# Contents

# Introduction

To start with the answer to one of the questions posed on the cover of this book – when will the next big war be? – I believe there is a very real chance that there will be another big war by the middle of this century. If I were forced to place a bet on the most likely date the next big war will start, my best guess would be 6 August 2045. To explain why we need to first understand why World War II, the biggest war ever, was so big and why there has not been a big one since. The reasons, as I see it, for why World War II was so big has led me to two further conclusions. The first is that in many respects we have been lucky that the big wars we had in the twentieth century were not even bigger and worse than they were. The second is that the circumstances that brought about the biggest war of all are likely, based on current trends, to return by mid-century.

A big war *is* one which involves large numbers of combatants, large human casualties, encompasses a large geographic scope, is fought with great intensity, involves the total commitment of the participants to achieving victory, and results in tremendous destruction. By all these measures World War II was the biggest war of all. As many as 100 million men and women served in uniform during the war. Proportionate to the size of the current global population (about two billion during World War II, about 7.5 billion today), this would be the same as all the people currently living in the United States becoming soldiers, sailors or air crew and fighting a war against each other. About 25 million of the soldiers, sailors and air crew who served in World War II would be killed.1 About 65 million people died in total as a direct result of the war – either killed in combat, caught in the crossfire, starved to death, dying of illness, or executed in atrocities such as the Holocaust. Proportionate to today's world population, the total death toll from

World War II would be the equivalent to every man, woman and child currently living in the United Kingdom, France, Germany, Belgium, and the Netherlands combined being killed in a single six-year war.

The geographic scope of the war was huge, stretching across continents and across hemispheres. In Europe it spanned from the Arctic circle in the north to the Sahara desert in the south, and from the French Atlantic coastline in the west to the Volga River and the Eurasian Steppe in the east. In the Pacific and Asia the war spanned from the frozen Aleutian Islands in the north, to the tropical island of Guadalcanal in the south, and from Kohima in India in the west to Pearl Harbour in the east. All the skies above these places, and the world's oceans connecting them, also became warzones.

The intensity of the combat can be illustrated just by looking at these geographic extremes. Deep in the Arctic circle the Germans invaded the Norwegian Port of Narvik in April 1940. During the ensuing naval battles, the Germans and British lost twelve destroyers sunk and nine damaged between them. This was just one small part of the global naval war, but these losses are comparable to the most significant naval battle since World War II, the Falkland's War in 1982. In the deserts of Africa far to the south of icy Narvik, a five-day battle took place in the now infamous Kasserine Pass in Tunisia in February 1943. General Rommel's Afrika Korp Panzers inflicted one of the most embarrassing and significant defeats on the American Army in all its history, suffering 6500 casualties and losing 200 tanks. Off the Atlantic coast of France (the western extremity of European fighting), on D-Day 6 June 1944 the largest amphibious armada ever assembled, some 7000 vessels, disgorged an army of 150,000 men onto the beaches of Normandy. The Volga River far to the east was the scene of arguably the world's largest-ever land battle, the Battle of Stalingrad.

In the Pacific, the Aleutians may mark a small, unimportant northern outlier to Japan's Imperial conquests, but it was captured as part of a decoy operation during the most important naval battle in modern history, the battle of Midway in May 1942. To the south, Guadalcanal Island and its surrounding waters saw some of the fiercest combined land, sea, and air battles of all-time. During the battle of Kohima and the ill-fated operation U-Go, an invasion of eastern India in March to June 1944, the Japanese suffered 30,000 combat deaths, about three-fifths

of all American combat deaths in seven years of combat during the Vietnam War. The Japanese attack on Pearl Harbour resulted in eight battleships being sunk or badly damaged on that one day of infamy, 7 December 1941, one of the biggest naval defeats in history. It took place a literal world away, 11,000 kilometres, from Kohima.

Therefore, even on the extremities of the fighting, some of the largest land battles, sea battles and amphibious assaults of all time took place. And such titanic clashes were repeated over and over for six years as first the Axis expanded to these far-flung coastlines, deserts, steppe, mountains, and tropical islands, and then the Allies drove them back to their homelands in Rome, Berlin and Tokyo.

How did such a massive global conflagration come about? The explanation can be divided into proximate causes and systemic causes. Every war is started and fought for specific reasons and unfolds in a certain way due to the ideas and decision of the personalities and groups involved. These are the proximate causes. Because World War II was the biggest war of all, great weight is placed on the proximate causes of the war in explaining how such a calamity could happen. The three culprits that are usually blamed are the mistake of appeasing Germany prior to the war, the evil nature of the Nazi regime and its leader Adolf Hitler, and the ideological nature of the war as a clash between different political systems: Fascism, Communism and Democracy.

In a way each of these factors did contribute to the war becoming so big. By appeasing Hitler, Britain and France allowed Germany to gobble up Austria and Czechoslovakia for little cost, thus increasing its resources and territory and making Germany more powerful when the conflict began. This may have contributed to Germany being able to overrun much of Europe, a process that would take many years of brutal combat to reverse. Likewise, without Hitler and the Nazis at the helm of one of the world's great powers, the various decisions to expand the war, such as invading Poland, France, or the Soviet Union, may not have been made and thus it may not have been so big. Finally, the ideological flavour of the conflict may certainly have lent some of the combat a more ruthless edge and contributed to some of the dreadful atrocities.

However, the problem with these proximate causes as explanations for why World War II became so big is that none of them are

historically unique to any great extent. The British and French appeasement policies before the war may have been a mistake, but mistakes and miscalculations are made before most wars. The conduct of French and British politicians prior to World War II was not egregiously worse than (and probably in many ways more sensible and considered) than their predecessors prior to World War I in 1914 or prior to the Crimean War in 1853, or for that matter their successors prior to the Suez Crisis in 1956.

The Nazi regime was evil, but not especially unique in historical terms. Hitler's program was a blend of territorial aggrandisement and national chauvinism, all tinged with racial bigotry. None of these motives are unique features of warfare. Territorial aggrandisement underwrote Napoleon's wars of conquest 150 years earlier, it motivated the Spanish under Charles V to build an empire 300 years before that, and drove the Romans to expand theirs 2000 years ago. Nationalism has been an important factor in all European wars in the past two or three centuries, and flavoured many wars long before that, such as the Hundred Years War between France and England six centuries ago or the Punic Wars between Rome and Carthage two millennia ago. Racial tensions have long been a factor in war. Take the Yanomamo people, a tribal group living in the Amazon who fight wars how many of our pre-civilised ancestors would have done. The Yanomamo occasionally fought among themselves, but reserved most of their hatred for fighting against non-Yanomamo tribes, almost exterminating one group.

Such genuine fierceness toward others derives from the Yanomamos' belief that 'they were the first, finest and most refined form of man to inhabit the earth' and that all other peoples are a degeneration from their pure stock.2

If the word "Yanomamo" is replaced with "German" then the above passage could easily describe the Nazis. Hitler's brand of racism was more bizarre than most, but its sentiments were hardly novel. Hitler himself is also not a unique character on the stage of history. He was a megalomaniac and brute, but no worse than some others. Julius Caesar was just as warlike, Attila just as cruel, Napoleon just as ambitious. Many of his personality traits, such as kindness to animals, lack of interest in women, willingness to murder formerly close associates and his top generals, and planning the destruction of hundreds of thousands in

the name of bringing Western culture to the East, have been compared to those of Alexander the Great.3 It is also hard to distinguish much between Hitler and more modern tyrants: the Kim dynasty in North Korea, Le Duan in North Vietnam, Pol Pot in Cambodia, or Saddam Hussein in Iraq.

As for ideology, it is difficult to believe that the causes were more noble, the differences between the combatants greater or more implacable, than was the case, for example, during the periodic barbarian invasions of the Middle Ages, or during the European wars of religion in the sixteenth and seventeenth centuries. The ideological clash between Nazi and Communist, or American and Japanese, were not uniquely different to that of Hun and Roman, Mongol and Arab, or Catholic and Protestant, even if the means of fighting had changed. Hitler and Stalin almost certainly had more in common with each other than Osama bin Laden and George W Bush. Thus, the things that are often blamed for making World War II so uniquely dreadful were not so unique at all, rather they were all too familiar.

So, why then was *this* war so big? If the proximate causes were historically familiar, there were systemic factors at play that were unique to that period of time. What made World War II so big was that it happened to occur at a point in time in history when two technological and military trends aligned in such a way to create a perfect storm. An alignment and a storm that had never happened before, or since. These techno-military trends were the level of *destructiveness* of the battlefield weapons involved, and the *numbers* of participants involved in those battles.

The diagram below is a graphic approximation of how these trends aligned during World War II. The horizontal axis is a timeline broken into three phases: the Musclepower Age from 2500 BC to 1450 AD; the Gunpowder Age from 1450 to 1850; and the Machine Age from 1850 to today. The H and L on the vertical axis represents when the destructiveness of battlefield weapons or the numbers of battlefield participants are high or low at a point in time. In terms of scale, the destructiveness of weapons can be measured in several ways: how lethal the weapons are, how easy they are to use, the range over which they operate, their explosive firepower, or their accuracy. From the bronze spears used at the start of the timeline in 2500 BC to the machine guns, artillery,

tanks, strategic bombers and aircraft carriers of World War II, I have assumed that the weapons were 1000 times more destructive, and that the supersonic jets, precision-guided bombs and missiles, nuclear-powered aircraft carriers and submarines, and nuclear weapons available towards the end of the Cold War in 1990 were 2000 times more destructive than bronze spears (the thermonuclear weapons available by then probably makes Cold War weaponry far more destructive than this, but it will suffice for illustration purposes). In terms of numbers, in 2500 BC battles would only have involved a few thousand soldiers at the very most. By World War II battles regularly numbered in the millions and might include thousands of tanks and aircraft. Thus, I have assumed that battles in World War II were 1000 times larger than the earliest battles on this timeline. With these scales in mind, the dotted lines and the black line respectively plot *destructiveness* and *numbers* over time as follows.
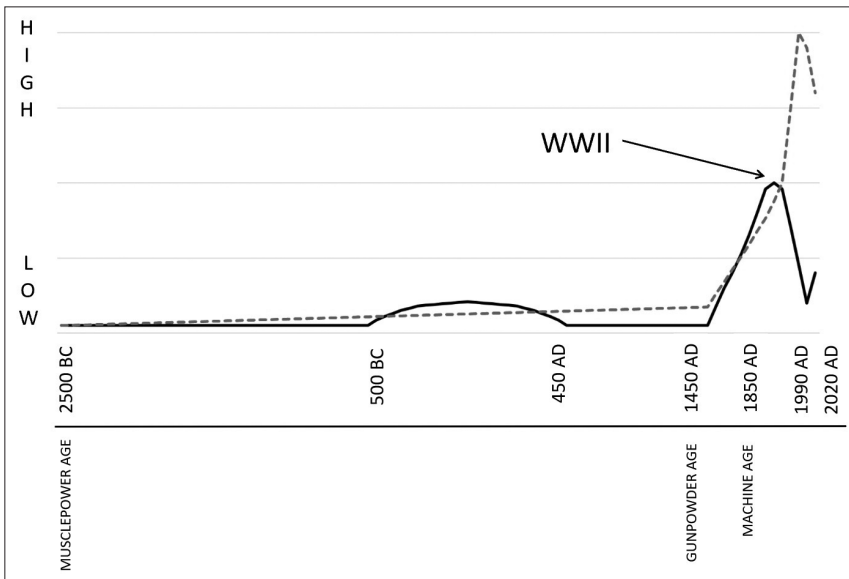


