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Firearms and Military Adaptation: The Ottomans and the European Military Revolution, 1450–1800*

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THE mass adoption of firearms as a tool of warfare dramatically changed the nature of military conflict from the mid fifteenth century onward, prompting historians of early modern Europe to describe the changes as a “gunpowder revolution” or “Military Revolution”—a thesis that provoked a spirited scholarly debate in the 1990s. Although the original concept, as set forth by Michael Roberts in 1955, did not single out firearms technology, in the influential elaboration of the thesis by Geoffrey Parker (1988), firearms and artillery fortifications (*trace italienne*, which were developed in response to artillery firepower) became the main building blocks of the thesis. According to the thesis, the new fortresses required much larger armies to successfully besiege them, leading to a dramatic increase in the size of European armies. To build and maintain artillery fortifications, large artillery trains and ever larger armies in turn required a more centralized government. Thus, the introduction of firearms led to the rise of centralized states in Europe—and, on a global scale, to the “rise of the West.”¹

* I thank Edmund Burke and the late Jerry Bentley for commissioning this article. I also thank Matt Romaniello and his colleagues at the Journal of World History for their patience, for this essay took far longer to prepare than their initial timetable envisioned. While sections of this essay draw on my *Guns for the Sultan: Military Power and the Weapons Industry in the Ottoman Empire* (New York: Cambridge University Press, 2005), new questions and substantial new material have also been incorporated.

¹ Geoffrey Parker, *The Military Revolution: Military Innovation and the Rise of the West, 1500–1800* (Cambridge: Cambridge University Press, 1988); rev. ed., 1999. The importance

Many embraced Parker's ideas, but his thesis also provoked criticism, both conceptually and empirically. Some suggested different chronologies for the military transformation of Europe, ascribing the revolutionary changes to periods other than Roberts's original 1560–1660 or Parker's broader 1500–1800. Others saw the changes as a more complex process involving several interrelated military revolutions, which were each usually preceded by periods of incremental change.² The most forceful challenge, however, came from David Parrott, who argued that “a wholly state-recruited and state-administered military force is an anomalous development,” “a particular preoccupation of European states from roughly 1760 to 1960,” and that prior to that “the characteristic pattern of European warfare” was “military organization on the basis of contracts with private suppliers.” Parrott not only deemphasized the role of military technology, but also challenged the causal relationship between war and the rise of the centralized state through “military revolution,” the very essence of the thesis.³

Students of non-Western history started to add their voices to the discussion only recently.⁴ The Ottomans typically appeared in the discussion as a counterpoint to their (supposedly) militarily more advanced European rivals. While the Ottomans' successful participation in the artillery “revolution” of the fifteenth century was acknowledged,⁵ and some historians even suggested that the Ottomans were a “gunpowder empire”—implying that firearms played a crucial role in the formation and consolidation of their empire⁶—others claimed that

of “the gunpowder revolution” in “the rise of Atlantic Europe” has been raised by others; see, for example, William H. McNeill, *The Pursuit of Power: Technology, Armed Force, and Society since A.D. 1000* (Chicago: University of Chicago Press, 1982).

² See, for instance, Clifford J. Rogers, ed., *The Military Revolution Debate: Readings on the Military Transformation of Early Modern Europe* (Boulder, Colo.: Westview Press, 1995); Jeremy Black, *A Military Revolution? Military Change and European Society, 1550–1800* (London: Macmillan, 1991); and Jeremy Black, *Beyond the Military Revolution: War in the Seventeenth-Century World* (Houndmills, Basingstoke, Hampshire: Palgrave Macmillan, 2011).

³ David Parrott, *The Business of War: Military Enterprise and Military Revolution in Early Modern Europe* (Cambridge: Cambridge University Press, 2012), p. 2.

⁴ Kenneth Warren Chase, *Firearms: A Global History to 1700* (Cambridge: Cambridge University Press, 2003); Peter Allan Lorge, *The Asian Military Revolution: From Gunpowder to the Bomb* (Cambridge: Cambridge University Press, 2008).

⁵ John Francis Guilmartin, “The Military Revolution: Origins and First Tests Abroad,” in Rogers, *The Military Revolution Debate*, pp. 304, 306; Kelly DeVries, “Gunpowder Weapons at the Siege of Constantinople, 1453,” in Yaacov Lev, ed., *War and Society in the Eastern Mediterranean, 7th–15th Centuries* (Leiden: Brill, 1997), pp. 343–362.

⁶ Marshall G. S. Hodgson, *The Venture of Islam, Vol. 3, The Gunpowder Empires and Modern Times* (Chicago: University of Chicago Press, 1974); William Hardy McNeill, *The Age of Gunpowder Empires, 1450–1800* (Washington, D.C.: American Historical Association, 1989); Douglas E. Streusand, *Islamic Gunpowder Empires: Ottomans, Safavids, and Mughals* (Boulder, Colo.: Westview Press, 2011).

from the late sixteenth century onward the Ottoman military lagged behind its western and central European rivals. The latter embraced the *trace italienne* and “a balanced mix of shock and shot infantry” of pikemen and arquebusiers, and thus—according to this view—established military superiority over the sultans’ forces.⁷ Underlying all the reasons put forward to explain the Ottomans’ inability to keep pace with the “West” (whatever that means) was an assumption that their deficiencies ultimately sprung from their conservatism, fanaticism, and despotism, which in turn stemmed from their culture and religion.⁸

Such explanations put undue emphasis on military technology and tactics, but an even bigger problem with this approach is the fact that each and every claim made therein flies in the face of the evidence, as this paper demonstrates. The paper is divided into three sections. The first two sections examine the adaptation, manufacturing, and deployment of firearms in the Ottoman Empire as well as the role of gunpowder technology in establishing and maintaining Ottoman military superiority against the sultan’s European, Asian, and Middle Eastern rivals in the early modern era. Challenging commonly held views about the Ottomans’ supposed conservatism and dependence on European military technology and imported weaponry, these sections demonstrate the Ottomans’ continued flexibility and pragmatism in adapting and improving on acquired weapons, as well as their self-sufficiency in the production of weapons and munitions. They also reveal that in addition to firearms, factors such as good intelligence; resourceful leadership;

⁷ Guilmartin, “The Military Revolution,” pp. 307–308; József Kelenik, “The Military Revolution in Hungary,” in Géza Dávid and Pál Fodor, eds., *Ottomans, Hungarians, and Habsburgs in Central Europe: The Military Confines in the Era of Ottoman Conquest* (Leiden: Brill, 2000), pp. 117–159.

⁸ The list of authors who share such views is long, and includes Kenneth M. Setton, Paul Kennedy, Eric L. Jones, Arthur Goldschmidt, and Bernard Lewis. See Ágoston, *Guns*, pp. 7–8. Despite evidence to the contrary, such views have been enduring; see, for example, Anthony Pagden, *Worlds at War: The 2,500-Year Struggle between East and West* (New York: Random House, 2009), p. 354: “why had they failed to maintain their advantage? The simplest, most compelling answer was and would remain: religion.” For an older view about Ottoman conservatism and backwardness, see E. L. Jones, *The European Miracle: Environments, Economies, and Geopolitics in the History of Europe and Asia*, 2nd ed. (Cambridge: Cambridge University Press, 1997), pp. 175–191, which is a hodgepodge of half-truths and biased generalizations based on the accounts of European travelers and other Orientalist “experts,” which, taken together, amount to a caricature of Ottoman history: “As Europe developed, they [the Ottomans] could have learned from there too. As it was they spat on the opportunity, and soon they were held in terror” (p. 178); “Technological stagnation and intellectual retrogression mark the check to Ottoman ambitions” (p. 179); “After tolerant start, typical perhaps of military despotisms in the first flush of confidence, the Ottomans came positively to encourage obscurantist thought. This militated against the borrowing of western techniques and against native inventiveness” (p. 181).

large and disciplined professional armies; superior supply and logistics; and the combined use of field artillery, infantry firepower, wagon fortresses, and cavalry charges were all important in Ottoman military successes. The last section of the paper examines the possible relationship between firearms and the growth of Ottoman military manpower. Older literature explained the increase in the number of musket-bearing janissary footmen with Istanbul's need to counter Habsburg infantry firepower in the war of 1593–1606 in Hungary. New evidence indicates that the growth of the janissary corps was part of a general military expansion that started under Sultan Süleyman I and accelerated during the Ottomans' Thirty Years War (1578–1611) against the Safavids and Habsburgs. In addition to increased demand for military manpower in these multiseasonal wars, Ottoman military expansion also reflected increased supply of fighting men due to domestic socioeconomic changes, which resulted in the emergence of provincial governors and local strongmen as military entrepreneurs with private armies.

ADOPTION AND INTEGRATION OF GUNPOWDER TECHNOLOGY

The Diffusion of Firearms in the Ottoman Realms

By the 1380s, the Ottomans were acquainted with gunpowder weapons, most likely via the Balkans, where firearms had been known from the 1350s onward.⁹ Ottoman registers of timar prebends or military fiefs mentioned gunners (sing. *topçu*) remunerated with timars from the 1390s.¹⁰ Sieges and defenses where Ottoman troops are known to have employed cannons include those of Byzantine Constantinople (between 1394 and 1402, 1422, 1453), Salonica (1422, 1430), Antalya (1424), Novo Brdo (1427, 1441), Smederevo (1439), Belgrade (1440), and the Hexamilion ("six-mile-wall") fortified wall across the Gulf of Corinth that guarded the only land route between mainland Greece and the Peloponnese peninsula. Considering that cannons became common in European sieges only from the 1420s on, the above

⁹ Djurdjica Petrović, "Firearms in the Balkans on the Eve of and after the Ottoman Conquests of the Fourteenth and Fifteenth Centuries," in Vernon J. Parry and M. E. Yapp, eds., *War, Technology and Society in the Middle East* (London: Oxford University Press, 1975), pp. 169–172, 175; Gábor Ágoston, "Ottoman Artillery and European Military Technology in the Fifteenth to Seventeenth Centuries," *Acta Orientalia Scientiarum Hungaricae* 47 (1994): 15–48.

¹⁰ Istanbul, Başbakanlık Osmanlı Arşivi (Istanbul, Prime Ministry's Ottoman Archives, henceforth BOA), Maliyeden Müdevver Defterleri (henceforth MAD) 231, p. 107. See İdris Bostan, "XVI. Yüzyıl Başlarında Tophane-i Amire ve Top Döküm Faaliyetleri," in Taşkın Takış and Sunay Aksoy, eds., *Halil İnalçık Armağanı-1* (Istanbul: Doğubatı, 2009), p. 251.

examples suggest that the Ottomans were on par with developments occurring elsewhere in Europe. By 1444, the Ottomans were using cannons in their Balkan castles, aboard their river flotillas on the Danube and its tributaries, and in field battles. They employed cannons against both fixed and moving targets—such as castles and enemy ships. By this time, they also used matchlock arquebuses (*tüfek*).¹¹

The Ottoman-Hungarian wars of the 1443–1444 and the Crusade of Varna (1444) were crucial in the proliferation of firearms among the Ottomans. A contemporaneous anonymous Ottoman chronicler of the Hungarian-Ottoman wars of 1443–1444 noted that the Ottoman defenders of Vidin had cannon, mangonels, and arquebus at their disposal, as did those in the castles of Niğbolu (Nicopol), Şumlu (Shumen), and Pravadi.¹² Extant survey registers from the mid fifteenth century on listed cannon and arquebus in Ottoman castles in the Balkans, though the Ottomans must have inherited many of the pieces from the Christians.¹³

Table 1. Number of cannons and arquebuses in Ottoman castles

Date	Castle	Cannons	Arquebuses
1455	Üsküp (Skopje)	12	148
1455	Sobri	4	2
1455	Novoberda (Novo Brdo)	8	55
1473	İvranya (Vranja)	10	16
1488	Semendire (Smederevo)	50	

Sources: Feridun Emecen, *Osmanlı Klasik Çağında Savaş* (Istanbul: Timaş, 2010), pp. 35–36; Bostan, “Tophane,” p. 252 n. 7. In Üsküp the source listed 125 lead shots for cannon, 4,000 arquebus bullets, 41 bows, 23 crossbows, 15,000 arrows, and 8,000 arrowheads.

¹¹ Petrović, “Firearms,” pp. 174–177; Colin Heywood, “Notes on the Production of Fifteenth-Century Ottoman Cannon,” in Colin Heywood, *Writing Ottoman History: Documents and Interpretation* (Aldershot: Ashgate, 2002), no continuous pagination, article XVI (originally published in 1980), pp. 3–9; Ágoston, *Guns*, pp. 16–17. The meaning of the Ottoman term *tüfek* changed through the centuries. In the fifteenth century it referred to weapons similar to European arquebus. However, unless we have data regarding the weapons’ weight, length, and caliber, it is difficult to tell whether our mid sixteenth-century sources referred to arquebuses or early muskets.

