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Stowed or Mounted
The Spanish Armada of 1588 and the Strategic Logistics of Guns at Sea

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Introduction

The sea can be used as a medium for warlike activity in two ways. The first involves the transport of military personnel and hardware to attack a terrestrial objective. This exploits the capacity of water craft to carry bulk over distance, and the ability to apply concentrated violence at a chosen landing point, often enhanced by the element of surprise. The principle is the same whether the operation involves a small-scale viking raid on an undefended coastal monastery, or a major amphibious task-force such as that deployed on D-Day in 1944.

The second approach is to create a weapons system integral with the ship so that it can engage other vessels in ways which exploit its technical and tactical advantages. An example of such a combination is the early modern Mediterranean galley with its forward-mounted ordnance, applied by pointing itself towards an enemy like a fighter aircraft (Guilmartin 1974, 295–303). A broadly contemporary symbiosis evolved in Atlantic Europe in the broadside-armed sailing ship, which sought to outmanoeuvre its adversaries and position its batteries of guns where they could be used to maximum effect (Cipolla 1965; Parker 1996).

Both approaches were combined in the strategic intentions, proposed tactics, and logistical planning of Spain's unsuccessful attempt to invade England in 1588. The Armada was conceived as an invasion task-force, modelled on the successful amphibious landing on Terceira in 1583 in the final phase of Spain's annexation of Portugal. This operation had been mounted from Lisbon, where the requisite military force was assembled together with all the provisions, weaponry, munitions and supporting services it needed to ensure a successful outcome of the land campaign when the troops came ashore. Shipping requirements were determined by the need to transport the combined force to its objective, defend its integrity while at sea, and provide close support for the landings and subsequent advance along the coast. The task-force was commanded by the marquis of Santa Cruz, an experienced officer who was a master of the complex mix of logistics and rigid battle-drills which characterised galley warfare (Guilmartin 1974, 221–252). The Terceira operation was an unqualified success and the assault on the beach, with the troops disembarking from their purpose-built landing-craft supported by galley squadrons working close inshore, is graphically represented in the Escorial's Hall of Battles (Guilmartin 2002, 119, 155).

The victory at Terceira was also commemorated in contemporary souvenirs, one of which has been recovered from the Armada wreck *La Trinidad Valencera* (Flanagan 1988, 133). It is an ornate metal bowl, decorated in relief with Spain's warrior patron Santiago mounted on his charger with sword-arm raised. But the foes beneath his horse's hooves are not the usual group of defeated Moors. They are the swirling waves of the Ocean Sea, the new theatre of naval activity which Spain's maritime prowess now dominated under her protective saint. The architect of this strategic shift from Mediterranean to oceanic amphibious warfare was Santa Cruz, and the successful outcome of the Terceira campaign provided him with a model for a more ambitious venture which Philip II ordered him to prepare – an Armada against England.

In his proposals for the invasion of England, Santa Cruz envisaged a much-enlarged version of the Terceira operation, involving almost 100,000 men and over 500 ships totalling 110,000 tons (Duro 1884, 250–319). Shortly afterwards an alternative plan was put forward by the duke of Parma, commander of Spanish forces in Flanders, who proposed that 20,000 of his crack troops should cross the Channel in landing craft under cover of darkness and strike for London (Martin and Parker 1999, 93–94). Both plans were viable, though each carried risks. The sheer magnitude of Santa Cruz's proposal created formidable problems of cost, scale, and attrition during its assembly, while Parma's depended on total secrecy, without which his unprotected barges might be intercepted and annihilated at sea. Philip II sought to resolve the issue (and bring the cost to manageable proportions) by combining both plans to create a much smaller Armada (30,000 men and 130 ships totalling 60,000 tons) which would rendezvous with Parma's troops

Figure 11.1. Armada wreck sites in Scotland and Ireland: 1. Santa Marìa de la Rosa *(Guipuzcoa); 2, 3,4.* Lavia*,* Juliana*, and* Santa Marìa de Vizon *(all Levant); 5.* Trinidad Valencera *(Levant); 6.* Girona *(Galleasses); 7.* San Juan de Sicilia *(Levant); 8.* El Gran Grifón *(Hulks).*

off Flanders and escort them across the Channel. In spite of the concerns of his senior commanders, both of whom feared that the new plan's complexity and the difficulty of communication between its two disjointed parts would almost certainly lead to misunderstanding, confusion and disaster, the king insisted that his compromise solution should be adopted. He was confident that the plan enjoyed God's approval and any difficulties would be overcome by divine support. Events proved Santa Cruz and Parma right, and blame for the Armada's failure (which he accepted) rests squarely with Philip II (Martin and Parker 1999).

From the historian's perspective the Armada is an extraordinarily well documented operation, and the copious paperwork generated by the fleet's assembly and associated policy matters survives virtually intact in the royal archives at Simancas. To this may now be added a growing resource of archaeological evidence derived from the investigation of some of the ships wrecked during the Armada's disastrous return voyage around the British Isles (Figure 11.1). These include the Guipuzcoan vice-flagship *Santa Marìa de la Rosa* (Blasket Sound, SW Ireland) (Martin 1973); the galleass *Girona* (Lacada Point, Co. Antrim) (Sténuit 1972); the hulks flagship *El Gran Grifòn* (Fair Isle, Shetland) (Martin 1998, 28–45); the Levant squadron's *San Juan de Sicilia* (Tobermory, Mull, off W. Scotland) (Martin 1998, 11–27); three ships

of the Levant squadron (Streedagh Strand, C. Sligo) (Birch and McElvogue 1999); and the Venetian ship *La Trinidad Valencera*, also of the Levant squadron (Kinnagoe Bay, Co. Donegal) (Martin 1979). The wreck of *La Trinidad Valencera* was located in 1971 by the City of Derry Sub-Aqua Club and subsequently investigated in association with the writer between 1971 and 1985. This ship served both as a front-line fighting unit and as an invasion transport carrying soldiers and military equipment, including part of a siege artillery train, and the wreck has provided extensive evidence of these two distinct but interdependent aspects of the Armada's composition. This paper considers the evidence of the ship's armament.

La Trinidad Valencera *(Martin 1979; 1983)*

The Venetian merchant ship *La Trinidad Valencera* (a Spanish corruption of her Italian name *Balanzara*) was requisitioned early in 1587 by Spanish authorities in Sicily to convey troops and war materials to Spain, where they were required for the forthcoming Armada. Together with five other Italian and Ragusan ships she arrived at Cartagena in May 1587, and by 18 June the *Valencera* was at San Lucar, where she was listed with an armament of 28 guns of unspecified types and sizes. After reaching Lisbon she was embargoed to take part in the Armada itself, an act against which her master (and perhaps part-owner) Horatio Donai protested vigorously but in vain.

In the muster held at Lisbon on 7 January 1588 the ship was allocated to Martin de Bertendona's Levant squadron, and by 19 March she was described as ready and equipped for sailing. A document dated 14 May lists various items of siege artillery and associated equipment loaded on board *La Nave Valencera*, including three 40–pounder *cañones de batir* each provided with two sets of land carriages. A Turkish gun of similar type, described as '*sin peso*' (*i.e.* with no weight mark stamped on it), was also stowed.

