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The *Dartmouth*, a British frigate wrecked off Mull, 1690
3. The guns

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The discovery and subsequent identification of the wreck site of HMS *Dartmouth* in the Sound of Mull has provided a unique opportunity to study and compare the real armament of a Royal Naval 5th rate of the 17th century with surviving contemporary records.

Invitations were extended to a number of guests with experience gained on similar sites in the United Kingdom, to join the first of a number of expeditions which returned to the site in November 1973 with the primary task of completing the pre-disturbance survey and the detailed recording of surviving timberwork.

The secondary tasks were the thorough examination and detailed measurement of the ordnance.

The wreck provided evidence of 20 guns, 15 of which were distributed fairly uniformly about the site. The remaining five were broken and difficult to identify lying together at the shallow eastern end of the site.

A visit to adjacent Duart Castle, stronghold of the McLeans of Mull, whose boats the *Dartmouth* under Captain Pottinger had been instrumental in destroying, shortly before the shipwreck in July 1690, revealed two cannon, amongst others on the ramparts which were possibly derived from the site. It was decided to include these in the survey and they were measured and drawn during the spring 1974.

Before discussing the work on site more fully, and analysing the information obtained it would appear beneficial to consider the theoretical aspects of the armament.

Ordnance establishments

The long and varied service of the *Dartmouth* is reasonably well documented and a number of Naval establishments list her allowance of guns at various times.

Most of her career was spent as a 5th rate, but she was reduced to a fireship of 10 guns and 50 men in December 1688. This commission as a fireship was extremely brief, for in March 1689, John Packman, later carriage-master for Woolwich, submitted a bill to the Ordnance for work as follows:

	£.	s.	d
'Drawne to ye Barne 4 load ffireworks Returned from GARLAND and DARTMOUTH ffireships	00	02	08
'Drawne to their places 30 Carr,? 4 guns of 30 cwt? for ye DARTMO: 1 Load shells to ye workhouse and one load to ye Proof house	00	07	10
'Do to ye Refinery 12 Load of trucks and from ye Rope Yard 2 load Junck and 28 Carr? to ye Wharf for ye GUARLAND and DARTMO:	00	12	04

Unfortunately, the writing is difficult to decipher in this document and we are still left in doubt as to the precise number of guns and carriages taken on board the ship (WO 51/38).

The *Dartmouth's* restoration to a 5th rate happened too late for her to be included in the current Ordnance Office list for 1689 as a 5th rate (WO 55/1763), and her name does not appear. Several other 5th rates of similar dimensions are included, however, and the types and lengths of guns carried appear to coincide with those found on site in the Sound of Mull[1]. Her Commander up to May 1689 was Captain John Leake, and in his biography she is referred to as a 40 gun ship (*NRS*, 1918, 1: 21).

The two most pertinent detailed references found are those of the Ordnance Establishment

Table 1

Ordnance Office. Establishment of guns 1687–HMS Dartmouth *(WO 55/1762)*

	Forts	Drakes	Cutts
Demi-Culverins		16	
Sakers		16	
Minnions	4		

of 1687 (WO 55/1762) and Edward Battines' *The Method of Building Rigging, Apparrelling and Furnishing H.M. Ships of Warr* of 1684 which includes a complete list of Ordnance items allowed to the *Dartmouth* as a 5th rate. The details as they appear are shown in Tables 1 and 2; the maximum total allowance shown being 36. Comparison of the Ordnance lists of 1687 and 1689 for 5th rates show a general and significant increase in the proportion of smaller guns carried towards the end of the war and in particular more 3-pounders. The presence of three 3-pounders on the *Dartmouth* site is significant, and would suggest that Leakes' complement of 40 guns was correct.

The headings in Table 1 require some amplification. Forts was the abbreviation for standard fortified true bored cannon, in use in large numbers throughout the service, whilst cutts were cannon which had developed defects in their muzzles either in usage or in casting. After survey by the Ordnance department, the defective section was cut off and the gun was brought into use again (WO 55/1763)[2].

Drakes were supposed to have been invented by Prince Maurice of Nasseau, being restricted until 1630 to the Royal service (*CSP* Doms. 1629–31: 389–99). Although simply described as taper bored guns there were other implications. Clowes states they were capable of firing a heavier charge than normal (Clowes, 1898, II: 12). In February 1653 Blake wrote 'whether the cannon contracted for the fleet be made drakes or home bored it is our advice that provided they be made of the same weight and yet allow the same metal as you do for whole bored guns, drake bored will be of most use, otherwise make them whole bored' (WO 47/2 and Hall, 1952: 18)[3].

Table 2A

Main armament 1684–HMS Dartmouth *(Battine)*

5th rates	Time	Location: Lower deck Demi-Culverin No.	Lower deck Demi-Culverin Ton	Upper deck Saker No.	Upper deck Saker Ton	Quarter deck Minnions No.	Quarter deck Minnions Ton	Total No.	Total Ton
Dartmouth	War	18	26	10	7½	4	1½	32	35
Dartmouth	Peace	16	23	8	6	4	1½	28	30½

Table 2B

List of ordnance. Shot, small arms and equipment and cost HMS Dartmouth *1684 (Battine)*