*Techno-military trends over time: Destruction (dotted line) and Numbers (black line)*

Instantly World War II stands out as the confluence where destructiveness and numbers have both risen sharply, before numbers start to drop away thereafter. It was the war involving the highest combination

of destructiveness and numbers compared to any other war. All previous wars used less destructive weapons and involved lower numbers of participants. Later wars may have involved more destructive weapons but involved lower numbers.

## Destructiveness

The trend in the destructiveness of weapons was one of constant increase until about 1990. The increase was slow at first. Warfare before 1450 involved weapons which almost exclusively relied on musclepower (human or animal) to operate them. There were some improvements here and there; better metals, fighting from horseback, some useful inventions like siege engines or crossbows. But the level of techno-military development was such that throughout this age, the destructiveness of battlefield weapons was limited in terms of lethality, ease of use, range, and firepower.

This changed with the introduction of gunpowder weapons (firearms and cannons) which, slowly at first but then with increasing ferocity, made battlefields highly lethal. For 500 years there was a ceaseless, escalating sequence of technological developments that progressively allowed battlefield weapons to deliver death from much greater distances, more accurately, and more rapidly than their musclepowered predecessors. More reliable guns, easier to reload, rifled gun barrels, exploding shells, rapid firing machine guns, and on and on until in 1945 the explosive power of the atom bomb was harnessed. The Industrial Revolution of the nineteenth century brought with it the capacity to mass produce weapons and ushered in the Machine Age. From steam-powered warships, to tanks, to aircraft; after 1850 wars were increasingly being fought with war machines. This meant that the destructive power of gunpowder became more mobile and could cause destruction over larger areas.

The destructiveness of weapons only increased after World War II. The propeller-driven aircraft was soon replaced by the jet which could travel faster, further, and could carry heavier loads. Diesel submarines and oil-powered aircraft carriers that could operate for days or weeks in World War II were superseded by nuclear-powered vessels that could do the same thing for many months. The delivery of explosive weapons ceased to rely on human aim alone and became guided and highly

accurate, such as heat-seeking missiles and laser guided smart bombs. But the biggest increase in destructiveness was due to more powerful nuclear weapons.

The atomic bomb of fifteen kilotons (equivalent to 15,000 tons of TNT explosive) used on Hiroshima in 1945 was soon dwarfed by hydrogen bombs measured in the megaton (a million tons of TNT). The means of delivering these weapons went from bombers to inter-continental rockets. A nuclear ballistic missile submarine, such as the American *Ohio* class, could carry twenty-four Trident missiles, each of which could deliver eight city-busting warheads of about half a megaton each.

## Numbers

Battlefield numbers have ebbed and flowed more throughout history. During the Musclepower Age there was a millennia-long period from 500 BC to 450 AD during which battlefield numbers increased substantially, before dropping again for another millennia or so. Battlefield numbers increased again, very dramatically, during the Gunpowder Age and into the Machine Age. This was not solely because of changes in population growth. The population of Europe in 1500 was about 80 million, in 1900 it was 420 million.4 Thus, battlefield numbers could have been expected to grow by a multiple of five during that time. But while a large European battle in the sixteenth century rarely exceeded 50,000 participants, by World War I some battles were far exceeding 1 million, a greater than twenty-fold increase.

Industrialisation in the nineteenth century had made it possible to field enormous armies. Railways could transport and maintain them, factories and mass-production techniques could equip them, and the weapons produced became more standardised and easier to use. All the resources of a society had become available to supply its armies. When new war machines were developed this did not initially change the paradigm of enormous armies. Artillery, tanks and other armoured vehicles, early propeller-driven warplanes, and diesel submarines all had, prior to 1945, some common traits. They were not especially expensive (they could be built in quantity with modern industrial processes), they were quite manpower intensive (fielding this equipment required large numbers of men, which matched or exceeded any resulting reduction in traditional infantry forces) and aiming and delivery techniques were

simple and largely reliant on human eyesight (so you needed a lot of artillery shells to silence an enemy position, a lot of bombs to destroy a particular target). In other words, the numbers of soldiers and the numbers of their war machines were both very large.

This changed after World War II. Weapons became more effective (faster, more rapidly firing, more accurate and more powerful), so in theory you could do more with less. They also became more expensive, as improved capabilities came at much increased cost. It became impossible for a nation to maintain an enormously large army, navy and air force equipped with the most modern and capable equipment without facing bankruptcy. The battlefield logic of doing so was also put in doubt by the deployment of nuclear weapons. Extra tanks, warplanes, army divisions, or submarines may not increase the chances of prevailing against a nuclear armed foe. Quality had therefore replaced quantity. The destructiveness of nuclear weapons also put into questions whether any war that might escalate to a nuclear showdown was worth the catastrophic risks. Thus, nuclear weapons have had a dampening effect on the use of military force. Many of the world's most powerful nations have nuclear weapons, and although they have never used them in anger since 1945, they also never dare fight each other either, other than a few rare exceptions. If getting involved in wars, especially potentially big ones, is risky for everyone, then maintaining an enormously large army, navy and air force is wasteful. The natural result of increased complexity, cost, and destructiveness of weapons was smaller defence forces, and thus when they are occasionally required to fight, the wars tend to be much smaller too.

## The Age of Big War

Whatever the reasons that led to war breaking out in 1939, and whatever the motivations, goals and personalities of the combatants, what made World War II so big was that this war happened to take place at a time when the steep increase since industrialisation in the number of battlefield participants and the number of war machines they used reached its all-time zenith before steadily decreasing. The weapons used at that time were lethal and highly mobile, and thus could cause dreadful destruction and spread that destruction across continents and across oceans. But they were not yet so complex, expensive, and overwhelmingly destructive as to make big wars unfeasible or even

impossible. There are two reasons why this techno-military perfect storm of high numbers and moderately destructive weapons could create the circumstances that might turn a war that was started and fought for historically familiar reasons into an event like World War II, the biggest war of all. First, when fighting with enormous numbers of soldiers, tanks, aircraft and warships, the war cannot be decided by one or two battles. The opposing military forces are simply too large and powerful and can shrug off a defeat or two. The only way to defeat an enemy is to wear down its forces. Thus, when fighting with large numbers, except in a few rare exceptions, victory can only be achieved after a long war of attrition. Huge armies in the millions can batter away at each other for months on end causing dreadful casualties. Cheap submarines, merchant ships, escorts, and naval aircraft meant naval warfare became a long gruelling tonnage war lasting for years. The limitations on piston-engined aircraft meant air warfare involved bombing cities night after night for months or years.

The second reason is that the combination of high numbers and moderately destructive weapons is likely to involve dreadful consequences for civilians. Military theorist Robert Pape claims that "the damage that conventional munitions can inflict is quite low when compared to the pain threshold of modern nation-states." Thus, in respect to how a nation might be "coerced" into doing something (such as to stop fighting), he concludes that it is the threat of military failure, or "denial", and not threats to civilians, which he calls "punishment", which provides the leverage necessary to coerce.5 What this means is that, generally, civilian populations can "take it" for as long as the military forces can hold out, and thus modern conventional wars are only won (or lost) when the military forces of one side or the other are defeated or threatened with imminent defeat. But when a war involves large numbers (and thus is inevitably a long war of attrition) civilians must "take it" for a long time, and the punishment they must take is quite severe when moderately destructive weapons that are highly mobile are used. Such weapons take a heavy toll on civilian populations by bombing them, blockading them, and overrunning their territory quickly, thus resulting in economic deprivation, loss of housing, disease, hunger, atrocities and mass death – and it all continues until military collapse is imminent.

Therefore, a combination of high numbers and moderately destructive weapons will tend to result in a war of attrition and dreadful suffering for civilians. When the numbers are as vast as they were in the mid-twentieth century, and with the lethal and mobile weapons systems available at that time, this was pushed to the absolute extreme: a perfect storm, a long *global* war of attrition, World War II. The fact the two trends of numbers and destructiveness have ceased to align in the same way again is why there has not been a big war since.

Having identified the systemic causes of a big war, it might be thought that we can therefore avoid such a scenario from happening again. Logically, a rerun of World War II coud be prevented if weapons systems remain overwhelmingly destructive (in which fighting big wars becomes unfeasible or pointless) and only small defence forces are maintained (in which case fighting long wars of attrition is impossible). However, we tend to be slaves to techno-military developments, rather than their master. The disconcerting fact is that the techno-military trends of destructiveness and numbers have, since 1990, started to realign in a way that could in the future start to resemble what they were in World War II.

This book is compiled into four parts. Part I will track the techno-military trends of destructiveness and numbers prior to World War II. Part II will look at World War II itself, how it started as a series of small wars, how it became a global war of attrition, and how such a war was fought and won. Part III will look at the post-war period, the rise of nuclear weapons and the decline of conventional war. Part IV will look at some perspectives on big wars, past and future. It looks at the big wars of the twentieth century and considers whether the outcomes of World War II were preordained (could the Axis have won the war?) and whether the timing of those wars was in fact fortuitous.