There is some confusion about the number of guns finally carried by the ship. In his interrogation after capture by the English, the *Valencera's* senior officer, Don Alsonso de Luzon, refers to '*4 cannons of brass*' as distinct from the ship's original 28 while his second-in-command, Baltasar Lopez del Arbol, confirms that the vessel carried '*32 pieces of brass whereof 4 were cannons of the king, the rest belonging to the ship being of divers kinds…*'. An addition of four battery cannons to the *Valencera's* original armament would make the total of 32 which both de Luzon and del Arbol attest, but the figure is ten short of the 42 guns with which the ship is credited in the final muster at Lisbon on 9 May 1588. The larger figure may be an exaggeration or, more probably, an unrealised intention, as Corbett (1898, 20) believed, citing the deposition of an Armada deserter who reported that '*the ships of Italy, nominally the largest, were badly provided with artillery*'. Nonetheless *La Trinidad Valencera* was, in comparison with the rest of the fleet, heavily armed. Her gunpowder quota of 125 *quintales* (5750 kg), listed in the 9 May muster, was only 15 *quintales* (690 kg) below that of the Armada's flagship *San Juan de Portugal*, which carried the largest ration in the fleet.

Thus armed, with a rating of 1100 tons, and carrying a complement of 79 seamen, 281 soldiers from the Neapolian *tercio* (which de Luzon commanded), together with a large contingent of officers and gentlemen adventurers, *La Trinidad Valencera* was the most powerful member of the Levant squadron, whose ten large converted merchantmen were all of Mediterranean origin. The

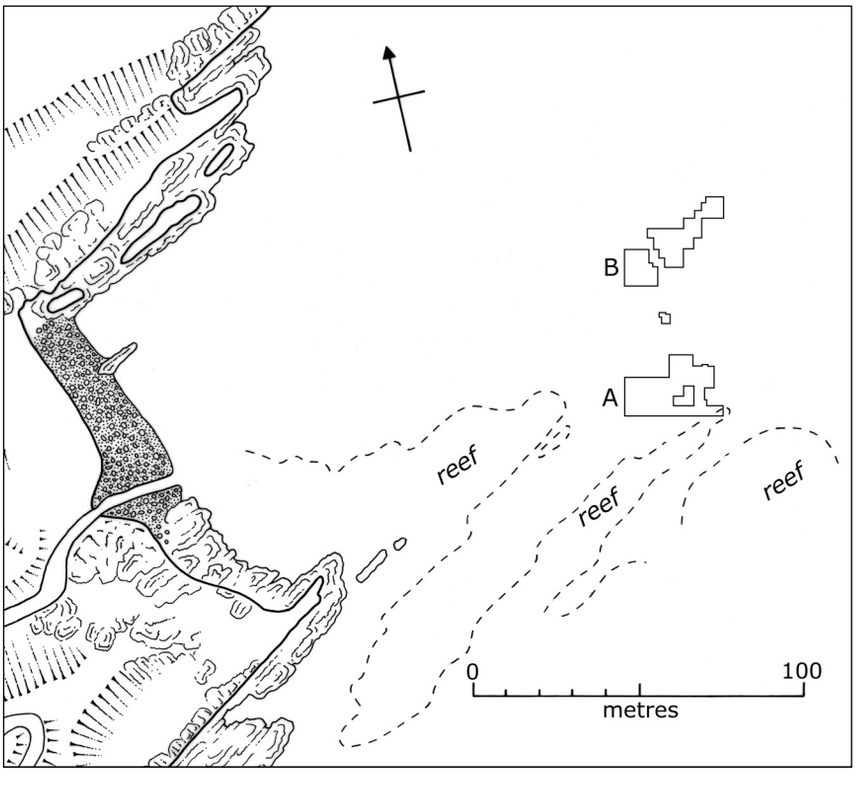

Figure 11.2. The Trinidad Valencera *wreck site in Kinnagoe Bay, Donegal. The areas A and B are the excavated zones shown in Figure 11.3.*

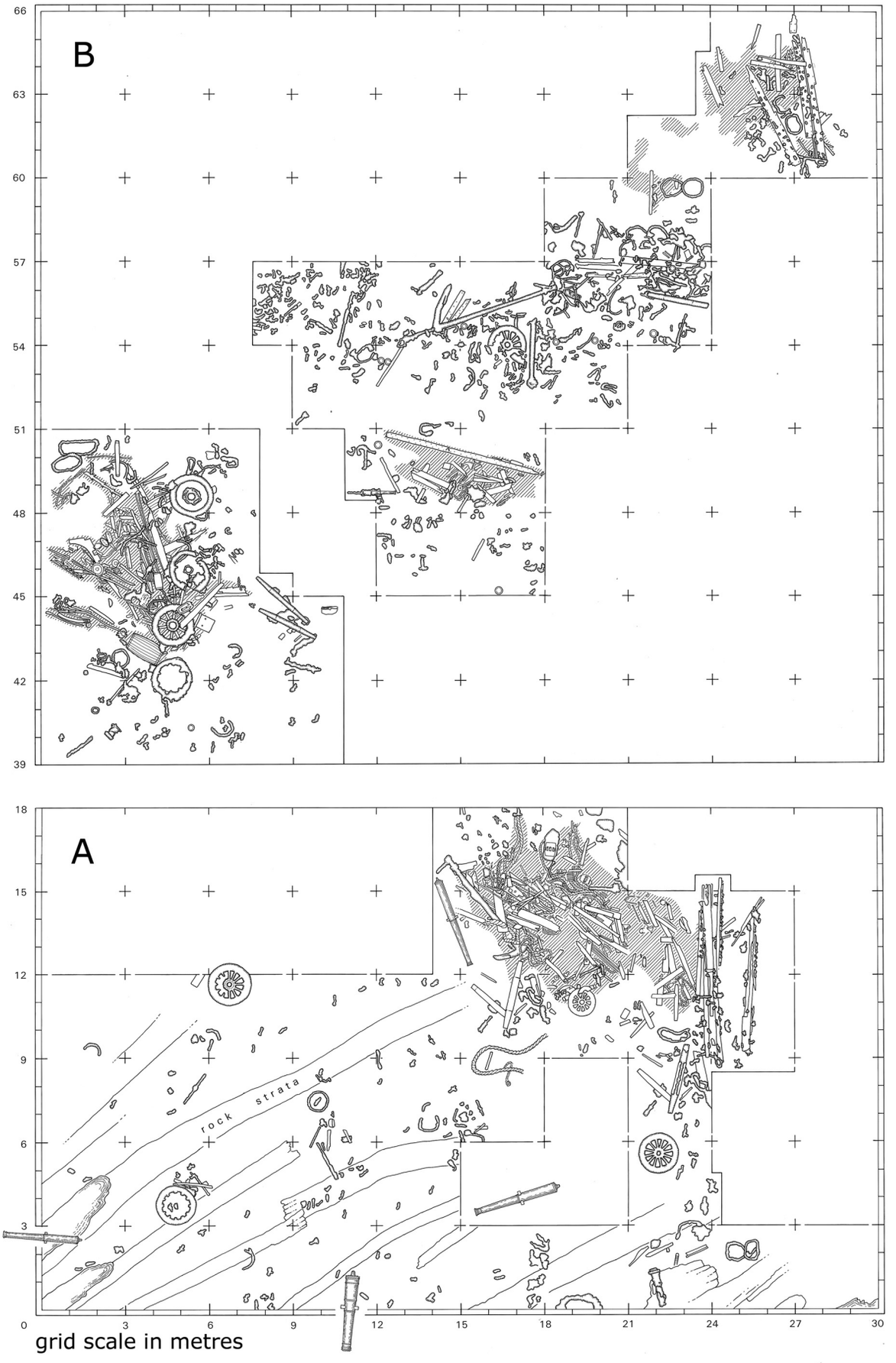

Figure 11.3. Excavated zones A and B, La Trinidad Valencera.

importance attached by the Spaniards to vessels of this type when gathering the Armada together gives a clear insight to their intended battle tactics. In his 1586 proposals Santa Cruz had earmarked a number of great-ships from Ragusa, Venice, Sicily, and Naples for the invasion fleet while the squadron's commander, Martin de Bertendona, writing to Philip II on 27 February 1588, states why he thinks his massive Levanters will be crucial in the forthcoming campaign. Although he admits that their *grandeça* – a word which implies overbearing magnificence as well as sheer size – may carry considerable risks in facing the Atlantic weather, it will give them, thinks Bertendona, an overwhelming tactical advantage when it comes to close-quarter battle. The capital ships of the Armada were to be, in effect, mobile fortifications filled with troops and their equipment, a Mediterranean-rooted concept of naval warfare diametrically opposite to the mobile "*weapons platform*" strategy adopted by the well-gunned and manoeuvrable front-line ships of Queen Elizabeth's navy.