¹² Halil İnalcık and Mevlüd Oğuz, eds., *Gazavât-ı Sultân Murâd b. Mehmed Hân: İzladi ve Varna savaşları (1443–1444) Üzerinde Anonim Gazavâtname* (Ankara: Türk Tarih Kurumu, 1978). English translation: Colin Imber, *The Crusade of Varna, 1443–45* (Aldershot: Ashgate, 2006), pp. 79, 82, 88, 90.

¹³ In Novo Brdo, for instance, the Ottomans registered eight cannons ten days after its conquest. A weapons inventory compiled before the Ottoman conquest listed three large and five “other” pieces. Petrović, “Firearms,” p. 185.

In mid October 1444, the Ottomans were successful in sinking a ship of the crusader fleet, which intended to prevent Sultan Murad II (1421–1444, 1446–1451) and his Asian troops crossing to Europe. Both the anonymous Ottoman chronicler and Zaifi, the author of a relatively unknown contemporaneous Ottoman *Gazavatname* (“Chronicle of Holy Wars”) who was participant of Murad II’s wars in the 1440s, mentioned the incident, which may be the very first example for the successful use of coordinated fire of coastal artillery from both shores of the straits to disable an enemy fleet. According to Zaifi, the sultan ordered his grand vizier to come with five thousand cavalry, four hundred arquebusiers, and two hundred artillery gunners to the European shores of the Bosphorus straits, opposite the “Anatolian castle” (Anadolu Hisarı) at the narrowest point of the straits, where the sultan decided to cross to Europe, following his failed attempt of doing so at the straits of Gallipoli.¹⁴ The anonymous chronicler added that the shots of Ottoman cannons, directed by the chief Ottoman artillery gunner, a man named Saruca, “smashed into one of the ships, splintering its hull and sending it to the bottom of the sea.”¹⁵ Under the cover of artillery fire, and with the help of Genoese ships, the Ottoman troops crossed to Europe and headed toward Varna.

In November the Ottomans defeated the crusaders at the battle of Varna, where both parties used artillery. Zaifi underlines the importance of Ottoman cannons in stopping multiple crusader assaults.¹⁶ The Ottomans’ use of artillery and handguns in the second battle of Kosovo (1448) is also well documented by both European and Ottoman sources.¹⁷

¹⁴ Zaifi, *Gazavat-i Sultan Murad Ibni Muhammad Han, Afyon İl Halk Kütüphanesi Gedik Ahmet Paşa Bölümü*, no. 18349, 51/a, as summarized in Gürol Pehlivan, “Varna Savaşı ve Bir Tarih Kaynağı Olarak Gazavatnameler,” *Turkish Studies: International Periodical for the Languages, Literature and History of Turkish and Turkic* 3, no. 4 (2008): 607. Jehan de Wavrin, whose account is based on the memoirs of his nephew, commander of the Burgundian ships on the Bosphorus in 1444, corroborates this information, putting the size of Halil Pasha’s army at about seven to eight thousand men, and underlining that the cannons and culverins he deployed were delivered to him by the Genoese of Pera. See Imber, *Varna*, p. 128. See also John Jefferson, *The Holy Wars of King Wladislas and Sultan Murad: The Ottoman-Christian Conflict from 1438–1444* (Leiden: Brill, 2012), pp. 339–340, for the significance of the event.

¹⁵ Imber, *Varna*, p. 84.

¹⁶ Zaifi, 74/a–81/b, Pehlivan, “Varna Savaşı,” p. 613. However, the two thousand arquebusiers, five hundred artillery gunners, and one thousand cannon given by Zaifi (53/b, Pehlivan, “Varna Savaşı,” p. 609) seem greatly exaggerated.

¹⁷ Artillery fire was especially heavy on the first day of the battle (18 October), when the Hungarians, on the suggestion of a Turkish “renegade” who had escaped to Hungary in the time of King Sigismund (1387–1437), attacked the Ottoman camp at night with

Hungarian Wagenburg and Ottoman Tabur

During the Hungarian-Ottoman wars of the 1440s the Ottomans acquainted themselves with the Hussite *Wagenburg* tactic. The *Wagenburg*, or wagon fortress, perfected by the Hussites in Bohemia during the Hussite wars (1419–1436), was a defensive arrangement of war wagons chained together. The Hussites manned their wagons with some twenty crossbowmen and gunners per wagon, and also protected them against cavalry assault by heavy wooden shielding and light artillery. The Ottomans first encountered the *Wagenburg* in their fight against János Hunyadi's troops in 1442. Hunyadi had learned the use of war wagons during his wars against the Hussites in Bohemia, where he served as a commander for Sigismund of Luxemburg, king of Hungary (1387–1437). When Hunyadi was preparing against the Ottomans in March 1443, he relied on the well-developed industry of the Saxon towns of Transylvania, his home base, which he governed in the name of the king. Hunyadi ordered the artisans of the Saxon town of Kronstadt (Braşov in modern Rumania) to send "war wagons furnished with guns, arquebuses and other war-machines," made according to the instructions of a certain Bohemian artisan whom Hunyadi had sent to the town to supervise the construction of war wagons. Hunyadi also spent a great amount of his own money on the construction of war carts, and his Czech mercenaries brought additional war wagons to his camp. In the end, some six hundred taborite war carts were deployed during the winter campaign of 1443–1444, although Hunyadi had difficulty manning them with the required number of infantry. In the 1444 Varna campaign, sources put the number of wagons in the crusaders' camp at two thousand.¹⁸

The Ottomans quickly realized the usefulness of the wagon laager and also determined how to overcome it—namely, by surrounding the laager out of range of the guns and forcing the enemy to give up its positions, a tactic they successfully employed at the battles of Varna

infantry and artillery. However, Murad II responded with equally strong artillery fire and repulsed the attack. See József Teleki, *A Hunyadiak kora Magyarországon*, 5 vols. (Pest: Emich és Eiseufels, 1852–1856), 2:91, based on Chalkokondyles and contemporary western sources.

¹⁸ Lajos Elekes, *Hunyadi* (Budapest: Akadémiai Kiadó, 1952), p. 189; Ágoston, *Guns*, p. 18; Jefferson, *Holy Wars*, pp. 320, 425. See also Constantin Emanuel Antoché, "Du tabor de Jan Žižka et de Jean Hunyadi au tabur cengi des armées ottomanes: L'art militaire husite en Europe orientale, au Proche et au Moyen Orient (XVe–XVIIe siècles)," *Turcica* 36 (2004): 91–124.

(1444) and Kosovo (1448).¹⁹ The battle of Varna demonstrated that the *Wagenburg* alone could not win the war, and that other factors were also important. In the case of Varna, Ottoman numerical superiority, discipline, and the young king's reckless charge (which he launched toward the end of the fight despite Hunyadi's advice to the contrary) against the sultan's well-protected position led to disaster.²⁰ In the battle, the Ottomans captured the crusaders' war wagons and firearms. It is possible that the two hundred *huffnitzbugschen* (according to another source, 140 *pixides*) that Sultan Mehmed II (1444–1446, 1451–1481) deployed and, after his failed siege, abandoned at Belgrade in 1456 were the ones that the Ottomans had captured at Varna in 1444.²¹ Both terms were used for smaller guns in the mid fifteenth century, but the former specifically referred to the guns (*haufnice*) that the Hussites of Jan Žižka and Hunyadi's Czech mercenaries used on their wagons.

It is not known when the Ottomans first used their wagon laager (*tabur*). Whereas at the second battle of Kosovo (1448) Hunyadi had some two thousand carts and used them as *Wagenburg*, it was not yet the Hungarian-style wagon laager that the Ottomans employed. Rather, it was the type of defensive embankment that had served the Ottomans so well at Varna in 1444: a deep trench and a dirt embankment strengthened with iron stakes and large shields, behind which stood janissary archers, arquebusiers, cannons, and camels laden with rich baggage.²² The combined use of artillery, arquebus, and *tabur* is usually cited as a decisive factor in the Ottomans' victory against the Akkoyunlu forces of Uzun Hasan (1457–1478) at the battle of Bashkent in 1473.²³

¹⁹ "You rely on your carts—recorded the anonymous Ottoman chronicler—, hoping that the House of Osman will attack them so that you can drive them back with cannon and arquebus. But do you not know that they have tumbled to this trick of yours and will not approach the carts? No, they will surround you completely, out of range of the guns, and stay there until you are reduced to eating one another." Imber, *Varna*, p. 59.

²⁰ Teleki, *A Hunyadiak kora*, 1:427–445; Elekes, *Hunyadi*, pp. 249–255; Jefferson, *Holy Wars*, pp. 455–481, for the reconstruction of the battle.

²¹ On 3 August 1456, one anonymous source reported from Vienna that the Turks lost "bombardas 22, maximas 32 palmas in longum et in latum 7, et huffnitzbugschen 200 et ultra." Similar information is reported from Vienna by Georgius de Welche: "Lucrati etiam sunt Bombardas magnas, quorum longitudo 32 palmarum, latitudo . . . 7 palmarum, parvas autem pixides 140." See Ödön Bölcskey, *Capistranói Szent János élete és kora*, 3 vols. (Székesfehérvár: Debreczenyi István Könyvnyomdája, 1924), 2:342.

²² Teleki, *A Hunyadiak kora*, 2:79 for the number of carts, and 2:87 for the embankment. See also Jefferson, *Holy Wars*, p. 458, for similar embankment and tactics at Varna. Should the enemy reach the embankment, the rich baggage would be used to distract the enemy to buy time.

²³ John E. Woods, *The Aqquyunlu: Clan, Confederation, Empire*, rev. ed. (Salt Lake City: University of Utah Press, 1999), pp. 118–120. It is puzzling why Uzun Hasan accepted battle

Firearms and Standing Troops

While the Ottomans' quick adoption of firearms and the *Wagenburg* tactic is notable, their main advantage lay in their early integration of gunpowder weapons into their standing forces. From the 1390s on, preceding their rivals by centuries, the Ottomans established a corps of permanent salaried troops who specialized in the manufacturing and handling of firearms. As mentioned above, in the time of Sultan Bayezid I they had artillery gunners paid with military fiefs, and a generation later began to employ salaried cannoneers. From the mid-fifteenth century onward there was a separate unit of armorers (sing. *cebeci*) within the sultan's household troops, who looked after and carried the infantry janissaries' weapons. Beginning in the second half of the same century the army had its own gun carriage drivers (sing. *top arabacı*) whose job was to manufacture, repair, and operate war wagons in campaigns, including the setting up of the *tabur*. The corps of bombardiers (sing. *humbaracı*) was established in the late fifteenth century. All this was in sharp contrast to most of the Ottomans' European adversaries, in whose realms the gunner remained a master craftsman who had special relationship to his weapon. In Europe, individual pieces had their names, and cannons were elaborately decorated.²⁴ While European sources mention the Mahometa, Mehmed II's giant cannon manufactured by the Hungarian renegade Orban before the siege of Constantinople (1453), such specialized names for artillery pieces are absent from Ottoman chronicles and fortress inventories. This also suggests that the business of the Ottoman gunner was more mundane, and while his profession required specialized knowledge and brought him prestige, he was first and foremost a professional soldier of the sultan's standing household forces, known as *kapıkulu* or "slaves-servitors of the [sultan's] gate."²⁵

The sultan's elite infantry janissaries are perhaps the best known among the standing household troops. Established either under Orhan (r. 1324–1362) or Murad I (r. 1362–1389)²⁶ and recruited through the

against the fortified Ottoman army in 1473 when the Akkoyunlu leader had been so cautious and successful in wearing out, with a long blockade and repeated raids, the wagon fort (*hisar-i araba*) of the Timurid Sultan Abu Said's (1451–1469) in 1469 (*ibid.*, p. 99).

²⁴ This is a point made by J. R. Hale, *War and Society in Renaissance Europe, 1450–1620* (London: Fontana Press, 1985), p. 50.

²⁵ Ágoston, *Guns*, pp. 28–29. The standard work remains İsmail Hakkı Uzunçarşılı, *Osmanlı Devleti Teşkilâtından Kapıkulu Ocakları*, 2 vols., 2nd ed. (Ankara: Türk Tarih Kurumu, 1984; 1st ed., 1944).