		£	s.	d.
Ordnance	No. 28	476	0	0
Carriages	No. 30	68	0	0
Shot, Cast	Tons 4	42	10	0
hammered	Tons ½	14	0	0
in tin case	Cwt. 4	4	0	0
*base & bur	Cwt. 2	1	0	0
iron barr	Cwt. 6	3	0	0
Hand grenades with fuses	No. 30	0	15	0
Ladels & sponges	No. 10	5	0	0
Cases for cartridge	No. 8	1	0	0
Musquetts Snaphaunce	No. 8	16	0	0
Spare rods	No. 8	0	2	0
Musquetoons	No. 4	4	4	0
Bandeliers	No. 20	1	5	0
Blunderbusses	No. 2	3	4	0
Pistols	No. 24	10	16	0
Corn Powder	Barrel 60	18	0	0
Match	Cwt. 5	5	5	0
Musquett shott	Cwt. 20			
Pistol shott	Cwt. ½	2	5	0
Sheet lead	Cwt. 1			
Aprons, lead	No. 30	0	15	0
Iron crowes	No. 20	0	5	0
Sledges	No. 1	0	3	6
Funnels of Plate	No. 1	0	3	0
Melt ladle, great	No. 1	1	6	1
small	No. 1	1	0	1

*Base and bur shot comprised of small Bullets, Nails, Stones, Pieces of old iron, fired in case form.

Apparently disputing these statements a table of cannon given by Robert Norton, gunner and engineer, in a work dedicated to the Duke of Buckingham in 1643 shows drakes, at that time, were both shorter and lighter than ordinary guns of the same bore diameter (Hogg, 1970: 270). These details were also confirmed by Botelar who held reservations about the use of drakes for sea service because their lightness allowed them to reverse too violently. In order to counteract this, the trucks had to be specially tightened on the axletrees of the carriage. They were also liable to overheat too easily due to the thinness of their metal, being of doubtful use in sustained battle (Botelar, 1634: 260–2)[4].

The most contemporary description of drakes was found in the following table (Venn, 1672: 72)

Name of piece	Height of bore	Lengths in diams.	Weight (lbs)	Weight of powder
Cannon Perrier	9, 10, 12	8	3500	3, 3⅓, 4
Demi-cannon drake	6½	16	3000	9
Culvering drake	5½	16	2000	5
Demi-culvering drake	4½	16	1500	3½
Saker drake	3½	18	1200	2

Binnings provides another table of proof charges for guns with taper bored chambers which are clearly one-third or less than those required for true bored cannon of the same calibre and recommends them as being most suited for use by a regiment in the field. He also emphasizes the dangers inherent in using such weapons in his instructions to gunners on joining a new ship. His first responsibility should be 'to diligently and carefully measure his guns to know whether they or any of them be fully fortified, reinforced or lessened in metal' and further 'that he shall search all his guns within, to know whether they be cracked, flaw'd or honeycombed and finding what ball she shoots to make the weight of the ball above the port, that thereby he may set the same mark or number upon the cartridge or case, that in time of service those who bring powder may not go wrong' (Binnings, 1676: 105–9).

From the contrasting evidence, one may conclude that apart from other ballistic advantages, a drake with a taper bored chamber, cast with the same amount of metal as a true bored gun, having a greater thickness of metal at the chamber (the bore at the rear of the chamber sometimes being only a quarter of the full) could accept the explosion of a heavier charge and produce a greater range than normal. Alternatively, by using less metal in the construction tapering the chamber and using smaller charges, the barrel could be made sufficiently strong to allow the same weight of shot to be fired over a shorter distance, giving the advantages of a lighter more manoeuvrable weapon.

Both variations appear to have been in service at different times, but the various Pepsyan tables and allowance lists viewed suggest the lighter variety predominated, being allowed to certain ships whose particular construction limited them to the lighter weapon. The *Dartmouth* appears to have been one of these, and by the establishment of 1687 was limited to almost a full complement of the lighter drakes[5].

In 1684–5 there were 9036 guns in naval service of which 14% were drakes. By the early 18th century they were no longer in use having fallen out of favour (*NRS*, 1903, Cat. of Pepsyan *MSS:* 243).

Work on site

On arrival on site in November each cannon was thoroughly inspected, numbered with a white tag and photographed against a scale. During the process it became apparent that all the complete guns on site were in an extremely soft and advanced state of deterioration to such an extent that it was possible to pass a knife blade through the metal of the barrel with ease. This is a condition not commonly experienced on similar sites in this country, being possibly due to the nature of the metal and the acidic content of the water in this particular area, which also appears to have protected the surviving timberwork from the ravages of the worm [6].

Recovery and conservation were ruled out as impractical and uneconomic.

The cannon were each covered by an uneven layer of fibrous concretion varying in thickness from 1·5 in (0·038 m) to 2 in (0·051 m) obscuring most of the features. By experimental chipping it was found that underneath the shell, despite the poor metal content, most of the mouldings were in relatively good shape. Surveys on similar sites have often produced vague measurements from amorphous concreted guns which are invariably of little use, due to fear of damaging the object. A precedent was necessary. Despite the fact that the guns were beyond recovery, much essential knowledge could be gained from the near accurate details obtained from a completely descaled gun on the seabed. Individual cannon representative of three sizes found on site, were therefore selected and divers were detailed to chisel away the crusts of concretion. Each gun was then measured and drawn. A fourth size was included in a further expedition in the spring of 1974.

The decision was fully justified, most of the features being clearly revealed and the mouldings often in pristine condition. Despite varying amounts of erosion, it is thought the measurements recorded are fairly accurate. The only difficulties were those of obtaining precise bore diameters, and the interpretation and tedious drawing underwater of the partly eroded detail at the cascabel and muzzle of some cannon. In some cases this had to be omitted.

