Odyssey Papers 23

A Late 17th-Century Armed Merchant Vessel in the Western Approaches (Site 35F)

Neil Cunningham Dobson
Odyssey Marine Exploration, Tampa, USA

Sean A. Kingsley
Wreck Watch Int., London, United Kingdom

Shipwreck site 35F comprises the poorly preserved remains of a merchant vessel lost at a depth of 110m in the Western Approaches to the English Channel. A small quantity of elephant tusks, copper *manilla* currency bracelets and hull remains are associated with a large cluster of 36 iron cannon. The wreck and cargo have been heavily impacted by offshore fishing activities, especially scallop dredges, and a further 12 cannon have been dragged offsite. Following an initial ROV dive in 2005, Odyssey Marine Exploration conducted a survey and excavation program in 2006 using the Remotely-Operated Vehicle Zeus, which was followed up by site monitoring in 2008 and 2009. Fishing related impacts were recorded during all visits.

Site 35F contains signature assemblages typical of 17th-century trade with West Africa. Material culture, including the earliest wooden folding rule found on a shipwreck, reflects a likely English origin. This article presents the results of the fieldwork and possible historical interpretative scenarios. Based on available data the shipwreck may be identifiable as a Royal Africa Company merchant vessel operating between *c.* 1672 and 1685. As well as the Westernmost example of a West African trader and the only example of this date known off the UK, if accurate site 35F would be the first Royal Africa Company shipwreck identified worldwide.

1. Introduction

Since 2005 Odyssey Marine Exploration has been conducting a program of offshore archaeological surveys in the Western Approaches to southwestern England and in the western English Channel using side-scan sonar, magnetometry and Remotely-Operated Vehicle (ROV) reconnaissance. Up to October 2008 the Atlas Shipwreck Survey Project discovered 267 shipwrecks in depths of up to 190m across an area of 4,725 square nautical miles. The program is the most extensive deep-sea shipwreck survey conducted worldwide.

In 2005, shipwreck site T7a35f-5 was investigated in about 110m of water in the Western Approaches, beyond the territorial waters and contiguous zones of England, France and Ireland.[1] A side-scan image revealed an anomaly composed of linear, cannon-like features and parallel-sided furrows running directly through it, evidence of impacts from the offshore fishing industry (Fig. 1). Visual ROV confirmation demonstrated that the site had been profoundly damaged, with hull remains, cannon and cargo severely broken up, scattered and destroyed. Less than an estimated 5% of the lower hull beneath the turn of the bilge survives, largely in areas where structural remains are pinned down by cannon or in a few cases are still inter-connected to the heavily eroded keel. The cargo is very widely scattered and predominantly destroyed.

Between 16 August and 11 October 2006 Odyssey initiated a 22-day survey and selective excavation of the wreck from the 76m-long, 1,431 gross-ton research support vessel R/V *Odyssey Explorer* using the ROV Zeus. The interlocking archaeological objectives of the project included:

- To produce a site photomosaic (Fig. 8).
- To generate a site plan (Fig. 9).
- To characterize the wreck's site formation and cargo composition (Fig. 10).
- To recover select artifacts for study, leading to site dating and interpretation.
- To determine the types of impacts and level of risk to which the wreck has been and continues to be subjected.

A selection of 58 diagnostic artifacts ranging from ballast stones to patches of lead hull sheathing, cannonballs and *manilla* copper bracelets were recovered from the site. This limited assemblage derives almost exclusively from the southern half of the wreck, identified as the bows (see Section 4 below and Fig. 10). The project produced

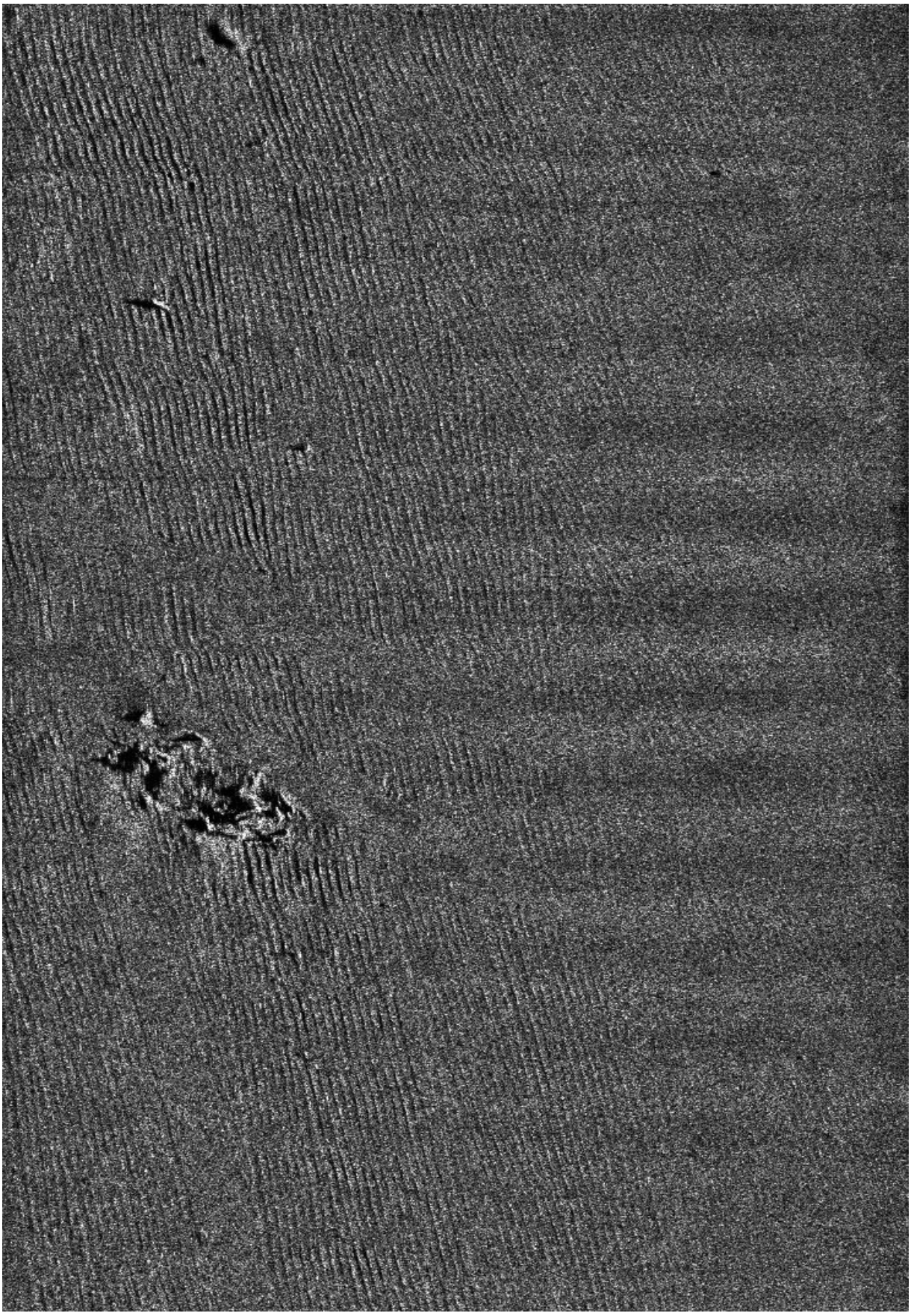

Fig. 1. A side-scan image of site 35F showing parallel-sided furrows made by scallop dredges running through the wreck. Note the cannon dragged offsite at left.

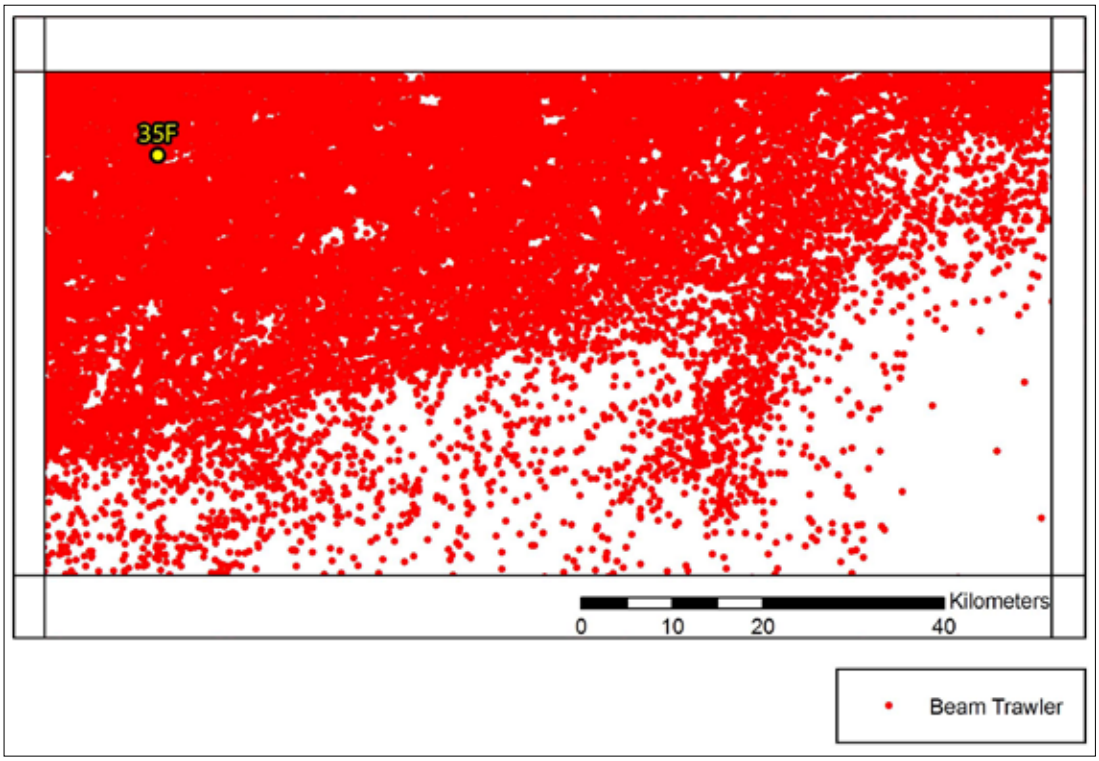

Fig. 2. Site 35F in relation to beam trawler activities.

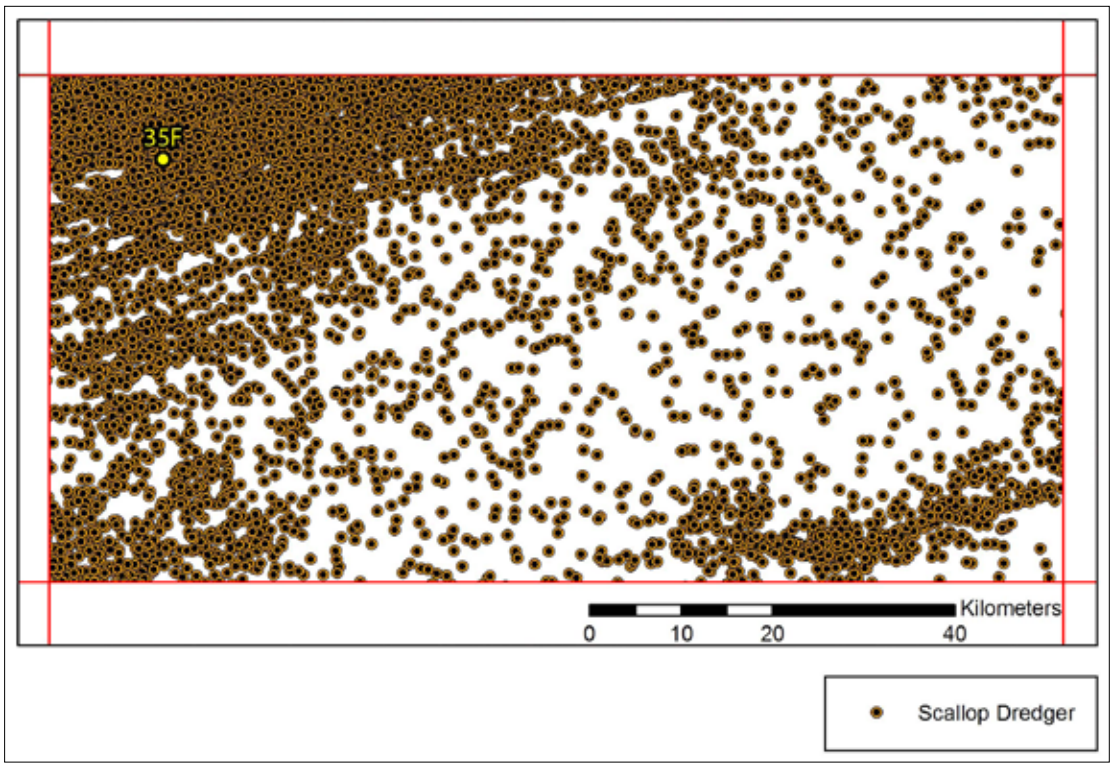

Fig. 3. Site 35F in relation to scallop dredge activities.

provisional evidence to interpret the site as an armed merchant vessel most probably dating to the later 17th century and transporting a consignment of elephant tusks – the most Western example of this form of shipwreck discovered to date – and seemingly iron cannon stowed as saleable ballast. Both the tusks and *manilla* bracelets, of a form used as primitive currency, suggest a sphere of circulation for the ship's final voyage that included trade with West Africa, or interaction with other ships or merchants engaged in the African trade. The vessel is likely to have been transporting a further primary organic cargo, which is no longer preserved. The recovery and study of a wooden folding rule, the best evidence available for the vessel's nationality, favors an English origin.