Part IV also looks to the future and addresses the undeniable fact that the systemic factors that have protected us from another big war since 1945 are starting to recede. Nuclear weapons are becoming fewer and smaller. Drones and robotics are making war machines cheaper and easier to mass produce. Guerrilla warfare or "people's wars" are on the rise, and such warfare can involve entire populations, just as entire populations were involved in World War II. Thus, we could be approaching a Second Age of Big War. If these trends continue, and if

we keep fighting wars, there could be another big war in the future, a World War III, and it might be far worse than any before it. If so, based on current trends and the cycle of big wars which has recurred in the past, the next big war will be about 100 years from the end of the last one. The Age of Big War effectively ended with the dropping of the atomic bomb on Hiroshima on 6 August 1945. My best guess is that the Second Age of Big War will start on 6 August 2045.

# Part I

# Lessons from Past Wars – What Makes a War Big?

# 1

# The Musclepower Age

*From earliest times to the present, man has always fought and has always had weapons, both natural and artificial, with which to decide his conflicts.*

Maurice R Davie: *The Evolution of War*[1]

Humans may always have fought, but they have not always fought in the same way or with the same weapons as they did in World War II. In most "pre-civilised" or "primitive" societies violence was endemic and a daily part of life. Hunter-gatherer lifestyle instilled strong tribal group loyalty in people as this fostered the cooperation necessary to survive in a harsh world. The corollary to this was that the members of a tribal group would be almost universally suspicious, and often implacably hostile, towards any outsiders to that group. For a stranger to stray into the territory of a rival tribe was mortally dangerous. Outsiders were fair game for rape, kidnapping and enslavement. Perceived crimes or insults committed by outsiders routinely led to blood feuds, vendettas and tit-for-tat reprisals that would make the Mafia seem forgiving. All manner of barbarities were committed by members of pre-civilised societies against tribal enemies, such as torture, cannibalism, scalp-taking, head-hunting and human sacrifice. If one hostile tribe descended upon the village of another and caught them badly outnumbered, unawares, or sleeping then a massacre was liable to ensue. The evidence suggests that in most pre-civilised societies, between 10 to 20 per cent of all people died violently at the hands of their fellow man (up to 25 per cent in the case of the male population).[2] In the biggest war of all, the highest

casualty toll was suffered by the Soviet Union – 27 million deaths – which was about 15 per cent of the total Soviet population. Thus, pre-civilised violence could match or exceed the death rate of the industrialised and mechanised slaughter of the Eastern Front, albeit the total population was far smaller, and the deaths would be accumulated over the span of a generation. But as violent as pre-civilised humans were, when one tribal group met another in large numbers and with forewarning, the "battles" they fought were a very different phenomenon to World War II.

This is not simply because of the different weapons involved. Clearly pre-civilised weaponry such as knives and axes made of sharpened stones, spears and clubs made of wood, rocks thrown or projected with a sling shot, and bows and arrows are all different to the machine guns, artillery, tanks and warplanes used in the twentieth century. But pre-civilised battles were fought with a different mentality. To the extent we know enough about them from archaeological findings or by observing pre-civilised communities who survived into more modern times so that their behaviour could be observed and recorded, three key generalisations can be made about the nature of pre-civilised battles.

First, they were usually highly ritualistic in nature. They were as much demonstrations of fierceness, courage or manly prowess as intended to capture or defend land or achieve any strategic purpose. There were often well-established rules and rituals governing and limiting the conflict, and there might be strict religious mores to observe. To take an example, battles among the Nguni people of Africa would not start until after a preliminary exchange of insults had concluded and would end as soon as a single casualty had been suffered. A warrior who happened to kill an opponent was immediately obligated to undergo a purification ritual.[3] In contrast, modern battlefields are unceremonious killing fields in which it would be inconceivable for the fighting to wait until an opponent has finished insulting you and to stop for someone to observe their religious obligations.

Secondly, warfare was undertaken by all able-bodied men in the community. The young, elderly and women were generally excluded from partaking in battles, although they may have participated as observers and cheerleaders, but there was rarely a distinct warrior class among the men. This also contrasts with modern warfare where only

a section of the community, usually wearing uniforms to distinguish themselves, engage in armed combat.

The third generalisation about pre-civilised warfare is that killing was not generally the main purpose, and in fact great lengths were sometimes taken to avoid killing. Perhaps the most famous example is the tribal people of New Guinea, whose battles consisted of running at each other, firing arrows, and trying to avoid being hit. The arrows the New Guineans used when hunting had fletching, that is feathers attached at the end of the arrow shaft for aerodynamic stability. But during battles the fletching was removed so that the arrows were less accurate. Thus, battles became more of a game of luck, courage and athleticism; a dangerous – possibly deadly – game of dodgeball. If someone were hit and killed or seriously injured, the battle was normally called off.[4] On a modern battlefield, nobody would eschew accuracy in favour of luck; in fact, failure to use the most precise munitions possible might be considered a form of war crime as it would increase the risk of civilian casualties.

This seeming inconsistency between murderous behaviour against lone strangers or sleeping villagers on the one hand and cautious, almost timid, battles on the other can only be reconciled by the conclusion that, in pre-civilised society, whatever issue was at stake was not worth fighting to the death over when the chances of success were no better than fifty-fifty.

Compare that to a typical World War II battle, for example the Battle of Arnhem. On 17 September 1944 the 1st British Airborne Division landed on the outskirts of the Dutch city of Arnhem to capture a crucial road bridge over the Rhine River behind the German front lines. A battalion of paratroopers under the command of Colonel John Frost captured the north side of the bridge, but the German Army held the south. An officer in the 9th Waffen SS Panzer Division, Captain Paul Grabner, led a force of forty German half-tracks and other vehicles over the bridge to recapture the north side. Author Cornelius Ryan in his book *A Bridge Too Far* describes the bloody carnage that ensued, and it is depicted with graphic realism in the 1977 film of the same name. Frost's forces engage the advancing German half-tracks with a lethal barrage of fire from anti-tank guns, machine guns and grenades. One British soldier shoots the driver of the first half-track to cross, and when

a second comes into view, he shoots that driver too. "The half-track came to a dead halt just off the ramp, whereupon the remainder of the crew of six, abandoning the vehicle, were shot one by one." Grabner's column presses on but chaos ensues when another driver is wounded. He panics and collides with another vehicle and suddenly the bridge is a tangle of German vehicles, all under heavy fire from British shells and mortars, with some vehicles bursting into flames. "Doggedly the Germans coming up behind tried to force a passage." Accelerating their vehicles, they rammed into each other adding to the growing pile of debris. Some vehicles crashed with such force they fell off the edge of the bridge plummeting to the street below. "Supporting German infantrymen following the half-tracks were mercilessly cut down."[5]

Aside from the modern weapons, the mentality of the soldiers was completely different to pre-civilised warfare. The Germans had the discipline to attack and push on even when they faced mortal peril and kept attacking despite mounting casualties. The British paratroopers killed the Germans clinically, with no ceremony, when they were simply exiting a halted half-track. The purpose of the battle was strategic, for control of an important bridge, not for spiritual purposes or to impress each other with their courage.

The diagram in the Introduction which plots the techno-military trends of battlefield numbers and destruction over time starts in 2500 BC because that is about the earliest time that we can be certain that some humans were fighting wars in a recognizably "modern" or "civilised" form. The Sumerian city states located in the Tigris and Euphrates River valleys (in modern day Iraq in the Middle East) fought battles with soldiers who were a special class of warrior distinct from other members of the community. They were armed with metal weapons (bronze-tipped spears), wore helmets and metal armour for protection, and dressed in a uniform manner. The soldiers were disciplined, fighting as a "phalanx" – that is, standing or marching side by side in rows – close to their comrades and using their large shields for mutual protection. They fought for political and strategic reasons, such as securing territory, conquering a neighbouring state and the like, rather than for ritualistic displays of prowess or for ceremonial reasons. We know the Sumerians were fighting like this by at least 2450 BC, based on a relief carving of a Sumerian phalanx, known as the Vulture Stele,

which has been dated to that time, although they probably started some time earlier.[6] And because they fought in a phalanx, we know they most definitely fought to the death. A phalanx battle such as those between two rival Sumerian city states involves two masses of men fighting in a way in which casualties and death are inevitable. The two sides march towards each other in rows, close together, shields in place, spears at the ready, until the front row of each formation meet and clash, at which point it becomes a process of slashing and stabbing, pushing and shoving, bleeding and screaming in pain. Hundreds or even thousands of soldiers might be killed or be seriously wounded within minutes during a Sumerian phalanx battle, all within an area the size of a football field.[7] If one side started to lose and panic set in, the winners were likely to run down the retreating losers and slaughter them all, and thus the battle would be definitively won or lost and decisively concluded.

This sort of hand-to-hand fighting to the death would be familiar to Greek hoplites fighting Persians in the fifth century BC, the Roman legions of Julius Caesar in the first century BC, or the English and French armies during the Hundred Years War in the fourteenth and fifteenth centuries. Standing face to face with your enemy was still a feature of battlefields in the nineteenth century, such as the Battle of Waterloo (despite the replacement of spears with muskets), and the sentiment of fighting to the death was going strong at Arnhem in the twentieth century.

What made men in the Middle East 4500 years ago fight in such a way? So different to the indecisive and cautious pre-civilised battle. As historian Ian Morris notes, it is one thing to have the ability to create sharp-edged metal weapons, "but it is another altogether to have the intestinal fortitude to walk right up to someone and stick it in him, especially while he and hundreds of his friends are trying to stick their spears into you."[8] One explanation is that the Sumerians were farmers, and as historian John Keegan has noted, agriculture "makes for war."[9] The Sumerians lived near an area, often known as the fertile crescent in the Middle East, where the very first farming civilisations were formed about 8500 BC. Author Jared Diamond in his popular book *Guns, Germs and Steel*, attributes this to the fact that the highest concentration of domesticable plants and animals on earth are found in the fertile crescent and its surrounds. This makes it the best and easiest place

possible to start farming, compared to any other area not so blessed, and so the first settled farming communities established themselves in that region.[10]

The farming of crops and livestock allows more food to be produced from an acre of land than is possible from hunting and gathering, more food than is needed for the immediate survival of the farmers that produce it. Thus, farmers can accumulate wealth, by setting aside some food for a rainy day, or trading it for other goods or services. Farming also produces a surplus of manpower, men that are not needed to produce food as sufficient food is produced by others. If everyone does not need to devote their energies to finding food, this allows greater specialisation. Some men can become soldiers, employed to defend the rest of the community. With time to train (freed from the burden of providing food for themselves) they could be expected to be quite proficient at it. They could refine the best techniques for fighting and might also develop camaraderie and bonds among themselves, a useful thing in combat. Other people could become skilled artisans, such as learning the techniques of metallurgy needed to produce metal weapons like spears, swords, shields, and armour. As historian Maurice Davie notes, "with bronze weapons came real warfare".[11]

Thus, the surplus manpower achieved by farming created professional soldiers, allowed them to become superior fighters, and meant they could be armed with metal weapons. This was effectively the model for all civilisations to come. Some people in the community produce the food, some people produce goods (such as weapons), and some people defend the rest as soldiers. Only the scale and proportions had changed by World War II, with far larger populations overall and the proportion of people working on farms significantly reduced, meaning vastly more excess manpower was available to produce weapons and fight as soldiers.