Ship's main armament

Most of the information can be seen by referring to the main site plan, (Fig. 1), Tables 3A, B and C and Fig. 2 which show details and probable relative identification of guns and ammunition.

The 3-pounder, saker-drake and 6-pounder have rounded and similar moulding profiles in most respects, but their relative proportions in thickness of metal are entirely different (Figs 2D, C, B).

On first inspection cannon 15, 16 and 17 were thought to be minions due to their small

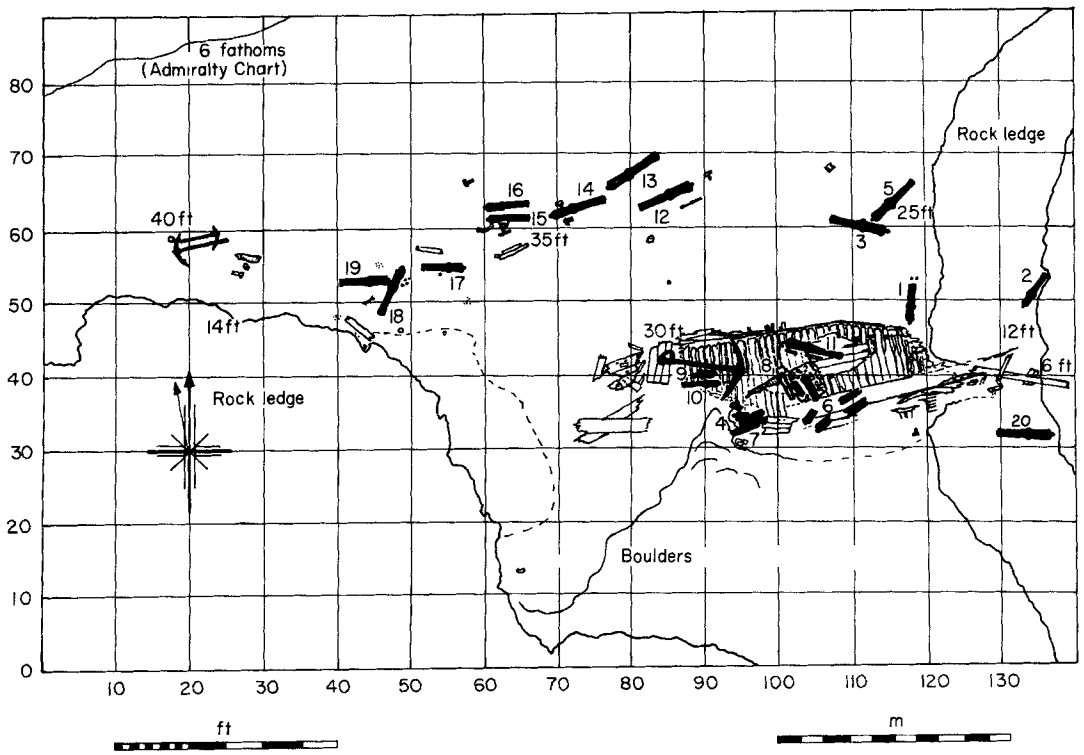

Figure 1. Site plan showing cannon indicated by relative numbers.

Table 3A

List of guns—Dartmouth *site and Duart Castle. (Columns 7 and 8 refer to numbered cannon illustrated on site plan, Fig. 1; column 1 refers to Fig. 2)*

Figure No.	Identification	Shot weight	Bore diam.	Length	Calibres	No. on plan	Similar guns	Ship location
2A	Demi-culverin	9 lb (4·08 kg)	4·2 in (0·107 m)	97·25 in (2·47 m)	22	13	3, 5, 12, 14, and 20	L.Deck
2B	6-pounder	6 lb (2·72 kg)	3·6 in (0·092 m)	84 in (2·13 m)	22	18	19	B.Chase U.Deck
2C	Saker-drake	4¾ lb (2·15 kg)	3·5 in (0·089 m)	67 in (1·70 m)	18	17	15, 16	U.Deck Fwd.
2D	3-pounder	3 lb (1·36 kg)	2·9 in (0·074 m)	62 in (1·57 m)	20	10	1, 2	Q.Deck
Not illus.	6-pounder	6 lb (2·72 kg)	3·6 in (0·092 m)	84·75 in (2·15 m)	22	—	Duart Castle	
Not illus.	Cutt?	7 lb?	3·7 in (0·094 m)	76 in (91?) (1·93 m)	?	—	Duart Castle	

Note. Guns 4, 6, 7, 8 on Site plan broken and unidentified.

external dimensions compared with the 3-pounder. This posed an enigma; the various establishments although conflicting in some respects, all referred to sakers or saker-drakes in quantity for upper deck use. None were apparent on site—could they all have been salvaged? As the number of shot recovered from the site grew, one of the most consistent sizes found was around 3·2 in (0·083 m) in diameter, and the area around guns 15, 16, and 17 yielded many of this calibre.

Finally, the detailed measuring of cannon 17, allied to research, established that these guns are in all probability specimens of the drakes discussed earlier in this report. Venn's table confirmed that these normally had a bore of 3·5 in (0·089 m) and were 18 calibres long and much lighter than the ordinary saker. This described our gun accurately. The external measurements analysed, did not relate to proportions for either true bored, ordinary fortified or double fortified culverins and lesser guns as laid down by Venn and confirmed by Sellers (Venn, 1672: 2; Sellers, 1691: 142–3), but tapered more towards the muzzle. These constructions were normally based on the thickness of metal at the various parts of the gun in relation to the bore diameter.