2. Environmental Context

Site 35F lies within the Western Approaches to the English Channel, a 520km-long funnel-shaped seaway aligned west-southwest to east-northeast. At the Approaches this seaway is 160km wide and opens into the North Atlantic Ocean. The Channel floor is a smooth, shallow shelf that gently inclines from a water depth of 30m at Dover Strait towards the continental shelf with a gradient of 0.3-0.5% (Gibbard and Lautridou, 2003: 195-9), reaching 120m deep at the Western Approaches. The Channel displays a maximum tidal range of 6-10m (Grochowski *et al.*, 1993: 683). The tidal stream is generally rotary clockwise at the Western Approaches. At depths of about 100m, close to where site 35F lies, the strength of the tidal stream 1m from the bottom is about half of the surface stream (Hamblin *et al.*, 1992: 80).

The prevailing sedimentological marine environment formed about 20,000 years BP, when the Würm regression was at its maximum and a low, smooth and straight shoreline along the Atlantic margin lay about 130m below the present sea level. Once the Holocene transgression began about 16,000 years BP, advancing gradually towards the northeast, the terrigeneous deposits were reshaped and redistributed. The 100m isobath that marks the entrance to the English Channel at the Western Approaches was reached and submerged around 15,000 BP (Larsonneur *et al.*, 1982: 860).

As the sea deepened between about 10,000 and 7,000 BP, bottom currents deposited a thin and discontinuous veneer of sandy gravel over solid formations and channel-fill sediments. The deposits of gravel and immobile sediment rarely exceed 0.5m deep, but are locally thicker where they lie on palaeovalley infill sediments. They are generally too coarse to be moved by currents (Grochowski *et al.*, 1993: 684). The sand fraction is typically coarse grained, with a mean grain size varying from medium (0.25-0.55mm) to coarse (0.5-1.00mm) (Hillis *et al.*, 1990: 79, fig. 49). It is classified as poorly or moderately sorted due to the presence of shell debris broken down by strong current action and reduced to sand-fraction size.

Vessel Type	Number	Percent of Total
Beam Trawler	33,741	63.2%
Bottom Seiner	3	0%
Gill Netter	4,277	8%
Freezer Trawler	75	0.1%
Lobster/Crab Potter	247	0.4%
Long Liner	1,971	3.7%
Pair Trawler	24	0%
Scallop Dredger	7,610	14.2%
Side Trawler	70	0.1%
Stern Trawler	173	0.3%
Trawler (Unknown)	8	0%
Unknown	5,128	9.6%

Table 1. The different fishing types conducted in the 76 x 55km ICES sub-square in which site T7a35f-5 is located (VMS satellite data 2000-2008). Total sample size: 53,327 sightings.

The seabed magaclasts are dominated by Cretaceous chert flint, including fresh, little-worn examples retaining their white patinas and black hearts, as well as brown worn flints derived from Tertiary gravels. Both varieties may have derived from seabed or cliff erosion during the transgression, by further cliff erosion during the Holocene adding to the deposit nearshore, or by fluvial transport during Pleistocene regressions (Hamblin *et al.*, 1992: 82). These deposits are conspicuous on the surface of many wooden shipwreck sites within the Atlas survey zone, immediately underlying the cultural assemblages.

3. Impacts

Site 35F is located within a designated International Council for the Exploration of the Seas sub-square measuring approximately 76 x 55km, which is a densely fished catchment zone. Satellite reconnaissance observed 53,327 fishing vessel sightings across this zone between 2000 and 2008 (Table 1). The sub-square is dominated by beam trawling (63.2%; Fig. 2), followed by scallop dredging (14.2%; Fig. 3), a high statistic that dovetails with the physical evidence of extensive dredge damage to site 35F visible on side-scan imagery taken at different times in 2006 and visibly conspicuous on-site. Gill netting is also highly represented (8%), with long line fishing less problematic (3.7%) in this zone.

Fig. 4. Steel fishing gear cable trapped beneath iron cannon to the south of the site.

Fig. 5. Fishing net snagged on cannon C5.

Fig. 6. Synthetic fishing net partly buried on the site.

Fig. 7. Fishing net cable snagged on site 35F.

Some 131 fishing vessel movements were documented by satellite during the 2000-2008 timeframe operating within 1km of site 35F: beam trawlers (45%), scallop dredgers (29%), gill netters (5.3%), stern trawlers (1.5%) and 17.5% undefined.

These data indicate that in addition to being heavily impacted in 2006, site 35F has also been damaged in the recent past. The wreck may be realistically defined as at high risk from destruction or unintended displacement or removal (in the case of cannon). The frequent passage of trawlers and scallop dredges across the wreck is demonstrated graphically by visual criteria:

A. The hull has been almost completely destroyed other than the heavily abraded keel and remains of approximately seven frames.
B. Sections of non-synthetic fishing net are snagged on an iron cannon, synthetic net is partly buried on the site, and steel trawler cable is caught on iron cannon and a deposit of elephant tusks to the south of the site (Figs. 4-7).
C. Almost no ceramic wares survive from either the cargo or domestic assemblage. Just five body sherds and two base fragments were recovered during the excavations (Figs. 11-12, 57-59). No rims were identified. The implication is that where vessels have not been snagged in nets, trawler impacts have broken up the ceramic assemblage so severely that bottom currents have been able to wash it offsite.
D. The cargo of tusks has been scattered around the site and, in cases, ends apparently snapped off.
E. 12 iron cannon are located considerable distances offsite (Fig. 13). The fact that six guns are located up to

Fig. 8. Photomosaic of shipwreck site 35F (2006).

Fig. 9. Plan of site 35F based on the 2006 photomosaic.

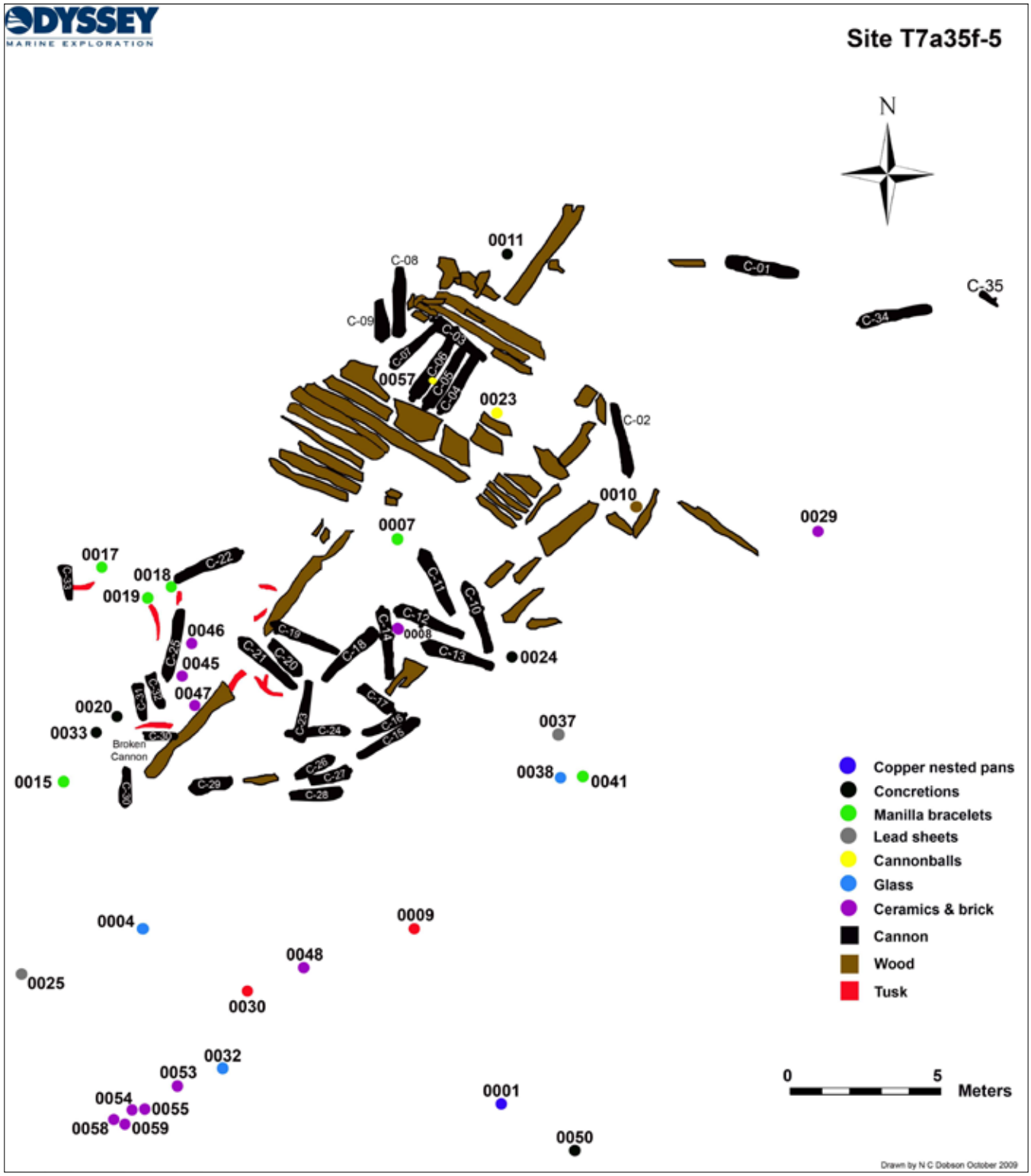

Fig. 10. Plan of site 35F based on the 2006 photomosaic and measurements taken in 2009.

Fig. 11. The pottery assemblage, reduced to a few sherd fragments.

Fig. 12. ROV Zeus' limpet suction system recovering a typically preserved potsherd.

60m away from site 35F to the north (C44) and 300m to the southwest (C46) suggests that both of these depositional patterns are unlikely to have been caused by ordnance jettison when the ship was sinking, and were likely dragged there by trawl nets.

F. When initially dived in 2005 and recorded in 2006, seven iron cannon lay parallel to one another and longitudinally overlying the keel on the northeast section of the wreck (Fig. 14). During a 2009 monitoring survey, cannon C3 was observed to have been relocated from a position at the easternmost end of this cannon concentration to now overlie the muzzle ends of this assemblage, with its cascabel facing west (Fig. 15 and compare Fig. 9 to Fig. 10). The only explanation for this disturbance is that C3 has been flipped by a trawler/scallop dredge running through

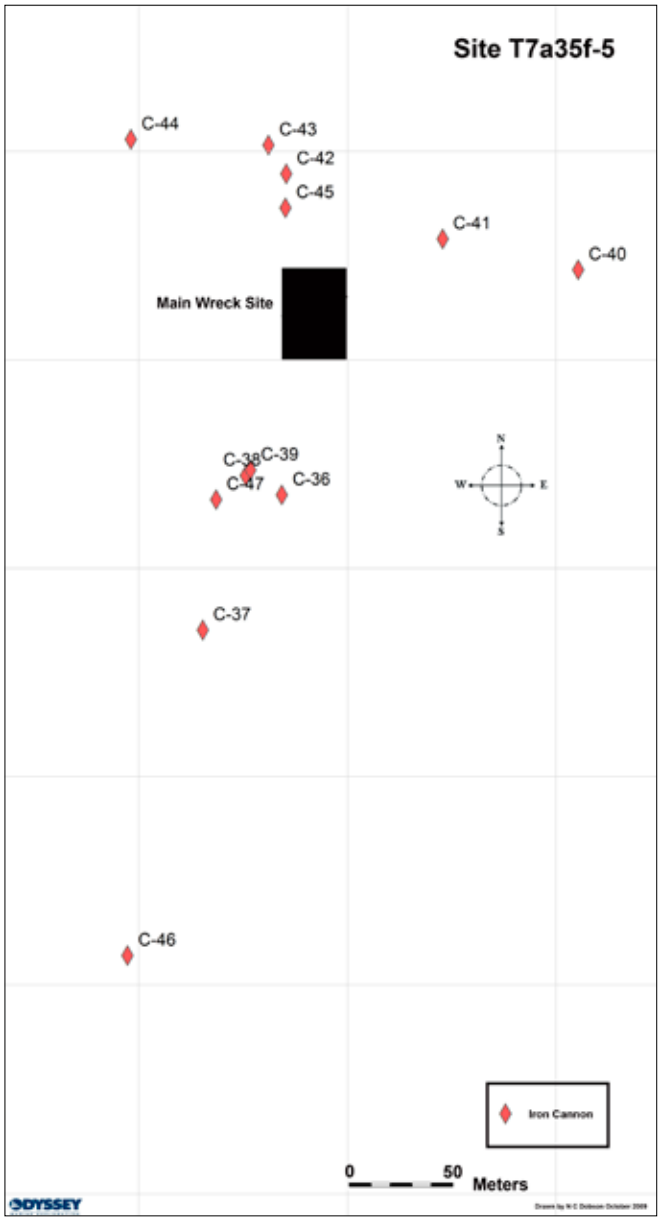

Fig. 13. Distribution of 12 cannon dragged offsite by fishing vessels in relation to site 35F.

the wreck site from the south towards the north. Additional cannon bear evidence of fishing cable abrasion and modern breakage (Figs. 16-17).

G. Parallel-sided scallop dredge furrow scars are visible on side-scan images running directly through the entire shipwreck site (Fig. 1). These extend in a direction from the east-northeast to west-southwest (70°/250° line bearing) and were caused by scallop fishing vessels towing 18 dredges per side.

H. Scallop dredge teeth scars are physically visible on some ballast stones and have cut into some cannon surfaces (Fig. 18).

Fig. 14. Cannon C3-C7 to the north (stern) of the site in 2005 and 2006, lying parallel across the keel.

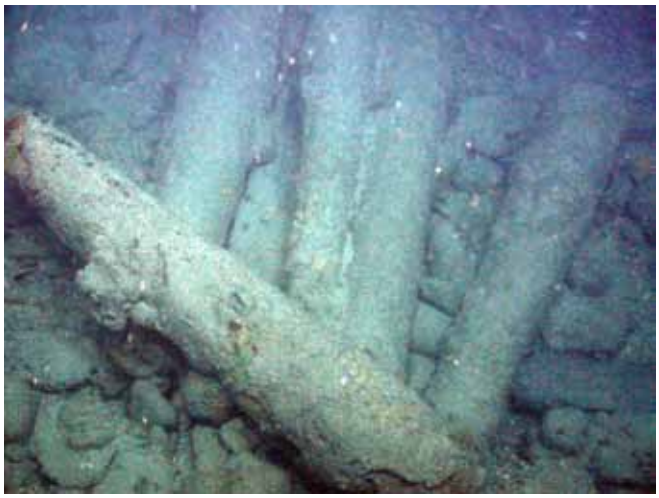

Fig. 15. Cannon C3-C7 in 2009 with C3 clearly displaced by fishing activities over the muzzles of C4-C7.