But it is not just that civilised farming communities could afford soldiers. Farming also gave people something worth fighting for. Farming a given area of land offers the farmer an expectation of a regular seasonal return on his efforts and the possibility of being able to plan his life accordingly. This rapidly instills a sense of ownership and proprietary rights over that land and a corresponding hostility towards trespassers or those who threaten his property or rights. In

turn, the wealth that settled farmers can accumulate make them the envy of others and therefore fat targets for raiding. And the chief raiders throughout history have been those that engage in another form of farming: pastoralists, that is, nomadic animal herders. Invasions of settled agricultural civilisations by nomadic pastoralists has been a recurring, and bloody feature of Eurasian warfare until only a few centuries ago in some parts. When Scythians, Huns, Turks, Mongols, and other pastoral people have invaded settled farming civilisations, the outcome has usually been brutal, deadly, even genocidal.

Just as agricultural farming allowed the early settled civilisations to develop professional soldiers and armies, pastoralism bestowed other military virtues on early nomadic raiders. For one, it made them highly skilled at using metal blades. Pastoralists would regularly slaughter their sheep and goats with their own hands via a slash to the throat or a blade to the head before butchering the meat. Herd management required the castration of most of the male animals and the unceremonious dispatch of those that were injured or deformed. It also meant such tasks needed to be done swiftly so as not to disturb others in the flock. A pastoral way of life was in effect a clinical program for killing living creatures.

Thus, when nomadic raiders descended on agricultural civilisations in order to raid them, skilled with a blade and clinical about death, they were "cold-bloodedly adept at confronting the sedentary agriculturists of the civilised lands in battle".[12] It is easy to imagine why settled farmers, territorial about their land and highly motivated to defend them, would adopt far more brutal military tactics than their pre-civilised forebears to fend off these frighteningly effective raiders. Gone, by necessity, would be the ritual, ceremony, and avoidance of killing, replaced instead by discipline and ruthlessness. And once such methods had been learnt they were not unlearnt, even when settled civilised people were fighting among themselves.

It was in the ancient Middle East that the first settled agricultural civilisations were formed. Thus, it was the Middle East where communities could first spare the manpower and afford to equip professional armies to defend their properties. Further, the civilisations of the Middle East were the first to have to deal with raiding pastoralists, and therefore the first to learn and adopt the disciplined, brutal, deadly combat techniques necessary to master fighting in a phalanx. From this

techno-military cocktail, and after the passing of many generations, emerged the first recognisably modern wars; fought by professional armies, equipped with metal weapons, fighting ruthlessly, to the death if need be, for strategic motives. Thus, we have a starting point, the ancient Sumerians of the third millennia BC. What concerns us now is how the weapons and techniques first used by the Sumerians have evolved over time and the effect these changes have had on the nature of warfare.

## Numbers

Since the time of the ancient Sumerians until the nineteenth century, among the innumerable and almost constant wars, the birth and death of great kings and queens, and the ceaseless rise and fall of empires, there were only four key technological changes in the weapons that soldiers have carried with them (or rode upon) into battle. From the nineteenth century, the pace of technological change would increase dramatically, but even though the pace of change was slower in past millennia it was clear that the size of battles was profoundly influenced by changes in military technology.

The four key technological developments were: chariots, iron weapons and armour, cavalry, and guns. Of these four, iron weapons and armour and guns are comparatively cheaper, more plentiful, and easier to use than their predecessor weapons, and thus they could facilitate the creation of large armies. While these weapon systems prevailed, quantity tended to outweigh quality in importance. In contrast, chariots and cavalry are more complex and expensive weapons systems. They rely on a qualitative advantage, and thus armies were generally smaller while these weapons systems prevailed. Because of these differences, during the period when iron weapons and armour and guns were predominant, societies tended to organise themselves in ways that could best facilitate the recruitment of large armies. This ultimately led to societies during the Iron Age and Gunpowder Age embracing universal conscription, the most prominent cases being the Greeks and Romans during the Iron Age, and the French after the French Revolution during the Gunpowder Age. At other times, military recruitment methods tended to be more limited and exclusive and political systems reflected this.

The consequence of these trends was that, in the Mediterranean world (the Middle East, Europe and North Africa) during the Musclepower Age, the period of Iron Age weapons and the ascendancy of Greece and Rome – that is, approximately between 500 BC and 450 AD – saw much larger battles than the period before or afterwards. Ascertaining the precise number of combatants that participated in ancient battles is difficult. Accurate records were not usually kept or have been lost. Ancient historical or eye-witness accounts of battles that have survived were notorious for over-inflating the size of armies. And the further back in history one looks, the harder it is to accurately ascertain what was happening. But if accuracy is elusive, overall trends within broad margins of error are less so. During the period between 500 BC and 450 AD there were numerous large battles that involved over 100,000 soldiers, sometimes far more than this. Whereas, before or after this period even the largest, most important battles never reached the figure of 100,000 combatants, or even came close. The reason why does not seem to be because the Greeks or Romans (or their enemies) were more warlike or because they were fighting wars for more important reasons. As we will see, the same trends at the same level of techno-military development occurred elsewhere outside of the Mediterranean world. The reason for this almost millennia long surge in the size of battles was changes in military technology.

### Musclepower weapons

All things being equal: "The more soldiers – whether bowmen, spears-men or swordsman – you could put into the attack, the greater your chances of victory."[13] Of course, this does not hold true in every situation. At the Battle of Cannae (216 BC) an outnumbered Carthaginian force under Hannibal comprehensively defeated a bigger Roman army, largely due to superior generalship. But when applied to soldiers equally well led and trained and with comparable weapons, morale and skill, the logic of more is best is sound. But at times it could be very difficult supplying soldiers with the bows, spears, or swords they needed, so scarcity of weapons was a limiting factor to deploying more bowmen, spearsmen, and swordsmen. At other times, even if you did have many bowmen, spearsmen, and swordsmen, new weapons or techniques came along that could trump sheer numbers.

In the wars fought by the Sumerians around 2500 BC, the dominant battlefield weapons of that era were bronze-edged weapons. Bronze is an alloy of copper and tin. Copper is an abundant metal but is soft. Tin gives bronze the hardness to be effective for stabbing and slashing but is far rarer. The rarity and expense of bronze meant that metal weapons, in historian William McNeill's words, could only be obtained by "a few privileged fighting men".[14] A small army made up of a privileged few armed with bronze weapons would be more effective than even a much larger army without them. Thus, in some ways the Bronze Age more closely resembles the techno-military paradigm of the present day than that of World War II. During the war in Afghanistan in 2001, and the invasion of Iraq in 2003, outnumbered American-led forces toppled the Taliban and removed Saddam Hussein. The reason why was because the American forces had satellite, radar and infra-red surveillance, digital command and communications systems, precision-guided bombs and missiles, air support from the latest jet fighter-bombers and helicopter gunships, and the latest tanks, artillery and infantry vehicles; while their enemies – although outnumbering them considerably – did not.

The first major change in weapons technology was the introduction of the chariot, which first appeared in wars in the Middle East around 1800 BC. It was developed by pastoralists, herding their animals on the great Eurasian Steppe stretching from the Ukraine to Mongolia. Pastoralists of the steppe were the first to domesticate horses, and although they were too small at that time to be ridden on their backs, someone had the idea of improving mobility by tethering one or two of them to a wheeled cart. Its introduction to the Middle East may have been part of the periodic nomadic raids on settled civilisations, or it may have been simply traded and sold. Whatever the cause, the disciplined armies of the civilised lands of the Middle East took to these new contraptions with gusto. With a crew of two – one to drive and one to shoot arrows – they were the perfect platform for manoeuvring around the battlefield. They could stay out of range of the spears and swords of the infantry phalanx, and with their speed, manoeuvrability and armoured frames they were hard for archers on foot to hit. One crew could hit six enemy infantrymen per minute. "Ten minutes' work by ten chariots would cause 500 casualties or more, a Battle of the Somme-like toll among the small armies of the period."[15]

The ability of one chariot to pick off multiple targets and remain invulnerable clearly gave whoever could master this new weapon system a qualitative advantage, even over an army equipped with bronze weapons, further tilting the balance in favour of quality over quantity. But it was a complex weapon system to produce for those times and did not come cheap. There was the cost of cladding them in bronze, along with assembling the hubbed wheels which were made of wood and needed to be perfectly circular and balanced so as not to rattle apart under the weight of the frame and crew. To shoot from a moving platform required short but strong bows, and the compound bows that were developed for this purpose also required a high degree of craftmanship.[16] Chariots were hand-built pieces of art, the Stealth bombers of the Bronze Age, and their deployment on the battlefield in many ways resembles present day military thinking where having a few brilliant, complex, and hugely expensive weapons – modern tanks, jet fighters, nuclear-powered submarines and aircraft carriers and the like – is generally preferred over sheer mass and weight of numbers. The largest chariot battle ever was the Battle of Kadesh (1274 BC) in which the Hittities and Egyptians had about 3500 chariots each. As impressive as this was, any state that could afford such an investment would have been able to field a huge army if these resources had instead been invested in equipping infantry. Obviously, they thought the advantages of chariots at that time was the better bet.

But the odds of this bet would change when it became cheaper to field a large infantry army. That is what happened with the next revolution in weaponry: the invention of iron from around 1200 BC. Iron weapons did not change battlefield techniques much (slashing and stabbing remains much the same regardless of the type of metal), but iron is far more plentiful than bronze. Deposits of iron are widespread in the earth's crust and once the techniques for smelting it were mastered, limitations in the supply of metal ceased to be a limitation on the size of armies. Far from being the preserve of a privileged few, once metal became dramatically cheaper, the abundance of iron meant that "a relatively large proportion of the male population could acquire metal arms and armour."[17] This would facilitate the creation of much larger armies.