²⁶ Colin Imber, "The Origin of the Janissaries," in Colin Imber, *Warfare, Law and Pseudo-History* (Istanbul: Isis, 2011), pp. 165–171.

child levy or *devşirme* system, the janissaries were initially equipped with their formidable recurved bow, saber, shield, and light coat of mail. However, under Murad II they began to use *tüfek*.

Sources summarized in Table 2 demonstrate that from the mid-fifteenth century onward, artillery gunners, handgunners, and crossbowmen (sing. *zemberekçi*) served in numerous Ottoman castles.

Data regarding the Ottoman castle of Novoberda (Novo Brdo) in 1455 are especially significant, for they demonstrate that by the mid-fifteenth century some of the janissaries serving in border forts

Table 2. Artillerymen, handgunners, and crossbowmen in selected Ottoman castles (1455–1491)

Date	Castle	Gunners (<i>topçu</i>)	Handgunners (<i>tüfekçi</i>)	Crossbowmen (<i>zemberekçi</i>)
1455	Novoberda (Novo Brdo)		11 (C) 10 Janissaries (M)	
1455	Güvercinlik (Golubac)		10 (C)	
1467–1468	Resava	4 (C)	10 (C)	
1467–1468	Güvercinlik		10 (C)	40 (C)
1467–1468	Niğbolu (Nicopol)	11 (C)		
1467–1468	Holovnik	9 (C)		
1488	Semendire (Smederevo)	18 (M) + 32 (C)	40 (C)	40 (C)
1491	Resava	4 (C)		
1491	Güvercinlik	2 (M)	10 (C)	
1491	Vidin	2 (C) + 2 (M)		
1491	İzvornik (Zvornik)	2 (M)	10 (M)	10 (M)
1491	Güzelce (Havala)	2 (M)		
1491	Yergöğü (Giurgiu)	1 (M)		
1491	Semendire	15 (M) + 35 (C)	40 (C)	40 (C)
1491	Hram	4 (M)		
1491	Akkerman (Bielgorod)	17 (M)		
1491	Kili (Kilia)	18 (M)		
1499	Novi (Castelnouvo)	11 (M)		
1500	Moton (Modon)	16 (M)		

Sources: Data for 1455: Olga Zirojević, *Tursko vojno uređenje u Srbiji, 1459–1683* (Beograd: Istorijski Institut, 1974), pp. 136, 139; Emecen, *Savaş*, pp. 35–36. Data for 1467–1468: Zirojević, *Tursko vojno uređenje u Srbiji*, p. 120 (Golubac); Bostan, “Tophane,” p. 253 (Niğbolu). Data for 1488: BOA Kamil Kepeci (henceforth KK) 4725, pp. 44–48. Data for 1491: BOA, MAD 15334, pp. 42, 44, 46, 49–50, 54–58, 44m–45m; 63, 71. Data for 1499: KK 4725, p. 24b (Novi); Bostan, “Tophane,” pp. 252–253. Abbreviations: C=Christian; M=Muslim

had already been armed with handguns. The table also shows that in the fifteenth century most artillery gunners, arquebusiers, and cross-bowmen serving in Ottoman forts in the Balkans were Christians or recent converts. However, in strategically located castles—such as the recently conquered Kili and Akkareman at the mouth of the Danube, and Moton on the southwestern edge of the Peloponnese—all of the artillerymen were Muslims. Muslim cannoneers gradually outnumbered their Christian peers in other Ottoman castles as well.

Unlike their Mamluk and European adversaries, who armed soldiers of lower social standing with gunpowder weapons, the Ottomans equipped their elite standing troops with firearms. Table 3 demonstrates the gradual increase and fluctuation in the number of artillery gunners, armorers, and gun-carriage drivers of the sultan's household troops. The increase, as with other household troops, started under Sultan Süleyman I (1520–1566), when the number of artillery gunners tripled between 1520 and 1567–1568. After a small decrease in the early 1570s, the growth continued, and the number of artillerymen doubled again between 1582 and 1597. Although the number for 1598 seems very high, it might reflect the needs to garrison recently conquered fortresses in Hungary in the wars of 1593–1606 (especially Győr/Yanık in 1594 and Eger/Eğri in 1596). After the war the corps was reduced drastically, almost to its prewar size by 1609, although the numbers of armorers continued to rise. The high number of 1669 reflects the need for cannoneers during the final siege of Candia (1667–1669), whereas the highest numbers coincided with the long war against the Holy League (1684–1699).

The number of janissaries carrying firearms in battles is difficult to discern. Ottoman narrative sources estimated them from two thousand to ten thousand men at the battle of Mohács in 1526. German contemporaries believed that in the 1532 campaign, when Charles V and Süleyman I came closest to confronting one another at the battlefield, some nine thousand janissaries were armed with handguns. However, Table 4 suggests that the spread of firearms amongst the janissaries was a slow process, and that in the Rhodes (1522) and Mohács campaigns about half, and in the 1533 Iraq campaign about 60 percent, of the janissaries listed in official pay sheets could have carried handguns, assuming full mobilization of janissaries.

The Question of Janissary Volley Fire

The janissaries were firing their guns row by row from the early sixteenth century on, as indicated by narrative sources and miniatures

Table 3. Number of salaried artillerymen, armorers, and gun carriage drivers, 1512–1705

Date	Artillerymen	Armorers	Carriage drivers	Total
1512	331	401	346	1,078
1514	353	451	378	1,182
1520	396	522	308	1,226
1521	560	504	544	1,608
1522–1523	688	484	543	1,715
1523	600	517	542	1,659
1523–1524	594	568	543	1,705
1524–1525	632	528	516	1,676
1527–1528	695	524	943	2,162
1530	687	528	1,168	2,383
1567–1568	1,204	789	678	2,671
1574	1,099	625	400	2,124
1582–1583	1,438	1,382	916	3,736
1598	2,827	3,000	700	6,527
1609	1,552	5,730	684	7,966
1652–1653	1,481	5,426	339	7,246
1654	1,455	5,128	322	6,905
1660–1661	1,481	5,426	339	7,246
1661–1662	2,026	4,189	282	6,497
1669–1670	2,793	4,789	432	8,014
1687–1688	5,243	12,275	477	17,995
1690–1691	3,996	8,782	576	13,354
1691–1692	2,970	4,932	407	8,309
1692–1693	3,941	7,493	838	12,272
1693–1694	3,385	5,257	498	9,140
1694–1695	5,869	14,726	1,229	21,824
1696–1697	4,433	9,188	1,105	14,726
1698–1699	4,604	9,692	1,174	15,470
1699–1700	4,177	8,924	980	14,081
1700–1701	3,592	7,105	788	11,485
1701–1702	3,429	6,760	704	10,893
1702–1703	3,217	6,138	655	10,010
1704–1705	3,437	7,719	695	11,851

Sources: 1512–1530: BOA, MAD 23, published in Gábor Ágoston, *Osmanlı'da Strateji ve Askerî Güç* (İstanbul: Timaş, 2012), pp. 177–178. 1567, 1652–1670, 1694–1705: Mehmet Genç and Erol Özvar eds., *Osmanlı Maliyesi: Kurumlar ve Bütçeler*, 2 vol. (İstanbul: Osmanlı Bankası Arşiv ve Araştırma Merkezi, 2006) 1:237–238. 1574, 1582, 1609, and 1687–1693, *ibid.*, vol. 2 and CD-ROM, *passim*. 1598: Ágoston, *Guns*, p. 30.

Table 4. Number of handguns and janissaries, 1521–1533

Date	Arquebuses in campaigns	Janissaries on pay sheets
1521		8,349
1522	4,500 small and 1,000 trench guns	
1522–1523		7,010
1524–1525		9,390
1526	4,000 small and 60 trench guns	
1527–1528		7,886
1530		8,407
1533	3,420 small and 1,300 longer guns	

Sources: Emecen, *Savaş*, p. 41; Nicolas Vatin, *Rodos Şövalyeleri ve Osmanlılar* (Istanbul: Türkiye Ekonomik ve Toplumsal Tarih Vakfı, 2004), pp. 450–451, for arquebuses. Ágoston, *Strateji*, pp. 177–178, for the janissaries.

describing the battle of Mohács in 1526. The Ottoman chronicler Celalzade Mustafa (d. 1567) claimed that “four thousand janissaries [under the command of the *beylerbeyi* of Rumeli] were deployed in nine consecutive rows according to the rules of imperial battles [led by the sultan],” behind the chained field pieces known as *darbzen* or *darbuzan*, and that these “gunners (*tüfekendaz*) were firing their guns (*tüfek*) row by row.” A miniature of the battle from 1558 shows the janissaries firing in two rows: Soldiers in the first row are in a kneeling position reloading their weapons, while those standing behind them in the second row firing their guns. The janissaries are depicted as being behind light field pieces, chained together, a well-known arrangement from earlier and later battles.²⁷ The question of whether these accounts refer to volleys known from Western European examples from the latter part of the sixteenth century and presented by historians as one of the hallmarks of the Military Revolution needs further examination. However, a description of the janissaries’ volley fire practice in 1605 outside Esztergom (Hungary) undoubtedly depicts volleys along the Western European style. “And in the middle of the field, the janissaries stood in

²⁷ Mustafa Çelebi Celalzade, *Geschichte Sultan Süleymān Kānūnīs von 1520 bis 1557, oder, Tabakāt ül-Memālik ve Derecāt ül-Mesālik*, ed. by Petra Kappert (Wiesbaden: Steiner, 1981), fols. 146b–147a; Ágoston, *Guns*, p. 24; Günhan Börekçi, “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 Scientiarum Hungaricae* 59, no. 4 (2006): 430–431.

three ranks, each musketeer (*tüfekendaz*) with matches ready [to fire], and they lined up the bigger *darbzens* (*şahi darbuzanlar*), chained one another, in front of the janissaries. Then, after the first rank of the janissaries fires their muskets, the second rank fires, too. Afterward, the rank that fired first bends double [= kneels] and begins to reload their muskets. And as the third rank fires, the second rank in front [of them] bends and prepares their muskets. Then, the first rank again stands up and fires their muskets."²⁸

While the above reference to the janissaries' volley practice can be seen as proof for their participation in the "European Military Revolution," a different explanation is also possible. It might, at least partly, be explained by the swelling of the corps and the resulting decline of the janissaries' fighting skills and discipline, which in turn required constant drills to keep their skills up to date and to enhance corps coherence. One should also be careful not to overstate the importance of the janissaries' volleys and consider the destructiveness of archers, whose arrows could cause more damage among the enemy than musket fire—as was the case in the first phase of the battle of Mezőkeresztes (26 October 1596), the main battle of the Long War of 1593–1606.²⁹ This is a reminder of the skills of the janissaries in archery and the enduring effectiveness of non-gunpowder weapons at the end of the sixteenth century.

Firearms and the Ottoman Cavalry

Based on an oft-quoted passage of Oghier Ghiselin de Busbecq, Habsburg imperial ambassador to the Ottoman Empire in the mid sixteenth century, historians have emphasized the aversion of the Ottoman cavalymen to firearms. Apart from reluctance of cavalymen to adopt firearms, one should remember that early matchlocks were inferior to the reflex bows of the Ottoman mounted archers with regard to force of penetration and range and speed of fire. The wheel lock was also unreliable, and although the Ottomans became acquainted with wheel-lock pistols as early as 1543 in Hungary, they did not adopt them en masse until about the Cretan war (1645–1669), when the snaphaunce lock made the pistols safer and easier to use. This explains the limited

²⁸ *Topçular Katibi Abdulkadir (Kadri) Efendi Tarihi*, p. 437, cited in English in Börekçi, "A Contribution," p. 416.

²⁹ Sándor László Tóth, *A mezőkeresztesi csata és a tizenöt éves háború* (Szeged: Belvedere, 2000), p. 238.

number of pistols in Turkish museums.³⁰ However, the Ottomans had mounted gunners in Egypt and trained gun-bearing janissaries in the Anatolian and Arab provinces to fight as mounted troops since the mid sixteenth century. The timariot *sipahis* and/or their retinues serving aboard Ottoman galleys at the battle of Lepanto (1571) and in the early seventeenth century also used handguns. The household cavalry of the sultans adopted short-barreled arquebuses in the long Hungarian war of 1593–1606, and perhaps even earlier.³¹

WEAPONS PRODUCTION AND FIREPOWER SUPERIORITY

The adoption and adaptation of firearms by the Ottomans significantly enhanced their military capabilities. However, these weapons had to be manufactured and deployed in large enough numbers to have an impact. This required the establishment of considerable weapons and ammunition manufacturing capabilities as well as an effective transportation system and logistics. The Ottomans proved successful in these areas as well.