Fig. 16. Fishing cable abrasion around a cannon cascabel.

Fig. 17. A recently broken iron cannon on site 35F.

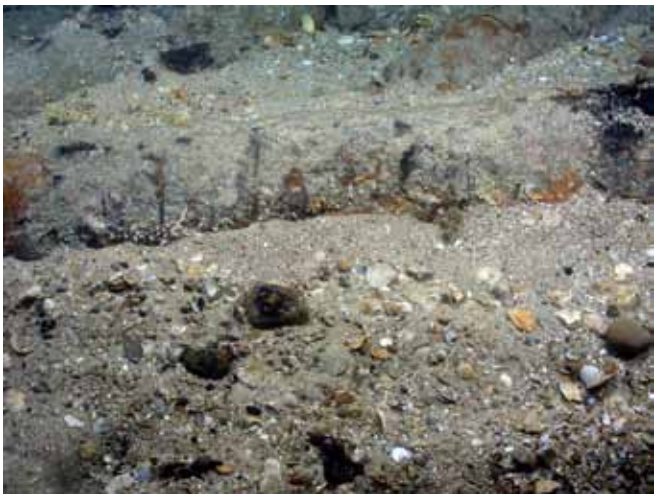

Fig. 18. Scars cut into the side of an iron cannon by a scallop dredge.

I. On 25 September 2006 a passing trawler warned the *Odyssey Explorer* to move off station so it could trawl the area where the wreck is located. The trawler captain emphatically stated that he had been trawling the area for years and that no obstruction was present on the sea bottom. This communication demonstrates that the commonly cited argument that fishermen are fully knowledgeable of wreck locations and actively avoid such 'snags' to protect their gear is not always correct. Instead, in some cases low-lying wreckage is apparently mistaken for natural geology that will not damage fishing equipment (but will and does heavily impact wreck sites). Because even heavily flattened sites provide some structure for fish, trawls dragged over sites would typically result in catches that would encourage repeated trawls over the same site.

4. Site Description, Hull Remains & Ordnance

Site 35F can be characterized as the poorly preserved remains of a heavily disarticulated wooden hull associated with an extensive set of cannon, with only a very minor part of its original cargo surviving (Figs. 8-10). The axis of the keel extends from the southwest to the northeast. The most conspicuous element of the wreck is 36 iron cannon (28 present on the photomosaic and site plan produced in 2006, with eight more exposed and recorded in 2009). No defined ballast mound or significant remnant of this feature exists, although stones underlying the wooden hull, and extending beyond the limits of the surviving hull structure, suggest that the original ballast concentration has been flattened and scattered, most probably by trawl nets and scallop dredges. The ballast itself consists of rounded, cobble-sized stones 10-20cm in diameter on average (Fig. 7). One recovered example measures 21.5 x 10.0 x 7.9cm.

The seabed matrix consists primarily of well-packed coarse sediments (light brown on the surface and gray within the anaerobic layers immediately beneath the sea bottom/water column interface) overlying a dense concentration of heavily fragmented scallop shells associated with rounded cobblestones and minor gravel deposits. The shell level emerges at 5-10cm below the surface of the sea bottom. Flint nodules with a maximum diameter of 5-10cm are also commonly encountered at this depth. Artifacts are present within the shell and sand matrix: twisted and folded lead sheet was excavated 16cm below the surface, graphitised cannon balls at a depth of 24cm, and an elephant tusk 28cm down. The wreck is heavily colonized by marine life: eels nesting in the bores of cannon and beneath hull structure, crabs sheltering amongst the wreckage, and schools of fish (Figs. 5, 20, 37, 45, 66).

The remaining keel is about 26.1m long and discontinuous between areas G14 and G21, a distance of at least 5m (Fig. 9). It is twisted and distorted, with highly abraded surfaces seemingly caused by trawler/scallop dredge impacts (Figs. 9, 19). Frames and strakes are only preserved along the northeastern section of the wreck in the form of up to 14 frame sections from some seven frames total, with preferential preservation on the western flank (Figs. 20-21). Strakes and frames derive from below the turn of the bilge. Neither the stem nor the sternpost survives and no mast step assemblage is evident. No keelson is present. Keel scarfs have not been identified. Only wooden treenails, and no iron nails, were observed securing frames and strakes in place (Figs. 20-21).

The wooden strakes are not sheathed externally in copper or lead, but are covered by a thinner exterior layer

Fig. 19. Section of site 35F's keel at grid area G14 with part of the garboard strake attached.

Fig. 20. Detail of the keel, frames and strakes. Note wooden treenail at far left.

Fig. 21. Frames and strakes with treenails visible at center. In the right foreground a strake is covered by a thin exterior layer of protective 'furring' associated with impressions indicative of burlap or coarse-woven fabric caulking.

Fig. 22. Animal hair (possibly horse) used as caulking between wooden planks.

Fig. 23. A lead hull tingle patch in situ.

Figs. 24-25. Lead hull repair patches recovered from the site (Th. 0.8cm).

of protective 'furring' associated with impressions indicative of burlap or coarse-woven fabric caulking (Fig. 21). Animal hair (probably horse) was employed to make seams between planks watertight (Fig. 22). Five sections of lead identified to the northeast and southwest of the hull may be interpreted as tingles, patches used to repair a leaking ship (Figs. 23-25). These patches measure 70 x 15cm, 54.5 x 27.0cm, 49 x 21cm, 55cm and 12cm long, and have square nail attachment holes measuring 0.3 x 0.3cm. Sheet 0036 is 0.8cm thick (Fig. 25).

The construction details observed on site 35F span the late 16th to early 18th centuries. Similar furring was relied on in the *Avondster*, an English ship bought by the Dutch East India Company and wrecked off Sri Lanka in 1659. The external hull planking contained at least three layers of planks, each between 2-6cm thick. The outer two layers may have been added by Dutch carpenters to facilitate the ship's reliability in the tropical waters of Asia. The same wooden sheathing technique is known from the late 16th and early 17th centuries, including the VOC ships *Mauritius* (1609) and the *Batavia* (1629) (Parthesius *et al.*, 2005: 227-8). At the other chronological bookend, the Dutch *fluit* the *Anna Maria*, which foundered in Dalaro harbour, Sweden, in 1709, was again covered with thin planks of outer sheathing to protect the hull from *teredo navalis* shipworms (Petersen, 1987: 295). Animal hair caulking similar to that on site 35F has been found wedged in the garboard seam of a merchant vessel of the first half of the 17th century off Poland (Bednarz, 2006: 274).

The system of fastening strakes to frames with treenails appears on the English *Sea Venture*, lost off Bermuda in 1609 (Wingood, 1982: 335). The planking on a vessel lost off Poland in the first half of the 17th century was connected to the frames with 3-4cm diameter pine treenails, although iron nails were also identified along the garboard strake and elsewhere (Bednarz, 2006: 274). Spoke-shaved oak treenails of 3.8cm diameter, the heads of which had been tightened by a triangular or criss-cross saw cut half an inch deep, into which oakum had been rammed, were used on the *Dartmouth*, lost off Scotland in 1690. Like site 35F,

Figs. 26-28. Brick fragments from the galley hearth and a section of lead (inv. 0037, L. 24.0cm) possibly used to insulate the hearth area.

the same ship was sheathed externally with 0.13cm fir deals, which sandwiched a layer of hair and tar about 3.2cm thick. These boards were held in place by flat-headed iron nails, arranged in a zig-zag pattern. The *Dartmouth* had also been repaired with lead tingles (Martin, 1978: 47-8).

A heavy square section of lead, lacking nail holes and measuring 24.0 x 14.5 x 0.40cm (T7a35f-5-06-0037-SF-LT) possibly originally lined the kitchen galley hearth to insulate the surrounding wooden structure (Fig. 28). Six 3.5cm thick red brick fragments are related to this entity (Figs. 26-27). Some 11 iron concretions were recorded around the site, including probable rigging, such as two ring-shaped objects (T7a35f-5-06-0050-CN: 19 x 10 x 7cm; Fig. 29). One object left *in situ* may be part of the storm shroud gear from along the preventer stays (pers. comm. John Batchelor, June 2009; Fig. 31).

The southwest section of the wreck may be interpreted tentatively as the bows through the presence of two poorly preserved sections of iron anchor concretions. To the southwest an iron anchor shank (potentially on the starboard bow) is broken in at least three places and is associated with what appears to be an anchor ring (Fig. 32). Two separate concretions near the crown to the northeast may be flukes and arms, the latter being straight rather than curved. No iron stocks were observed. To the southeast, a second possible anchor ring was recorded, possibly remains of the port bower anchor.

Given this positional data, and if not a pattern distorted by trawler activities, combined with the hull's preservation and the configuration of 18 cannon clustered on the eastern flank of the keel to the south of the site (C10-C21, C23, C24 and C26-C29), it may be tentatively concluded that the vessel landed on the sea bottom with the bows to the southwest and the stern to the northeast, and settled to port side before the majority of the structural remains and hull on this side collapsed and deteriorated. This would explain why the above cannon are concentrated between grid areas H2-I15 and F6-N12 (Fig. 9).

A highly characteristic feature of the wreck are two clusters of iron cannon at each end of the hull, with more scattered around the margins of the site. When discovered, seven cannon towards the northeast (C3-C9) were aligned parallel to the keel line, still in their original stowage positons (Figs. 14-15), and thus resembled a commercial consignment of ordnance simultaneously functioning as saleable ballast, rather than the ship's weaponry. This configuration may be supported by the fact that these guns rest directly on ballast and hull structure, indicative of placement in the hold. The fact that all of their cascabels are oriented towards the southwest again favors this interpretation.

Fig. 29. A concreted section of iron rigging (inv. 0050, L. 19.0cm).

Fig. 30. Concreted rigging or a keel bolt (?) (inv. 0016, L. 55.0cm, max W. 24.0cm).

Fig. 31. An iron concretion in situ*, possibly part of the storm shroud gear from the preventer stays.*

Fig. 32. Concreted iron anchor ring to the south of the site.

Figs. 33-34. Iron cannon on the southern half of wreck site. Note damaged surfaces and scratches to the gun in the foreground.

Figs. 35-36. Iron cannon on the southern half of the wreck site (at top with horizontal scratched scars, at bottom with a broken muzzle).

Fig. 37. Concreted iron cannonballs in situ.

Figs. 38-39. Iron cannonballs from site 35F (top to bottom: inv. 0023., Diam. 8.5cm and inv. 0057, maximum Diam. 12.5cm).

Fig. 40. An iron cannonball (inv. 0034, maximum Diam. 4.5cm) associated with concretion and wood.

Cannon	Length (m)	Comment
C1	2.33	
C2	2.50	
C3	2.90	Muzzle seemingly broken off. Cannon moved by trawlers post photomosaic production.
C4	3.20	
C5	2.20	
C6	2.80	
C7	2.90	
C8	2.60	
C9	1.60	Muzzle seemingly broken off.
C10	2.90	
C11	2.30	
C12	2.90	
C13	2.80	
C14	2.30	
C15	2.70	
C16	1.40	Muzzle seemingly broken off.
C17	1.50	Partly buried, only cascabel end visible.
C18	2.00	
C19	2.00	
C20	1.00	Muzzle seemingly broken off.
C21	2.30	
C22	2.80	
C23	2.80	
C24	2.40	Muzzle seemingly broken off. Cannon moved by trawlers post photomosaic production.
C25	2.90	
C26	2.30	Partly buried, only cascabel end visible.
C27	1.70	Partly buried, only cascabel end visible.
C28	2.20	
C29	1.50	Muzzle end broken off.
C30	1.90	Muzzle end broken off.
C30	0.80	Cascabel end broken off.
C31	1.00	Partly buried; only muzzle end visible.
C32	1.00	Partly buried; only muzzle end visible.
C33	1.00	Partly buried; only muzzle end visible.
C36	2.55	
C37	2.99	
C38	1.03	
C39	2.50	
C40	2.88	
C41	1.37	
C42	2.27	
C43	1.91	
C45	1.43	
C46	3.19	

Table 2. Lengths of cannon concretions associated with shipwreck site 35F.

The second cluster of 18 cannon is located along the southern half of the wreck, east of the keel (C10-C21, C23, C24 and C26-C29; Figs. 9, 33-36). This concentration displays a roughly preferential east/west orientation, with muzzles in eight examples facing eastwards. Cannon C1 and C2 on the northeastern periphery of the wreck share this pattern. The overall ordnance orientation thus again suggests that the ship struck the sea bottom to portside, forcing the starboard cannon to break their restraints and roll over to portside, either when the vessel foundered or after deposition as the ship's wooden superstructure broke apart.

A survey of the site and surrounding area conducted using high-resolution side-scan sonar in 2005 and 2009 identified an additional six cannon to the north and a further six to the south of site 35F (Fig. 13). In some cases these guns exhibit trawl scars reflecting the cause of their displacement. Cannon C36-C39, C46 and C47 are located 55-305m to the south of the site. Since the other outlying guns are lying to the north and northeast, 15-55m from the northern edge of the site, it is improbable that guns lying on both sides of the site are indicative of jettisoning. If so, one would expect a line of cannon to lead to the wreck site from one direction, reflecting the drift of the ship as the guns were pushed over the side.