The next revolution in weaponry was cavalry. Selective breeding

for generations had meant horses had grown much stronger than the ones that pulled early chariots, and their masters could now ride on their backs. The benefits from the improved mobility and lethal striking power of a well-trained archer on horseback was demonstrated during the periodic invasions into the settled agricultural civilisations of the Mediterranean world by nomadic pastoralists. First the Sarmatians in the first century AD, then the Goths, Huns, Bulgars, Avars, Magyars, Turks and finally, and worst of all, the Mongols, there would be over a thousand years of successive incursions by nomads descending from the Eurasian Steppe on horseback. But cavalry transformed battlefields most completely when the armed horseback rider was matched with the invention of the stirrup. Stirrups first appeared in Europe in the fifth century and allowed a warrior on horseback to brace himself and therefore be able to use solid weapons (such as a lance or sword) rather than just fire arrows. If the horse, with a stirrup mounted and lance armed rider, were both clad in body armour for protection, they could unleash a fearsome new battlefield technique: the cavalry charge. This proved to be an exceedingly effective technique because "a knight's charge, delivered at full gallop, concentrated an enormous momentum at the lance tip. Only an army similarly equipped could hope to counter such concentrated force."[18]

According to military historian Michael Howard: "Horsemen thus armed had an advantage over men fighting on foot as absolute as that which, a millennium later, men armed with breech-loading firearms had over enemies armed only with spears."[19] However, fighting on horseback was expensive. A mounted knight would need a lance, a coat of mail from neck to knee, a battle sword, helmet and shield, the horse itself and more than one for an extended campaign. A cast of retainers were also needed for the knight as well: a shield bearer, a groom, a mounted horseman to scout and skirmish for him and a foot soldier or two to stand guard. "The whole apparatus came very expensive indeed."[20] It was impossible for soldiers equipped in such a way to appear on battlefields in large numbers.

### Recruitment

Thus, of the dominant battlefield weapons of the Musclepower Age, the period of iron weapons and armour facilitated large armies because they

were cheap and abundant, while the expense and scarcity of bronze, chariots and cavalry did not. But creating a large army was easier said than done. Equipping an army with weapons is only part of the process. An army needs to be recruited somehow, and each method brings risks to the ruling class who wish to utilise such an army. Soldiers can be paid to serve, but the state needs to have the organisational wherewithal to efficiently tax the population to pay for a large army. Unpaid soldiers are liable to turn against their masters, as is an overtaxed population. Soldiers can be compelled to serve, but the state needs to have the requisite strength to enforce such orders, or else such compulsion is liable to lead to rebellion and uprisings among the population. Soldiers can be encouraged to volunteer for service, but what rights and privileges need to be offered as inducement, and what risk does the grant of such rights expose the ruling class to? A large group of armed men can become a source of political power, and thus pose a risk of insurrection or challenge to its rulers. Arming the masses can be dangerous, and therefore to successfully create large armies equipped with cheap iron weapons and armour required states to be strong, organised, or popular, or preferably some combination thereof (even volunteers expect to get paid; even if soldiers can be compelled it will be easier if service is also popular). Those states that best mastered this were rewarded with military success over weaker states. If the weaker state became absorbed into the stronger state, and if the methods of organisation and recruitment could be scaled up, the stronger state would become even stronger again. Thus, in the Iron Age, success would beget more success and led to the era of the large and powerful empires of the ancient world, and when these empires clashed, the largest battles yet seen.

The military benefits of being strong, organised, or popular would recur in World War II. The military was a source of political instability for the rulers of three of the six main combatant nations during that war, all three of which counted among the losers. The Italian military was instrumental in removing dictator Benito Mussolini from power in July 1943, who was replaced by army commander Marshal Pietro Badoglio. The leadership of Imperial Japan before the outbreak of war has been described as "Government by Assassination"[21] as members of the civilian government were likely to be killed if they pursued policies disagreeable to the Japanese military, such as proposing limitations on

armaments expenditure, which hamstrung the development of sensible strategy. There were several plots by the German military to kill Adolf Hitler, the one that came closest to fruition being the bomb plot of 20 July 1944 carried out by a Wehrmacht Colonel, Claus von Stauffenberg. In contrast, the democracies had no such problems, nor did the Soviet Union. Stalin had systematically purged and decimated his officer corps in the 1930s to the point where they were so cowed as to be politically powerless. Thus, the popular governments, and the very strong, feared their militaries less, and had greater control over them.

A Bronze Age tyrant had an easier time controlling the military because the limited availability of bronze weapons and chariots meant armies were smaller and could be recruited from a more limited and exclusive group within society, and the high cost, scarcity, and difficulty in making these weapons made it easier for a central government to control their availability. Keeping the keys to the armoury was one way to help keep control of your army. In contrast, during the Iron Age iron weapons were so cheap that anyone could afford them. "Iron swords were the ancient equivalent of AK-47s, giving every angry young man the same killing power as the representatives of law and order."[22]

The first state that successfully managed to deal with these angry young men with iron swords and create a large army out of them was the Assyrian Empire in the 800s BC. This empire was sufficiently strong and internally well governed to be able to conscript large numbers of its subjects and had the capability of raising enough taxes to pay them properly. To illustrate the military consequences, Sargon of Akkad, a Bronze Age ruler in the Middle East at about 2250 BC, in territory over-lapping that of the Assyrians one and half millennia later, was thought to have a great army for the time, which numbered about 5400 men.[23] In 870 BC the Assyrians had an iron equipped army of 50,000, and by 845 BC it exceeded 100,000.[24]

In the era when cheap iron weapons and armour dominated bat-tlefields, the system of recruitment adopted by two states, the Greeks and the Romans, would prove the benchmark for raising large, quality armies. This was because they were able to elevate service in the army to the status of a civic virtue. These societies were highly democratic and egalitarian compared to most ancient states, although not utopias by our modern standards; they owned slaves, women had no vote, suffrage

was limited to the propertied class, and authoritarian strongmen occasionally took control of the reins of power. But ancient Greece and Rome had a degree of representative government, respect for liberty, free thought, and debate, and thus a level of popularity among the citizenry that the government, when needed, could recruit soldiers in enormous numbers.

In 216 BC Rome faced military disaster at the height of the Punic Wars (264–146 BC). The Carthaginians under Hannibal had inflicted defeat after defeat on the legions of Romans, culminating in the catastrophe of the Battle of Cannae in which 50,000 Romans were slaughtered. However, the citizens of Rome responded:

> Within a year after the defeat, the Romans navy was on the offensive in Sicily, all the losses of Cannae had been replaced, and the thrice-defeated legions were twice the size of Hannibal's victorious force.[25]

It was the ability to replace losses and field larger armies that led to Rome's eventual victory over Carthage and thus to the creation of the Roman Empire. Rome could do this because it was able to mobilise its citizenry for war, "and do so in legal, constitutional fashion that guaranteed the support of even the lowliest farmer". Historian Victor Davis Hanson calls this ability to raise large numbers of loyal, willing soldiers from among the free citizenry "civic militarism". It was the notion that, "those who vote must also fight to protect the commonwealth, which in the exchange had granted them rights".[26] Thus recruitment into the military was universal, open to and expected of all citizens. Far from the central government limiting the distribution of weapons as a means of control, citizens were often expected to provide their own, which of course had become possible even for the common citizen due to cheap and abundant iron weapons and armour.

Rome would again face dangerous enemies – Numidians, Germans, Gauls, Goths – who might annihilate a Roman army, but the "most stunning victories of the enemies of Rome meant yet another Roman army on the horizon, while their own armies melted away with a single defeat".[27] Such sentiments could equally apply to the Soviet Union during World War II. The Red Army would lose some six million men killed, wounded or captured in the first six months of Operation Barbarossa,

the German invasion of the Soviet Union in June 1941. Yet these losses were replaced, and fresh armies were always on the horizon. The key difference however was that far from the Germans "melting away" they would endure their own enormous losses and still kept on fighting.

When the Roman Empire eventually declined and fell, the new management was not so enlightened or capable of mobilising the masses, and because cavalry was becoming the preeminent battlefield weapon, nor did they have to. The Mediterranean world was attacked by barbarian horse nomads from the Eastern Steppe, by sea-borne Viking marauders from the north, and Arabs enthused by the new religion of Islam from the south. After these invaders had conquered, settled, fought with and absorbed one another the ultimate outcome was the creation of much smaller, weaker, less organised, and less popular states. Universal recruitment was over for now, and other methods of raising armies were adopted. In Europe, the principal such system was feudalism.

Military recruitment under feudalism involved a sovereign monarch granting land to a subordinate nobleman from which he may extract rents, taxes and services from the local populace working that land. This grant also carried with it the right to bequeath the land to that nobleman's descendants. But obtaining such a grant was on the condition that he maintain a military force on his land. The size of the force would depend on the size of land and would generally be recruited from the lesser nobility of that region (who in turn had been granted further subordinate property rights over a portion of the land) perhaps fleshed out with mercenaries paid for from the rents and taxes extracted from the populace. This force could be called upon when the ruling monarch required it in order to help fight his wars. A system which relied on military service being provided by a small propertied class was highly exclusive and therefore could never reach the manpower heights of the era of the Greeks or Romans. Armies became tiny and fragmented in comparison to the vast Roman legions. By feudal times no kingdom in Western Europe could muster an army even close to the size of the Roman force that had been annihilated at Cannae hundreds of years before.[28] Outside of Europe, highly restrictive military recruitment methods similar to feudalism were also being adopted. In the Muslim lands of the Middle East and North Africa, after their conquest by Arabs

from the seventh century, religious strictures dictated that soldiers could only be drawn from a class of slaves, such as the Marmelukes of Egypt and the Janissaries of the later Ottoman Empire, which severely restricted the size of their armies also.