Some Europeanist historians and Middle East generalists continue to repeat the old myth that the Ottomans were unable to manufacture their own cannons and thus relied on European weapons, which they either confiscated from their rivals or imported from Europe. When they managed to manufacture their own weapons, it was only with the help of European renegades.³² Alas, claim yet others, Ottoman cannons remained obsolete—huge and unwieldy pieces in a time when European powers were casting smaller, mobile pieces. According to this narrative, Ottoman technological backwardness and dependence on foreign military know-how and hardware eventually led to their

³⁰ Robert Elgood, *Firearms of the Islamic World in the Tareq Rajab Museum, Kuwait* (London: I. B. Tauris, 1995), p. 45. A seventeenth-century wheel-lock pistol in the Military Museum of Istanbul (catalogue no. 241) was sixty centimeters long and had a bore diameter of eleven millimeters; see Aysel Çötelioglu, *Askeri Müze Osmanlı Dönemi Ateşli Silahlar Kataloğu* (Istanbul: Askeri Müze, 2000), p. 107.

³¹ Elgood, *Firearms*, p. 45; İdris Bostan, *Osmanlı Bahriye Teşkilâtı: XVII. Yüzyılda Tersâne-i Âmire* (Ankara: Türk Tarih Kurumu, 1992), p. 231.

³² Victor Davis Hanson, *Carnage and Culture: Landmark Battles in the Rise of Western Power* (New York: Doubleday, 2001), pp. 254–255, which claims that the artillery pieces of the sultans were “for the most part stolen and plundered from Christian forces rather than fabricated on the premises.” Bernard Lewis, *The Muslim Discovery of Europe* (London: Phoenix, 1995), p. 223, which maintains that the “majority of their [i.e., the Ottomans] gun-founders and gunners were European renegades or adventurers.”

defeat at the hands of technologically and tactically superior European rivals.³³

In fact, the Ottomans were self-sufficient in the manufacturing of cannons and powder well into the eighteenth century, and the majority of the cannons that they cast and deployed were similar to those used by their European rivals. The crux of the matter is in the details, for in order to compare the weapons used by the Ottomans and their rivals, one has to make sense of the bewildering nomenclature of Ottoman firearms and employ quantifiable data as to the composition of Ottoman ordnance, instead of citing a few readily available, but often unreliable, observations by European military “experts,” a lazy method too often employed even by distinguished historians when writing about the Ottomans.

Cannons

The Ottomans were fortunate to have abundant ore deposits (copper, iron, and lead) needed for cannon casting, and raw materials (saltpeter, sulfur, charcoal, and fuel wood) necessary for powder manufacturing. The only metal they lacked was tin. However, the alloy of the Ottoman bronze cannons usually contained only about 10 percent tin, and Istanbul managed to obtain the needed amount from import, mainly from England. The rest of the ore came from the empire’s copper and iron mines. The amount of copper received by the Imperial Cannon Foundry from the Balkan and Anatolian mines was substantial: in 1684–1685, for example, almost 850 metric tons, sufficient to cast hundreds of field pieces and siege cannons. At the same time the iron mines in the Balkans and Anatolia cast hundreds of thousands of iron shots annually, the total weight of which varied, according to demands, from one hundred to eight hundred metric tons in the seventeenth and eighteenth centuries.³⁴

The Ottomans cast cannon in their foundries along the Adriatic (Avlonya and Prevesa), in their Hungarian provinces (Buda and Temesvár), the Balkans (Rudnik, Semendire, İskenderiye, Novaberda,

³³ See, for example, Carlo M. Cipolla, *Guns, Sails and Empires: Technological Innovation and the Early Phases of European Expansion 1400–1700* (New York: Barnes and Noble, 1996; 1st ed., 1965), pp. 95–99; Parker, *The Military Revolution*, 1st ed., p. 126; Jonathan Grant, “Rethinking the Ottoman ‘Decline’: Military Technology Diffusion in the Ottoman Empire, Fifteenth to Eighteenth Centuries,” *Journal of World History*, 10, no. 1 (1999): 191–192; and McNeill, *The Pursuit of Power*, p. 112, on the Asian “gigantesque siege cannon.”

³⁴ Ağoston, *Guns*, pp. 171–178, for the mines and their output levels.

Pravište, and Belgrade), Asia Minor (Diyarbakir, Erzurum, Birecik, Mardin, and Van), Iraq (Baghdad and Basra), and Egypt (Cairo), mainly for local needs. The center of cannon casting, however, was the Imperial Cannon Foundry (Tophane-i Amire) in Istanbul, which Mehmed II established after his conquest of the city in 1453. This was one of the first arsenals in late medieval Europe to be built, operated, and financed by a central government, in a time when European monarchs obtained their cannons from artisanal workshops. The Istanbul foundry cast hundreds of cannons annually and could easily ramp up production during major wars, a sign of adaptability. For instance, whereas in 1676 the foundry manufactured only forty-six pieces, between July 1684 and June 1685, at the beginning of the long war against the Holy League (1684–1699), it cast 785 cannons, mainly small field pieces.³⁵

Moreover, production statistics demonstrate that, contrary to claims about the gigantesque nature of Ottoman ordnance, the majority of Ottoman cannons cast in the Istanbul foundry were small- and

Table 5. Distribution of cannon cast in the Imperial Cannon Foundry, 1685–1772

Date	Total	Small no.	%	Medium no.	%	Large no.	%	Mortars no.	%
1685–1686	416	376	90.4	38	9.1	2.0	0.5	—	—
1691–1692	298	187	62.4	61	20.5	50	16.8	1	0.3
1693–1694	679	524	77.2	125	18.4	6	0.9	24	3.5
1695–1696	208	92	44.2	115	55.3	1	0.5	—	—
1696–1697	1322	1169	88.4	111	8.4	26	2	16	1.2
1704	167	164	98.2	—	—	3	1.8	—	—
1704–1706	130	25	19.2	105	80.8	—	0	—	—
1706–1707	177	91	51.4	53	29.9	26	14.7	7	4
1712–1713	103	28	27.2	58	63.3	2	1.9	15	14.5
1731–1732	83	—	—	79	95.2	4	4.8	—	—
1732	486	147	30.2	208	42.8	95	19.6	36	7.4
1748	22	20	90.9	2	9.1	—	0	—	—
1769–1770	350	290	82.9	60	17.1	—	0	—	—
1771–1772	188	140	74.5	20	10.6	—	0	28	14.9

Source: Ágoston, *Guns*, p. 186.

Note: Figures for 1685–1686 and 1732 represent inventory; all other data are production output figures.

³⁵ Ibid., pp. 183–184, for output statistics.

medium-caliber pieces. I consider guns that fired projectiles less than 1.5 *okka* (1.8 kilograms) small-caliber pieces, and those that used round shots weighing between 1.5 and 11 *okka* (13.5 kilograms) medium-caliber cannons. The 1.5-*okka* Ottoman pieces were smaller than most European 6-pounder *sakers* and somewhat bigger than the 3-pounder falcons. Yet the great majority of small Ottoman pieces, such as *şakaloğ* and *prangı* guns, fired projectiles of merely 0.1 and 0.33 pounds, respectively, and thus were considerably smaller than the 1-pounder European falconets. By the same token, the 11-*okka* Ottoman guns were similar to the Spanish 30-pounders (*culebrina*) and the Habsburg 24-pounders (Half *Karthaun*). However, most medium-caliber Ottoman cannons, such as small and medium *darbzens*, fired projectiles that weighed between 0.33 and 2 pounds.

While large cannons could be found in the empire's fortresses, the distribution of artillery pieces in selected Ottoman castles, based on extant inventories from the era of Sultan Süleyman I, demonstrates a wide variety of ordnance and indicates that Ottoman fortress ordnance, too, was dominated by small- and medium-caliber cannons.

As Table 6 shows, the most popular weapons in castles were small *şakaloğ* and *prangı* guns. Made of bronze and iron, *prangı*s used shots of 150 grams (0.33 pounds) in weight, whereas *şakaloğ* guns fired projectiles of about 60 grams (0.13 pounds), although the smallest Ottoman *şakaloğ* pieces used projectiles as small as 31 grams (0.068 pounds) and 37 grams (0.081 pounds) in weight.

Darbzens (also known as *zarbzzen*, *darbuzan*, and *zarbuzan*) were popular both in castles and as field pieces. The length and weight of these cannons varied from 88 to 352 centimeters and from 54 to 540 kilograms, respectively. The smallest ones weighed 54 kilograms and fired shots merely 150 grams in weight. Medium-size *darbzens* fired lead and iron shots of 307, 461, 614, and 921 grams (0.68, 1, 1.35, and 2 pounds) and were small field pieces, similar to 1- and 2-pounder European falconets. Larger *darbzens* used shots of 1.2 kilograms (2.6 pounds) and 2.5 kilograms (5.5 pounds), and would be similar to European *sakers* and falcons.

Bacaloşkas were the most common siege guns, which used cannon balls made of iron, copper, and stone. The smallest ones fired shots of 1, 5, 7, and 14 kilograms (2.2, 11, 15.4, and 30.8 pounds) and would roughly correspond to European *sakers*, falcons, half culverins, 30-pounder culverins, and cannons. Bigger *bacaloşkas* used cannon balls of 17, 20, 22, 25, 27, and 28 kilograms (37.4, 44, 48.4, 55, 59.4, and 61.6 pounds) in weight and would correspond to 40-, 50- and 60-pounder European cannon.

Table 6. Number of cannons in selected Ottoman castles, 1520–1566

Date	castle	şakaloz (S)	prangi (S)	darbzen (S/M)	bacaloşka (L)	şayka (L)	top (G)	mortar (L)	other	total
1520–1566	Rodos/Rhodes	263	26	100	42	12	241	3	—	687
1520–1566	Anavarin/Navarino		55	18			56			129
1520–1566	Moton/Modon	4	8	53	15	12	239		10	341
1520–1566	Arhos/Argos	170	1	1			10		55	237
1520–1566	İskenderiye/Škodra	—	2	41	—	—	—	—	34	77
1520–1566	İstanköy/Kos	—	1	—	1	1	—	—	141	144
1523	Bodrum	20	2	17			25			64
1524	Kladovo		38	38						76
1530	Bodrum	8		205	13					226
1530	Antalya		44	7					41?	95
1536	Semendire/Smederevo	900	—	313	1	15	—	6	91	1,326
1536	Belgrad/Belgrade	230	150	75	2	6	—	2	30	513
1565	Budin/Buda	160	—	—	—	—	40	—	—	200
1565	Esztergom/Esztergom	60	—	—	—	—	22	—	—	82
1565	İstolni Belgrad/ Székesfehérvár	200	—	—	—	—	57	—	—	257

Sources: Salim Aydlüz, *XV. ve XVI. Yüzyılda Tophâne-i Âmiriye ve Top Döküm Teknolojisi* (Ankara: Türk Tarih Kurumu, 2006), pp. 455–457; Klára Hegyi, *A török hódoltság várai és várakozásága*. 3 vols. (Budapest: História, 2007), 1:126–127.
 Note: S = small, M = medium, L = large, G = general term for cannon.

The term *şayka* was used for large siege cannons as well as for smaller pieces used on riverboats. Given their small numbers in the above fortresses, it is assumed that these were large siege cannons, which used balls of 25, 27, and 30 kilograms (55, 59.4, and 66 pounds; medium *şayka*) and 34, 44, 52, 54, 55, 61, and 68 kilograms (74.8, 96.8, 114.4, 118.8, 121, 134.2, and 149.6 pounds; large *şayka*), usually made of stone. These latter pieces were very large siege cannons by west European standards, but similar large pieces could be found in Venice, Spain, and Habsburg Austria, especially in castles.³⁶

Narrative sources demonstrate that the majority of guns that the Ottomans deployed in their campaigns in the sixteenth and seventeenth centuries were smaller field pieces, called *darbzen*. Ottoman chroniclers differentiated between *darbzens* and cannons proper (*top*). One chronicler, writing about the battle of Mohács (1526), referred to *darbzens* as “[battle]line-breaker” (*saff-şiken*) and “neck-destroyer” (*merad-efgen*), and called cannons “castle-destroyer” (*kale-ken*).³⁷ The Mamluk chronicler Ibn Zunbul noted that Ottoman *darbzens* employed in Sultan Selim’s Syrian and Egyptian campaign of 1516–1517 fired projectiles large enough to fill a palm of a man’s hand, and that their carriages had four horses.³⁸ Other sources indicate that *darbzens* needed three artillery gunners to operate, while their carriage required two carriage drivers.³⁹

While some contemporary European observers praised the quality of Ottoman gun barrels, others had less positive view, and Europeanists usually favor the latter opinion, citing, for instance, that the Venetians melted down and recast the captured Ottoman cannons after Lepanto (1571), because they found the metal “of such poor quality.”⁴⁰ However, other explanations are also possible: The great variety of the Ottoman pieces, not all of which were compatible with the Venetian pieces in terms of caliber, would have made supplying shots for these captured cannon a nightmare. This was a major concern for all belligerents, and at the siege of Candia in 1667–1669 the Ottomans, too, cast new can-

³⁶ Ibid., pp. 74–87.