The iron cannon concretions on site 35F display a wide variety of dimensions (Table 2). In terms of overall length (tip of cascabel to end of muzzle), and on the basis of the measurement of 33 guns whose entire length was visible, three measure in the ranges of 1.0-1.5m (9.1% of the total), three between 1.5-2m (9.1%), 11 from 2.0-2.5m (33.3%), while the majority range between 2.5-3.2m (48.5%). The smallest cannon measures 1.03m (C38) and the largest 3.2m (C4). Concretion growths of course mean that these dimensions are no more than rough approximations. All cannon were left *in situ* rather than recovered, so it has not been possible to measure concretion thicknesses. Three different sizes of iron cannonballs were recovered from the site with diameters of 4.5cm, 8.5cm, and 12.5cm. At least three piles of concreted iron cannonballs were identified on the site, presumably reflecting the contents of the shot locker (Figs. 37-40).

5. *Manilla* Copper Bracelets

Nine horseshoe-shaped copper artifacts known as *manillas* – a non-monetary form of currency – were recovered from the southern half of site 35F (Figs. 41-44). All are uniform in shape and size from 8.6-9.0cm long, 6.8-7.1cm wide, 0.8-1.0cm thick and feature flared terminals averaging 1.9 x 1.9cm in width. Weights range from 105-140 grams (Table 3).

Fig. 41. A copper manilla *bracelet* in situ.

The word *manilla* is of Latin derivation (*manus*, hand, or *monilia*, necklace or neckring) undoubtedly transferred into usage via Portuguese merchants. According to legend they were originally cast from copper hull-fastening bolts removed from ships wrecked on the West African coast. These uniquely shaped objects remained highly uniform between the 16th and 20th centuries and are thus poor indicators of chronology.

Manillas were not used uniformly across West Africa, but competed with tribes' localized preferences for cowrie shells shipped from India to Western Europe from the Maldive islands, copper rods and iron bars. Thus, for instance, in Southern Nigeria *c*. 1450-1560 the Portuguese bartered with brass *manillas* on the Slave Coast, brass and copper *manillas* along the Western Delta, and copper *manillas* on the Eastern Delta. But by the late 17th/early 18th century, cowries and iron bars prevailed along the Slave Coast and cowries on the Western Delta, while copper *manillas* and iron bars were only preferred along the Eastern Delta and copper rods at the Cross River (Jones, 1977: 276-8).

West African exchange demanded enormous quantities of this form of currency. As early as 1504-07, just one trading station along the Guinea coast imported 287,813 *manillas* from Portugal (Davies, 2002: 47). In modern terms of monetary exchange they yielded high dividends. In 1505 a Portuguese merchant reported that at Calabar a large elephant tooth could be exchanged for one *manilla* and a slave purchased for eight to ten copper *manillas* (Einzig, 1949: 150-1; Johansson, 1967: 12). In his *Esmeraldo de Situ Orbis* of *c*. 1508, Pacheco Pereira described the means of trade conducted in the 'Bight of Biafra' of the eastern Nigerian and Cameroon coasts (Jones, 1977: 43-4), stating that peddlers:

> "…come from a hundred leagues or more up this river bringing yams in large quantities; they also bring many slaves,

Artifact No.	Length (cm)	Width (cm)	Terminal W. (cm)	Th. (at center) (cm)	Weight (grams)
0007-JL	8.8	6.8	1.8 x 1.8	0.80	121
0015-JL	9.0	7.0	1.9 x 1.9	0.90	133
0017-JL	8.9	7.1	1.9 x 1.9	0.90	123
0018-JL	8.85	6.9	1.8 x 1.8	0.95	118
0019-JL	8.8	6.9	2.0 x 1.9	0.95	137
0022-JL	8.9	6.9	1.95 x 1.95	1.0	122
0041-JL	8.6	7.1	2.0 x 1.7	0.90	114
0005-OR	9.0	7.7	1.9 x 1.9	0.9	105
0006-OR	9.0	7.6	2.1 x 2.1	1.0	140

Table 3. Measurements of copper manilla *bracelets from site 35F.*

> cows, goats and sheep… They sell all this to the natives of the village for salt, and our ships buy these things for copper bracelets, which are here greatly prized – more than those of brass; for eight or ten bracelets you can obtain one slave."

Eighty years later the London merchants Bird and Newton visited Benin in 1589 on the 100-ton *Richard of Arundell* and found that copper *manillas* were exchanged for pepper, ivory, palm oil and local woven cloth (Johansson, 1967: 11-12). A century afterwards, Dr. Dapper's *Description de l'Afrique* asserted that in 1668, the approximate period when the site 35F ship was lost:

> "Along the river of Kalbaria the white races, especially the Hollanders, trade with the inhabitants, and in exchange for slaves offer rough grey copper armlets, which must be oblong with a rounded curve and very well made, since the natives are very particular on these points and frequently will reject two or three hundred out of one barrel… the armlets brought there by white men, which they call Bochie, are used solely for money."

The Dutch dominated long-distance commerce along the Rio Real at this time, exchanging one slave for 14-15 unpolished copper bracelets (Jones, 1977: 44).

The name 'Bochie' for *manillas* also appears in John Barbot's *Description of the Coast of North and South Guinea* (1746: 382), which described the West Coast trade as it existed from 1678-82. In his section on 'Rings for Money', Barbot confirmed that:

> "The principal thing that passes in Calabar, as current money among the natives, is brass rings, for the arms or legs, which they call Bochie; and they are so nice in the choice of them, that they will often turn over a whole cask before they find two to please their fancy. The English and Dutch import there a great deal of copper in small bars, round and equal, about three feet long, weighing about a pound and a quarter, which the Blacks of Calabary work with much art… to make what sorts of arm rings they please."

Excavations at Ke along the eastern Niger Delta have exposed a hoard of 800 *manillas* contextualized with terracotta masks, clay molds, fragments of wine jars, imported gin bottles and iron slag dating between 1315 and 1686. A *terminus post quem* of 1450 for the import and use of these *manillas* in the Delta has been proposed (Anozie, 1988: 158).

The origins of the *manillas*' copper and place of manufacture between the 16th and 17th centuries remain undetermined. However, by the end of the 18th century European merchants were mass-producing the currency, predominantly in England, but also in France and the Netherlands.[2] *The Statistical and Economical Review* published in 1949 to examine the problem of pervading *manilla* use in West Africa, when European powers were attempting to enforce a Westernized monetary economy, reported that the earliest imports were made by R. & W. King of Bristol. In the 19th century, *manillas* were manufactured in Birmingham (Grey and George, 1951: 54, 56).

The *manilla*'s popularity refused to dwindle in the early modern era. As late as 1858, the British consul T.J. Hutchinson was familiar with this unchanged form of currency in Equatorial Guinea, observing that "They are pieces of copper of a horse-shoe form, about four inches in the measurement of the circumference of their circle, and about half an inch in that of their density being terminated by two lozenge shaped ends facing one another" (Johansson, 1967: 11). In the 20th century, the Ibo tribe of Wukai in Nigeria considered a deep bowl filled with corn or a cup-shaped receptacle containing salt each to be equal in value to one large *manilla* (Einzig, 1949: 151).

After the end of World War II, the United Africa Company still found it necessary to trade in *manillas*, even

Fig. 42. Copper manilla *bracelets inv. 0005 (L. 9.0cm), 0006 (L. 9.0cm) and 0007 (L. 8.8cm).*

Fig. 43. Copper manilla *bracelets inv. 0015 (L. 9.0cm), 0017 (L. 8.9cm) and 0018 (L. 8.9cm).*

Fig. 44. Copper manilla *bracelets inv. 0019 (L. 8.8cm), 0022 (L. 8.9cm) and 0041 (L. 8.6cm).*

though the Native Currency Proclamation of 1902 had prohibited their import, except with a permit from the High Commissioner (Davies, 2002: 47). When *manillas* were finally forcefully banned from circulation in 1948, 32.5 million were withdrawn during the six months ending on 31 March 1949 (Grey and George, 1951: 63).

No reliable typologies exist for *manillas*, which were largely considered stylistically identical by Europeans. T.J. Hutchinson's report for the British Consulate of June 1856 confirms their indistinct uniformity to Westerners despite the fact that the tribes of Nigeria differentiated between five different forms (Geary, 1927: 82):

> "Although the casual observer could scarcely discriminate between them, yet the practiced eye of the natives does it at once and cannot be deceived. The *'Antony Manilla'* is good in all interior markets; the *'Congo Simgolo'* or 'bottle necked' is good only at Opungo market; the *'Onandoo'* is best for the Ibo country between Bony and New Calabar; the *'Finniman Fawfinna'* is passable in Juju Town and Qua market; but it is only half the worth of the *'Antony'*; and the *'Cutta Antony'* is valued by the people at Umballa."

Despite the presumption (not least amongst manipulated West African tribes) that *manillas* were made of pure copper or brass, European merchants heavily degraded the currency with other metals. Chemical analysis of an array of differently shaped and dated *manillas* using energy dispersive x-ray fluorescence has identified unexpectedly high levels of lead, unattested in recorded descriptions. In 11 of 16 samples, copper did not even register 50% of the total metal. Rather, lead comprised over 50% in five samples and over 40% in two others (Kuntz *et al.*, 2002: 31). The implication is that excessive lead was incorporated into *manillas* produced by Europeans and imported into West Africa for trade in order to maximize company profits. Modern 20th-century *manillas* similarly contained a mix of 65% copper and 25% lead (Grey and George, 1951: 54).

Manilla currency is relatively common on shipwrecks dating between the mid-17th and mid-18th centuries across Europe and Africa. A single *manilla* was recovered on the Saint-Quay-Portrieux wreck of 1711/1719 off Brittany, France, in association with over 100 elephant tusks and 40 glass trade beads (Herry, 2004: 97). The site is considered to have possibly been a slave trading enterprise. A second wreck off France at Pen Azen has again produced *manillas*, but is otherwise uncharacterized (Webster, 2008: 16). Meanwhile, 100 brass examples have been excavated from an 18th-century site off Bermuda in association with 10,000 beads and two-dozen Dutch cannon (Karklins, 1991: 40). This cargo may have been

jettisoned by the *Amazon*, a damaged French ship sailing from St. Domingue to Nantes in 1739 (Smith and Maxwell, 2002: 79).

The commercial archaeology company Arqueonautas has recovered *manillas* in the anchorage of Cidade Velha off the Cape Verde islands.[3] Divers have also retrieved large numbers of glass beads and *manilla* bracelets from the wreck of the *Douro*, a Liverpool ship that foundered on Round Rock, Scilly Isles, in 1843. She was allegedly heading to Portugal with a cargo of textiles and ordnance. Dating 36 years after British ships were banned from slaving, the *Douro* may have been involved in illegal actions.[4]

6. Elephant Tusks

Elephant tusks are a dominant characteristic of site 35F's cargo. Nine tusks are visible on the surface of the southern half of the site, perhaps indicative of storage in the bows (Figs. 45-46). Further examples are evidently buried in shallow sediments (Fig. 47): one tusk of 60cm approximate length was excavated by Odyssey in 2009 at a depth of 28cm.

Two tusks were recovered for short-term shipboard analysis in 2006. Both displayed heavy iron oxide staining and surface pitting. One example (T7a35f-5-06-0009-IY-TK; Fig. 50) proved to be 69.0cm long, 4.8cm wide at its hollow base and 3.0cm wide at its tip (munsell color code 7.5YR 4/6). A second example (T7a35f-5-06-0030-IY-TK; Fig. 48) is 65cm long with a maximum diameter of 6cm. A third tusk examined in June 2008 was far larger: 1.45m long, 8.0cm wide at its base and weighed 24kg (Fig. 49). Following examination at sea, the elephant tusks were returned to the shipwreck site.

The procurement of West African elephant tusks (and to a lesser extent hippopotamus) was a highly lucrative commercial pursuit for European traders from the early 16th century onwards – third most profitable after gold and slaves. Ivory from African elephants was considered to be of far finer quality than the Asian elephant because of its superior hardness, pale blonde transparency and ability to be more finely polished. African elephant tusks can measure up to 2m in length, with diameters of 9-11cm and weigh up to 90kg, while tusks of Asian elephants are smaller and lighter. The best African ivory derived from Gaboon, Mozambique and Zanzibar (Tripati and Godfrey, 2007: 334-5).

The mass exploitation of ivory from Africa dates back to the Roman period, and in the second half of the 13th century Marco Polo remarked while travelling in East Africa that "They have elephants in plenty and drive a brisk trade in tusks." During the period of Portugal's domination of West African commerce in the 16th century, 30,000lbs of ivory passed through the port of Sofala annually (Beachey, 1977: 216). When the region opened up to

Fig. 45. Sections of four elephant tusks trapped under cannon C21, with modern fishing cable alongside.

Figs. 46-47. Elephant tusks in situ.

European trade, between 1634-64 the Dutch imported an average of 40,000lbs of tusks each year through the Geoctroyeerde Westindische Compagnie (Green, 1977: 241). More broadly, Dutch and English shipping records reveal that at least 2,500 tons of ivory – over quarter of a million tusks – left West Africa between 1699 and 1725.

The English were the Dutch's greatest competitors in the mid to late 17th century. In 1663 the Portuguese missionary André de Faro watched an English ship sail along the Upper Guinea coast loaded with thousands of tusks, some weighing 4 *arrabas* (128lbs) (Walker, 2009: 65). Records reveal that 23 tons of ivory were imported into England in 1675 by the Royal Africa Company, which since 1672 had exercised a royal monopoly over trade with West Africa, and 83 tons by 1680, the peak year until 1725. In 1692, 61 tons of ivory were imported into England, after which the trade dropped off to an annual low of 11 tons between 1702 and 1707 (Johnson, 1978: 12).

The elephant hunting Vili tribe of the coastal kingdom of Loango near the mouth of the Congo river had traded ivory with Europeans since the 1570s, and in 1608 sold 23 tons a year to the Dutch. Not surprisingly elephants became increasingly rare and by the 1660s Vili hunters had to undertake journeys of three months' duration to the middle Congo before locating adequate stocks of ivory (Walker, 2009: 65-6). Elephants hunted for ivory also proliferated in the forest of Ashanti-Brong Ahafo in Ghana, but also across Southern Ghana, including the coast. Tusks were exchanged for a wide range of European commodities, including linen, silk, brocades, guns and ammunition, iron and silver bars, copperware and brassware, and alcoholic drinks. The tribal demand of the Asin, Denkera, Fanti, Akwamu and Ashanti for Western goods always exceeded the supply to Southern Ghana (Dickson, 1977: 142, 144).