These trends had a major impact on the size of battles during the Musclepower Age. The two largest Bronze Age battles that we know of were the battles of Megiddo (1457 BC) and Kadesh (1274 BC). The numbers involved were about 25,000 in the case of the former, perhaps 37,000 in the case of the latter. After the rise of the Greeks from about 500 BC large battles would dwarf these numbers. Plataea (479 BC), a clash between the Greek city states and Persia, could have involved as many as 110,000 Greek troops alone, and well over 200,000 soldiers overall. When Alexander the Great set off on his far-reaching campaigns in the Middle East, he took with him 50,000 Greek soldiers. The three great battles he fought against the Persian King Darius – Granicus (334 BC), Issus (333 BC) and Gaugamela (331 BC) – all involved more than 100,000 soldiers. If it is true that Darius amassed a force three times his size (160,000 soldiers) at Gaugamela, that battle also involved over 200,000 soldiers. In Roman times, Cannae (216 BC) involved about 110,000 soldiers. The culminating battle of Julius Caesar's conquest of Gaul, at Alesia (52 BC), started as a Roman siege but would involve a clash with a relieving army of Gauls under Vercingetorix which was an incredible 250,000 strong. Barbalissos (253) between Rome and Persia involved 60,000 Roman soldiers and more than 100,000 overall. Two battles at Adrianople in 324 (a Roman civil war) and 378 (a battle between Roman and Gothic armies) probably involved a massive 300,000 and 250,000 soldiers respectively.[29]

After the fall of Rome, feudal battles saw the numbers of soldiers, even during the largest battles of these times, plummet. During the Battle of Poitiers (732), perhaps the most important clash between Islam and Christendom in Europe, each side had between 20,000 to 30,000 soldiers. Another important medieval battle, the Battle of Lechfeld (955) involved the defeat of an invading Magyar army of 25,000 by 8000 German soldiers, armies that have been described as, "sizeable for the time". The Battle of Hastings (1066), perhaps the most famous feudal battle, involved only 15,000 soldiers. Other notable battles such as Legnano (1176), Bouvines (1214), and Agincourt (1415) involved

10,000, 15,000 and 30,000, respectively.[30]

It was not only in terms of sheer numbers in which the period of the pre-eminence of large iron armed armies resembled the later big wars of the twentieth century. Of all the wars during the Musclepower Age, the Punic Wars fought in the second and third centuries BC were most similar to World War II. Rome and Carthage had the most heavily militarised societies and economies ever seen prior to industrialisation. At their height, historian Gwynne Dyer estimates that 3 per cent of the total population of the Mediterranean world were under arms, an enormous military commitment for agrarian societies to maintain. "That was probably close to the upper limit that any pre-modern civilised society could afford to devote to war."[31] This was the closest the ancient world came to total war, both sides committing all the human and material resources they could muster to waging war and defeating their enemy.

The flow of events also had a rhythm familiar to World War II. The ultimate winners had to endure their enemy making deep inroads into their territory. Carthage under Hannibal marched from Spain to Italy to defeat the Romans on their own territory at Cannae. Two millennia later the Germans would conquer Western Europe and reach the gates of Moscow, and the Japanese made it into India and deep into the Pacific. In both wars these fortunes would change. The Roman legions would end up besieging the Carthaginian capital, which was eventually conquered, sacked, and destroyed. Likewise, the Axis victories in Europe and the Pacific were also reversed. The ruins of Berlin would be occupied by the Red Army in 1945. The Japanese surrendered in Tokyo harbour in the same year with their capital flattened by firebombing.

The tendency for Iron Age weaponry to lead to the recruitment of the biggest armies and result in the biggest and most destructive wars was also evident beyond the Mediterranean world. The same techno-military changes that occurred in the Mediterranean world would occur in comparable ways in the other regions where agricultural civilisations had formed within Eurasia: in South Asia and China. The exact timing and pace of the changes, such as when chariots or iron weapons were introduced, or when empires were invaded by nomads disrupting the status quo, would differ somewhat between regions, but the overall trends were similar. In particular, the level of techno-military

development that was producing big wars in the Mediterranean world during the Musclepower Age would do the same thing in India and China. The starkest illustration of this similarity occurred during the 260s BC. In this decade, the Punic Wars in the Mediterranean got started (the biggest wars in the Mediterranean world during the Musclepower Age), a war in China between the Qin and the Zhao (the biggest war in China during the Musclepower Age) was in full swing, as were the Kalinga Wars in India between the Mauryan Empire and the state of Kalinga (the biggest war in India during the Musclepower Age). These were all massive wars fought by large states with big armies equipped with cheap iron weapons and armour. In each case the victors would go on to create large, dominant empires, and thus they were all strong enough to conscript their subjects on mass. The battles were correspondingly huge, the biggest yet seen. The Changping campaign in China from 262–60 BC involved over 500,000 soldiers, the largest military operation anywhere during the Musclepower Age.[32] It seems it was a global phenomenon that the combination of cheap iron weapons and armour and the corresponding ability to recruit large masses of soldiers led to the biggest of wars.

By World War II the numbers of soldiers involved in battles had grown to enormous sizes, far exceeding even these titanic ancient clashes. If the prevailing weapons systems and methods of recruitment do, as it seems, have an impact on the size of battles, by either facilitating large armies on the one hand or emphasising quality over quantity on the other, then it would be expected that the prevailing weapons systems and recruitment methods during World War II must have encouraged size over quality in the most extreme way. The changes that were brought about to create such a state of affairs is the subject of the next two chapters of this book.

There was one final noteworthy change that took place towards the end of the Musclepower Age: the decline in the pre-eminence of cavalry and its replacement by infantry. It was a gradual decline occurring over a few centuries, rather than brought about by a revolutionary technological change, although new weapons did play a role. Cheap and plentiful access to iron had meant a mounted knight and his horse could be well covered in armour, making them all but impervious to traditional projectile weapons. But the crossbow could fire a metal bolt

capable of piercing armour. The use of crossbows became widespread in Europe as an infantry weapon from the thirteenth century. A mercenary army equipped with crossbows destroyed an army of mounted French knights in Sicily in 1282. But crossbows were never on their own a game-changing battlefield development, as evidenced by the fact that long after their introduction some armies still preferred more traditional longbows. Crossbows do not have the range of longbows, and are slow to reload, which means crossbowmen remained vulnerable to a well-timed cavalry charge.

To get the most out of crossbowmen, they needed to be coordinated with infantry armed with pikes, who could protect them from a cavalry charge. A pike is a long pole with a metal spike on the end, and when pikemen have the discipline and fortitude to stand their ground, their pikes can break a cavalry charge. As early as the Battle of Legnano (1176), Italian pikemen defeated the mounted knights of the Habsburg forces. This story would be repeated over and over: if infantrymen held their ground, they could defeat the soldier on horseback, if they buckled or fled, they were run down and slaughtered. Rebellious Flemish infantrymen defeated French cavalry at the Battle of Courtrai (1302). The Scottish pikemen of Robert the Bruce defeated English cavalry at the Battle of Bannockburn (1314). Swiss pikemen would develop the best reputation for discipline and sturdiness, defeating cavalry at the battles of Montgarten (1315), Laupen (1339) and Sempach (1386).

By the time of the Battle of Agincourt, where French cavalry were stopped and slaughtered by English archers fighting on foot, it was clear that the reign of cavalry was over. Cavalry would still be useful in certain circumstances (for scouting and reconnaissance, the occasional charge against poorly prepared defenders, or to run down a retreating force), but purely in a supporting role, and their numbers would steadily decrease in proportion to infantry. Men fighting on foot would henceforth dominate battlefields. Whatever a foot soldier may be armed with, whether sword, pike, crossbow, longbow and eventually handguns, and however he may be recruited, was likely to be far cheaper and easier than arranging a mounted knight with an expensive horse and all the panoply of equipment which that entailed. From this reality would grow steadily larger infantry armies.

When the Germans during World War II launched Operation

Barbarossa on 22 June 1944, their Panzers led the way, but there were four million Axis soldiers accompanying them, most of them infantrymen. They would initially be met by about three million Soviet soldiers, with more thrown into the cauldron of battle soon after. This clash of millions of infantrymen was the greatest battle of all time. Despite all the new technology of war – tanks, fighters, bombers, submarines, and aircraft carriers – it was humble infantrymen and how to arm them, recruit them, transport them, and support them, that largely determined who won and lost World War II, as had been the case for hundreds of years.

## Destructiveness

The bronze spears of the Sumerians, chariots, iron swords, and stirrup equipped cavalry were each revolutionary for their time, but far less lethal than the guns, explosives, and war machines used in World War II. Despite this, Musclepower Age battles could still be terribly deadly. During the Battle of Issus (333 BC) the Greek Army of Alexander the Great defeated the Persians and in the process slaughtered about 20,000 Greek mercenaries fighting for the other side and 50,000–100,000 Persian soldiers, all in a single day.[33] As mentioned earlier, the Battle of Cannae (216 BC) between Rome and Carthage during the Second Punic War (218–201 BC) also resulted in a massacre. The Carthaginian commander, Hannibal, with an army of 40,000 men was able to encircle and trap a much large Roman army some 70,000 to 80,000 strong. In the ensuing bloodbath 50,000 soldiers died, again in a single day.[34]

Thus, despite only being armed with swords, spears and arrows, a Musclepower Age slaughterhouse like these could count among some of the deadliest days in military history. For comparison, the death toll from some famous bloody days in more recent military history falls far short of Issus or Cannae. The Battle of Antietam (17 September 1862) during the American Civil War, often referred to as the bloodiest day in American military history, involved about 4700 deaths (2000 Union, 2700 Confederate).[35] The first day of the Battle of the Somme (1 July 1916) resulted in 20,000 British deaths.[36] On D-Day (6 June 1944) about 2000 American soldiers died storming Omaha beach.[37] The deadliest day of World War II was only possible because of the invention of air power, when Tokyo was firebombed on the night of 9–10 March 1945

and 100,000 residents were incinerated.

