. Chalford: Spellmount, 2007.

Saito Tsutomu齋藤努, Takatsuka Hideharu高塚秀治, Udagawa Takehisa 宇田川武久. "Hihakai bunseki niyoru teppō jūshin no zaishitsu to seisaku gihō no kaiseki" 非破壊分析による鉄砲銃身の材質と製作技法の解析. Kokuritsu Rekishi Minzoku Hakubutsukan kenkyū hōkoku 国立歴史民俗博物館研究報告 136 (2007): 237–265.

Sasama Yoshihiko笹間良彦. *Kakyū bushi ashigaru no seikatsu*下級武士足軽の生活. Tokyo: Yūzankaku雄山閣, 1991.

Smith, Pamela H. "Nodes of Convergence, Material Complexes, and Entangled Itineraries." In *Entangled Itineraries: Materials, Practices, and Knowledges Across Eurasia*, edited by Pamela H. Smith, 5–24. Pittsburgh: University of Pittsburgh Press, 2019.

Smythe, Sir John. *Certain Discourses Military*, edited by J.R. Hale. Ithaca: Published for the Folger Shakespeare Library by Cornell University Press, 1964.

Sherer, Idan. *Warriors for a Living: The Experience of the Spanish Infantry in the Italian Wars, 1494–1559*. Leiden: Brill, 2017.

Siegmund, Felix. "Circulation of Military Knowledge and its Localization. Some notes on the Case of Military Techniques in Late Chosŏn Korea." In *Space and Location in the Circulation of Knowledge* (1400–1800): Korea and Beyond, edited by Marion Eggert; Dennis Wrthner. Frankfurt/Bern: Peter Lang GmbH, Internationaler Verlag der Wissenschaften, 2014.

Siegmund, Felix. "The Adaptation of Chinese military techniques to Chosŏn Korea, their validation, and the social dynamics thereof." In *Civil Military Relations in Chinese History: From Ancient China to the Communist takeover*, edited by Kai Filipiak. London/New York: Routledge, Taylor & Francis Group, 2015.

Sin Yu 申瀏. *Pukchŏng ilgi*北征日記, translated by Pak Tae-gŭn 朴泰根. Kyŏnggi-do, Sŏngnam-si: Han'guk chŏngsin munhwa yŏn'guwŏn, 1980.

Sŏnjo sillok 宣祖實錄 [Veritable Records of Sŏnjo's Reign]. Edited by Kuksa p'yŏnch'an wiwŏnhoe. Kuksa p'yŏnch'an wiwŏnhoe, 1955–1958.

Stephenson, Michael. *The Last Full Measure: How Soldiers Die in Battle*. London: Duckworth Overlook, 2016.

Stravos, Matthew. "Military Revolution in Early Modern Japan" *Japanese Studies* 33.3 (2013): 243–261.

Sugawa Shigeo. *The Japanese Matchlock: A Story of the Tanegashima*. Published by the author in Tokyo; distributed by Kogei Shuppan, 1991.

Sun Laichen. "Military Technology Transfers from Ming China and the Emergence of Northern Mainland Southeast Asia (c. 1390–1527)." *Journal of Southeast Asia Studies* 34.3 (2003): 495–517.

Sung Ying-Hsing. *T'ien kung K'ai wu; Chinese Technology in the Seventeenth Century*, translated by Sun, E-Tu Zen, Sun, Shiou-Chuan. University Park: Pennsylvania State University, 1966.

Swope, Kenneth. *A Dragon's Head and a Serpent's Tail: Ming China and the First Great East Asian War*, 1592–1598. Norman: University of Oklahoma Press, 2009.

Udagawa Takehisa. *Edo no hojutsu: Keishosareru bugei* 江戸の炮術: 継承される武芸. Tokyo: Tōyō Shorin, 2000.

von Friedrich Wilhelm Ludolf Gerhard Augustin Steuben, Baron. *Regulations for the Order and Discipline of the Troops of the United States*. New Hampshire: Exeter, printed and sold by Henry Ranlet, 1794.

von Pivka, Otto. *Armies of the Napoleonic Era*. Newton Abbot: David & Charles, 1979.

von Scharnhorst, Gerhard Johann David. *Results of Artillery and Infantry Gun Trials*, translated by Bill Leeson. Hemel Hempstead: B. Leeson, 1992.

Wells, William R. *Shots that Hit: A Study of U.S. Coast Guard Marksmanship, 1790–1985*. Washington, D.C.: U.S. Coast Guard, Historian's Office, 1993.

Wilson, Guy M. "Some Important Snap Matchlock Guns," *Canadian Journal of Arms Collecting* 26.1 (1988): 3–10.

Wong, R. Bin. "Tonio Andrade. The Gunpowder Age: China, Military Innovation, and the Rise of the West in World History." *The American Historical Review* 122.2 (2017): 464–467.

Yerxa, Donald A., ed. *Recent Themes in Military History: Historians in Conversation*. Columbia: University of South Carolina Press, 2008.

Yi Chinho, *Chinpŏp ŏnhae chuhae* 陣法諺解 註解. Seoul: Hyŏngsŏl Chulpansa, 2011.

Yungwŏn p'ilbi 戎垣必備 [Essential Weapons for the Commander]. Special Manufactory, 1813, Toyo Bunko Collection, VII-3-127.

Zhmodikov, Alexander, and Yuri Zhmodikov. *Tactics of the Russian Army in the Napoleonic Wars*, Vol. 2. West Chester: The Nafziger Collection, 2003.