Table 3C is a comparative list of the details for these weapons shown against the theoretical

Table 3B

Comparative proportions of cannon showing thickness of metal at various parts based on diameters of the bore. Dartmouth *guns and contemporary theoretical constructions*

Construction	Cannon type	Cannon no.	Thickness of metal at the vent	Thickness of metal at trunnions	At muzzle neck
Venn (1672) and Sellers (1691)	Ordinary fortified culverings and lesser pieces		1	11/16	7/16
	Double fortified culverings and lesser pieces		1 1/8	15/16	9/16
General Armstrong (early 18th century)	All pieces		16/14	13/14	8/14
On site	Demi-culverin, Low	13	1 1/8	15/16	9/16
	Saker-drake	17	1	3/4	2/5
	6-pounder	18	1 1/6	5/6	3/8
	3-pounder	10	16/14	13/14	8/14

Table 3C

Grouping of shot diameters found—Dartmouth *site*

Description	Average diam.	Weight	Probable weapon	Remarks
Round Shot, Iron	6·0 in (0·153 m)	32 lb (14·5 kg)	Demi-Cannon	Probably Ballast
	4·4 in (0·112 m)	12 lb (5·4 kg)	12-pounder	
	4·2 in (0·107 m)	10·3 lb (4·7 kg)	Demi-culverin, ord.	
	4·0 in (0·102 m)	9 lb (4·1kg)	Demi-culverin, low	
	3·4 in (0·086 m)	6 lb (2·72 kg)	6-pounder	
	3·25 in (0·083 m)	4¾ lb (2·15 kg)	Saker-drake	
	2·8 in (0·071 m)	3 lb (1·4 kg)	3-pounder	
	2·0 in (0·051 m)	1·3 lb (0·6 kg)	Falconet	
Round Shot, Lead	1·69 in (0·043 m)	1 lb (0·045 kg)		
	0·69 in (0·018 m)		Musket	14 to the pound
	0·62 in (0·016m)		Carbine & Musketoon	20 to the pound
	0·52 in (0·013 m)		Pistol	34 to the pound
	0·49 in (0·012 m)		Musketoons or Blunderbuss	40 to the pound
Grenades Iron,	4·0 in (0·102 m)		Hand grenade	Approximate diam. of 9 lb shot
	3·38 in (0·086 m)	1·8 lb (0·084 kg)	Hand grenade	Approximate diam of 6 lb shot
	2·95 in (0·075 m)		Hand grenade	Approximate diam. of 3 lb shot

contemporary dimensions suggested by Venn, Sellers and Colonel Armstrong, Surveyor General of Ordnance in 1716. From these it can be seen that the 3-pounder follows Armstrong.

The demi-culverin (no. 13) appears to be a classic double fortified gun of the period and similar 9-pounders have recently been measured on the Scilly Isles Tearing Ledge Site dated 1707 (Cowan & McBride, 1975; Appendix II).

The moulding profiles of this gun however, are much sharper and more pronounced than those of other calibre guns on the *Dartmouth* (Fig. 2A).

A brief but enlightening statement by Captain Pottinger testifies to the effectiveness of these the largest guns on board, when reporting his action against McDonald, Chief of Sleat, whilst off the Isle of Skye. He wrote 'playing smartly upon the same for two or three hours with our best guns, Major Ferguson landed our men under protection of my guns, burned both houses to the ground in the highlanders view, the whistling 9-pounders sending them scampering to the hills to overlook what they could not prevent' (Prebble, 1966: 94).

The 6-pounders (nos 18 and 19) which are adjacent to the two small bow anchors are obviously bow-chase guns. These needed to be relatively longer than the other upper deck guns, as the carriages could not come square to the ships side at the bow to fire forward, and the blast from a shorter weapon could damage the upperworks and destroy the gunports (Sellers, 1691: 185).

No gunfounders marks could be discerned on any gun, but the remnants of possible figures or

letters appear on the breech ring of one. The Ordnance records reveal three principal gun-founders contracted to supply cannon at this time; Westerne, Baker and Benson, but their respective marks are not recorded.

Both the 3-pounders on site and the 6-pounder at Duart Castle carry a broad arrow or pheon, denoting government property, on the first reinforce[7]. In December, 1690, the same John Packman responsible for carrying the guns of the *Dartmouth* in 1689 was paid £17. 11s. 11d for engraving the broad arrow and weight on several guns at Woolwich after proof, by now a standard practice. (WO 51/38: 88).

The second gun from Duart is dissimilar to the others and in the absence of a pheon there is no evidence to suggest it is from the ship. However, the proportions appear to be late 17th century.

The trunnions of all the cannon have their centre line of axis passing below the bottom of the bore and not central. This was the practice throughout Europe at this time, later decried by Muller as absurd due to the pendulous motion created in firing which often destroyed the carriage. (Muller, 1768: 41). On the 3-pounder, saker-drake and 6-pounder the trunnions are placed 3/7 of the length of the piece from the base ring, as suggested by Muller. Those of the demi-culverin differ in that they appear to be placed 3/7 of the length of the bore as described by Moore.(Moore (T. Moretti), 1683: 37). There is no apparent relationship between bores and trunnion diameters.