Part of the reason that a battle involving only edged metal weapons powered by human muscles alone might still involve enormous casualties was that such battlefields were congested places. Soldiers had to come very close to their opponents, as a man bearing a lance, sword, dagger, mace, battleaxe or other metal weapons was restricted in his ability to kill "to the circle centred on his own body, within which his reach allowed him to club, slash or stab".[38] Further, the tactics of the time were generally for soldiers to bunch together in a phalanx for mutual support and protection. A mass of soldiers, armed with deadly weapons, standing close together and bent on each other's destruction, could lead to a calamitous outcome. During the Battle of Cannae, the battlefield was "unusually tiny" because it involved an envelopment of the Roman legions, the Carthaginian forces squeezing the trap ever tighter until it became "one of the smallest killing fields to have hosted such large numbers in the entire history of infantry battle."[39]

In John Keegan's *The Face of Battle* he describes in detail the battles of Agincourt (1415), Waterloo (1814) and the Somme (1916), which correspond neatly with the periods referred to here as the Musclepower, Gunpowder and Machine Ages. In the case of Agincourt, the area over which the battles were fought was half a square mile, for Waterloo it was four miles and for the Somme 260 square miles.[40] Thus, using these three battles as a guide, battlefields have clearly tended to spread out after the end of the Musclepower Age. A primary reason for this is the increased use and range of projectile weapons. Projectile weapons were available at most Musclepower Age battlefields in the form of arrows fired by bows, but even the best longbows were limited to a few hundred metres. A 15-inch artillery piece used at the Somme had a range of nearly ten kilometres, about five times further than a 9-pounder used at Waterloo, and fifty times further than a longbow used at Agincourt.

As well as battles expanding spatially after the invention of gunpowder, they also expanded temporally. Although a large Musclepower Age battle could be terribly deadly, they were comparatively rare events and were normally over within a day. During World War II very bloody battles (if not quite on the same 24-hour casualty scale as Issus or Cannae, but very deadly nonetheless) were occurring nearly every day for six years. Alexander the Great's conquest of Persia involved four

major field battles – Granicus, Issus, Guegemela and the Battle of the Persian Gate (330 BC) – in five years, all of which were over within a day or so. Hannibal's two-year campaign across southern Europe leading up to Cannae involved three other major battles: Ticinus (218 BC), Trebia (218 BC) and Trasimene (217 BC). Two one-day battles a year, a rapid pace by the standards of the Musclepower Age. Compare that to the length of fighting during the Battle of the Bulge (six weeks), the Battle of Okinawa (nearly three months), or the Battle of Stalingrad (over five months). In fact, on the frontlines during World War II, there was never any real break in the fighting, one bloody day leading into the next for years. On the Eastern Front there were on average 25,000 fatalities per day from 1941 to 1945: 50 per cent of Cannae every day for 1412 days.[41]

During the Musclepower Age, sometimes whole wars, the fate of nations, or even whole continents could be decided in a single day. In 1066, the conquest of Anglo-Saxon England by the Norman ruler William the Conqueror was accomplished by winning a single battle on a single day at Hastings. The Battle of Ain Jalut (1260) involved Egyptian Mameluke soldiers defeating a horde of Mongol invaders, and thus in one day the Marmelukes became "the saviours of the Muslim and, indeed, much of the rest of the civilised world".[42] In comparison, the battles of World War II were long, bloody affairs that took weeks or months and were soon followed by another battle, and then another, for years.

However, not all Musclepower Age battles were done and dusted in a day. Throughout history, there have been three main types of battle. The first involves two armies meeting in the "field" and engaging each other in the open, as was the case at Issus, Cannae, Hastings, or Agincourt for example. The second is naval combat where warships engage each other in battle on the seas. The third is the siege, where one army is fortified behind walls as a defence against an attacking foe. Sometimes there is an overlap between these three types. A fortress near a waterway may be besieged by both soldiers and naval ships. Naval vessels may be used to make an amphibious assault, merging the naval and field battle. But at least prior to the invention of the airplane, which introduced the concept of an aerial battle, these three types have been the mainstay throughout history.

Siege warfare was a very different beast to the field battle, often as much an engineering project as a clash of warriors, and unlike the decisive one-day decision of a field battle, they might take weeks, months or even years. Fortifications have been discovered in the Middle East that pre-date the phalanx battles of the Sumerians by thousands of years. As early as 9300 BC a tower was built at Jericho which may have been used as a fortress. Fortress walls have been discovered at Mersin in modern Turkey dating to 4300 BC and fortresses spread rapidly thereafter. And when someone has the wherewithal to build imposing fortress walls, the odds are that someone else "will simultaneously be acquiring the discipline and logistics needed to mount a serious siege".[43]

We do not know much about sieges dating back that far, but what we do know of more recent sieges is that they should not be undertaken by the impatient. The Battle of Cannae may have been over in a day, but the culmination of the Punic Wars – the siege and sacking of Carthage – took three years (149–46 BC), and this was by no means a unique outlier. The very first siege we know much about was at Megiddo (1457 BC) and it lasted seven months. At the end of the Musclepower Age, the Siege of Harlech Castle (1461–68) during the English Wars of the Roses lasted seven years. Most sieges lasted within these ranges, sometimes shorter, often much longer.

The walls of a fortified stronghold, castle or city can be overcome by an invading force in one of five ways: (1) scaling the walls, as was done by the Crusaders besieging Jerusalem in 1099; (2) digging underneath them, as English King John's armies managed to achieve against rebellious Barons during the siege of Rochester castle in 1215; (3) bashing a way through them such as the Romans did to the walls of Jerusalem in 70 AD, and the Huns did in return to the Romans at the siege of Naissus (modern Nis in Serbia) in 442 AD; (4) having the defenders open the gates for the invaders through negotiation or treachery, the latter of which was achieved by the Crusaders during the siege of Antioch in 1097–98; and finally (5), starving out the defenders such as the Romans did to the besieged Gauls during the Battle of Alesia (52 BC). All these methods take much longer to achieve than field battles, in particular starvation. Starving out a besieged fortress, whether as the primary tactic or as a precursor to one of the others, represents a true war of attrition.

It might be thought that the besiegers would have the advantage in this regard. A community trapped behind walls clearly cannot replenish its resources and so is bound to run out eventually. In reality, most of the advantages in pre-industrial times lay with the defenders. Fortresses were usually provisioned in advance and well stocked with food and other essentials. The invaders in contrast could only live off what they brought with them (with the primitive transport of the time), or what they could pillage from the nearby countryside. Starvation or disease was as likely to befall the invaders as rapidly or more so than their intended victims.

Staring at impregnable walls day after day, watching your own men slowly get weaker, must have given the commanders of ancient besieging armies time to ponder, and every motivation to find a solution to the military predicament. On a field of battle, courage, strength, and aggression are all military virtues. They may not always overcome superior strategy, numbers, or training, but they certainly help. But no amount of musclepower alone can overcome fortified walls. Innovation and intelligence are needed. Thus, the first machines of war to appear on land appeared outside fortress walls.

If the test of the best-known war in history is assessed based on the most people throughout history knowing a small detail about it, the winner would likely be the Trojan Wars, and the detail would be the story of the Trojan Horse. The Battle of Troy took place in 1183 BC, although we know so much about it due to the writings of Homer in the *Iliad* which was actually written four centuries later. It was in fact a ten-year siege, and the reason the wooden horse that would become so famous was built was to try and break the deadlock by trickery. The Trojan Horse may or may not have existed. According to Gwynne Dyer it is possible that it represents a "garbled account" of the siege machinery which was used to breach city walls during sieges of that era.[44] Numerous inventions were designed to overcome fortress walls: battering-rams to knock down fortress gates; scaling-ladders and siege towers to climb walls; mineshafts to collapse walls, sneak men into a fortress, or set off explosives under fortifications; catapults, trebuchets, mangonels (all stone slinging contraptions) and ballistas (a form of giant crossbow) to launch projectiles at walls.

These siege machines were often used in combination with each

other, which gave at least some sieges the appearance of being quite complex and technically sophisticated operations, in contrast to a clash of phalanx armies hacking each other to death.

A besieged fortress would be surrounded by dozens of ballistas and mangonels, launching their missiles in sequence or in salvoes. A medieval fortress under siege, with someone trying to set light to the door, someone else approaching its battlements with assault towers, someone crashing a battering ram into the lower walls, someone mining underneath, all to the accompaniment of a constant rain of arrows and great missiles from siege engines, was no place for the weak or irresolute.[45]

When it all works the result was tolerably short sieges. When the Mongols besieged Baghdad in 1258 they brought Chinese siege engineers with them. The siege was over in twelve days, bad news for the thousands of residents who would be slaughtered in the process. However, throughout the Musclepower Age the defenders generally had the advantage. John Keegan asserts that the "strength of castles greatly exceeded the force of siege craft, a truth not to be overturned until the coming of gunpowder."[46] Sixth century BC Chinese strategist Sun Tzu and author of *The Art of War* would agree with this sentiment. His advice is that the worst policy of all for any general is to "besiege walled cities" if it can "possibly be avoided". The preparation of the various implements for mounting an attack will take six months:

> The general, unable to control his irritation will launch his men
> to the assault like swarming ants, with the result that one-third
> of his men are slain, while the town still remains untaken. Such
> are the disastrous effects of a siege.[47]

But despite the difficulties, innovative besiegers finally came up with a device that could reverse the advantages that the defenders had behind their castle walls. When Ottoman Sultan Mehmet II sought to conquer the fortress city of Constantinople in 1453, capital of Byzantium and the last refuge of the old Roman Empire, he brought with him dozens of giant siege cannons, capable of firing large stones at the walls of the ancient city. These walls, which had withstood sieges for millennia, fell and the Ottoman Turks destroyed the Byzantine Empire.

The gunpowder age had arrived.

## Naval Warfare

Before departing the era of musclepowered weapons for those powered by gunpowder, it is worth taking a look at the third type of battle, the naval battle. A modern nuclear-powered aircraft carrier is just about the largest, most complicated machine humans currently build, and to use one in combat about the most capital-intensive mode of warfare currently imaginable. Naval warfare has always involved larger, more expensive, or more technically complex weapons than warfare on land. Thus, while wars have been fought on land well before civilisation, albeit in different ways and with different weapons, naval warfare had to wait for civilisation before it was even possible.

The first warship that made it possible was the wooden galley. Powered by rows of men pulling oars to propel it through the water, combat between galleys involved two techniques: ramming and boarding. Ramming required rowing hard to build up speed and then crashing into another galley, smashing it with a prow at the front of the ramming ship, which was hardened in bronze, and thus hopefully sinking or crippling the enemy ship. Boarding involved a galley approaching close to an enemy galley and storming it with marines carried on the attacker's deck to overwhelm the crew of the enemy vessel.