The African ivory resources were largely culled from the male and female *Loxodonta Africans*, whose tusks are composed of a dense and complex weave of collagen fibers mineralized by minute, tightly bound calcium hydroxyapatite crystals. This composition makes them resistant to fracture, while the nanometric size of the hydroxyapatite crystals makes ivory highly susceptible to being polished. The density of the crystals easily resists contamination by air pollutants.

Either through direct import from West Africa, or alternatively through an established system of re-export, elephant tusks were thus an ideally exotic, rare and expensive medium for the artistic and functional manufacture of combs, knife handles, sewing articles, keys for clavichords, syringes and myriad decorative objects. Thus, for instance, Nathaniel Bowers & Son of London were amongst the earliest manufacturers who started in business as ivory comb makers in 1685 and whose descendants were still in business in the 1960s (Brown and Kelly, 1987: 4-5).

Ivory carving exploded into life in the Baroque, with specialist carving centers established in Germany and Dieppe in France in the early 1600s. Sculptors created small statuary, medallions and lavish furniture, while the soft, satiny surface of ivory was considered perfect for the detail required for portrait busts and relief medallions. Queen Anne, King George I, Isaac Newton, Christopher Wren and Samuel Pepys all sat for ivory busts created by David Le Marchand (1674-1726), an expatriate Huguenot who fled France to Edinburgh and then London. Ignaz Elhafen of Germany's ivory masterwork relief, *The Death of Cleopatra* of *c.* 1700, remains a major attraction in London's Victoria & Albert Museum.

In 1637 Marcus Heiden, who served under several Saxon dukes, described his spectacular *chef d'ouevre*, a

drinking vessel balanced on an elephant and topped with a ship under full sail. Completed in 1639, the tusk from which it was carved was unusually large and heavy and was allegedly meticulously selected in Amsterdam from 300,000 tusks. In the 1700s ivory went on to be used more prosaically to create lifelike medical models of the eyeball; a century later elephant tusks would be exploited for prosthetic limbs, false teeth, artificial legs and noses, and even an ivory penis (Walker, 2009: 75, 78, 79, 91).

Elephant tusks have been recorded on at least 14 shipwrecks scattered throughout the world from Goa to Florida and Brittany, dating between the 10th century and the early 19th century (Table 4). A small tip of a tusk excavated from the Intan shipwreck, lost off southeast Indonesia between AD 918-60, was probably an item of private trade or a curiosity. Some 16 large pieces of elephant tusks were shipped as cargo on the 13th-century Java Sea wreck (Flecker, 2002: 95, 122, 138; 2003: 397; Wade, 2003: 20-1).

A larger collection of 41 tusks was stowed amongst an overall cargo of 80 examples minimum raised from a Ming period junk of 1480-90 off the Lena Shoal in the Philippines (Goddio, 2002a: 12; 2002b: 248-9). Some 67 elephant tusks discovered in 2008 during diamond mining operations in a dry marine basin 20km north of Oranjemund in southwest Namibia are associated with 20 tons of Augsburg copper ingots, 3.5 tons of tin and 2,159 gold coins from a 16th-century Portuguese wreck (Alves, 2011: 5).

Exploration off Sunchi Reef, Goa, yielded eight elephant tusks of different sizes ranging from 32-65cm long (one inscribed with the letters 'ICM') on an early 17th-century Portuguese shipwreck (Tripati *et al.*, 2004: 1242; Tripati and Godfrey, 2007: 332-9). Around 300 elephant tusks up to 1.6m-long were originally present on the Dutch East Indiaman *Vergulde Draeck*, which struck a reef 120km north off Perth, Australia, in 1656; its excavation has produced 7,881 Spanish coins (of 78,600 guilders total attested in historical records of the shipment) (Green, 1973: 273, 278, 287; 1977: 241-2). The Dutch East Indiaman *fluit Risdam*, lost near Mersing off eastern Malaysia in 1727, also yielded 90 elephant tusks (one 1.3m long) alongside over 125 tin ingots, lead ingots, Dutch bricks and storage jars (Green, 1986: 100, 101).

The British merchant vessel *Henrietta Marie*, wrecked in 1701 on New Ground Reef, 22km off Marquesas Keys, Florida, has yielded six elephant tusks, 11,000 Venetian glass beads, and over 300 pewter wares and iron bars (Moore and Malcom, 2008: 20-38.). Over 100 ivory tusks and 40 glass trade beads are associated with the Saint-Quay-Portrieux site off Brittany in France dated to

Fig. 48. Elephant tusk inv. 0030 (L. 65.0cm) recovered for examination (and subsequently returned to the seabed).

Fig. 49. A 1.45m-long elephant tusk recovered for examination (and subsequently returned to the seabed).

Fig. 50. Elephant tusk inv. 0009 (L. 69.0cm) recovered for examination (and subsequently returned to the seabed).

1711 or 1719 (Herry, 2004: 96-105). The Dutch East Indiaman *Zeewijk*, lost on Half Moon Reef in Southern Abrolhos, Australia, in 1727, has yielded an unknown volume of tusks. The ship was also transporting 315,836 guilders in ten chests.[5] The largest assemblage found on any shipwreck are the 822 tusks recorded on the *Princess Louisa*, an English East Indiaman lost off the Cape Verde islands in 1743. The ship was also transporting woolen textiles for Persia, gunpowder, iron guns, sailcloth, cordage, iron, lead for Bombay and 20 chests of Spanish silver coins.[6]

Some 51 small and large elephant tusks and 13 hippopotamus examples were found alongside 300 mahogany

Wreck Location	Ship Nationality	Date	Cargo
Java Sea, midway between Bangka Island & Jakarta	Indonesian	Mid to late 13th century	340 tons of iron pots & bars, 100,000 Song dynasty ceramics (25-30 tons), 16 elephant tusks
Rang Kwien, Gulf of Thailand	----	1270 ± 60	200kg copper coins, copper ingots, ceramics, gongs, bells & elephant tusks
Lena Shoal, Philippines	Chinese junk	1480-90	Minimum of 80 tusks, L. 56-85.2cm
130km south of Luderitz, Namibia	Portuguese	16th century (post-1525)	67 elephant tusks, 1,845 (20 tons) Augsburg copper ingots, 3.5 tons tin, 2,159 gold coins
Sunchi Reef, Goa	Portuguese	Early 17th	Elephant tusks, hippopotamus teeth, Chinese ceramics, cannon
Southland, Australia	*Vergulde Draeck*, Dutch East Indiaman	1656	Around 300 elephant tusks & 7,881 Spanish coins (of 78,600 guilders total)
Mombassa, Kenya	*Santo Antonio de Tanna*, Portuguese	1697	Two hippopotamus teeth
New Ground Reef, 22km off Marquesas Keys, Florida	*Henrietta Marie*, British	1701	6 elephant tusks, 11,000 Venetian glass beads, over 300 pewter wares, iron bars
Saint-Quay-Portrieux, Brittany, France	------	1711 or 1719	>100 ivory tusks, 1 *manilla* bracelet, 40 glass trade beads
Mersing, eastern Malaysia	*Risdam*, Dutch East Indiaman	1727	90 elephant tusks, 125 tin ingots, lead ingots
Half Moon Reef, Southern Abrolhos	*Zeewijk*, Dutch East Indiaman	1727	Elephant tusks, 315,836 guilders in ten chests
Cape Verde Islands	------	----	*Manilla* bracelets
9.7km northeast of Bermuda	Dutch West India Company, possibly the *Amazon*	1739?	100 *manilla* bracelets, 10,000 glass trade beads
Cape Verde Islands.	*Princess Louisa*, English East Indiaman	1743	Woolen textiles for Persia, 822 ivory tusks, gunpowder, iron guns, sailcloth, cordage, iron, lead for Bombay; 20 chests of silver Spanish coins
Island of Arendal, Norway	*Fredensborg*, Danish–Norwegian	1768	927kg of elephant tusks, hippopotamus teeth, slaves, cinnamon, tobacco, cotton
Approaches to Elmina, Ghana	Dutch (or possibly British)	Early 19th century	European sheet brass 'battery ware' basins, rolls of lead sheathing, brass *manillas*, ceramics & beads
Pen Azen, France	------	Undated	*Manilla* bracelets
Loup Garou, Martinique	------	Undated	1 elephant tusk

Table 4. Shipwrecks recorded with elephant tusks or manilla bracelets and related cargo wares.

planks and dyewood on the wreck of the slave ship *Fredensborg*, which from 1767-68 sailed the triangular trade route from Copenhagen to the Gold Coast in Africa, and then onward to the Danish West Indies with a cargo of slaves, before returning home to Denmark over the North Atlantic (Svalesen, 2000: 181-2). Finally, one elephant tusk has been found on an undated shipwreck at Loup Garou, Martinique (Webster, 2008: 16).

As well as representing the Westernmost cargo to contain elephant tusks, site 35F has also yielded amongst the largest examples discovered underwater. The 1.45m example compares highly favorably with the length of those carried by Dutch East Indiamen, such as a *Vergulde Draeck* example of 1.6m.

7. Wooden Folding Rule

One arm of a carpenter's folding wooden rule was recovered intact from the northeastern, stern end of site 35F in grid area O19 between two scattered planks (Figs. 51-56). At first sight the 1ft-long artifact seems relatively ordinary, with straight sides, two bronze pins protruding perpendicular out of the interior edge and a wooden hinge with a bronze/brass pin, which would originally have folded two arms together. Remnants of the pin survive at the hinge's center. This find is extremely rare, with Stephen Johnston, Curator of the Museum of the History of Science at Oxford University, observing that, "this exact form of carpenter's rule has not, so far as I know, been published in a modern study" (pers. comm., 2006). The rule was conserved at the York Archaeological Trust.

Site 35F's folding rule incorporates five different scales, in addition to a separate table located at the foot of side B (Fig. 52), which functioned as a timber borde. Incised graduation marks from three different scales extend vertically along side A of the rule (Figs. 52, 53). The external, outer master scale consists of 12 inches, marked by lines graphically and numerically, progresses in ascending order from the base upwards towards the hinge. These inches are subdivided through vertical incisions into 1/2, 1/4 and 1/8in. A further 12 inches, marked 13-24, would have continued along the corresponding lost arm, creating a 2ft-long carpenter's rule.

At the foot of the rule's arm on side B, a separate table is laid out in eight columns and four rows (Fig. 56) and functioned as a primitive mathematical 'calculator' to assess the cubic content of timber. Typically, but not in the case of the site 35F example, such scales are titled along rules 'Borde measure' and 'Timber measure'.

The ruler's dimensions are:

- L. 30.7cm (excluding circular hinge bracket protrusion)
- Total L. 31.9cm (including hinge bracket)
- W. 1.7cm
- Th. 1.1cm
- Hinge Diam. 2.5cm
- Hinge Th. 0.95cm
- Hinge pin 0.9 x 0.8cm, with circular rivet Diam. 0.45cm
- Preserved brass hinge pin L. 3.0cm, Th. 0.17cm
- Upper pin L. 1.39cm, Th. 0.15cm, L. of protrusion beyond wood surface 0.42cm (based on x-ray)
- Lower pin L. 1.3cm, Th. 0.14cm, L. of protrusion beyond wood surface 0.45cm (based on x-ray)

A. Rule Scale Descriptions

Side A, Rule 1 (Figs. 52, 53): 12 inches, each inch 2.5-2.55cm, with the exception of the 3in to 4in increment, which measures 2.6cm. This is an inch scale [0]-12, divided to unit, half, quarter, eighth and numbered by 1. This would have continued to 24 on the missing leg.

Side A, Rule 2: letter 'C' at start. Numbered 'I0' to 'I40' at every 10 increment. Each unit measures 1.65cm.

Side A, Rule 3: letter 'D' at start. Numbered 5 to 40 at every 5 increment and extends up to 45. Each unit measures 2.65cm, except unit 35-50, which deviates at 2.85cm. Rules 2 and 3 are a pair of scales labelled C and D, standing for Circumference and Diameter. The two scales share the same format: each begins with a subdivided segment and then a scale of equal parts from [0] to the limit imposed by the length of the rule.

Side B, Rule 1: numbers visible are I2 to 36, labelled I2, I3, I4, I5, I6, I7, I8, I9, 20, 22, 24, 27, 30, 33, ?6. Two arced lines at end of rule. I3-I4: 2.0cm; I4-I5: 1.78cm; I5-I6: 1.5cm; I6-I7: 1.35cm; I7-I8: 1.2cm; I8-I9: 1.0cm; I9-20: 0.98cm; 20-22: 1.65cm; 22-24: 1.45cm; 24-27: 1.65cm; 27-30: 1.39cm; 30-33: 1.15cm; 33-?6: 0.92cm. This is the end of a line of board measure running from 12 (at the hinge) to 36, each unit subdivided to half. The scale ends 4in from the end of the leg (4 x 36 = 144 = 1 square foot).

Side B, Rule 2: numbers visible are 6, I0, II. 6-I0: 10.45cm; I0-II: 7.50cm. The beginning of a line of timber measure from 9 to 12 (at the hinge), each unit subdivided to quarter.

Side C (side edge): numbers visible, 3-4: 3.72cm; 4-5: 2.92cm; 5-6: 2.40cm; 6-7: 2.0cm; 7-8: 1.72cm. Located along the edge, this is a logarithmic line of numbers 1-10. The missing leg would have carried the same scale to make a double radius line 1-100.