³⁷ Celâlzade, *Tabakât ül-Memâlik*, fol. 139a. It is possible that Celalzade meant *merd-efgen*, meaning “over-thrower of men, mighty in battle, powerful.” See James W. Redhouse, *A Turkish and English Lexicon* (Constantinople: A. H. Boyajian, 1890; repr. Istanbul: Çağrı Yayınları, 1978), p. 159.

³⁸ V. J. Parry “Warfare” in P. M. Holt, Ann K. S. Lambton, and Bernard Lewis, eds., *The Cambridge History of Islam, Volume 2B: Islamic Society and Civilization* (Cambridge: Cambridge University Press, 1970), p. 841.

³⁹ Uzunçarşılı, *Kapukulu Ocakları*, 2:50.

⁴⁰ Parker, *The Military Revolution*, p. 128.

nons in situ with calibers that enabled them to reuse the cannon balls that the Venetians fired at them from the fortress. Chemical analysis of extant Ottoman cannon barrels and production data suggest that Ottoman founders cast bronze cannons whose alloy contained 8.6–11.3 percent tin and 89.5–91.4 percent copper, an alloy very similar to that suggested by the famous Italian metallurgist Vanoccio Biringuccio (1480–1539) in his posthumously published *De la pirotechnia* (1540) and used by European founders in the sixteenth century.⁴¹

Janissary Guns

Contemporary observers and later historians noted that janissary muskets were much heavier and thus less practical than European guns. However, we should remember that the janissaries were using two types of guns: lighter and shorter muskets used for volleys in battles, and heavier and longer siege guns. The guns used in the Iraq campaign in 1553, for instance, fired lead projectiles of 15 grams (5 *dirhem*) and were 88 centimeters (4 *karış*) and 110 centimeters (5 *karış*) long. The 2,498 guns that were manufactured in the imperial workshops and sent to the armory in 1555 were registered as being 88 centimeters long and firing projectiles of 12 grams (4 *dirhem*).⁴² Such lighter guns remained in commission in the latter part of the sixteenth century, too, for archival sources mention janissary guns firing lead projectiles of 12 and 15 grams, which would correspond to calibers of 13 and 14 millimeters, respectively. Extant janissary guns in Turkish museums are 115–140 centimeters long, weigh 3–4.5 kilograms, and have bore diameters of 11, 13, 14, or 16 millimeters. These janissary guns are similar to the “typical” European matchlocks of the sixteenth century, which were about 120–150 centimeters long, weighed 2.5–4.5 kilograms, and had calibers of 14–18 millimeters. In siege warfare, however, the janissaries used their longer (130–160 centimeters) and heavier trench guns (*metris tüfeği*), with bore diameters of 20–29 millimeters (and occasionally of 35 or 45 millimeters).⁴³

Most janissary guns were matchlocks (*fitilli tüfek*) or had *miquelet* locks. The Ottomans are credited with perfecting the serpentine mechanism, but they also imported lock mechanisms from Europe in

⁴¹ Ágoston, *Guns*, p. 189.

⁴² Emecen, *Savaş*, p. 41, although it is not clear if the length refers to that of the barrel or the weapon.

⁴³ Ágoston, *Guns*, pp. 89–90.

the thousands and mounted those on barrels manufactured locally. From the late sixteenth century onward, Ottoman troops also started to use flintlock muskets (*çakmaklı tüfek*), but matchlocks remained the favored weapon. However, one should also remember that with the proliferation of firearms in the empire in the sixteenth and seventeenth centuries (due to illicit manufacturing and trade), the weapons used by temporarily hired musket-bearing infantry mercenaries (*sekban*, *tüfenk-endaz*, etc.) varied greatly and reflected regional manufacturing traditions, different styles, and varying quality from the Balkans to the Maghreb.⁴⁴

European observers and commanders of the Habsburg armies fighting the Ottomans in Hungary considered Ottoman musket barrels to be made of good-quality metal and maintained that their range and force were superior to those made in Europe. Historians of technology ascribed the strength and reliability of Ottoman musket barrels to the techniques by which flat sheets of steel were coiled into a spiral. Such Damascus-twist barrels manufactured in the Ottoman Empire were highly sought after in Europe and were mounted and remounted on European firearms from the sixteenth century on.⁴⁵ Ottoman muskets were also held in high esteem in Safavid Persia, Mughal India, and Ming China, where a treatise in the late 1590s considered Ottoman handguns better than Portuguese muskets. Ottoman muskets, which reached China through Central Asia, weighed 4.18–4.78 kilograms (and occasionally 3.58 kilograms) and were 187–218 centimeters in length. The barrel itself was only 140–143 centimeters long and weighed 2.39–2.98 kilograms. The bigger guns fired bullets of about 18 grams, while the smaller ones used projectiles of 12 grams. The touch-hole was farther from the rear sight, and thus when the musketeer fired his weapon the smoke did not interfere with aiming.⁴⁶

There is an interesting feature of these Ottoman (Rumi) guns: In the butt of the weapon there was a steel knife, which could be used if

⁴⁴ Elgood, *Firearms*; Elgood, *The Arms of Greece and Her Balkan Neighbors in the Ottoman Period* (London: Thames and Hudson, 2009,) for locally manufactured firearms.

⁴⁵ Elgood, *Firearms*, p. 38; Elgood, *The Arms of Greece*, pp. 78, 80–81.

⁴⁶ Kazuaki Sawai, "Japon Teknolojisine Karşı XVI. Yüzyıl Doğu Asyada Osmanlı Tüfeğinin Yeri," in Feridun M Emecen, ed., *Eskiçağ'dan Modern Çağ'a Ordular: Oluşum, Teşkilât ve İşlev* (Istanbul: Kitabevi, 2008), pp. 341–354. See also Giray Fidan, *Kanuni Devrinde Çin'de Osmanlı Tüfegi ve Osmanlılar* (Istanbul: Yeditepe, 2011). The writer of the treatise, Chao Shizhen, based his observation on the testimony and muskets of a Central Asian military expert, who had come to Ming China in the 1550s. See also Chase, *Firearms*, p. 2, and Lorge, *The Asian Military Revolution*, p. 77, for the praise of Ottoman muskets in a 1644 Chinese treatise.

the enemy attacked the gunner after he fired his gun and thus was vulnerable. While the Ottomans were late in introducing the bayonet en masse,⁴⁷ the above information indicates that the vulnerability of the gunner after he fired his weapon, mainly to swift cavalry charges, was a concern among the Ottomans, and that they experimented with possible countermeasures, including combination weapons similar to the one described in the Chinese treatise.

Gunpowder

The Ottomans manufactured gunpowder in the main gunpowder works in Istanbul, as well as in the empire's provincial centers, including Cairo, Baghdad, Aleppo, and Yemen in the Arab provinces; Buda, Esztergom, Pécs, Temesvár, Belgrade, Salonica, and Gallipoli in the European provinces; and Izmir, Bor, Erzurum, Diyarbakır, and Van in Asia Minor. Provincial powder works usually were able to meet local demands and also helped to ease the logistical burden and costs associated with transporting hundreds of tons of powder to the theaters of war during major campaigns. Moreover, the decentralized Ottoman system of powder production was flexible enough to respond to the exigencies of wars. At time of increased demand the Ottomans reactivated previously disused powder mills or set up new ones closer to the theaters of war. The establishment of the powder works in Eğriboz (Negroponte), Hanya (Chania), and Salonica during the Cretan wars (1645–1669) are examples of Ottoman adaptability, as is the ability of the Salonica powder works to double its production in 1716–1718, in a time of renewed wars against the Habsburgs in Hungary and the Venetians in the Morea. All together, Ottoman powder works met the demands of the army, the navy, and garrisons well into the eighteenth century, producing an estimated 650–1,000 metric tons annually from the late sixteenth century through the late seventeenth. However, in the 1770s diminishing production forced Istanbul to import substantial quantities of powder from Europe. At the end of the eighteenth century the new Azadlı gunpowder works in Istanbul, modernized with French assistance, were again able to manufacture sufficient quantities of gunpowder—and of a much better quality.⁴⁸

⁴⁷ The Habsburgs used bayonets against the Ottomans at the siege of Buda in 1686. Later Baron de Toth tried in vain to introduce the weapon in the Ottoman armies in the 1770s. The Ottomans used bayonets en masse only from early nineteenth century on.

⁴⁸ Ágoston, *Guns*, pp. 128–163.

Quality, Quantity, and Logistics

All this said, one has to be cautious not to overstate the importance of weapons technology. In an age when standardization of calibers and quality was only attempted but never achieved, and when there were no major technological breakthroughs in weapons design and manufacturing, the quality of weapons remained of secondary importance relative to that of their quantity. Firepower and military superiority were achieved through the sheer numbers of weapons and troops, and not so much by their quality. In battles and sieges the party that outnumbered its opponent in terms of deployed weaponry and troops had a good chance of winning the engagement, provided that all other factors were equal.

In this regard, the Ottomans were superior to their opponents until about the end of the seventeenth century. The availability of local cannon foundries, powder works, and major weapons depots in the Balkans and Hungary, eastern Anatolia, and Iraq greatly facilitated the deployment of military hardware against both the Austrian Habsburgs and the Safavids. The Ottomans were also aided by the availability of water transport. Heavy artillery and gunpowder was shipped from Istanbul via the Black Sea to Varna, whence it was loaded on carts, transported to Belgrade, and transferred onto hundreds of ships of the Ottoman Danube flotilla, which then transported the weapons and powder to the Hungarian theater of war. In their campaigns against the Safavids, military hardware traveled to Trabzon on the Black Sea, where it was loaded onto camels and other draft animals, and transported to the theater of war. When possible, the Tigris and Euphrates rivers and the Ottoman river flotillas on these waterways—including hundreds of ships well armed with smaller guns and well manned with thousands of troops—were also mobilized for transport and amphibious warfare. Due to their production and transportation capabilities, the Ottomans managed to accumulate large quantities of weapons and ammunition in their fortresses—indeed, often more than was needed or could be used.⁴⁹ It was not until the very end of the seventeenth century that

⁴⁹ Before the unsuccessful Habsburg siege of Buda in 1684, the Ottomans amassed 540 metric tons of powder in the fortress, and by February 1686 had replenished the diminished stocks with some 400 metric tons of new shipment. See Ágoston, *Guns*, p. 154. After the Habsburg reconquest of Buda in 1686, the Habsburgs found 460 cannons in the fortress, of which 213 pieces lay unused in the depots. See Endre Veress, "Gróf Marsigli Alajos olasz hadi mérnök jelentései és térképei Budavár 1684–1686-i ostromáról, visszafoglalásáról és helyrajzáról," *Budapest Régéségei* IX (1906).

the Austrian Habsburgs and their allies were capable of matching their Ottoman enemies in terms of numbers of deployed troops and weapons.

War-Winning Weapons?

Military historians usually cite the Ottoman conquest of Byzantine Constantinople (1453) and Ottoman battlefield victories at Çaldıran (1514) against the Safavids, Marj Dabiq (1516) and Raydiniyya (1517) against the Mamluks, and Mohács (1526) against the Hungarians, as examples for the decisiveness of firearms. These Ottoman victories fundamentally altered the geopolitics in Europe and southwest Asia. They signaled the end of the thousand-year-old Byzantine Empire (1453), of the Mamluk sultanate in Syria and Egypt (1516 and 1517), and of the medieval Hungarian kingdom (1526). They also extended Ottoman rule over most of eastern Asia Minor (1514), Greater Syria, and Egypt. The battles of Mohács and Çaldıran inaugurated a long struggle between the Ottomans and their Habsburg and Safavid rivals, which determined the history of both Europe and western Asia for the next two hundred years. But were these Ottoman victories due largely to firearms? The reexamination of the above engagements suggests a more complex picture.⁵⁰

While cutting-edge military technology, which enabled the Ottomans to deploy the largest bombards known of the day, played an important role in breaching Constantinople's walls in 1453, it was but one element in the Ottoman success. Other important factors included careful planning, resourceful leadership (portaging some seventy smaller ships overland from the Bosphorus into the Golden Horn and the surprise attack on the weakest section of the defense), prowess in siege warfare (mining, "triangle" firing technique, and the "invention" and use of mortars), numerical superiority (seventy thousand Ottomans versus ten thousand defenders), better logistics (abundant supplies in weaponry and food), and the lack of Byzantine relief forces. Firepower, even in combination with numerical and logistical superiority, was still insufficient in the mid fifteenth century if a relatively strong relief army with superior leadership arrived in time, as Mehmed II's failed siege of Belgrade in 1456 demonstrated.