There were less noteworthy techno-military developments in naval warfare during the Musclepower Age compared to warfare on land. Once an effective warship had been designed, states with the resources to build a navy stuck with it. The Battle of Salamis (480 BC), a naval clash between Greece and an invading force of Persians, was fought with wooden oared galleys, about 120 feet long with a crew of 200 (170 sailors with thirty marines).[48] About 2000 years later at the Battle of Lepanto (1571) between the Ottoman Empire and the Holy League alliance between the Papal States, Spain and Venice, similar ships and largely the same tactics (ramming and boarding) were used as had been the case at Salamis. The galleys at Lepanto were bigger, 160 feet long with crews of 400–500 sailors and marines, and the ships and some of the marines riding on them were now armed with guns (although Ottoman Janissaries were still armed with composite bows, not handguns). But the range of their cannons was limited and sufficiently slow to reload so that galleys advancing to battle soon found themselves within range to ram or storm each other's decks. Thus, the essential nature of naval

warfare had changed little in two millennia.[49]

But naval warfare did inspire one important form of technical development, albeit away from the battlefield. It was the first form of warfare in which mass production methods became crucial. The Battle of Salamis probably involved 600–1000 Persian galleys against 300–370 Greek ships.[50] To produce such forces, more than 2000 years before the first steam engine was built, was an incredible manufacturing achievement. During the Punic Wars two centuries later, which involved – as had been the case on land – the greatest naval clashes of the ancient Mediterranean world, the shipyards of Carthage could build an amazing sixty galleys *per month*.[51] During the Battle of Lepanto each side had about 300 galleys of various sizes, and the Ottomans lost well over 200 of theirs, but had largely replaced them just a year later with 150 new ships, a single year's production. Venetian shipyards during a demonstration three years after Lepanto built an entire galley in one hour and could launch an entire fleet within days.[52]

In World War II, shipping production also played a crucial role. The Germans would build over 1000 U-boats during the war. The United States would build nearly 1000 warships of destroyer size or greater along with 3200 Liberty ships: big, cheap, mass-produced cargo vessels connecting the output of American factories with the battlefronts in Europe, Asia, and the Pacific. Ships, whether musclepowered galleys, wooden sailing ships, or World War II aircraft carriers and submarines, are all machines, and when fighting with machines, winning the production war is the key to winning battles.

Galleys are primitive compared to World War II naval vessels, but as was the case with warfare on land, battles were still deadly. Fighting in relatively flimsy wooden vessels, floating on water, filled with men, was a dangerous enterprise. At Salamis 200 Persian galleys were sunk for the loss of forty Greek ships, and 40,000 Persians died, mainly from drowning.[53] In 256 BC during the Battle of Ecnomus near Sicily, nearly 700 Roman and Carthaginian galleys loaded with 290,000 crewmen and marines clashed. Carthage lost the battle with nearly 100 galleys sunk or captured, and 40,000 men killed or captured. But on the return home from Sicily the following year, the Roman fleet lost 270 galleys to a storm with nearly 100,000 men drowning.[54] At Lepanto there were 180,000 men present, and again 40,000 were killed. The Ottomans lost

the vast majority of their 300 galleys, 180 of them being captured and towed away.[55]

Despite more modern weaponry, no single naval battle in World War II, or at any time since 1571 for that matter, could compare to the warship losses or human casualties of these massive galley clashes. One reason for this is that warships have become progressively more complex and expensive, "the shift from wood to iron, sail to steam and smoothbore to rifled artillery had entailed huge increases in the construction costs of individual ships".[56] Thus, the numbers involved in a single clash have diminished. During the Battle of Trafalgar (1805), a naval battle fought by cannon armed sailing ships, the British had twenty-seven ships, the French and Spanish thirty-three. Although constructed of wood, these ships were enormous and complex compared to galleys. For example, the British flagship, HMS *Victory*, was constructed of 300,000 cubic feet of timber, about what is yielded by a hundred acres of woodland, before accounting for her ropes, sails, and canon. At the Battle of Jutland (1916), fought with metal monsters powered by steam, the British had thirty-seven capital ships, the Germans twenty-seven. During the Battle of Midway (1942), of the warships crucial to that battle – aircraft carriers – the Japanese had only four and the Americans just three.[57]

As well as diminished numbers, the warships themselves have become more survivable and safer for their crews. Lifeboats, life jackets, firefighting equipment, damage control teams, and ships doctors and surgeries were unheard of in the age of galleys. It was comparatively rare for warships of wood and sail to be completely destroyed and sunk. Wood absorbed punishment from cannons firing solid shot quite well, as long as the magazine rooms holding the gunpowder did not catch fire. They were more likely to be damaged and taken captive than sunk. Despite the firepower of large guns firing explosive shells, such firepower was aimed at ships made of metal which are not easy to sink and offer their crews some protection. But a rammed galley that flooded meant almost certain death by drowning for the entire crew.

Thus, gunpowder naval battles rarely produce losses and casualties like those of Salamis or Lepanto, but cumulatively the losses from modern naval warfare add up. As with land battles, titanic clashes of galleys were comparatively rare, and always over in a day or so. In contrast,

the Battle of the Atlantic in World War II was more or less constant for six years, during which the Kriegsmarine lost a startling 70 per cent of its 1000 U-boats, but not before sinking some 3000 merchant ships. Globally, the loss of Allied merchant ships was 5150 vessels, or 21.5 million tons, equal to about 100 per cent of Britain's pre-war merchant fleet, the largest fleet in the world.[58] The most vicious naval clashes of World War II took place in the Pacific. Some 400,000 men of the Japanese Imperial Navy would die in the war over a four-year period, similar to the entire military death toll suffered by the United States, even though the accumulation of American casualties included the losses suffered from bloody land battles like Kasserine, Anzio, Omaha Beach and the Ardennes.[59]

Galleys needed to be very close to their enemy to engage them by ramming or boarding. They were geographically limited in other ways also. Galleys were filled with men exerting themselves by rowing. Therefore, they needed regular replenishment of food and fresh water. They also had limited methods of navigation when out of sight of land. Thus, they were largely limited to coastal areas. Salamis, Ecnomus, Lepanto and most galley battles took place within sight of land.

The first truly oceanic naval clash did not occur until 1747, the Second Battle of Finisterre during the War of the Spanish Succession, which was largely a fluke as a French and British fleet of transoceanic sailing warships happened to stumble across each other some 300 kilometres from land. By World War II naval battles were regularly being fought literally in mid-ocean, such as the battles of Midway (June 1941) and the Philippine Sea (June 1944) in the Pacific, the hunt for the German battleship *Bismarck* (May 1941), and many of the great convoy battles in the Atlantic such as the U-boat attacks on convoys SC-122 and HX-229 in March 1943.

Thus, Musclepower Age naval battles in many respects resembled their land-based equivalents in that the battles were over quickly, they occurred only rarely, were fought in only a small area, but if two large fleets met each other, and given the flimsy nature of the vessels and the added perils of drowning at sea, the casualties suffered could be enormously high. A battle like that at Salamis, Ecnomus or Lepanto was comparable to fighting a battle of Cannae, only at sea. The main difference between Musclepower Age naval warfare and World War II was

therefore not that modern naval technology is necessarily more deadly. Clearly torpedoes, dive bombers, submarines, and battleships with 16-inch guns are more sophisticated weapons than wooden boats that are rowed by humans that ram into each other. But the vulnerability of wooden galleys and their close proximity to each other in battle make both forms of naval warfare deadly in their own way. The real difference between the two is that industrialised naval warfare is more constant and geographically all encompassing.

The comparative ease in which Greeks, Persians, Romans, Carthaginians, Ottomans, and Venetians seemed to be able to build or replace large fleets of wooden galleys may also have played a role in the nature of naval warfare. Risking all in a titanic naval clash such as Salamis, Ecnomus, or Lepanto was probably only entertained by the belligerent navies because galleys could be reasonably easily replaced. Something that is readily replaceable is therefore expendable, and something expendable is more likely to be used in the first place.

The best sail, coal, oil, or nuclear-powered warships are complex and expensive machines and not easy to replace. The all or nothing approach to galley warfare can be contrasted with the tentative Battle of Jutland (1916) in which the giant, enormously expensive dreadnoughts of the British Royal Navy and German Imperial Fleet were kept on tight leashes to prevent costly, irreplaceable losses. Hitler routinely gave his battleship admirals highly restrictive rules of engagement limiting them to only fighting when they had clear superiority to prevent an embarrassing loss. The Japanese on several occasions turned their fleets of battleships around, even when victory loomed, to prevent their loss. Could anyone imagine the United States Navy today risking all eleven of its $10 billion nuclear-powered aircraft carriers in one all-out battle like the Greeks did at Salamis, the Romans at Ecnomus or the Holy League at Lepanto?

This lesson might equally apply to land warfare as well. The loss of 380,000 killed and wounded Frenchmen during the Battle of Verdun (1916) or 400,000 Germans during the Battle of Stalingrad (1942–43) were only possible because they had armies numbering in the millions and replacements could be found. Expendability of resources is one contributing factor as to why big wars can happen.

## Conclusions

Despite the slow pace of development in military technology during the Musclepower Age, reasonably small changes in weapons systems, such as making weapons from a different type of metal, or new ways to ride horses, could have major impacts on the nature of warfare, including the size of armies and battles. When the prevailing techno-military circumstances tended towards quantity over quality – because of cheap and plentiful iron weapons and armour – and when two states that are both strong enough to recruit large armies clashed (such as the Romans and Carthaginians, the Mauryans and the Kalinga, the Qin the Zhao) the result was massive battles like Issus, Cannae or the Changping campaign that were some of the deadliest days in human history.

However, the destructiveness of Musclepower Age warfare was limited because the most deadly battles (large field and naval battles) were brief and rare events, while the longest battles (sieges) involved only slow attrition from disease or starvation, at least before the moment of decision when a city might be overrun (and its citizens slaughtered), or the attackers broken against the fortress walls. It would be when battles were both deadly *and* long that the level of destruction would increase substantially, but the limitations on Musclepower Age logistics, transport and production meant combining both was not possible.

The Musclepower Age did however see the first battles between war machines, albeit musclepowered machines, with the clash of the ancient wooden galleys. Even millennia before industrialisation the rules for how such clashes can be won and how war machines are likely to be used were being made clear. Winning the battle of production was at least as important as how well the machines are used in combat, and if war machines are relatively easy to produce, they are likely to be considered expendable and thrown into the cauldron of battle in great numbers.

If a techno-military change came about that could result in increasing the size of armies, making battles both deadly and long, and making war machines easy to produce and expendable, it would lead to much bigger wars. The techno-military change that led to this outcome was the most significant military development ever: the invention of the gun.