Side B Table (Timber Borde; Fig. 56):

1	2	3	4	5	6	7	8
?	36	16	9	5	1	2	2
0	0	0	0	9	0	11	3
0	0	0	0	1	0	2	0

This is a table of timber undermeasure (Table Dimensions: L. 4.1cm; H. 1.5cm). This is continuous with the timber line and supplies values for 1 to 8 inches, which the rule cannot accommodate on the scale line.

B. Carpenters Tools & Shipwrecks

While navigational equipment and tools are relatively common on shipwrecks of the 16th to 18th centuries, such as the Dutch East Indiamen the *Lastdrager* (1653), lost off Yell, Scotland (Sténuit, 1974: 213-56), and the *Kennemerland* (1664), off the Shetland Islands (Price and Muckelroy, 1974: 257-68), as well as on the Jutholmen wreck in the archipelago of Stockholm, Sweden (*c.* 1700) (Ingelman-Sundberg, 1976: 57-71), rules of any form – wood, bronze, brass or ivory – are extremely rare. As Walker has emphasized (Walker, 1983: 20-30):

> "When we get back to the 17th century, however, the situation starts to become more interesting. The surviving tools… have a rarity value and, what is more intriguing, they lead us straight into the realm of pre-history. We have, as yet, no evidence whatever to tell us where the standardized forms, which had appeared in several countries by the end of the century, had originated, who has first made them or to what designs."

A range of navigational equipment on the Dutch East Indiaman the *Hollandia*, wrecked on the Isles of Scilly in 1743, included bronze dividers, an octant, bronze drawing compass and a small bronze case containing drawing instruments, including a small pair of bronze dividers and two folding rules, one of bronze, the other of wood (Marsden, 1975: 287). A folding rule on the steamship *Bertrand*, sunk in 1865 along the Missouri River, featured a circular brass hinge and edges protected by strips of brass. As on the site 35F artifact, this rule was incised numerically 1-12 on one arm (and 13-24 on the other). Additional marked units include 1/2-inch and 1/4-inch increments on one side and 1/10th and 1/12th-inch increments on the other (Corbin, 2000: 81).

A 1ft-long wooden measuring stick was recovered off Western Australia from the Dutch East Indiaman the *Vergulde Draeck*, lost in 1656 (Green, 1977: 236-7). It adheres to the Amsterdam foot of 283mm and displays no

Fig. 51. Wooden folding rule in situ *in grid area O19 to the northeast of the wreck.*

sign of a hinge or folding capability. A wooden ruler far later in date than the site 35F example has been excavated from the *Maidstone*, a British man-of-war lost in 1747 off Noirmoutier, France (de Maisonneuve, 1992: 22). The wreck of Imperial Russia's 32-gun frigate *Nicholas*, lost on 9 July 1790, in the battle of Svensksund, Finland, was rich in navigational equipment, including a telescope, compass bowl and a sophisticated sector rule with legs of bone and a brass joint incised with lines of sines, tangents, secants and polygons. In conjunction with a pair of dividers, this sophisticated tool was used to solve problems involving nautical triangles in plane or Mercator sailing (Ericsson, 1975: 67). Sir John Franklin's final expedition of 1845-48 left behind a folding wooden carpenter's rule on King William Island with a brass center hinge and steel reinforcements at the ends, its arms held together when shut with two steel pins. However, no other folding wooden rule has been identified on a shipwreck of the 17th century.

C. Cultural Context

Navigational and nautical equipment witnessed a leap in mathematical and technological sophistication during the late Renaissance, especially the decades 1610-80. In 1614 John Napier discovered the logarithm that made it possible to perform multiplications and divisions by addition and subtraction. The spyglass, later known more familiarly as the telescope, evolved in the early 17th century followed by the barometer in 1643. Between 1620 and 1630, William Oughtred of Cambridge invented the circular slide rule. In 1671 the first of four volumes of *The English Pilot* appeared, covering Europe, the Far East and North America. The constellation *Sextans Uraniae* was identified around

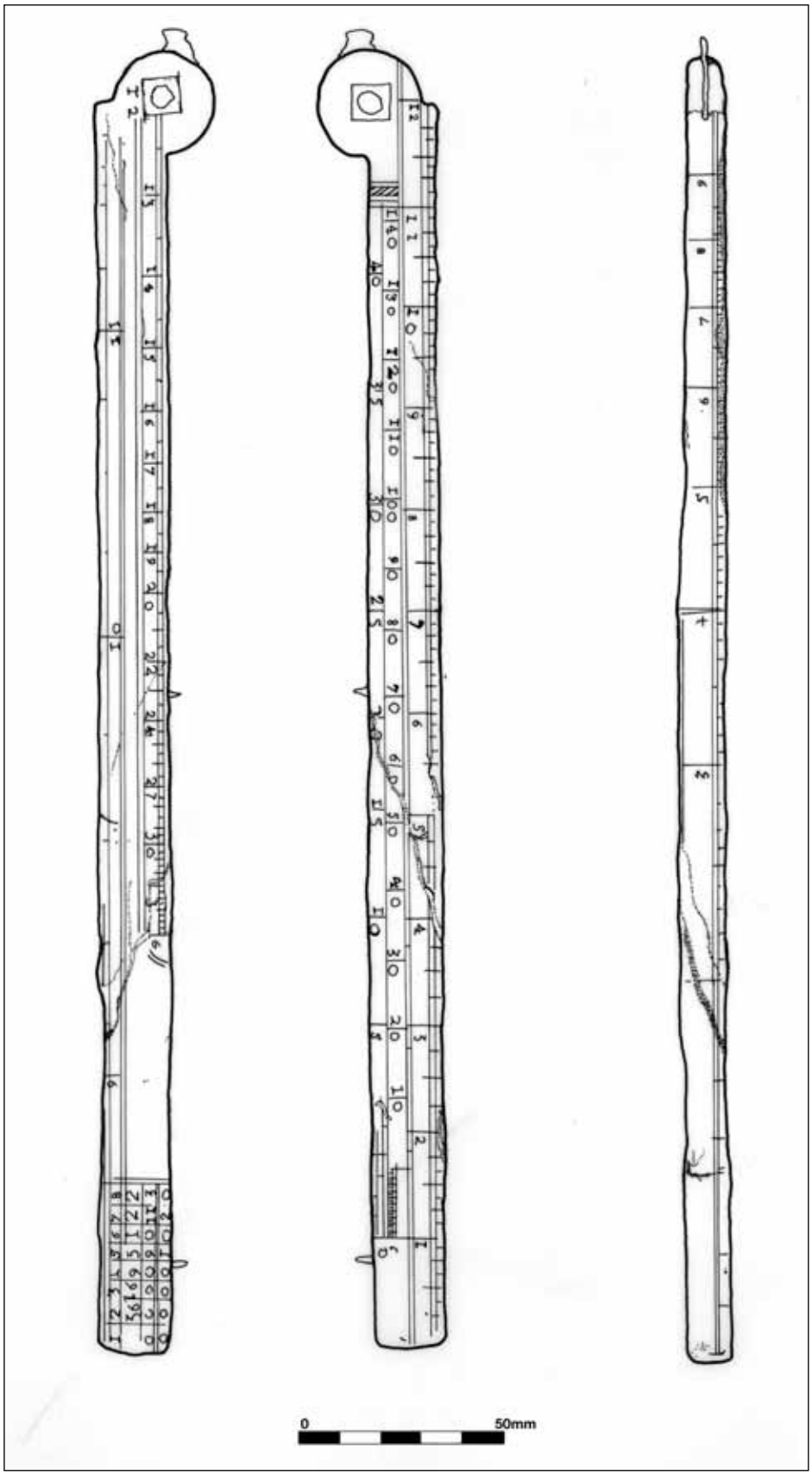

Fig. 52. Drawing of the wooden folding rule (inv. No. 0010). Left: Side B. Centre: Side A.

Fig. 53. Detail of the hinge and inch scale on side A of the folding wooden rule.

Fig. 54. Detail of the hinge and scale on side B of the folding wooden rule.

Fig. 55. Detail of the side B scale of the folding wooden rule.

Fig. 56. Detail of the table at foot of side B.

1680 by the Polish astronomer Johannes Hevelius, who went on to devise an astronomical map of seven constellations, interpreted using a 6 feet radius brass sextant (Bud and Warner, 1998).

The folding rule represented a pivotal phase in the transformation of surveying practices from direct measurement using rods and lines to more mathematically sophisticated techniques. It stands at the beginning of the precision instrument making trade. When the *Mary Rose* foundered in 1545, she carried the original and elementary form of carpenter's rule, a single piece of straight oak, 2ft long, incised with inch scales and a timber measure to calculate cubic content of timber. This rule is characterized by an absence of numerals; instead, graduations were denoted graphically using circles and arcs (Knight, 1990: 43-55). The *Mary Rose*'s rule is the only single complete British tool of the 16th century allegedly known (Walker, 1983: 21).

The invention of the two-armed and hinged folding rule form discovered on site 35F is credited to Humfrey Cole (died 1591), who pioneered an all-brass tool in his workshop located amongst the bookstalls of St Paul's Churchyard. Cole's rare prototype became the standard for later instruments and by the mid-17th century a variety of formats was available (Johnston, 2006: 233-53). Simultaneously, Richard More became concerned by imprecise recording in woodworking, an issue that he addressed through mathematical finetuning in his *The Carpenter's Rule* of 1602:

> "After I had long considered, and that not without some griefe, the great losse that commeth to those of my Company and others, by errors ordinarily committed in measuring of timber… and so to have desired you in all charity to have provided a remedie… And when I did also see, that most men are very ignorant in true measure, though they seeme and professe to know much therein; and did also remember that not only Carpenters in this Citie doe in this sort erre, but also Carpenters elsewhere, as also Shipwrights & others, and that throughout the whole land… The best course that I could thinke upon, was, to publish some booke, wherein not only true measure should be set downe, but also the common errors plainly laid open to the capacitie of the simplest, so that all men might take knowledged thereof."

Notably, More's guide does not specifically mention folding rules, perhaps indicating that the form was yet to enter mainstream production. Soon after the mid-17th century, though, George Atwell's *The Faithful Surveyor* of 1662 emphasized that "I would have the Rule (whether it be of box, or of brass; whether jointed in the middle, or streight out) to be just two foot long." This is the exact form present on site 35F, which was standardized in the 17th century.

D. Function

On site 35F's wooden folding rule, the side B timber and board measure was used for measuring areas and volumes. This particular format was established during the 17th century as an adaptation of a design first published by Leonard Digges in 1556 (Knight, 1988: 12-19). (For the 16th-century development, see also Johnston, 1994: 39-45, and for a detailed study of an unusual straight carpenter's rule of 1635, see Johnston, 2006, 233-53.) The complete instrument would have had a board line running from 7 to 36, with a table of undermeasure from 1 to 6 inches at the end of the other leg. The timber line would run on to 36 on the other leg, terminating 1 1/3 in from the end. The functionality, origin and date of the site 35F folding rule have been discussed elsewhere (Johnston, 2011).

In summary, the logarithmic line on the folding rule would have been used with a pair of dividers or compasses as a general purpose calculator – in effect, a slide rule. The most distinctive scales are those marked C and D. They would have been used with compasses or dividers. If the circumference of a log had been measured with string, the scales provided the diameter without calculation. These scales would have been matched by another pair on the missing leg, most likely labelled SE for Square Equal and SW for Square Within.

The presence of such scales was first referred to in print by the mathematical instrument maker John Brown in 1661 and may have been a relatively recent innovation. The Science Museum in London holds an instrument manufactured to the same design as the site 35F example and is dated by an inscription to 1659. Its four scales, fully labelled as circumference, diameter, square equal and square within, are the earliest currently known. A unique 3ft brass carpenter's rule in the National Museums Scotland, Edinburgh, displays three of the scales. Evidently made in London, the instrument is inscribed '1655 Robert Trollap of yorke free mason'. Like the site 35F example, it is for board and timber measure and also has an inch scale and a double radius logarithmic line of numbers.

In terms of longevity, the characteristic set of four scales was mentioned as an optional extra for joint rules by John Brown in 1677, and they were still current in 1688 when he added their use to a new impression of his *The Description and Use of the Carpenters-Rule*. The latest example of a wooden folding rule of site 35F form currently known dates to 1685.

E. Preliminary Conclusions

The following comments are based on the underlying acceptance that wooden folding rules are relatively rare on land and underwater due to their medium and that the available comparative database is currently biased by very low levels of preservation. No progressive typology is currently available.

1. Odyssey's site 35F folding wooden tool was used for measuring timber and planking in general shipboard and shipyard situations. It should not be mistaken for a gunner's folding rule designed to measure the inclination of cannon barrels and the distance to the target.
2. The publication of John Brown's *The Description and Use of the Carpenters-Rule…* in 1656, including direct reference to the use of a 2ft carpenter's rule, serves as a chronological touchstone for the tool's widespread availability.
3. The earliest archaeological comparison manufactured to the same design as the site 35F folding rule is an example in the Science Museum, London, dated to 1659.
4. George Atwell's *The Faithful Surveyor* confirms that the folding ruler was in production by 1662.
5. Typologically, site 35F's folding wooden ruler arm predates the more sophisticated brass and ivory variants recorded on the shipwrecks the *Hollandia* (1743), the *Nicholas* (1790) and the *Bertrand* (1865).
6. The absence of a brass hinge and brass edge protectors favors a pre-18th century date.
7. Research conducted by Stephen Johnston, Curator of the Museum of the History of Science at Oxford University, suggests that the artifact was probably made between the 1660s and 1690s, with the 1670s and 1680s perhaps most likely (Johnston, 2011: 50).
8. Wooden folding rules are commonly inscribed with the date of production and name of the manufacturer. Regrettably, this key information may have been placed along the missing rule arm. However, each of the 12in on side A measure between 2.5-2.55cm (with the exception of the 3-4in increment, which measures 2.6cm). This coincides with the English inch of 2.54cm length (de Maisonneuve, 1992: 22; Green, 1977: 237), but not the Prussian inch of 2.46cm or the French *pouce* of 2.71cm (Young and Glover, 1996) The Dutch inch seems to have varied from region to region: 2.57cm in Amsterdam, 2.61cm in Rijnland and 2.7cm in Gelderland. The current consensus points towards English manufacture for site 35F's folding rule (Johnston, 2011: 39).