The Armada's formation as it advanced along the English Channel towards the rendezvous with Parma was arranged to provide defence without the fleet becoming dispersed or deflected from progress towards its objective. Following the precepts of galley warfare in the Mediterranean the ships were arrayed like an army on land, with a central core or main battle flanked by extended wings on either side. Most of the vessels had instructions to keep formation on the flagship at all costs, failure to do so being a capital offence for the officer responsible. But an ingenious defensive device protected the formation from attack by heavily gunned sailing ships. Scattered through the fleet were 20 or so powerfully armed and nobly officered ships, *La Trinidad Valencera* among them, which were authorised to act on their own initiatives whenever the formation as a whole was threatened. In this way an immediate response to any attack, led by courageous and high-spirited aristocrats, was guaranteed, and no further orders were needed to set it in train. Meanwhile the main body would plod on towards its objective, its formation intact, with gaps in its ranks to which the aggressive "*troubleshooters*" might return when their business was complete (Martin and Parker 1999 15–17).

At first the English were nonplussed by the Spaniards' tight defensive formation, vigorous response to attack, and inexorable progress – "*we durst not adventure to put in amongst them, their fleet being so strong*", wrote Lord Admiral Howard in worried frustration. In fact the fleets were tactically stalemated. The English, whose ships were more manoeuvrable and had heavier guns, could keep clear of danger and dictate the range at which they fought, but could not physically overwhelm their adversaries. On the other hand the Spanish troubleshooters were unable to engage in the close combat and boarding actions in which their superior military strength would have been likely to prevail.

Early in the fighting the *Trinidad Valencera* and Don Alonso de Leiva's *Rata Encoronada* (the Genoese merchantman *Santa Maria Incoronata*, built by *Gio. Maria Ratti* in 1571. Information from R. G. Ridella), also of the Levant squadron, were detached as independent battle-groups with two Neapolitan galleasses attached to each, though for reasons which are not clear these powerfully armed units were not effectively deployed in combat. After the rendezvous with Parma had failed, the *Valencera* was one of the twenty or so ships which fought in Medina Sidonia's close support in the final battle off Gravelines, so saving the now retreating Armada from destruction.

Following Gravelines there was no alternative but the perilous north-about route around Britain and into the Atlantic for the long southward run to Spain. Autumn was approaching, and the equinoctial gales of that year blew early and with unusual violence, driving many of the returning Spanish ships towards the western coasts of Scotland and Ireland. On 14 September *La Trinidad Valencera* grounded on a reef close to the eastern end of Kinnagoe Bay, County Donegal, and two days later she broke up and sank.

The wreck site (Martin 1979)

The main area of wreckage lies 150 m offshore, adjacent to a reef complex which runs from the shore and rises to within 4 m of the surface close to the wreck (Figure 11.2). Here the ship evidently grounded. On discovery the visible remains comprised a spread of wreckage extending northwards from the reef for 65 m over a flat sandy sea bed at a depth of about 10 m. Wreckage spill among the reef continued southwards for another 30 m. The visible wreckage included two anchors, five large spoked wooden guncarriage wheels, three wooden axles, and seven bronze guns, one of which lay in the broad gully which runs through the reef.

Excavation of the sandy deposits north of the reef revealed several discrete deposits of organic material, sealed in scour hollows which had evidently formed around the hull while it was still partially intact, filling again when the upstanding structures disintegrated. The deposits were exceptionally well preserved and contained a broad sampling of the ship's contents, including military equipment and weaponry (Figure 11.3). These finds form the basis of a detailed analysis of the ship's fighting capacity.

The siege train (Martin 1988; 2001b)

In February 1588 the Venetian ambassador to Spain reported "*they have embarked twelve heavy siege guns and forty eight smaller ones, with a double supply of gun carriages and wheels for the field batteries…*". Most of the twelve heavy pieces were carried by the capacious ships of the Levant squadron. Three full *cañones* were loaded aboard *La Trinidad Valencera*, and are described thus:

> "*…one cast bronze* cañon de batir *from the Flemish foundry, having on the first reinforce a shield with the royal arms picked out in paint and an inscription reading Felipus Rex. Behind the vent are three inscriptions, one reading 'Juan Manrique de Lara ordered me to be cast' and another recording the date 1556. The gun*

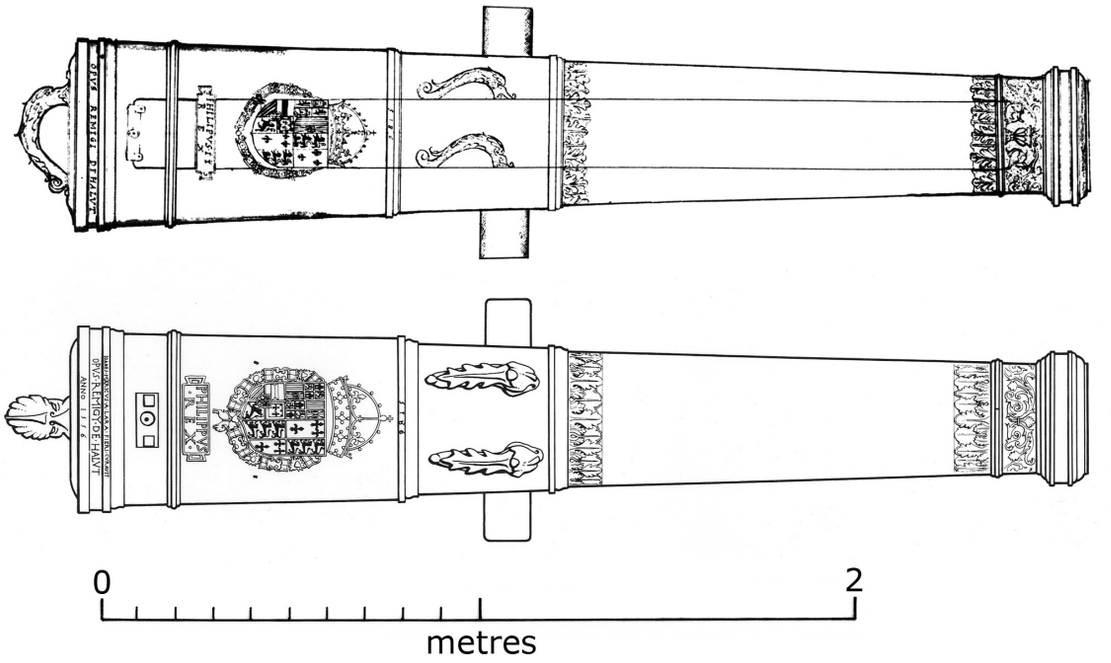

Figure 11.4. The Remigy de Halut caňon de batir *bearing the weight mark 5186: top, as illustrated in 1587 (Archivo General de Simancas, Planas y Diagramas, V-18); bottom, as recorded in 1987 (top illustration courtesy of the Director, Archivo General de Simancas).*