At Çaldıran in 1514, the fifty thousand to sixty thousand Otto-

⁵⁰ This section draws on my "War Winning Weapons? On the Decisiveness of Ottoman Firearms from the Siege of Constantinople (1453) to the Battle of Mohács (1526)," in *Journal of Turkish Studies* vol. 39 (2013): 129–143.

mans might have outnumbered the Safavids two to one. While Safavid sources and earlier historiography claimed that Sultan Selim I employed twelve thousand to twenty thousand janissary arquebusiers, it is more likely that only about one third of the 10,065 janissaries, who were listed in the pay sheets, carried firearms. Similarly, the 293 artillery gunners and 334 gun carriage drivers present in the battle could have served about 100–150 field pieces, and not 300–500 cannons, as suggested in earlier works. However, even this more modest firepower proved crucial against the Safavids, who had no arquebusiers and cannons in the battle. Moreover, the Ottoman wagon laager, described by Safavid sources as an impenetrable strong fortress or wall, effectively protected the janissaries against Safavid cavalry charges. In addition to Ottoman numerical and firepower superiority, Shah Ismail's tactical errors (his enabling the Ottomans to set up their wagon laager and his frontal attack against the fortified Ottoman camp) were also important factors that led to Safavid disaster.

Unlike the Safavids, the Mamluks deployed dozens of field guns and had trained arquebusiers at Marj Dabiq, but could not match Ottoman firepower and numbers of troops. Like the Safavids, the Mamluks too were unable to penetrate the Ottoman wagon laager. But there were other factors that decided the battle in the Ottomans' favor. Of these, the most important were the Mamluk Sultan al-Ghawri's death halfway through the battle, the looting of the Mamluk soldiers and the disorder it caused, and the treachery of one of the Mamluk generals who changed sides with his troops. At Raydaniyya, the Mamluks and Ottomans were more comparable in terms of troop numbers and firepower. The Mamluk sultan Tumanbay also learned the lessons of Marj Dabiq and decided to use entrenched positions, firearms, and wagon laager. However, the Ottomans learned about Tumanbay's plans through their spies and captured Mamluk soldiers and altered their tactics accordingly. Before they reached the range of fire of the Mamluk cannons, the Ottomans turned to the side and outflanked the enemy's gun emplacement.

Contrary to received wisdom, Ottoman victory at Mohács was not due to the Ottoman cannons, which supposedly slaughtered the obsolete Hungarian heavy cavalry. Recently discovered sources show a mixed Hungarian army consisting of sixteen thousand horsemen and ten thousand footmen, armed with handguns, pikes, and large shields, and supported by eighty-five cannons, six hundred smaller hook guns, and five thousand wagons that could be used as *Wagenburg*. However, having about sixty thousand professional troops—including some nine thousand janissaries and forty-five thousand provincial timariot cav-

alry—the Ottomans greatly outnumbered the Hungarians. While the Ottomans had twice as many field guns as the Hungarians, infantry firepower was more comparable, with four thousand handguns used by the janissaries. In the end, it was the much larger Ottoman cavalry and reserves, and the discipline and volleys of the janissaries protected by chained cannons, that decided the battle. It seems that the Ottoman cannons played a minor role, for their shots landed beyond the attacking Hungarians, due to uneven terrain and the resulting elevation of the gun barrels.

In short, firearms were useful in combination with the Ottoman *tabur* and cavalry on the wings, both of which provided protection to the infantry janissaries. The Safavid, Mamluk, and Hungarian cavalry were unable to penetrate the *tabur*, and were decimated by janissary volleys. Except for Raydaniyya, the Ottomans greatly outnumbered their enemies in terms of deployed troops and firearms. This, in turn, reflected the strength of the Ottoman administrative-fiscal and logistical systems, which maintained and supplied one of the largest professional armies in Europe and southwestern Asia in the fifteenth and early sixteenth centuries. The janissary core comprised less than 15 percent of the mobilized Ottoman army, yet, at critical moments, their discipline and endurance proved crucial.

FIREARMS AND THE GROWTH OF OTTOMAN MILITARY MANPOWER

A spectacular increase in military manpower in most European armies is one of the hallmarks of the Military Revolution. It has been explained alternatively by the rise of the “new monarchies” and their bureaucracies, by inter-state rivalry, and by the emergence of the “artillery fortress.”⁵¹ The Ottoman experience supports Parker’s suggestion in several respects, but at the same time it demonstrates that Ottoman military expansion was a more complicated matter, explainable by both military and nonmilitary factors.

Until recently most Ottomanists accepted Halil İnalcık’s suggestion that the increase in the janissary corps and the hiring of peasant militias (*sekban*, *levend*) armed with firearms was attributable to the Ottomans’ need to match Habsburg firepower in the Long War

⁵¹ Geoffrey Parker, “In Defense of *The Military Revolution*,” in Rogers, ed., *The Military Revolution Debate*, p. 344.

of 1593–1606, fought in Hungary.⁵² One reason for this thesis was the scarcity of data on the number of janissaries. Sources available in the 1970s and 1980s showed that the number of janissaries rose sharply from 12,798 in 1567 to 37,627 in 1609, which was then explained by the Long War. At the same time, Hungarian historians demonstrated that the imperial forces fighting against the Ottomans in the war of 1593–1606 were in the forefront of the Military Revolution in terms of the high proportion of gun-carrying infantry relative to pikemen.⁵³ This corroborated the narrative sources' view, cited by İnalcık, that the Habsburgs attained firepower and tactical superiority over the Ottomans, who then responded to the challenge by increasing the number of janissary gunners and by recruiting gun-carrying peasant militias in order to counter Habsburg firepower.

In light of new research, however, both the timing of the growth of the janissary corps and its underlying reasons now seem more complicated. I propose the following. First, this growth was part of a more general military expansion and transformation that affected the entire Ottoman military. Second, the beginnings of military expansion can be located in Sultan Süleyman's reign, and the trend was further accelerated from the late 1570s on—that is, the process predated the Long War in Hungary, although that war (along with the Safavid wars and the Celali revolts) did play an important role in it. And third, Ottoman military expansion and transformation must be explained by a more complex socioeconomic approach, with an emphasis on both increased demand for and supply of military manpower, rather than the challenge of the European Military Revolution alone, which is indeed a reductionist reasoning bordering on technological determinism.

The Beginning of Army Growth

Data summarized in Table 7 show that the first spike in the number of the standing *kapukulu* troops occurred under Süleyman's reign. While between 1520 and 1530 the household salaried troops averaged less than 16,000 men (19,000 men with janissary novices or *acemi oğlan*), by 1567 their number rose to 26,500 men (34,000 men with janissary novices). The most spectacular expansion occurred not among the janissaries but in the palace cavalry, whose number more than doubled

⁵² Halil İnalcık, "Military and Fiscal Transformation in the Ottoman Empire, 1600–1700," *Archivum Ottomanicum* 6 (1980): 283–337.

⁵³ Kelenik, "The Military Revolution in Hungary."

Table 7. Paper strength of the salaried troops, 1484–1711

Date	Janissary	Artillery	Palace Cavalry	Total
1484	7,841	—	4,306	12,147
1512	8,164	1,078	3,896	13,138
1514	10,065	1,182	6,202	17,449
1520/Selim	7,780	1,217	5,667	14,664
1520/Süleyman	8,361	1,226	6,380	15,967
1521	8,349	1,608	6,192	16,149
1522–1523	7,010	1,715	6,022	14,747
1523	7,164	1,659	6,118	14,941
1523–1524	8,641	1,705	5,882	16,228
1524–1525	9,390	1,676	5,997	17,063
1527–1528	7,886	2,162	5,088	15,136
1530	8,407	2,383	4,906	15,696
1547	12,131	—	—	—
1567–1568	12,798	2,671	11,044	26,513
1569	11,535	—	—	—
1574	13,599	2,124	5,957	21,680
1582	16,905	3,736	8,346	28,987
1592	23,323	—	—	—
1597	35,000	6,527	17,000	58,527
1609	37,627	7,966	20,896	66,489
1652–1653	55,151	7,246	20,479	82,876
1654	51,047	6,905	19,844	77,796
1661–1662	54,222	6,497	15,248	75,967
1666–1667	47,233	6,193	13,267	66,693
1669–1670	53,849	8,014	14,070	75,933
1687–1688	62,826	17,995	19,800	100,621
1691–1692	35,839	8,309	10,807	54,955
1694–1695	78,798	21,824	13,395	114,017
1696–1697	69,620	14,726	15,212	99,563
1699	67,729	15,470	13,447	96,646
1700	50,102	11,934	12,992	75,028
1701–1702	39,925	10,893	12,999	63,817
1702–1703	40,139	10,010	12,976	63,125
1704–1705	52,642	11,851	17,133	81,626
1709–1710	16,609	3,265	14,101	33,975
1710–1711	43,562	8,775	15,625	67,962

Sources: 1484–1568, 1582, and 1592: Ağoston, *Strateji*, pp. 177–179, 203. 1547: Ömer Lütfi Barkan, “H. 954–955 (1547–1548) Mali Yılına ait bir Osmanlı Bütçesi,” in Barkan, *Osmanlı Devletinin Sosyal ve Ekonomik Tarihi: Tetkikler-Makaleler*, ed. by Hüseyin Özdeğer, 2 vols. (İstanbul: İstanbul Üniversitesi İktisat Fakültesi, 2000), 2: 931. 1569: BOA, KK nr. 1767, p. 4, also cited in Nejat Göyünç, “Tarih Başlıklı Muhasebe Defterleri,” *Osmanlı Araştırmaları* 10 (1990): 27. 1574, 1597, and 1609: Murphey, *Ottoman Warfare*, p. 45. All other data are from Mehmet Genç and Erol Özvar, *Osmanlı Maliyesi Kurumlar ve Bütçeler*, 2 vols. (İstanbul: Osmanlı Bankası Arşiv ve Araştırma Merkezi, 2006), 1:237, with minor corrections.

Note: The artillery in 1597 is unknown; I used the figure for 1598 from Ağoston, *Guns*, p. 30.

between 1530 and 1567. Data regarding the janissaries and janissary novices demonstrate that the spike started before 1547: the number of janissaries rose from 8,407 in 1530 to 12,131 in 1547, while that of the novices rose from 3,640 to 5,840. The sharp increase in the number of janissary novices from a median 3,500 men in the 1520s to 7,745 men in 1567 and again to 9,396 men in 1582 suggests that the Istanbul government filled in the vacancies in the salaried corps principally with janissary novices, as opposed to the post-1580 period, when sons of janissaries and “outsiders” (*ecnebi*), that is, commoners from the tax-paying subjects, were the main source of recruitment.

The increased demand for military manpower under Süleyman might be explained in part by the need to garrison newly conquered frontier provinces—Baghdad (1534), Erzurum (1535), Buda (1541), Basra (1546), and Temeşvar (1552)—and to besiege artillery fortifications. In general, military manpower in newly conquered castles was largely met by local soldiers (*neferat-i yerliyan*), often redeployed from the empire’s neighboring interior provinces and paid from local provincial treasuries. However, central *kapukulu* troops, especially janissaries, were also sent to the key fortresses in increasing numbers. By 1547 there were 4,648 janissaries on garrison duty, who constituted 38 percent of the 12,131 janissaries paid from the imperial treasury.⁵⁴ Amphibious operations and longer sieges of modernized *trace italienne* fortifications in the Mediterranean islands of Malta (1565) and Cyprus (1570–1571) also added to the demand on military manpower. The casualty rates of these sieges and of the battle of Lepanto in 1571 were significantly higher than those suffered in similar amphibious operations in the early sixteenth century.