8. Other Finds

Site 35F has been heavily stripped of its lower wooden hull, cargo and domestic assemblage by natural and man-made forces. Except for two patches of lead sheathing and copper cauldrons, the bulk of the highly limited surviving arti-

Fig. 57. Pottery base inv. 0008 (base Diam. 13.1cm; body Th. 0.5cm, base Th. 0.9cm).

Fig. 58. Potsherd inv. 0046 (13 x 13 x 1cm).

Fig. 59. Potsherd inv. 0045 (28 x 11 x 2cm).

facts were excavated from the southern half of the site (the bows?), where they were clustered amongst cannon (C11 to the north and C33 to the west), as well as 5m east and 13m south of the visible nucleus.

The typically ubiquitous pottery assemblage encountered on the majority of wreck forms is restricted to five body sherds and two base fragments (Figs. 11-12, 57-59). None are sufficiently preserved to be typologically diagnostic. Just six brick fragments (10.0 x 6.5cm maximum and 3.0-6.5cm thick) from the galley hearth were retrieved from the site (Figs. 26-27).

A. Tobacco Pipe

The bowl of a tobacco pipe (T7a35f-5-06-0029-CP) was recovered from between frames and plank seams in area S21 (H. 4.5cm, max Diam. 1.3cm). The stem is broken at the bottom of the bowl and the spur is further damaged (Fig. 60). Rouletted milling made with a piece of braided twine or fine rope is present near the lip of the bowl (Fig. 61). The pipe's color ranges from black to dark green/dark grey, which may not be original but the result of heat, discoloration and staining. Marine growth near the bowl lip suggests that the pipe once lay on the wreck's surface before ending up buried beneath sediments.

Without more distinctive decoration or a recognized maker's stamp, this pipe type does not have a tight chronological range. Examples with comparable rouletted milling near the bowl lip are known from the wrecks of the *Swan*, lost off Duart Point, Scotland, in 1653 (Martin, 1995: 23), the *De Liefde* of 1711 recorded off the Out Skerries of northern Scotland (Bax and Martin, 1974: 85, fig. 6D) and

Fig. 60. Tobacco pipe bowl inv 0029 (H. 4.5cm).

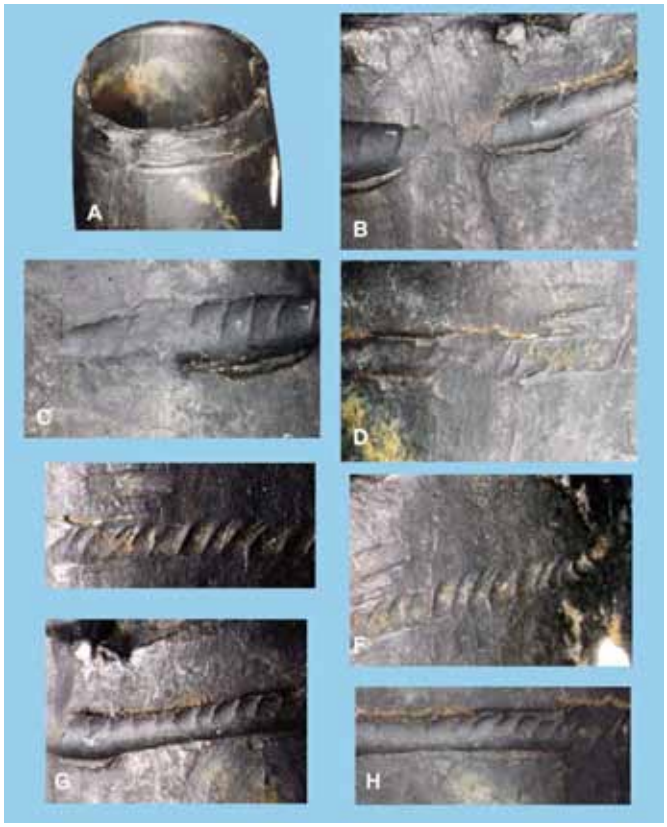

Fig. 61. Milling treatment that appears to be a rope pattern on the tobacco pipe bowl. Photo: J. Byron Sudbury.

the Dutch East Indiamen the *Adelaar*, which foundered off the Outer Hebrides, Scotland, in 1728 (Martin, 2005: 204). The shape is replicated on an example excavated from the *Vergulde Draeck*, another Dutch East Indiaman, that went down off Western Australia in 1656 (Green, 1977: 157-8).

Examples reflecting the same date range are common across England. A pipe from a pit at Bankside Power Station is associated with Delft and Metropolitan slipware dating between *c.* 1650 and 1670. Examples from a rubbish pit at Crook Street in Chester display a slightly wider range of *c.* 1660-90. Exactly the same date is provided by pipes excavated in York, while those from Stamford in Lincolnshire continue up to 1710. Tobacco pipe bowls excavated in Farham have been attributed to *c.* 1717-45. The latest dated assemblage containing the site 35F pipe type from Whieldon in Stoke-on-Trent provides parameters of 1740-50 (Davey, 1979: 69, 207, figs. 1, 3; 1980: 79, fig. 16; 1981: 243, fig. 2; 1985: 16, 284, figs. 2 and 16). Thus, a largely southern English distribution and broad chronology from the mid-17th to mid-18th century exists for the form, albeit with a notable concentration between *c.* 1660 and 1690.

B. English Bottle Bases

A 5 x 5cm and 0.3cm thick aqua blue glass sherd (inv. 0049) with a faint, blowpipe type pontil scar from site 35F comes from the base of a square case bottle (Fig. 62), possibly similar to those excavated from the wrecks of the *Dartmouth* and *Sapphire* (Holman, 1975: 258-9). Often termed apothecary or medicinal 'case' bottles, such utilitarian containers were typically used for a host of liquid products including liquor, medicines, chemicals and oils (pers. comm. Bill Lindsey, 28 July 2011). Similar forms are associated with the La Natière 2 shipwreck off St. Malo, France, identified as the frigate *L'Aimable Grenot* lost on in 1749 (L'Hour and Veyrat, 2002: 96, no. 49). The site 35F example would seem to be an unusually earlier example.

Two sherds and three bases (inv. 0004, 0032 and 0038) from free blown, thick-walled green and black glass wine bottles with large disk or glass tipped pontil scars were recovered from the southeastern end of site 35F and 10m south of cannon C29 (Fig. 10). All are heavily corroded:

- Inv. no. 0004: base Diam. 10.0cm, body Th. 0.2cm, base Th. 0.9cm (Fig. 63)
- Inv. no. 0032: base Diam. 7.8cm, body Th. 0.6cm, base Th. 1.0cm (Fig. 64)
- Inv. no. 0038: base Diam. 9.5cm, body Th. 0.6cm, base Th. 1.0cm (Fig. 65)

The form is common on 17th-century shipwrecks, including the *Dartmouth*, lost off Mull, Scotland, in 1690, from which a spectrum analysis of one base revealed traces of the lees of a Bordeaux type red wine (Holman, 1975: 258-9). Necks and bases excavated from the fifth rate Royal Navy frigate *Sapphire* can be dated to 1696 or slightly earlier (Barber, 1977: fig. 5), while one base (Diam. 5.0cm) was recovered from the Danish frigate *Mynden* lost in 1719 off the island of Rügen in Mecklenburg-Vorpommern, northern Germany (Auer, 2004: 275-6).

Round-base English wine bottles such as 0004, 0032 and 0038 emerged onto the mass market between 1630 and 1650. In 1696, John Houghton's *Letters for the Improvement of Commerce and Trade* described the existence of 88 glasshouses in England manufacturing flint, green and ordinary glass, 24 of which were in and around London and Southwark. Nine of the latter produced bottles (Morgan, 1980: 14; Tyler and Willmott, 2005: 10-11).

Typologies are based exclusively on rim, neck and body shape profiles, diagnostic features that are missing from the assemblage. Within several comparable typological schemes proposed by well-dated contexts, they may be broadly attributed to McKearin and Wilson (1978: 52-3) Types 1-3

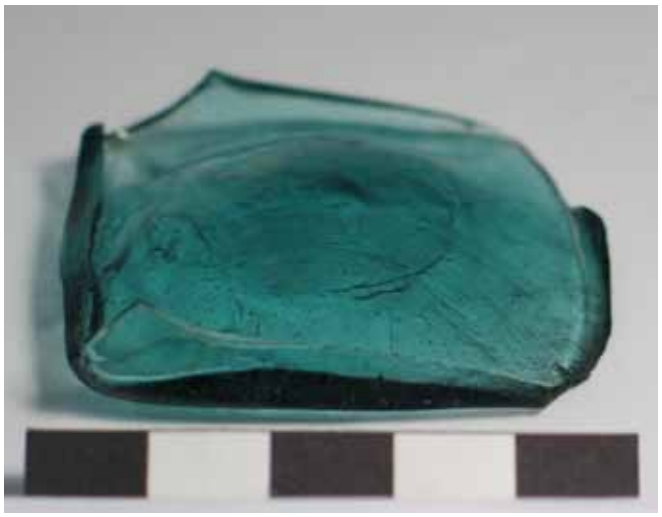

Fig. 62. Base of glass bottle inv. 0049 (Diam. 5.0cm).

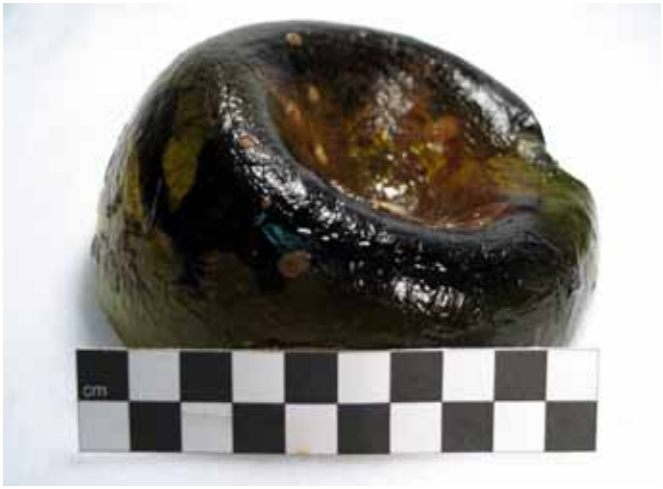

Fig. 63. Base of glass bottle inv. 0004 (Diam. 10.0cm).

of *c.* 1630-90. Bases 0032 and 0038 display close affinities with Van den Bosche (2001: 30) Type 2 with its strongly rounded base of 1640-60, while the slightly wide 0004 with its angular profile and high base kick is closest to Type 3 of 1660-75. Base 0004 is suggestive of Morgan (1980: 24-5) Type 3 bottle of *c.* 1670-80.

The site 35F bases are comparable to bottles manufactured in John Baker's glasshouse at Vauxhall in London excavated by the Museum of London Archaeological Service. This assemblage demonstrates that both bases with low and high kicks were manufactured simultaneously and are not typologically variable. With its angular side and high kick, base 0004 is identical to the G21 green glass shaft and globe example (base Diam. 6.4cm) dated to *c.* 1650-1680. Narrow base varieties of *c.* 1650-80 with low base kicks include G22-G23 (base Diam. 5.2-5.8cm). Both site 35F bases 0038 and 0032 resemble the base and globe profile of G29, again dated to *c.* 1650-80 (base Diam. 5.0-7.8cm) (Tyler and Willmott, 2005: 71-2). At 7.8-10.0cm diameter, it must be acknowledged that the wreck's bases are significantly wider.

The site 35F glass bottle bases can be attributed to the middle period of John Baker's Vauxhall glasshouse's production, before it went into disuse in 1704 and was demolished in 1706. However, the factory only started to operate some time between 1663 and 1681. Earlier styles are thus unavailable with which to compare these later variants. The ship's bottles also appear to be narrower than those used on the Norwegian frigate *Lossen*, lost of Sweden in 1717 (Molaug, 1998: 164-5).

Fig. 64. Base of glass bottle inv. 0032 (Diam. 7.8cm).

Fig. 65. Base of glass bottle inv. 0038 (Diam. 9.5cm).

C. Copper Basin Bases

Although heavily damaged, four copper artifacts found stacked inside each other (inv. no. 0001), 11m southeast of cannon C28 (Figs. 10, 66), appear to be basins or cauldron/kettle bases whose upper surfaces no longer survive. The vessels' sides taper faintly inwards towards the bases, which exhibit concentric circles (Fig. 67). The dimensions for T7a35f-5-06-0001-UN are: total H. of all stacked basins 8.1cm; H. of lower basin 5.0cm; Diam. 23.4cm; total nested Th. 4.6cm; Th. basin A 1.03cm; Th. basin B 0.89cm; Th. basin C 0.96cm, Th. basin D 1.08cm.

Although ship's cooking cauldrons used in galleys, such as an example from the Danish frigate *Mynden* (Diam. 50cm), lost in 1719 off the island of Rügen in Mecklenburg-Vorpommern, northern Germany (Auer, 2004: 274), are commonly twice the diameter of the site 35F examples, two typologically comparable cauldrons are associated with the Danish merchant vessel the *Sainte Dorothea*, lost in 1693 at Villefranche-sur-Mer, near Nice, France. Her cauldrons (Diam. 54.5cm and 57cm, H. 61.5cm and 55.5cm) are flat-based with vertical side surmounted by two handles at the top and an everted bead rim. One is inscribed with the date '1655', implying prolonged use at sea over nearly four decades (L'Hour, 1993: 317). Another comparable kettle (Diam. 40cm, H. 43cm) with heavy rivets along the sides has been excavated from the *Swan* off Duart Point, Scotland (Martin, 1995a: 24, fig. 17; 1995b: 42), and an identical example (H. 38.8cm, base Diam. 35.0cm) is associated with the *Vergulde Draeck*, a VOC merchant vessel lost off Western Australia in 1656 (Green, 1977: 199). The function and date of the site 35F examples remain undetermined. (See Section 9 below for their possible use in African exchange.)