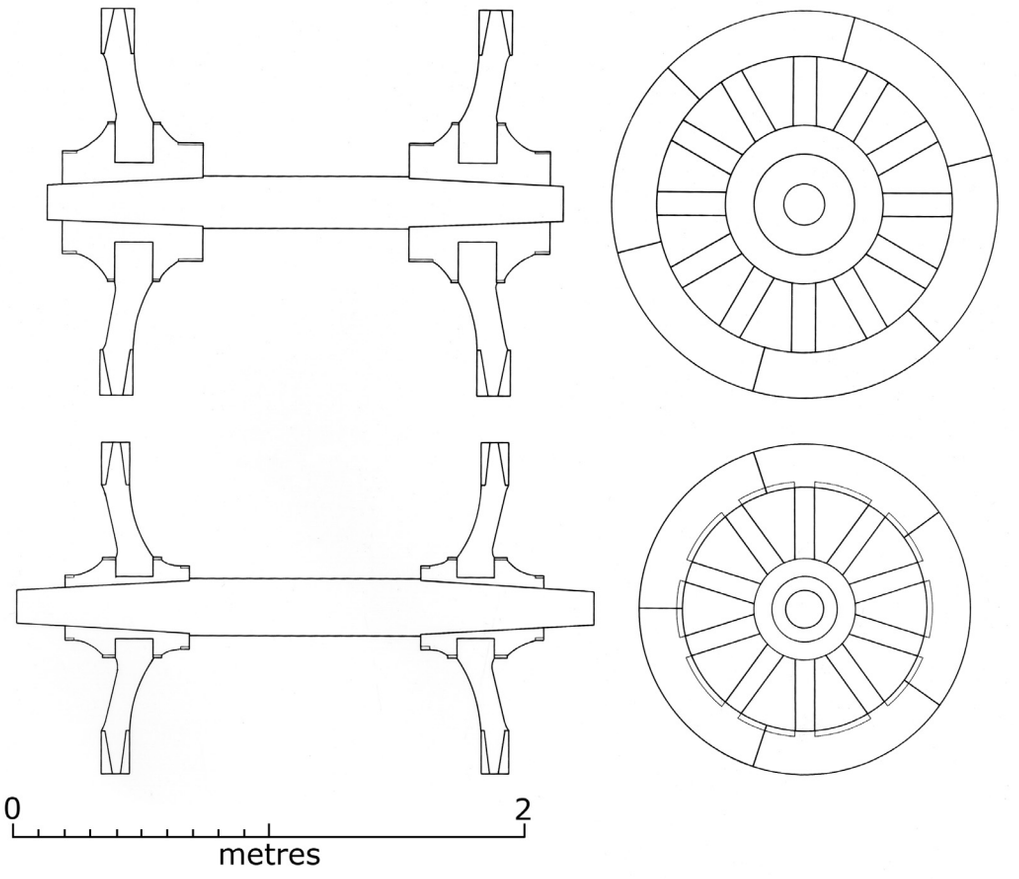

Figure 11.5. Undercarriage assemblies for the caňones de batir, La Trinidad Valencera.

weighs 5186 libras and fires a cast-iron ball weighing 40 libras".

The other two *cañones* were identical except for their individual weights, recorded as 5316 and 5260 *libras*. All three have been recovered from the wreck, and their weight marks match those recorded in the document. As noted in the inventory, the guns carry the arms of Philip II and the date 1556 – the first year of his reign. At the time he was consort to Mary Tudor, queen of England, so her arms are incorporated in the escutcheon. The Flemish gunfounder, un-named in the lading document, is revealed as Remigy de Halut, master of the king's foundry at Malines near Antwerp. Juan Manrique de Lara was Captain-General of Artillery at the time. Specifications common to all the pieces are:

> Bore 0.184 m. Shot diameter (5% windage) 0.175 m. Shot weight (by the Spanish estimate) 40 Castillian *libras* (18.4 kg). Overall length 2.92 m. Muzzle to breech ring 2.68 m. Calibre: length 1:14.5. Average gun weight 2416 kg (5254 Castillian *libras*). Shot gun-weight 1:131.

Gun weights were established after casting and marked on the barrels. This was in part an accountancy procedure to ascertain the amount of metal used in each piece but also, since even guns cast to the same specification were unlikely to have exactly the same weight, a means of identifying individual pieces. The accuracy with which this operation was conducted was confirmed by a controlled weighing of the 5316 piece, which yielded a unit value very close to the expected 460 g Castilian *libra*. By a remarkable coincidence the gun marked 5186 can be identified with the weight recorded in a scale drawing of a Remigy *cañon de batir* dated 1587. The 16th century drawing shown in Figure 11.4 has been scaled for comparison with a modern record of the actual gun. The proportions of the original drawing are remarkably accurate, though there are minor discrepancies in the treatment of the decoration and inscriptions. The three guns' dimensions, as well as their weights, fall within one percent of their median values, a level of uniformity on a par with modern heavy castings. This shows that 16th century manufacturing processes, when conducted within self-contained parameters under state control, were capable of working to repeatable standards of conformity.

Each *cañon* had been provided with two dismantled sets of field carriages for service ashore. It appears that these were manufactured specially for the campaign. On 17 October 1587 Juan de Acuña Vela, the incumbent Captain-General of Artillery, informed Philip II that his men were cutting timber to make wheels and carriages for the fleet's *cañones de batir*, and a week later he reported the necessity of making wheels of unseasoned wood because of the urgency with which they were needed.

Ten large spoked wooden wheels and six axletrees have been located on the wreck (Figure 11.5). The wheels are of two types. One (Type A) has 12 spokes and a diameter of 1.5 m, while the other (Type B) is of 10-spoke construction and spans 1.3 m. It seems likely that 12-spoke wheels, of which five have been identified, are carriage wheels, while the smaller 10-spoked ones belong to limbers.

On both wheel types the spokes are of cleft oak. The naves are turned out of elm heartwood. Those for the carriage wheels are 0.62 m in diameter and 0.55 m wide, reinforced with iron bands at the hub ends and at either side of the spokes. A tapered hole accommodates the axle bearing, and rectangular mortices house the tenoned spoke ends. All the felloes are of ash, and each is mortised for two spokes. Thus a carriage wheel has six felloes, a limber one five. The butt-ends of the felloes are set tangentially to the wheel arc, and joined to their neighbours with dowels. An unused felloe blank – presumably one of the spares noted in the Spanish inventory – was recovered. No mortises or dowel holes have been cut in it and, in comparison with the felloes on the assembled wheels, which are sound and well made, the spare is shoddily derived from a blank of ash which includes the sapwood and presents a waney edge at two corners.

The wheels were clamped around their rims with short iron strakes, each starting at the centre of a felloe and ending on the centre of its neighbour in order to span the joint. The strakes were secured to the felloes with iron clamps. The angle at which the spokes are set gives the wheels a noticeable 'dish', or concave appearance. This concavity faces outwards: that is, the apex of the shallow cone thus formed sits on the inside of the axle arm. Such an arrangement, which had been the general practice in Europe since *c*. 1500, absorbs wheel stresses more evenly and improves rotational stability.