The artillery tables in Smiths *Seamans' Grammar* are frequently quoted as an authoratative source on sea gunnery, but comparison of these, and the tables in Sellers (1691), with the Ordnance Office records and evidence from the

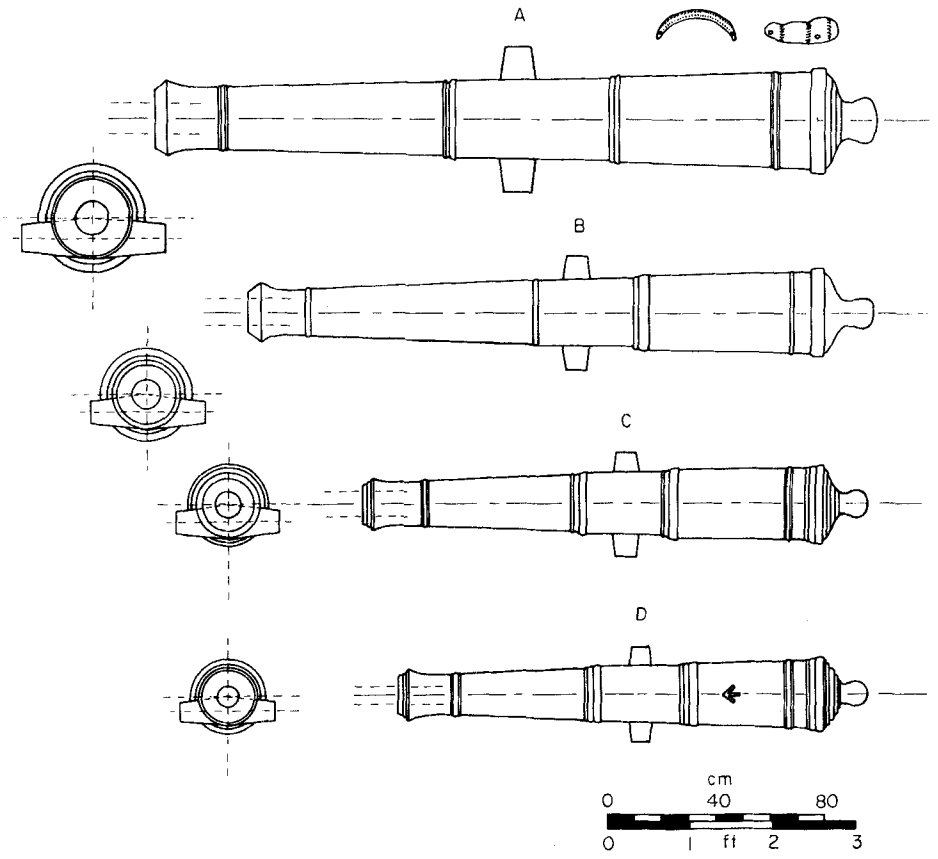

Figure 2. A. 9-pound demi-culverin (no. 13) showing lead apron vent cover. B. 6-pounder (no. 18). C. Saker-drake (no. 17). D. 3-pounder (no. 10).

Dartmouth guns suggest that the lengths shown by both Smith and Sellers are relevant only to shore cannon and not reliable when applied to British naval shipwrecks of the period. Naval guns were of generally shorter calibres. In addition the windage shown by Smith, which in the majority of cases is shown as 0·25 in is very suspect. Binnings, a much more reliable source remarked 'some have thought it to declare one-quarter of an inch sufficient wind to all balls, and others have declared that a twentieth part of the diameters of the ball is sufficient wind for all guns. I hold that a quarter-inch to be altogether absurd', and presents the geometry necessary for working out the correct windage, which he says should normally be just 20½ parts of the shot diameter (Binnings, 1676: 49, 51). Moore states that the usual rule was to make it 'the one and twentieth part' (Moore, 1683: 10), whilst Sellers suggests it should be one-twentieth of the bore diameter (Sellers, 1691: 147).

A lead apron 0·12 in (0·003 m) thick measuring 10 in X 10 in (0·254 X 0·254 m) was found in close association to a 9-pounder (Fig. 2A). The apron was well rounded, bearing the contours of the base ring, vent field and vent astragal, over which it fitted snugly. Two lace holes were provided on either side, at the edge, for securing it to the guns. After loading the charge, touchholes were usually plugged with tallowed hemp and the aprons were fitted over the top to ensure the touchhole and charge remained dry until the gun was brought into use. Lead aprons were in use from the 16th and well into the 19th century. According to Steele in 1821, those for 9-pounders measured 12 X 10 in (0·305 X 0·254 m) being tied by two pieces of marline each 6 ft long (1·8 m). (Steele, 1821, **II**: 104).

Ammunition, main armament

Iron round shot suited to all *Dartmouth* guns were found in various locations throughout the site and are shown in Table 3A; some however, bear the mark of the broad arrow, paralleled by the sand cast iron shot recovered from the remains of HMS *Sapphire* (5th rate) wrecked off Newfoundland in 1695 and currently under archaeological investigation. (Barber, 1975: 6).