Ottoman military expansion was also triggered by domestic developments unrelated to foreign wars. During the dynastic struggles of the Ottoman princes under Bayezid II and Süleyman I, the prince, who was unable to secure the support of the reigning sultan and the central standing troops, recruited thousands of landless peasants, townsfolk, nomads, and vagrant irregular soldiers (*levend*). Referred to as “daily wagers” (*yevimlû*) after their salary, these militiamen were ordinary taxpaying subjects (*reaya*). They volunteered for military service in order to eventually join the ranks of the sultan’s salaried troops, and thereby enter the privileged, tax-exempt *askeri* (military) class. The process reached its peak under Süleyman, when Prince Bayezid, whom Sultan Süleyman declared a rebel, reportedly recruited ten thousand

⁵⁴ Barkan, “H. 954–955 (1547–1548) Mali Yılına ait bir Osmanlı Bütçesi,” p. 933.

yevimli soldiers, pledging to enlist them into the janissary corps. With the support of the sultan, Prince Selim also hired thousands of ordinary taxpayers with daily salaries. While about eight thousand soldiers perished in the battle of Konya between the competing armies, and the government persecuted Bayezid's men in the purges following the rebel prince's execution (1562), many of his levend soldiers escaped. Forming bands of fifty to sixty men, they roamed the countryside as bandits.⁵⁵ Since scores of timariot cavalymen also sided with the rebel prince, the government could not trust them to perform their traditional function of maintaining law and order in the Anatolian countryside. To reestablish public order, Istanbul sent janissaries to towns and villages in increasing numbers. Settled in the countryside as "guardians" (*yasakçı*), these janissaries supplemented their salaries by collecting fees for transgression—a function and privilege traditionally belonging to the timariot provincial cavalry—and by establishing businesses in towns and acquiring farmlands in villages. As public order deteriorated further during the Celali rebellions at the end of the sixteenth century, more and more Anatolian cities and towns requested janissaries from the government. The proliferation of janissaries and other *kapukulu* troops in the provinces created opportunities for the ordinary taxpayers and levends to disguise themselves as janissaries and janissary novices. How many of these pseudo-janissaries managed to add their names to the official pay lists is unknown, but the practice was the first sign of the massive "civilianization" of the janissary corps, and it also further worsened the already existing lawlessness and disorder in the countryside.⁵⁶

The Expansion of the Salaried Troops from the Late 1570s

The next, and more spectacular, phase of expansion of the salaried troops occurred from the late 1570s onward. The number rose from less than twenty-two thousand in 1574 to twenty-nine thousand in 1582, and to more than fifty-eight thousand in 1597. The number of janissaries doubled between 1569 and 1592 (from 11,535 men to 23,359

⁵⁵ Şerafettin Turan, *Kanuni Süleyman Dönemi Taht Kavgaları* (Ankara: Bilgi Yayınevi, 1997), pp. 81–84, 93–95, 103–104, 145–149. See also Mustafa Akdağ, *Türk Halkının Dirlik ve Düzenlik Kavgası: "Celali İsyanları"* (İstanbul: Cem Yayınevi, 1995), pp. 108–109.

⁵⁶ Turan, *Taht Kavgaları*, pp. 150–152; Mustafa Akdağ, "Yeniçeri Ocak Nizamının Bozuluşu," *Ankara Üniversitesi Dil-Tarih Coğrafya Fakültesi Dergisi* 5, no. 3 (1947): 291–309; Inalcık, *Military and Fiscal Transformation*, p. 286.

men)—that is, immediately before the Hungarian war of 1593–1606. It reached about thirty-five thousand by 1597, and stabilized at about thirty-seven thousand in 1609, after the war. These figures reflect the general demand for, and availability of, military manpower during Istanbul's Thirty Years' War (1578–1611), when Ottoman troops fought, often simultaneously, against the Safavids in the east (1578–1590, 1603–1611), the Habsburgs in the north (1593–1606), and the Celali rebels in eastern Anatolia and Syria (ca. 1595–1610). Other spikes in the numbers of the standing salaried army coincided with the wars against Venice over Crete (1645–1669) and against the Holy League (1684–1699).

Besieging Hungarian castles at the end of the sixteenth century was a more difficult business than under Süleyman. Beginning in the 1570s, the Habsburgs had modernized the country's key castles, such as Szigetvár, Kanizsa, Győr, Komárom, Újvár (modern Nové Zámky in Slovakia), Eger, and Temesvár (modern Timișoara in Romania), with the help of Italian military engineers. In the case of the strategically most important castles, such as Győr, Komárom, and Újvár, not just the castle but also the entire town was rebuilt and transformed into a fortified town (*Festungstadt*).⁵⁷ To garrison these fortresses, the Habsburgs recruited experienced German, Italian, and Spanish mercenaries by the thousands, and by 1576 stationed some twenty-three thousand troops in about 120 castles in Hungary. While prior to the Long War of 1593–1606 the modernization of the Hungarian castles was only partially completed due to lack of financial resources, these modern fortresses with garrisons numbering several thousands of German, Italian, and Spanish mercenaries required substantially more Ottoman troops, firepower, and time to invest and conquer.⁵⁸

Similarly, after their conquest, the Ottomans had to leave behind large garrisons in these fortresses, including thousands of *kapukulu* janissaries. Whereas in 1547 the Ottomans stationed 2,282 janissaries in their key fortresses in Hungary, by 1596–1597 their number rose to 7,581, which alone amounted to 22 percent of the total number of

⁵⁷ Gábor Ágoston, "Habsburgs and Ottomans: Defense, Military Change and Shifts in Power," *Turkish Studies Association Bulletin* 22, no. 1 (1998): 126–141; György Domonkos, *Ottavio Baldigara: Egy itáliai várfundáló mester Magyarországon* (Budapest: Balassi Kiadó, 2000).

⁵⁸ Géza Pálffy, "The Origins and Development of the Border Defence System against the Ottoman Empire in Hungary," in Dávid and Fodor, eds., *Ottomans, Hungarians and Habsburgs*, 49.

janissaries in 1597.⁵⁹ Although these were war years and two of the castles were recently conquered and thus needed larger garrisons, the figures reflected general trends in the empire. While the ratio of janissaries on garrison duty to their total number changed little from 1547, in absolute numbers the increase was noticeable. In contrast to 1547, when fewer than five thousand janissaries served in the empire's fortresses, in the seventeenth century between fourteen thousand and thirty-six thousand janissaries were on garrison duty.⁶⁰

Local circumstances and the exigencies of warfare also influenced the size of the janissary contingents on garrison duty. For instance, the number of janissaries serving in the empire's garrisons increased from 14,379 men in the spring of 1670 to 21,728 in the summer of the same year.⁶¹ Most of the increase is attributable to the 5,925 janissaries deployed in the recently conquered Kandiye (Candia).⁶² Typically, as the Ottomans consolidated their rule and governors of newly established provinces managed to man their fortresses with local troops, Istanbul was able to considerably reduce the size of janissary garrisons.⁶³

From the late sixteenth century on, the Ottomans faced large imperial field armies in Hungary that cannot be compared to the medieval Hungarian troops. Whereas the army that Süleyman defeated at Mohács numbered about twenty-six thousand men, in 1595 the Habsburg emperor deployed some eighty thousand men in his two expeditionary armies, which operated in Hungary. According to one record, the main army that recaptured Esztergom from the Ottomans in 1595 numbered 57,945 men. While actually deployed troops were smaller than these paper numbers, the imperial field armies fighting the Ottomans in Hungary still constituted a formidable military force.⁶⁴

⁵⁹ There served 2,676 janissaries in Buda, 370 in Yanık, 1,414 in Temeşvar, and 3,121 in the recently conquered Eğri. See Caroline Finkel, *The Administration of Warfare: The Ottoman Military Campaigns in Hungary, 1593–1606* (Wien: VWGÖ, 1988), p. 77. The 22 percent represented a slight increase from 19 percent in 1547.

⁶⁰ Based on the account books of the imperial treasury, published by Ö. L. Barkan, M. Genç, and E. Özvar. The majority of the garrison forces remained local troops (*neferat-i yerliyan*).

⁶¹ Barkan, 2:750, 800.

⁶² BOA, MAD 1951, p. 144.

⁶³ Gábor Ágoston, "Defending and Administering the Frontier: The Case of Ottoman Hungary," in Christine Woodhead, ed., *The Ottoman World* (Abingdon, Oxon, U.K.: Routledge, 2012), pp. 220–236, at p. 229, for examples.

⁶⁴ Zoltán Péter Bagi, *A császári-királyi mezsei hadsereg a tizenöt éves háborúban: hadszervezet, érdekérvényesítés, reformkísérletek* (Budapest: Históriaantik Könyvkiadó, 2011), pp. 47–49, 371–374.

More important, the musketeers and gunners (*Schützen*) usually outnumbered the pikemen (*Spiesser*) two to one, and as a result the imperial forces enjoyed firepower and tactical superiority over the Ottomans, a fact that contemporaries on both sides noted.⁶⁵

In general, the multiseason wars of the late sixteenth and seventeenth centuries resulted in much higher rates of casualty and desertion than the wars of Süleyman. Combined, these multifront, year-round wars created continuous demand for new recruits, both infantry and cavalry, that could not be met by traditional recruiting techniques and required new methods of mobilization, opening the doors for those tax-paying *reaya* who wanted to become *askeri*. This trend is reflected in the changes in the recruitments of janissaries and in the temporary recruitment of peasant militias. Whereas the number of janissary novices almost tripled between 1530 and 1582, there is no similar sharp increase in their number after 1582: It stayed at about nine thousand to ten thousand until the early seventeenth century, and even dropped to about 4,100 by 1661–1662. More important, the *acemi* corps, too, went through its own metamorphosis: Alongside janissary novices recruited through the waning child levy (*devşirme*), increasingly more novices were handpicked recruits in the personal service of the commander of the janissary corps (*ağa çırağı*) and sons of the salaried cavalry (*ferzend-i sipahi*).⁶⁶ A recent comparison of *devşirme* recruitment registers of the 1490s and 1603 demonstrated that the average age of recruited boys had risen from 13.5 to 16.6, indicating that in the early seventeenth century the government preferred older boys, who could immediately be turned into soldiers. This reflected the increased need for military manpower, but also the changed nature of warfare, for it took only a couple of months to train musketeers, whereas previously it took years to train a skilled janissary archer.⁶⁷

⁶⁵ Kelenik, "The Military Revolution in Hungary"; Halil İnalcık, "The Socio-Political Effects of the Diffusion of Fire-arms in the Middle East," in V. J. Parry and M. E. Yapp, eds., *War, Technology and Society in the Middle East* (London: Oxford University Press, 1975), pp. 195–217; Colin Imber, "İbrahim Peçevi on War: A Note on the European Military Revolution," in Colin Imber, Keiko Kiyotaki, and Rhoads Murphey, eds., *Frontiers of Ottoman Studies: State, Province, and the West*, 2 vols. (London: I. B. Tauris, 2005), 2:7–22.

⁶⁶ Rhoads Murphey, ed., *Aziz Efendi's Book of Sultan's Laws and Regulations: An Agenda for Reform by a Seventeenth-Century Ottoman Statesman* (Cambridge, Mass.: Harvard University Office of the University Publisher, 1985), p. 55; Gülay Yılmaz, "The Economic and Social Roles of Janissaries in a 17th Century Ottoman City: The Case of Istanbul," PhD diss., McGill University, Montreal, 2011, p. 79.

⁶⁷ Yılmaz, "The Economic and Social Roles of Janissaries," pp. 75–77.

The Metamorphosis of the Janissaries

We saw that the “civilianization” of the janissaries in greater numbers started under Süleyman, partly as a consequence of the succession struggle between Princes Bayezid and Selim. Under Murad III (1574–1595), the government tried in vain to recall the *yasakçı* janissaries from the countryside. The failure also meant that the timariot cavalymen lost not just their role of policing the countryside and maintaining public order, but also the transgression fees that they had collected from commoners found guilty of criminal acts. These sums now enriched the janissaries, who desperately needed the extra revenue, as the real value of their salaries had substantially declined, due to inflation and the repeated devaluation of the silver *akçe*. In fact, the government long realized the problem, and in addition to their regular salaries provided the janissaries with an annual clothing allowance, plus set up a special fund to subsidize the janissaries’ purchase of staple commodities such as bread and meat.⁶⁸ Such subsidies, along with revenues from transgression fees, artisanal activities, and trade, as well as the availability of credit from the corps fund, were important incentives for commoners aspiring to enter the corps.⁶⁹ Indeed, janissary life in the provinces offered plenty of opportunities for amassing and investing substantial sums, as can be seen from the examples of two janissaries (one officer and a rank-and-file), who respectively had loaned sixteen thousand and thirty thousand *akçe* to a Ragusan trading company operating in Ottoman Buda sometime before the company’s liquidation in 1591. Considering that these investments constituted sums that were several times (in the case of the rank-and-file janissary, thirteen to seventeen times) larger than their regular annual salary, we may assume that these janissaries had access to substantial extra revenues.⁷⁰ In the seventeenth century, a good portion of the janissaries became craftsmen, shop owners, merchants, and tax farmers, while ordinary tradesmen, merchants, and tax farmers also bought their way into the corps using opportunities created by the exigencies of wartime economies.⁷¹ Therefore, it is

⁶⁸ Murphey, *Ottoman Warfare*, p. 85.