Of the five axletrees recorded on the wreck three were too severely damaged to allow accurate measurement. One, however, was almost completely free of abrasion and concretion, and appeared from its condition to be an unused spare. Another, although somewhat abraded and partly obscured by concretion, retained enough of its original surfaces for its primary dimensions to be obtained. The two axles are of different lengths and proportions, and it is likely that Type A, which is shorter and stubbier, is for carriage assemblies, while the longer and more slender Type B is for limbers. Both are of ash.

The Type A axle is smoothly and accurately made, with a bed 0.8 m long and 0.22 m square, save for a 0.065 m chamfer along its two lower corners. Symmetrically-placed arms extend 0.6 m on either side, tapering from a distance of 0.18 m at the slightly stepped shoulder to 0.13 m at the end. That this type of axle is for the main carriage assemblies is suggested by the bed length, which closely matches the trunnion span of the Remigy *cañones de batir*. A wrought iron bar is set into the underside of the axle along its full length and secured to the axle ends by cup-like fittings over the hubs. Integral upper and lower clout plates extend from the hub caps to reinforce the axle arms and reduce friction and wear on the axle and rotating nave (Figure 11.6).

The bed and arms of the Type B axle are rather longer,

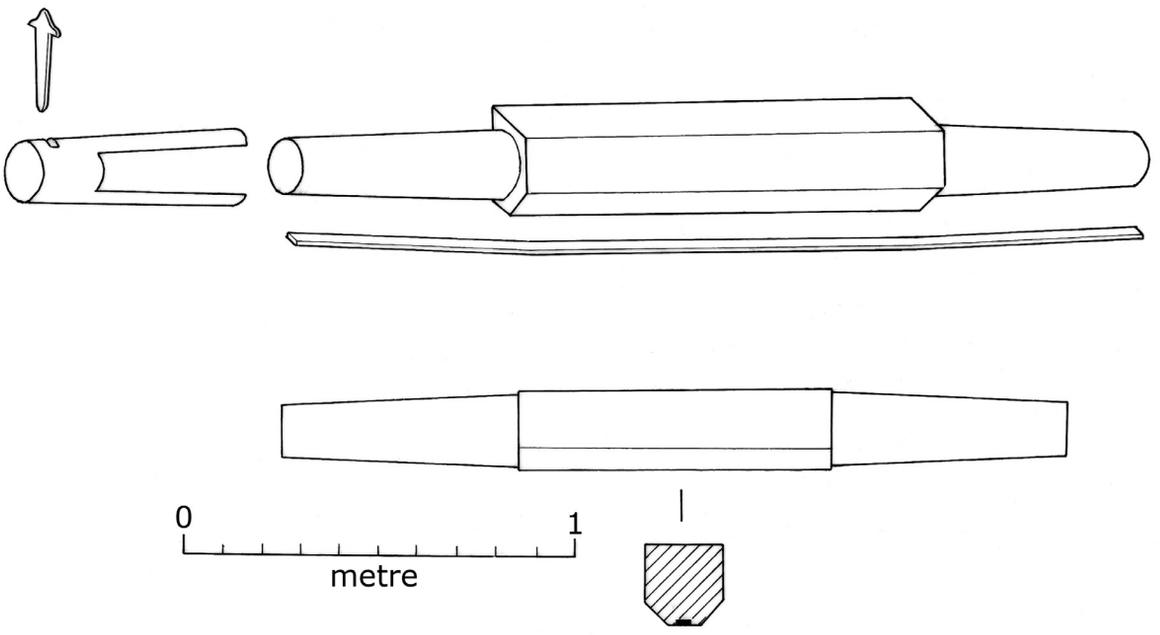

Figure 11.6. Main carriage axle (bottom) and exploded diagram of parts (top).

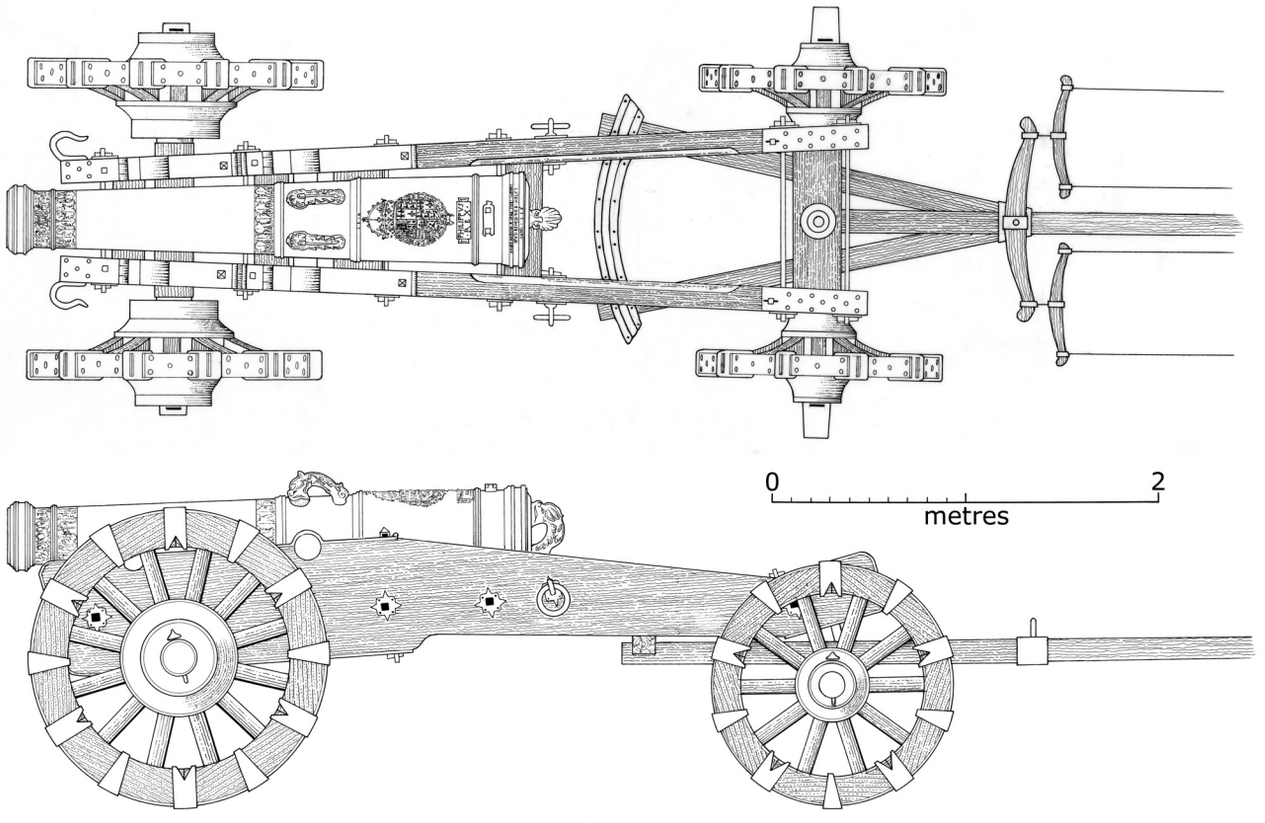

Figure 11.7. Reconstruction of carriage and limber for the Remigy cañones de batir*, shown in travelling mode.*