In addition, sizes of shot relevant to a falconet, and lead shot of 1 lb (0·045 kg) were discovered, but no trace of appropriate weapons. A reference to several guns being recovered by salvors in the years following the wrecking is known to exist, but has not yet come to hand. It is presumed that the first items salvaged were probably the lighter, more valuable guns. The log of Captain Finch of the *Fanfan* sloop records an interesting entry, when at anchor off Greenock on 27th August 1690. 'This morning the *Dartmouth* sailed for the Sound of Mull. Captain Pottinger, the Commander, sent his Lieutenant on board in my absence and took away two small brass guns from on board the *Fanfan* (Adm. 51/343). The Admiralty Disposition list for 1689/90 gives the *Fanfan's* armament as 6 guns, 2 pates (Adm. 8/2). Pates is an abbreviation for Petriero a braga, the short range anti-personnel breech loading swivel guns often made of brass and sometimes called murderers. These were normally mounted in the waist, forecastle and quarter deck areas, and apart from firing stone and case shot could well have fired the 1 lb calibre lead shot found.

At the shallow south eastern end of the site, in proximity to cannon 11 and the surviving timberwork, are several large mounds of concretion bearing much ironwork in the form of shot, iron ingots and sections of broken cannon. Two of the latter could be described as cutts. The fact however, that large numbers of the shot were too big for the *Dartmouth* guns, some being 32 lb (14·5 kg) and relevant only to guns of a 1st or 2nd rate, tend to indicate that this is a ballast area of which the broken guns have formed part. A similar situation was experienced during the survey and identification of the *Mary*, Charles II's yacht, by the author, in 1972 (McBride, 1973: 66). It has been established that this was common practice of the period. In June 1675, broken guns and unserviceable shot were ordered by the Navy Board towards the ballasting of the 6th rate HMS *Larke* (*NRS* Cat. of Pepsyan MSS, **III**: 63).

Hand grenades

Specimens of three different sizes of cast iron hand-grenades were recovered, each with tapered beechwood plugs inserted through the aperture in the shell which was partly filled with an amount of congealed powder[8].

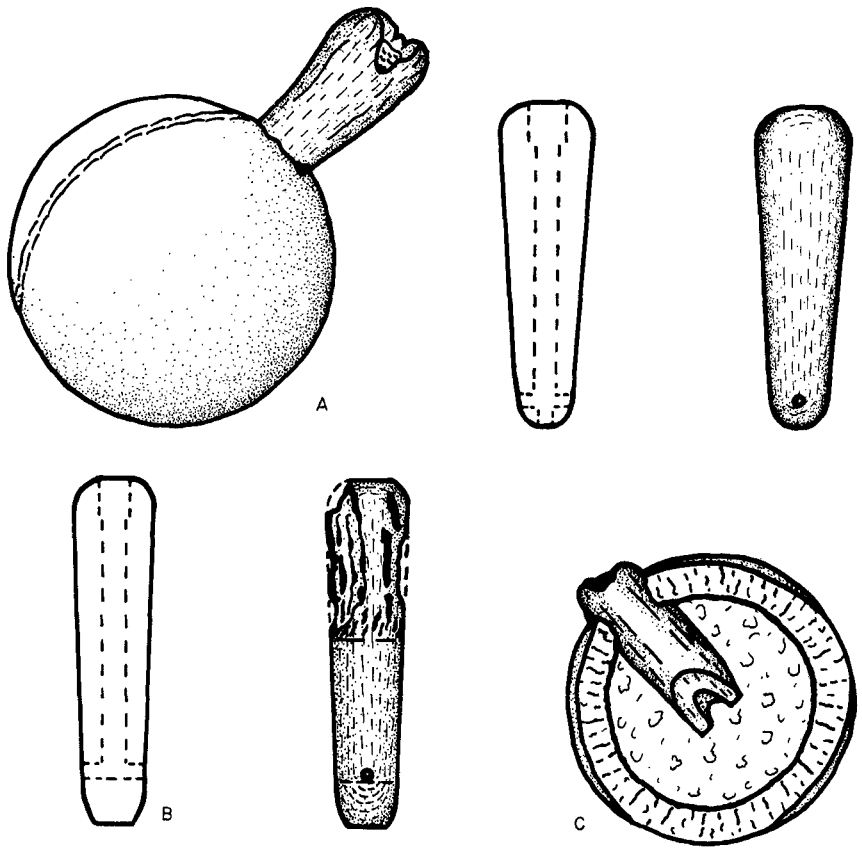

Figure 3. A. 3·38 in (0·086 m) hand-grenade showing relative section and full fuse recovered. B. Fuse of 3·50 in (0·089 m) length recovered. Note the termination of fusehole in comparison to 3A. C. Cross section of 2·95 in (0·075 m) grenade. Scale 1 : 2.

Moulding flashes ran around the equator in line with the aperture. (Two of these are shown in Fig. 3A, C.)

Venn advised the use of as little wrought iron as possible in the construction and described the normal sizes in use as being equivalent in diameter to 5, 6 or 8 lb shot, weighing 1, 1·5 and 2 lb (0·454, 0·847, 0·907 kg) respectively. He also gave the normal proportions based on parts of the diameter of the grenade. The thickness of the shell 1/9, the length of the fuse 2/3, the fusehole 1/18, inner end 1/9 and outer end of the fuse 2/9 of the diameter. The top of the fuse must be broad and rounded like a hemisphere. They were normally filled with a slow burning gunpowder compound, fastened with tow or oakum and a composition of 4 parts pitch, 2 parts colophonia, 1 part terebinthe and 1 part wax (Venn, 1672, **III**: 8).