⁶⁹ Baki Tezcan, *The Second Ottoman Empire: Political and Social Transformation in the Early Modern World* (Cambridge: Cambridge University Press, 2010), p. 25, for the importance of credit.

⁷⁰ Ágoston, “Defending and Administering the Frontier,” p. 235. See also Tezcan, *The Second Ottoman Empire*, pp. 184–190, for janissaries as financial entrepreneurs.

⁷¹ Virginia H. Aksan, “Whatever Happened to the Janissaries? Mobilization for the 1768–1774 Russo-Ottoman War,” in Aksan, *Ottomans and Europeans: Contacts and Conflicts*

hardly surprising that only a portion of the janissaries recorded on the pay sheets participated in campaigns: in 1597 about 26 percent, and in the second half of the seventeenth century between 25 and 33 percent of the total. By the early eighteenth century, in the Prut campaign against Peter the Great in 1711 and in the wars of 1736–1739 against Austria and Russia, the majority of mobilized janissaries had nothing in common with the once-elite corps: between 70 and 80 percent of them were fresh recruits, hired before and during each campaign from among the commoners.⁷²

In addition to the corps of the salaried army, state-financed militia-men (*miri levend*) accounted for an increasingly larger share of new recruits.⁷³ In the 1736–1739 wars, for instance, the thirteen thousand to sixteen thousand *miri levend* troops constituted between 10 and 15 percent of the deployed army. However, if one adds all the state-funded militiamen whom the government deployed in other fronts (Vidin, Bosnia, Bender), the number of these troops reaches more than forty thousand men in 1738, and twenty-eight thousand men in 1739.⁷⁴

The Decline of the Prebendal Cavalry and the Rise of the Governors' Household Armies

The military demands and sociopolitical changes that shaped the evolution of the janissaries also profoundly affected the prebendal *sipahi* cavalry. As with the janissaries, the changes started under the reign of Süleyman, when the timariot cavalry's involvement in the succession struggles led to the government's distrust of these forces. Not only

(Istanbul: Isis Press, 2004), pp. 223–238; Cemal Kafadar, “Janissaries and Other Riffraff of Ottoman Istanbul: Rebels without a Cause?” in Baki Tezcan and Karl K. Barbir, eds., *Identity and Identity Formation in the Ottoman World: A Volume of Essays in Honor of Norman Itzkowitz* (Madison: Center for Turkish Studies at the University of Wisconsin, 2007), pp. 113–134; Tezcan, *The Second Ottoman Empire*, pp. 175–190.

⁷² Finkel, *The Administration of Warfare*, p. 77. While 9,202 janissaries were registered in the spring of 1597 as being “on campaign,” chronicler evidence put the size of the janissary regiments that left the capital at fifteen thousand. Gábor Ágoston, “Empires and Warfare in East-Central Europe, 1550–1750: The Ottoman-Habsburg Rivalry and Military Transformation,” in Frank Tallett and D. J. B. Trim, eds., *European Warfare, 1350–1750* (Cambridge: Cambridge University Press, 2010), pp. 110–134, at pp. 128–129.

⁷³ On the levends the standard work remains Mustafa Cezar, *Osmanlı Tarihinde Levendler* (Istanbul: Çelikkilt Matbaası, 1965); see also Virginia Aksan, “Ottoman Military Recruitment Strategies in the late Eighteenth Century,” in Aksan, *Ottomans and Europeans*, pp. 191–207.

⁷⁴ BOA, Baş Muhasebe Kalemi Defterleri (DBŞM) no. 2286, pp. 2–3; DBŞM no. 2390, pp. 2–3.

did they gradually lose the privilege of maintaining public security (and the associated revenues) to the *yasakçı* janissaries, but many of their fiefs were also given to janissary companies, especially in frontier regions. Other prebends were turned into royal estates in order to pay the expanding standing army and to hire peasant mercenaries (*miri levend*). The policy also aimed at easing the burden on the treasury, which faced recurring deficits from the early 1590s onward.

Istanbul also realized the prebend holders' diminishing capabilities in maintaining proper military preparedness, and adjusted government policy accordingly. Small prebend holders were now less likely to be summoned for campaigns. Instead, the government ordered them to keep the peace in their respective districts, or assigned them temporarily to guard frontiers, whose more capable military forces had been ordered to join the imperial expeditionary armies elsewhere. This practice, like the other changes, started either under Süleyman or soon after his reign. Istanbul also adjusted the minimum income after which ordinary timariot *sipahis* and holders of medium-sized prebends (*zeamet*) were obliged to field an armed retainer (*cebelü*): In the case of the former, the threshold was raised from three thousand to six thousand *akçe*, in the latter from four thousand to five thousand *akçe*. In other words, holders of smaller prebends were now exempted from military service. Timar holders possessing prebends worth of 10,000 to 19,999 *akçe* annual revenue were all required to maintain three retainers. As a result of these adjustments, the contingents that the prebendal cavalry mobilized for campaigns declined significantly. The missing soldiers were now substituted by the private troops (*kapı halkı*) whom the commanders of the prebendal cavalry, the district and provincial governors (sing. *sancakbeyi* and *beylerbeyi*), fielded. Whereas in the 1520s the private armies of the *sancakbeyis* and *beylerbeyis* made up only 33 percent of the timariot troops, by the late seventeenth century their share had risen to 58 percent.⁷⁵

By the seventeenth century it was expected that provincial governors maintain large household armies, and such a capability had become the condition for their appointments. Many of them enjoyed the revenues of whole districts as *arpalık* (literally, fodder money) in order to maintain their households and armies even when temporar-

⁷⁵ Géza Dávid and Pál Fodor, "Changes in the Structure and Strength of the Timariot Army from the Early Sixteenth to the End of the Seventeenth Century," *Eurasian Studies Yearbook* 4, no. 2 (2005): 157–188.

ily out of office.⁷⁶ The manpower pool of these private armies was the same as that of the state-financed militiamen: landless peasants and vagabonds, created by the combination of socioeconomic and environmental changes since the latter part of the sixteenth century. If not employed by provincial governors or the central government, these individuals usually turned to banditry, leading to an increase in rural disorder and violence.⁷⁷ The number of such levends was already substantial by the mid-sixteenth century, when a rebel ("Prince Mustafa") in 1555 managed to gather some ten thousand levends and timariot cavalymen under his banner.⁷⁸

CONCLUSIONS

For too long historians have focused on the alleged superiority of European arms and tactics over the Ottomans—ostensibly beginning in the late sixteenth century—and on the resulting Ottoman military reforms, which, starting in the late eighteenth century, reshaped the sultan's armies along European lines. Recent research has called into question any major technological, tactical, or organizational advantage of European militaries over the Ottomans until the late seventeenth century. Due to their receptivity and adaptability, the Ottomans not only integrated firearm technology into their military structures with ease and swiftness; they also established domestic production facilities that were capable of meeting the needs of their armies, navies, fortresses, and river flotillas in terms of weapons, ammunition, and military hardware. With administrative, fiscal, and logistical capabilities to match their military might, the Ottomans had established military superiority over their immediate neighbors by the late fifteenth century, an advantage they maintained through a succession of rivals, until some time in the late seventeenth century.

With regard to the possible relationship between firearms and army growth, we have seen that Ottoman military expansion was only partly due to external military challenges and that domestic socioeconomic

⁷⁶ İ. Metin Kunt, *The Sultan's Servants: The Transformation of Ottoman Provincial Government, 1550–1650* (New York: Columbia University Press, 1983), pp. 87–93.

⁷⁷ Oktay Özel, "The Reign of Violence: The Celalis c. 1550–1700," in Christine Woodhead, ed., *The Ottoman World* (Abingdon, Oxon, U.K.: Routledge, 2012), pp. 184–202; Sam White, *The Climate of Rebellion in the Early Modern Ottoman Empire* (New York: Cambridge University Press, 2011).

⁷⁸ Akdağ, *Türk Halkının Dirlik ve Düzenlik Kavgası*, p. 71.

factors also played an important role in the transformation of the sultans' armed forces. More important, whereas in Western Europe the Military Revolution supposedly led to enhanced state centralization and resulted in the rise of military-fiscal states, the Ottoman experience was military devolution. In contrast to Europe, the Ottoman government directed the changes only to an extent. Realizing Istanbul's need for infantry troops, the janissaries themselves seized the moment and used it to enlist their sons and relatives into the corps. Selling janissary certificates—that is, “entry tickets” to the corps—became a lucrative business for janissary officers. District and provincial governors and local notables also profited from the devolution of power. In return for their access to state revenues through state offices and tax farms, they provided the government with troops and provisions.

The implications of military expansion and devolution for the composition of the Ottoman expeditionary forces and their military capabilities were significant. Whereas the salaried troops of the court constituted only about 20–25 percent of Süleyman's armies, their share rose to 40–50 percent by 1697–1698. Conversely, while in the early sixteenth century timariot provincial cavalry accounted for 60–75 percent of the Ottoman combat forces, their proportion had dropped to 10–15 percent by the late 1690s. In 1526 Süleyman could mobilize some forty-five thousand provincial cavalry from his European and west Anatolian provinces (Rumeli and Anadolu); in the 1697 campaign the two provinces provided just eleven thousand timariot *sipahis*. By the late 1690s, the private household armies of provincial governors and grandees gave 16–18 percent of the mobilized troops. As a result of these transformations, the formerly cavalry-heavy Ottoman army also changed significantly: In the late 1690s infantrymen made up 50–60 percent of the deployed troops, mirroring the infantry-to-cavalry ratio of their Habsburg rivals.⁷⁹

In general, the advantages of a European Military Revolution against the Ottomans remain highly questionable, at least until the late seventeenth century. Even then, the successes of Habsburg arms against the Ottomans can better be explained by improved capabilities in marshaling troops and resources, and, as a consequence, the ability of the Habsburgs, for the first time, to match Ottoman troop strength and logistical capabilities, rather than by tactical and technological

⁷⁹ BOA, MAD no. 7483, pp. 2–5, for 1697; and Dávid and Fodor, “Changes in the Structure and Strength of the Timariot Army,” pp. 177–178, 188, for 1698.

advantages emanating from a European Military Revolution. Even more important was the Habsburgs' ability to form alliances and wage a coalition war against the Ottomans, which forced their archenemy to fight on four different fronts, an impossible task for all contemporary belligerents.

The expanded salaried corps and the household troops of provincial governors and grandees remained surprisingly effective through the early eighteenth century. It was with such forces that the Ottomans nearly captured the capital of the Holy Roman Empire in 1683, defeated Peter the Great in 1711, defeated the Venetians and recaptured the Morea in 1715–1717, and both retook Belgrade from Austria and scored victories against both Austria and Russia in the 1736–1739 war. Therefore, European victories against the Ottomans prior to the Russo-Ottoman war of 1768–1774 should not be overstated.

Instead of focusing on the putative military superiority of European arms, future studies must consider the reverse proposition: the impact of Ottoman military strength and prowess on developments among the Ottomans' rivals and contemporaries. Such an approach helps to avoid the trap of relating Ottoman military developments to a hypothetical "Military Revolution" involving the emergence of "ideal forms of conduct" among a handful of "paradigmatic powers"—powers with whom the Ottomans had little confrontation before the late eighteenth century and whose impact on the evolution of the Ottoman military was minimal.⁸⁰ Examining changing Ottoman military capabilities vis-à-vis their main rivals yields a more realistic assessment of Ottoman strength and weaknesses.⁸¹ It also reveals the long-unappreciated role the Ottomans played in catalyzing military developments across a vast terrain from Mughal India to central and eastern Europe.

⁸⁰ See Black, *Beyond the Military Revolution*, p. 1, for problems associated with "ideal forms of conduct" and "paradigmatic powers."

⁸¹ See, for example, Aksan, *Ottoman Wars*; Ágoston, "Military Transformation in the Ottoman Empire and Russia, 1500–1800," *Kritika: Explorations in Russian and Eurasian History* 12, no. 2 (2011): 281–319; Brian L. Davies, *Empire and Military Revolution in Eastern Europe: Russia's Turkish Wars in the Eighteenth Century* (London: Continuum, 2011).