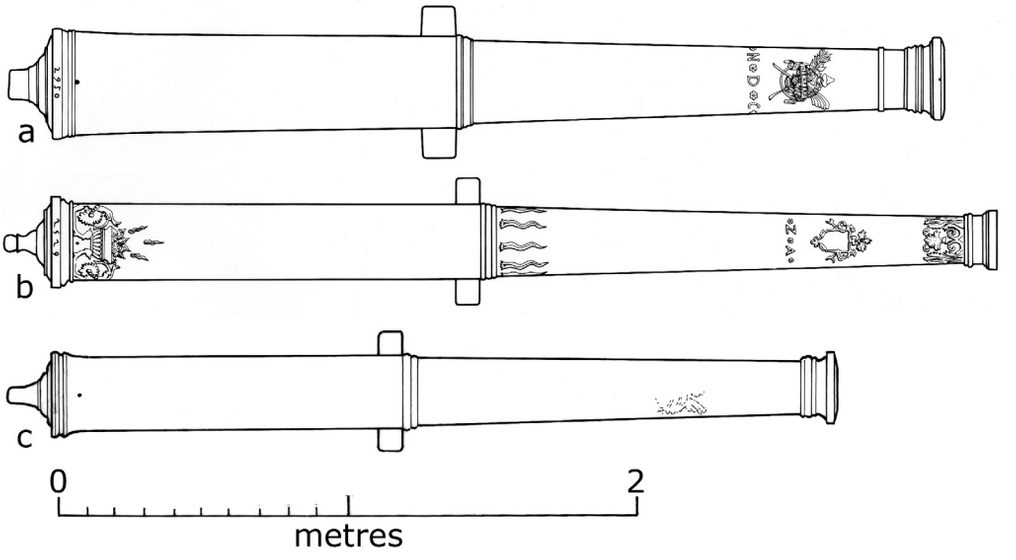

Figure 11.8. Venetian guns from La Trinidad Valencera.

and seem to be intended for the smaller diameter 10-spoked wheels of the postulated limber assemblies. The greater length of this axle was doubtless conditioned by the splay of the trail, and the need to accommodate the turning radius of an articulated limber. Like the Type A axle, the Type B example appears to have been fitted with a countersunk iron bar on its underside, and to have had similar hub caps and clout plates.

Luis Collado (1592, f.21) describes a guncarriage axle with characteristics very similar to those recorded from *La Trinidad Valencera*. Set into its under surface, he writes, is an *anima*, which he describes as "*...a true iron bar ... set into the wood of the axle, as wide as the same is long*". The function of the *anima* (which he sometimes calls a *contraexe*, or counter-axle) was, he explains, to prevent overheating, wear, and shearing of the axle stubs. The end fittings were called *mangas*: these were iron hub-caps which reinforce the axle ends and provide a solid seating for the linch pins. Iron plates extend from the *mangas* at top and bottom to serve as bearing surfaces for the wheel. These components are clearly the *animas* and *manguetas* of the inventoried *Trinidad Valencera* axles, and visible in the examples from her wreck.

No hollow (downwards inclination) or lead (forward toe-in) – the stabilising offsets which were to become common in later periods – is apparent in the set of the axles. Thus the wheel discs ran parallel to one another. These arrangements would have greatly increased the axles' strength, particularly against shearing stresses at the arm/bed interfaces. It is not clear when counter-axles were introduced, though it seems that the *Trinidad Valencera* examples are the earliest to be reliably identified. They may be seen as a technically elegant response to what had been, from at least the mid-15th century, a major problem in the design of heavy-wheeled vehicles, which were prone to failure at the weak point between the square-sectioned bed and the rounded axle arms. Perhaps this is why new carriages were built for the Armada's *cañones de batir* in 1587, for by this time the Remigy guns' original mountings would have been more than 30 years old and, in addition to being worn out, were probably regarded as obsolete too.

Sufficient evidence thus exists for replicating the carriage and limber undercarriage assemblies, but no trace was found of cheeks (side pieces) or transoms (cross members). However a drawing in the Simancas technical papers dated 1592 shows the side view of a field carriage, while the Venetian artillery writer Pietro Sardi (1621) provides extensive information on the components, fittings and construction of such mountings. The proportions of the *cañon de batir* carriages, moreover, are defined by the guns for which they were made. A resolution of these data permits a full and probably accurate reconstruction to be attempted (Figure 11.7). A limbered-up configuration is shown, with the gun mounted in a travelling position some distance behind its firing position at the front of the carriage. This arrangement was necessary to shift the centre of gravity closer to the middle of the articulated assembly for vehicular stability in transit.

The reconstruction shows the extender piece and swingletrees for the first pair of horses, and the draft pole running between them. Nine further pairs would probably have been required to draw the 5–tonne rig, making it about 30 m long. This underlines just how cumbersome a heavy artillery train was, and how advantageous it was to employ water transport wherever possible.

The ship's guns (Martin, Parker 1999, 269–274)

Of the 28 guns belonging to the ship, five have been identified on the wreck. Three are bronze muzzle-loaders. There is also a composite bronze and wrought-iron *petriera da braga*, or breech-loading swivel gun (a Spaniard would have called it a *falcon pedrero*), and the wrought-iron breech-block of a similar but larger piece. The pieces are described individually below. Shot-weights are estimated on the basis of 5% windage and an arbitrary specific mass of 7.0.

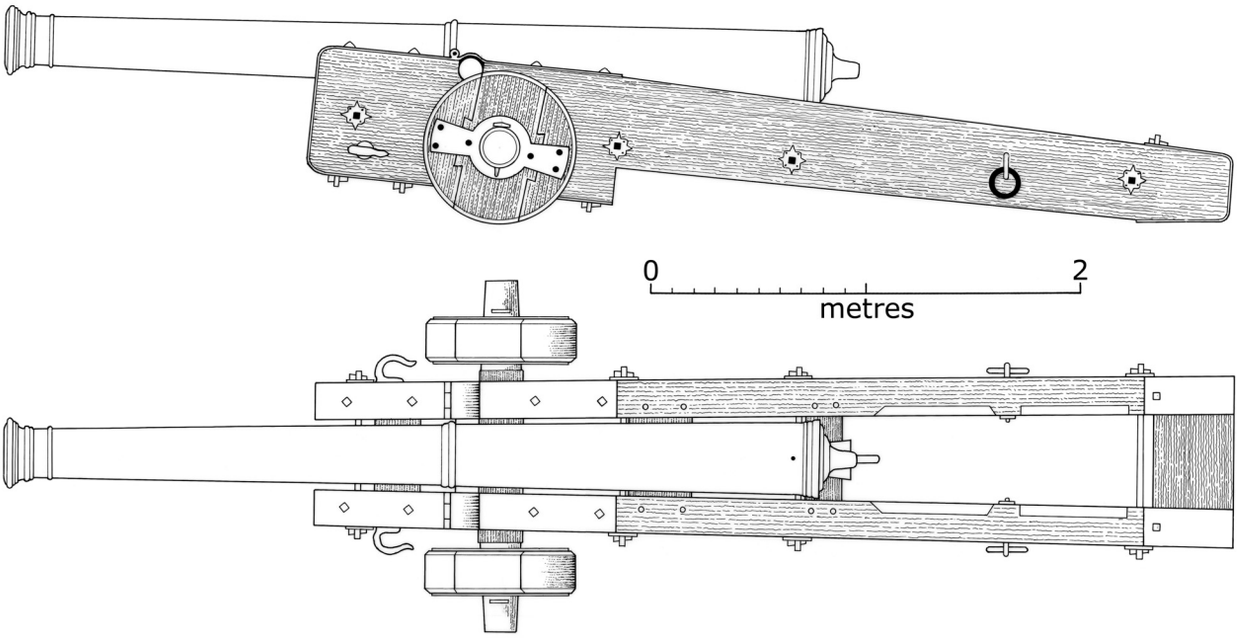

Figure 11.9. Reconstruction of two-wheeled sea carriage recorded on the Trinidad Valencera *wreck site in 1987, with hypothetical gun mounted.*

1. (Figure 11.8 a) Bore 0.124 m. Shot diameter 0.118 m. Shot weight 6.2 kg. Overall length 3.25 m. Muzzle: base ring 3.1 m. Calibre: length 1:25. Weight mark 2950. Estimated weight 1392 kg. Shot: gun-weight 1:224.