Dartmouth grenades were equivalent to 3, 6, and 9 lb shot. Most of the fuses were worn or badly distorted, but by reconstruction there were three distinct types.

The commonest (Fig. 3A) is relevant to a 3·38 in (0·086 m) diameter grenade and appears to be lathe turned, tapered and smoothed to a high standard, both ends being carefully rounded. The proportions do not conform to Venn, but the inner end of $\frac{9}{16}$ in (0·014 m) is 1/6 the diameter of the grenade, whilst the small fuseholes at the inner end are $\frac{3}{32}$ in (0·002 m) or 1/36. The outer end is 1 in (0·026 m) whilst the overall length is 3·38 in (0·086 m) exactly the diameter of the shell from which it protrudes by half it's length. There is a small hole drilled through the fuse plug at right angles about ¼ in (0·006 m) above the point.

A fuse of a second design (Fig. 3B) was found

loose and could not be related to a particular grenade, but it has an overall length of 3·5 in (0·089 m). It is lathe turned also, but it is only partly rounded to a flat tip at the narrow end. It also differs particularly from the first specimen in that the central bore hole terminates where it enters a small hole drilled at right angles through the plug ½ in (0·013 m) above the tip instead of continuing to the end. The hole is $\frac{1}{8}$ in (0·003 m) in diameter.

The third type was found in a grenade of 2·95 in (0·075 m) (the diameter of a 3 lb shot) (Fig. 3C) and is less tapered and rough formed. The plug is ¾ in (0·019 m) diameter above the inner end which is paired to a tapered chisel point. The fusehole is $\frac{5}{16}$ in (0·008 m) in diameter.

Although the latter compares favourably with the following description of fuses by Muller nearly a century later, it is interesting to note that Venn in the 17th century makes no mention of an additional quick match which could be readily cut to timed requirements. 'Fuses are chiefly made of very dry beechwood. They are turned rough; bored at first, and then kept for several years in a dry place. The diameter of the hole is about a quarter of an inch at the bottom, and the head is made hollow in the form of a bowl. The composition is drove in with an iron driver whose ends are capped with copper to prevent the composition from taking fire, and equally hard as possible, the last shovelful being all mealed powder, and two strands of quick match laid across each other being laid across it, the ends of which are drove into the bowl, and a cap of parchment tied over it until used. When the fuses are drove, the lower end is cut off in a slope, so as the composition may give fire to the powder' (Muller, 1768: 204).

Small arms ammunition

Two specific sizes of lead shot were found in great quantity. These are musket and pistol shot of 0·69 in (0·018 m) and 0·052 in (0·013 m) respectively, sizes which continued to be standard for the service smooth bore musket and pistol into the 19th century. These were commonly differentiated by their weight ratio to the pound avoirdupois, as described by Muller 'the diameter of the musket bores differ not above one fiftieth part from that of the bullet, for if the shot but just rolls into the barrel, it is sufficient. The Government allows 11 bullets in the pound for proof of muskets, and 14 in the pound or 29 in the two pound for service. Twenty-eight in the pound for proof of pistols and 34 for service' (Muller, 1768: 14).

Battine shows an allowance of 20 snaphaunce muskets and 24 pistols to the *Dartmouth*. The larger rates were also entitled to a small proportion of matchlocks, but by now the snaphaunce or flintlocks predominated.

A few shot of two other sizes were also obtained. These were 0·062 in (0·016 m) and 0·49 in (0·012 m) or 20 and 40 to the pound respectively. Two blunderbusses and four musketoons were also listed by Battine. In 1598, Henrik Thielmans of Echton was granted a patent for 'certain types of gun called a donderbuss that are concealed inside the ship, useful and advantageous in inflicting damage against the enemy, the same on land as on sea' (Doorman, 1940, PAT. (43)). Blunderbusses came into English naval use during the Commonwealth period. (CSP (Doms), 1657: 46). Their large bore, multi-shot capability were ideal for clearing decks, repelling boarders and the close quarter fighting between ships. The heavier naval models were often fitted with swivels (Baxter, 1970: 12–14).

A naval musketoon is more difficult to define and the name was applied to a variety of weapons in the 17th and 18th centuries. Originally it appears to have been a short form of carbine for cavalry use (Blackmore, 1961: 32). The Marquis of Worcester's *Century of Inventions* (1655) quotes 'a way for musketoons fastened to the pummel of a saddle so that a common trooper cannot miss to charge them, with 20 or 30 bullets at a time even in full career' (Oxford English Dictionary). The relative cost shown by Battine is more than a musket and less than a blunderbuss. It was probably a short, light form of blunderbuss evolved for ship use from the bastard carbine. Botelar expressed a particular preference for the latter, 'I know of none fitter than the ordinary musket; it being not only good on execution and of good reach, but manageable enough by an ordinary man, whose station is to be upon the hatches. As for such men who are to be betwixt the decks or in the round house, or under the half deck or forecastle, there can be no better or more useful weapon

be put in their hands than the short carbines being well breeched and full bored' (Botelar, 1634: 261). Blunderbuss, musketoon and carbine could all have fired the others shot, and Muller again confirms that 20 to the pound was the standard for a service carbine in the mid-18th century (Muller, 1768: 14).

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References

Adim Series, *Admiralty Records.* Public Records Office.
Barber, V., 1975, *HMS Sapphire project proposal report 1975.* Newfoundland Marine Archaeological Society.
Battine, E., 1684, *The method of building rigging, apparelling and furnishing H.M. ships of war.*
Baxter, D. R., 1970, *Blunderbusses.* London.
Binnings, T., 1676, *A light to the art of gunnery.* London.
Blackmore, H., 1961, *British military firearms 1650–1850.* London.
Botelar, N., 1634, *Six dialogues about sea service.* Navy Record Society, 1929.
Clowes, W. Laird, 1897, *A history of the Royal Navy.* London.
Cowan, R., 1975. *Tearing ledge site, Scilly Isles.* Interim report appendix II. P. McBride (Survey report of guns). Privately Printed.
CSP (Dom) *The Calendar of State Papers (Domestic series).* Public Record Office.
Derrick, C., 1806, *Memoirs of the rise and progress of the Royal Navy.* London.
Doorman, G., 1940. *Octrooien voor uitvindingen in de Nederlanden uit de 16e–18e eeuw met bespreking van enkele* onderwerpen uit de geschiedenis der techniek door. D. Gravenhage.
Ffoulkes, C., 1937, *The Gunfounders of England.* Cambridge.
Hall, A. R., 1952, *Ballistics in the 17th century.* Cambridge.
Hogg, O. F. G., 1963, *English artillery 1326–1716.* London.
Hogg, O. F. G., 1970, *Artillery, it's origin, heyday and decline.* London.
Mainwearing, H., 1644, *The life and works of Sir Henry Mainwearing (Seaman's dictionary).* Navy Record Society, 1922.
McBride, P., 1973, *The Mary Charles II's yacht her history, importance and ordnance. Int. J. Naut. Archaeol.,* 2: 59–73.
Monson, W., 1635, *The naval tracts of Sir Wm. Monson, Vol IV* Navy Record Society, 1913.
Moore, J., 1683, *A general treatise on artillery.* (Translated from the Italian T. Moretti). London.
Muller, J. 1768, *A treatise on artillery.* London.
NRS, 1903, *A catalogue of Pepsyan MSS Vol. I & IV* Navy Record Society.
NRS, 1946, *Journals and narratives of the 3rd Dutch War* Navy Record Society.
NRS, 1918, *The life of Sir John Leake* Navy Record Society.
Prebble, J., 1966, *Glencoe, the story of the massacre.* London.
Sellers, J., 1691, *The sea gunner.* London.
Smith, J., 1692, *A seaman's grammar and dictionary.* London.
Steele, D., 1821, *Elements and practice of rigging, seamanship and naval tactics,* II. London.
Venn, T., 1672, *The complete gunner (from military and maritime discipline).* London.
WO *War Office Records (Ordnance Office Series).* Public Records Office.

Notes

[1] Establishments of 5th rates similar to the *Dartmouth* show great variation.

	1687 (WO 55/1762)			*1689 (WO 55/1763)*		
Garland	34	16 demi-culverin drakes 8 sakers fort 8 sakers cutt 2 3-pounders	*Milford*	32	22 demi-culverin 10 3-pounders	8 ft 5 ft

Guernsey	32	16 demi-culverin drakes	*Pembroke*	32	4 demi-culverin	8 ft
		14 6-pounders			20 6-pounders	7 ft
		2 3-pounders			8 3-pounders	5 ft
Mermaid	30	8 demi-culverins fort	*Portsmouth*	32	4 8-pounders	
		18 sakers fort			20 6-pounders	7 ft
		4 falcons			8 3-pounders	5 ft

[2] A list of guns in store at Portsmouth (1689) gives each type and size listed in five columns under:
Fortified
Drakes
To be proved
Muzzle to be cutt
Unserviceable (WO 55/1763)

[3] The *Fairfax* in 1672 carried 'two saker drakes cutts of brass on the poop' (*NRS*, 1946: 189). An example of the variation of gun possible.

[4] Oppenheim states the opposite, claiming that there was less recoil with drakes (*NRS*, 1913, Monson's Tracts IV: 39). The contemporary account of Botelar, a seafaring captain and gunner of the time would appear more reliable.

[5] The earliest establishments of 1677 as shown in NRS Catalogue of Pepsyan *MSS:* 234–5 are unreliable in relation to 5-rates. Tables conflict, showing 12-pounders and demi-culverins in one, as against culverins and sakers in the other. The latter would appear more correct as confirmed by later establishments.

[6] A recent survey carried out by the author on the Scilly Isles Tearing Ledge Site (1707) revealed solid guns in much better state of preservation beneath a particularly obstinate adhering, protective type of concretion shell 0·05 m thick.

[7] The derivation of the pheon or broad arrow mark denoting crown property is a subject of controversy. As early as the reign of Richard II it appears to have been in use as a royal mark. 'In the 10th year of Richard II, Thomas Stokes was brought before the Mayor and Alderman and questioned that he had pretended to be an officer and taker of ale for the household of our said Lord the King, and at divers times within the preceding 8 days had gone to the houses of several brewers and there marked several barrels full of ale with a mark called—AREWEHEDE—saying that those barrels were for the household of our Lord the King; whereas in truth he was not any officer belonging to the same our Lord King' (Hogg, 1963: 62).

[8] Venn explains the derivation of grenade from its similarity to the fruit Pomegranite. Grenades at this time were manufactured in a variety of ways, but principally they were made of iron, latten (copper and brass), earthenware or glass. In 1701 the *London Post* records amongst other things entered into the Customs House for the East India Company '4400 iron grenades and 1000 glass grenade shells'.