   The chase of this piece is decorated in relief with crossed olive and palm branches with the with the motto SENPER (*sic*) set in a scrolled cartouche. The founder's initials N D C spaced with rosettes appears below it. The initials are probably those of the Venetian gunfounder Niccolò di Conti.
2. (Figure 11.8b) Bore 0.095 m. Shot diameter 0.090m. Shot weight 2.67 kg. Overall length 3.45 m. Muzzle: base ring 3.27 m. Calibre: length 1:34.4. Weight mark 2529. Weight by weigh-bridge 1194 kg. Shot gun-weight 1:447. The marked weight unit resolves to 472 g, identifying it as the Venetian pound. A motif which appears to represent swans and crustacea supporting a vase emitting flames is moulded in relief around the touch-hole. Three darts of flame are placed above it. More flames encircle the rear end of the chase, just forward of the trunnions. Towards the muzzle end of the chase there is a floriated shield, with no internal device, below which the letters Z A appear within rosette spacers. There is further foliation around the muzzle. The initials are of Zuanne Alberghetti, a prominent Venetian gunfounder.
3. (Figure 11.8c) Bore 0.076 m. Shot diameter 0.072 m. Shot weight 1.37 kg. Overall length 2.92. Muzzle: base-ring 2.77 m. Calibre: length 1:36. Estimated weight 874 kg. Shot gun-weight 1:638.

   This gun had lain exposed on a rock outcrop and has suffered from severe abrasion and pitting, particularly on its left side. It is of similar proportions to 1 above, and bears the abraded traces of a similar escutcheon on the chase together with the terminal letter C. It is probably another product of the Niccolò di Conti foundry.

Sea carriage (Figure 11.9)

In 1987 the remains of a sea carriage were found adjacent to the main site, and it was recorded *in situ* before being consolidated with sandbags. The assembly lay right way up, and although its upper part had been reduced by erosion the buried lower elements were in good condition. Both cheeks and all four transoms were present and the axle was in place, with one of its arms intact. The other was missing, as were both wheels.

No associated gun was found, but the proportions of the piece can be reconstructed from the width and splay of the cheeks, the trunnion recesses, and the position of the third transom on which the breech ring would have rested. The diameters of the missing wheels are estimated from the height of the axle to be about 0.70 m, and a solid tripartite construction based on contemporary sources has been chosen for the reconstruction (Figure 11.9). Though it is impossible to be precise about the missing gun's bore, 0.12 m is a reasonable estimate, which would give it a shot-weight of around 6 kg. The reconstructed gun is 3.96 m long, and the combined assembly measures 5.8 m from muzzle to trail. It is assumed that the carriage, like the ship's guns, is of Venetian origin.

More than one eye-witness claimed that during the Armada battles, the English rate of fire was double that of the Spaniards (Martin and Parker 1999, 198), and this may have been due in part to the design of the carriages. The

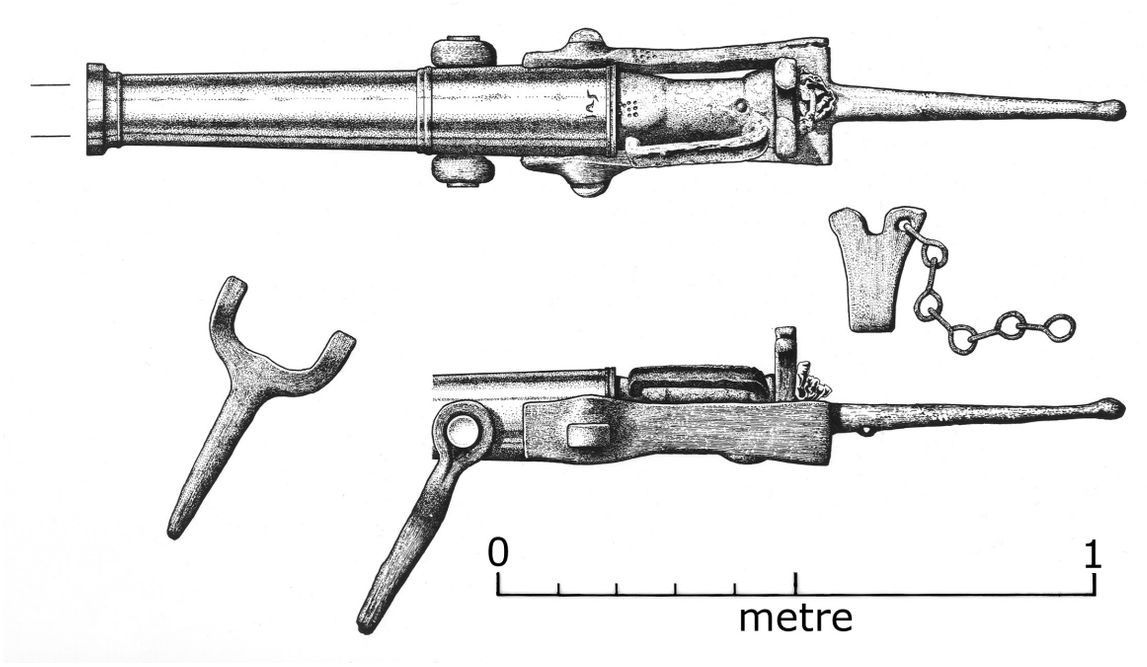

Figure 11.10. Petriera da braga *(swivel gun) from* La Trinidad Valencera.

long trails, in particular, would have made them difficult to manoeuvre within the confines of a gundeck. "*The fashion of those carriages we use at sea*", wrote Sir Henry Mainwaring in the 1620s, "*are much better than those of the land, yet the Venetians and Spaniards and divers others use the others in their shipping*" (Manwaring and Perrin 1922, 119). During comparative trials in 1988 a replica of the *Valencera* carriage took twice as long to load and run out as a compact four-wheeled truck carriage of the kind used by the English (Martin 2001a, 383–399).

Breech loaders

4. *Petriera da braga* (swivel gun) (Figure 11.10). Bore 0.086m. Shot diameter 0.082. Shot weight (stone specific mass 2.6): 0.75 kg. Barrel length (including *mascolo*): 1.2 m. Overall length (including tiller): 1.73 m. Calibre: length (barrel and chamber) 1:14. Weight mark (referring to the bronze barrel only): 125. Total weight (estimated) 160 kg. Shot gun-weight 1:213.

   The barrel is cast in bronze but the gun's other fittings – breech stirrup, removable breech-block, wedge with attachment chain, aiming tiller and mounting swivel – are made of wrought iron. The piece is preserved as its gunner left it, ready for action, in 1588. It has a stone shot in the barrel, a charge (stoppered with a wooden plug) in the breech, and a twist of hemp in the touch-hole to keep the priming dry. A folded pad of leather has been inserted behind the wedge to ensure a tight fit. Nine punch-holes relate the breech-block to the gun, which has a similar pattern of marks on its right-hand side. Guns of this kind could be reloaded much more quickly than muzzle-loading types, and were extensively used as anti-personnel weapons.
5. Wrought-iron chamber with lifting rings for a similar but larger gun of 0.15 m calibre. Stone projectile: *c*. 4.6 kg . Length: 0.61 m. Estimated weight of chamber: 100 kg. If barrel was bronze (no iron guns are mentioned in association with the ship), it may have been one of the 31 bronze *medios cañones pedreros* firing shot of between 10 and 16 Castillian *libras* (4.6–7.4 kg) issued jointly to five of the Levant squadron's ships including the *Valencera* on 26 September 1587 (Martin 1983, 114).

Gunners' rules and shot gauges (Figure 11.11)

A wooden gunner's rule was recovered from the wreck of *La Trinidad Valencera.* This simple device was intended to relate the diameter of a gun's bore to the weight of roundshot appropriate to it. Progressive scales are marked on either side, one evidently calibrated for iron projectiles and the other for lead. By assuming constant specific gravities for each of these materials (cast iron 7.3 and lead 11.4) calculations can be applied which, if the instrument is correctly scaled, should reveal the value of the weight unit involved and its consistency across the range of shot-sizes given. However the fourteen shot sizes given on the iron side of the scale, covering balls weighing nominally from one to 120 pounds, resolve into units ranging in value from 241 to 367 g, a variation far too great to allow any particular weight standard to be identified. The calibrations clearly have no basis in rational mathematics. Calculations for the lead-calibrated scale reveal an even greater error on the part of the instrument-maker, who has evidently worked on the false assumption that the relative mass of lead to iron can be expressed in the same linear proportions. The resulting units resolve into patently spurious values of between 82 and 131 g.

At the level of an individual gunner aboard a particular ship these errors would not of themselves necessarily been misleading. Gunners' rules were complemented by annular

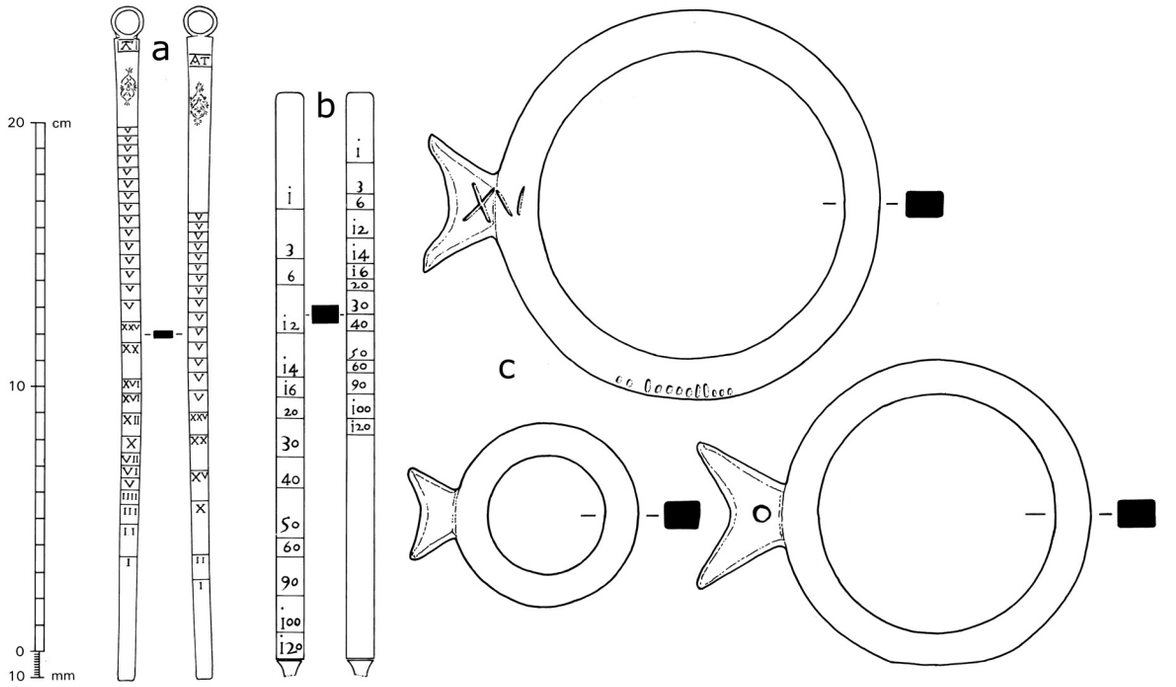

Figure 11.11. *a) brass gunner's rule from the* San Juan de Sicilia*; b) wooden gunner's rule from* La Trinidad Valencera*; c) wooden shot gauges from* La Trinidad Valencera.

wooden gauges matched to the shot-weight graduations, of which three have been recovered from *La Trinidad Valencera*. They accurately match the 1, 12, and 16 divisions on the rule's scale, so if the rule was used to gauge the shot required by measuring across a gun's bore, and the corresponding gauge applied to checking the diameter of an appropriate ball, the errors would cancel one another out. Had all gunners' rules and gauges in the Armada been to this common standard, and had the same erroneous but consistent standard been applied to the processes of manufacturing and distributing roundshot, no difficulty would have been experienced in matching projectiles to bores. But this was not the case. Another Armada gunner's rule from the *San Juan de Sicilia*, a fellow-member of the Levant squadron, has been recovered from her wreck in Tobermory Bay on the west coast of Scotland. Though it carries errors quite as serious as those recognised on the *Trinidad Valencera* rule, they are of different and unrelated kinds. The two instruments articulate, so to speak, in different and untranslatable languages. The problem of relating bore size to shot weight and diameter in early modern gunnery as well as its relevance to wider questions of standardisation, repeatability, popular mathematical understanding and the growth of industrialisation, will be explored in a forthcoming paper.

Conclusion

In many respects *La Trinidad Valencera* can be seen as a microcosm of the Armada as a whole. Her primary function was as a bulk carrier, for which her origins as a grain ship suited her. On board were 300 soldiers together with their weaponry, munitions and provisions, and also elements of a heavy artillery siege train. This military cargo was a self-contained element of the integrated force whose strategic purpose was to land in England as a back-up to Parma's troops in support of the *blitzkreig* on London.

But her secondary role as a warship was complemented by her function as an invasion transport. The ship's fighting potential while at sea focussed on the need to defend the task force without impeding its progress towards a terrestrial objective, and she had been nominated as one of the free-ranging 'trouble-shooters' charged with protecting the formation as a whole. As a front-line combat unit, the *Valencera* relied mainly on her cargo – the superior numbers, quality, and equipment of her soldiers. Short of sinking the *Valencera* by artillery fire alone – an almost impossible feat – an Englishman was effectively powerless against her in ship-to-ship combat, for if he came too close he would almost certainly be overwhelmed by the superior military force on her decks and fighting tops.

To prevail in such close-quarter actions the Spaniards deployed specialised close-quarter weapons, of which the *Valencera's* breech-loading *Petriera da Braga* is a fine example. Her wreck has also yielded incendiary firepots (*alcancias*) and a wooden fire trunk (*bomba*). These would have supported the troops in the aggressive boarding tactics by which they hoped to overwhelm individual enemies without hindering the Armada's progress towards its objective (Martin 1994).

The role of a ship's guns in such an action was to fire a salvo at very close range, just before ship-to-ship contact was made to launch a boarding assault. This is how galleys normally fought. The guns were prepared at leisure before battle was joined by crews of soldiers. Once the guns were loaded, the troops took up their battle-stations on deck and aloft, leaving the gunners to fire a single crucial salvo just

before the assault went in. Guns were just one element in the Armada's aggressively structured defensive posture, and not the main one. They should certainly not be seen as the dominant part of an integrated weapons system in its own right. In 1588 the seeds of that future naval revolution were being sown – tentatively and with more than a hint of desperation – by the other side. The Armada conflict was not so much an historical turning-point as a foretaste of what was to come (Rodger 1996).

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