Fig. 66. Nested copper basins in situ *on the surface of site 35F.*

Fig. 67. Stacked copper basins (with base at top) (H. 8.1cm, Diam. 23.4cm).

9. Conclusion: a Royal Africa Company Trader?

Albeit containing sparse material culture, Odyssey Marine Exploration site 35F is an unusual and intriguing shipwreck. It is believed to be the Westernmost example associated with a cargo of elephant tusks and *manilla* bracelets. Pre-dating the Saint-Quay-Portrieux wreck of 1711 or 1719 off Brittany, it is the earliest known cargo combination of this form. The site has also yielded the earliest folding wooden rule discovered on any wreck to date.

Currently, inadequate data exist with which to reconstruct the precise date of the ship's loss. Neither the *manilla* bracelets nor the ivory tusks are typologically sensitive. The three most promising dating criteria offer the following chronological parameters:

- A generic form of tobacco pipe with no maker's mark: mid-17th to mid-18th century, with a notable floruit between c. 1660 and 1690.
- Three glass bottle bases, 1630-90, with close parallels to products manufactured in Vauxhall, London, from the mid to late 17th century.
- The wooden folding rule, which is not inscribed with a date: a suggested chronology of manufacture in the 1660s to 1690s, with a possible focus in the 1670s or 1680s.

Based on internal archaeological data the meagre evidence is suggestive of a date between *c.* 1660 and 1700 for the loss of the shipwreck at site 35F.

In terms of the vessel's form, cultural background and trade orbit, the wooden rule, smoking pipe and glass bottle bases all point towards an English nationality. In particular, the English formula used on the folding rule almost

certainly reflects the nationality of the carpenter who owned it and thus the lines of the ship which he was employed to keep in working order. In the same way, the 1ft-long rule from the Dutch East Indiaman *Vergulde Draeck* (1656) relied on the Amsterdam foot.

The site 35F vessel itself seems to have been an armed merchantman. Some 36 iron cannon characterize the wreck nucleus, while a further 12 guns have been located to the south and north. A total of 48 cannon is an extensive set of ordnance, which is unlikely to have served exclusively to protect the ship during her trading ventures. Between 1602 and 1655, for instance, Dutch East Indiamen were equipped with a great variety of armament. A large fleet vessel such as the *Anisterdain*, crewed in 1604 with about 170 sailors and 50 soldiers, was armed with 40 cannon (Kist, 1988: 101-102), less than are present on the Western Approaches shipwreck in question.

Similarly, the VOC *De Liefde*, lost on the Out Skerries, Shetland, in 1711, was 166ft long (50m) with a beam of 44ft (13m) and held a cargo of 250 *lasten* (500 tons). The ship carried an armament of 40 guns comprised of ten iron 12-pounders, two bronze eight-pounders, 18 iron eight-pounders and 10 smaller pieces (Bax and Martin, 1974: 82). In general, a vague Dutch East Indiaman company rule of 1630 stated that all large outgoing ships should carry 32 guns (24 iron, six brass and two minions), while smaller ships would carry 20 iron and four brass guns (McBride and Whiting, 1985: 15). Site 35F's cannon quantity also exceeds the 30 examples mounted on the 435-ton, 90ft long and 30ft wide English East Indiaman the *Royal Katharine*, launched from Blackwell yard in 1662 (Sutton, 1981: 42).

A collection of 48 guns is considerable even by Royal Navy standards and hence would be especially so for a merchantman. Between the mid to late 17th-century, fourth-rate warships were equipped with 50 guns, fifth-rates with 32-50 guns and sixth-rates with up to 32 guns (Cates and Chamberlain, 1998: 127). Fourth- to sixth-rates were not used in lines of battle, but as support vessels, yet it would be surprising for a merchant vessel carrying elephant tusks to be armed with as much ordnance as either these or the 36 cannon on the fifth-rate *Dartmouth* (keel length: 24.4m), lost in 1690 (Martin, 1978: 29-30).

A major problem of distinguishing between what percentage of cannon on site 35F was shipboard weaponry as opposed to potential saleable ballast cargo is the complexity of determining the vessel's magnitude. Its 26.1m-long keel mirrors the size of a Baltic trader lost *c.* 1593 in the Wadden Sea, Netherlands, whose total length has been estimated at just over 30m (Manders, 2003: 320). However, neither the stem nor the sternpost or associated scarfs in the keel are evident on site 35F, which leaves the issue of the ship's reconstructable length unresolved. The hull remains serve only to provide a minimum magnitude.

In the absence of more concrete data, site 35F's length of 26.1m is seemingly indicative of a medium-sized merchant vessel. In terms of volume, the presence of 48 iron cannon appears to reflect at least partial transport as cargo. This view is strongly reinforced by the parallel configuration of cannon C3-C9, which overlie the keel in a regularly stowed configuration towards the northern end (stern) of the wreck.

The commercial structure of site 35F's orbit can be theorized. *Manilla* bracelets were the currency of European exchange with West Africa *par excellence*. They comprise one of the signature sets of material culture associated with the triangular trade between Europe, Africa and home via the Caribbean/Americas. The site also contains a second set of artifacts intimately attributable to such exchange – elephant tusks. It should also be emphasized that copper objects, such as the site's four nested cauldrons, are of a class that comprised another form of currency in this era.

Despite its enormous fascination and archaeological importance, site 35F remains enigmatic due to the limited material culture surviving following extensive natural and fishing impacts. However, assuming an English origin and date between the 1660s and 1690s, with the most likely period of loss in the 1670s or 1680s (Johnston, 2011: 50), one specific attribution is highly possible – the Royal Africa Company of 1672-1698. In the first half of the 17th century the trade to Africa for slaves, gold and other commodities was numerically small-scale. English trade to the West Coast started to take shape in 1618 through the affairs of the Company of Adventurers of London (Guinea Company), who largely dealt in gold. A single ship imported £30,000 of gold into England in 1636, but otherwise the organization's track record was dismal. Their levels of commerce increased in 1660 and 1663 with new charters, but by 1668 the company had virtually ceased trading on a joint-stock basis due to financial difficulties (Davies, 1957: 40; Morgan, 2003: x).

From its ashes arose the Royal African Company, which bought up the Adventurers' assets and gained a royal monopoly over English trade with Africa. The Company passed the great seal on 27 September 1672 and was granted the monopoly over 5,000 miles of western Africa's coastline from Cape Sallee in the north to the Cape of Good Hope. The organization's Governor from 1672 to 1688 was James, Duke of York, and later King of England. The Company maintained in West Africa some 15-20 fortified establishments housing 200-300 civilian and military personnel. In the late 1680s fort-factories were operating along the Gold

Coast at Cape Coast, Sekondi, Komenda, Fredericksburg (Fort Royal), Anashan, Anomabu, Egya and Accra. The Company's Agent-General resided at Cape Coast Castle on the Gold Coast in modern Ghana (Davies, 1957: 9, 97, 156, 213; Law, 1997: vii; Morgan, 2003: xi, xii).

To secure a profit on a venture, outgoing vessels mainly departing from London, but with some Bristol craft involved, transported various miscellaneous products, chiefly cloth, metal goods (including re-exported iron and copper from Sweden and Germany), firearms and French brandy, with the objective of selling English products to an annual value of £100,000. This was never accomplished between 1672 and 1713, when exported goods were valued at just £40,000 a year. Sailing times from England to northwest Africa took five to seven weeks.

The return trade can be separated into two geographical and commercial branches: the purchase of African slaves for sale in the West Indies and, secondly, the purchase of African products, such as gold, ivory, dyewood, hides and wax for disposal in England. Up to 1713 the Royal Africa Company delivered at least 125,000 slaves to the English West Indian islands of Barbados, Jamaica, Nevis, St. Christopher's, Antigua and Montserrat. Most ships sailed the triangular route to the West Indies before heading home. Thus, of 32 ships that departed from London for Africa in 1686, 23 discharged slaves in the West Indies, two delivered slaves in Virginia, four remained in Africa as supply ships, and three returned directly to England. When timings permitted Company vessels took on cargos of sugar: in 1677, 43 ships were employed by the Royal Africa Company to import sugar from Barbados, Jamaica and Nevis, each carrying an average of 32 tons (Davies, 1957: 44-5, 166, 170, 186, 188; Morgan, 2003: xv).

The main products imported to England by the Royal Africa Company were summarized in September 1679 in *Certain Considerations Relating to the Royal African Company of England* (London, 1680). The paper stated that "The Importation of Gold, Elephants Teeth, Wax, and other useful Commodities thereby discharging this Nation of superfluities, and making compensation in things of Necessity and Conveniency, is a double advantage."

For the first 30 years of its operations, all gold obtained in West Africa by the Royal Africa Company was delivered to the Mint in London and coined into guineas stamped with an elephant. From 1673-1713, 548,327 guineas were coined, accounting for some 7% of all gold received by the Mint. The Company imported more than £250,000 of gold between 1682 and 1692 (Davies, 1957: 225).

Ivory was ranked second to gold in value, and over the course of 40 years 17,000 counterweight was imported, of which 9,300 arrived between 1680-89. Ivory could be procured almost anywhere along the coast of Africa, although most Royal Africa Company imports derived from Gambia and the Windward Coast. At a sale held in 1679 the highest price paid for this high-value import was £6 13s a counterweight and the lowest £4 7s per counterweight. The best quality was bought for £10 or £12 a counterweight. Redwood from Sierra Leone and the Sherbro River constituted one of the most profitable commodities, which was bought in Africa for about £3 a ton and sold in London for £40 or more. From November 1679 to April 1680, takings amounted to 5 tons of ivory, 4 tons of wax, 13,000 hides and 106 slaves. The principal exports to Africa in this period were 3,294 iron bars, 85 reams of paper, 3,587lbs of beads, 89 guns, four barrels of gunpowder, 392lbs of brasswares and 284lbs of pewter (Davies, 1957: 181-2, 219, 225).

The local correspondence of West Africa confirms the relationship between the Royal Africa Company, elephant tusks and *manilla* bracelet exchange. A source dated to 20 April 1681 indicates that the merchant John Thorne traded "490 manilloes att 220 per slave" (Law, 1997: 221-2). Richard Pears of the *James* bought "about eleaven hundred weight of elephants teeth" at Cape Lahoe on 5 January 1686, while records for 12 March in the same year record that Henry Wood reported from Cape St. Johns that he had secured "about one thousand weigt of teeth" (Law, 2001: 349, 351). The Company differentiated between "manilloes black" and "manilloes bright" and outward bound shipments typically carried between 1,500 and 4,000 examples (PRO T70/1212, T70/1222).

Between 1672 and 1713 the Royal Africa Company dispatched more than 500 ships from England to Africa. The trade peaked from 1680-88 with 249 voyages. Average ship capacities were well under 100 tons. Nevertheless, records for the years 1683 and 1691 display Company ships outgoing to West Africa ranging widely from as low as 40 tons up to 450 tons (PRO T70/61).

Due to common problems of securing homeward bound cargos, physical ownership of a fleet was uneconomic, so it was as a charterer that the RAC made its greatest impact. Thus, of 165 ships sent out to West Africa in 1680-85, 124 vessels were hired. Between the years 1689-97 the Royal Africa Company lost 64 ships at sea (Davies, 1957: 191-2, 195, 206).

Due to the date of the site 35F shipwreck, the royal monopoly over exchange between England and West Africa in the period when this vessel probably sailed, and the signature assemblages of elephant tusks and *manilla* bracelets, the best-fit interpretation of this wreck on available data is as a Royal Africa Company craft.

Further, the tusk consignment points towards an incoming merchant vessel. The presence of unused *manillas* on an inward bound Company ship would not have been unusual because *manillas* were often rejected as of poor quality and because trade was often slow. Thus, currency may have remained unused. For instance, on 24 March 1688 John Bridges on board the *Guinea Friggatt* between Tackerado and Succondee "found but miserable trading, for I have taken but very little money, no teeth, and about 5000 weight mallagetta" (Law, 2001: 411). Such ships would also have been armed as at site 35F. Local West African correspondence frequently complained about Dutch and French pirates and interlopers. Once the War of the Grand Alliance broke out in 1689, trading vessels simultaneously served as privateers against French craft. Royal Africa Company records demonstrate that their merchant vessels were armed with between two and 36 guns maximum (PRO T70/61).

The current working hypothesis for Odyssey site 35F suggests a possible identification as the first wreck of a Royal Africa Company ship discovered worldwide. The presence of elephant tusks and *manilla* bracelets prove without doubt that the ship had commercial links with West Africa. The available data point towards an English origin for the vessel. In light of the royal monopoly, as the wreck of a Royal Africa Company ship site 35F would date between 1672 and 1698, when the monopoly was rescinded by an Act of Parliament (Morgan, 2003: xvi).

Internal archaeological data suggests a loss date between the 1660s and 1690s, with a possible preference for the 1670s and 1680s. The absence of references to *manilla* bracelets in the local correspondence of West Africa between 1685 and 1699 may be further informative (cf. Law, 2001; 2006), perhaps favoring a date between *c*. 1672 and 1685 for the loss of the site 35F wreck. Until an artifact conclusively enables the ship to be identified, however, the ultimate identity of this enigmatic site will remain unverifiable.

Acknowledgements

The authors wish to extend their sincere gratitude during the 2006, 2008 and 2009 fieldwork seasons to a multitude of Odyssey Marine Exploration staff, colleagues and fellow contractors. To the vision of Greg Stemm (co-founder and Chief Executive Officer), Project Managers Tom Dettweiler, Andrew Craig and Mark Martin for their professionalism, encouragement, support and patience. To the ROV supervisors Gary Peterson, Eric Peterson, Ewan Bason and their crew of technicians, Jesus Perez, Roberto Blach, Jose Rodreiguez, Dave Bugos, Paul Money, Rubin Liero, Jeff Thomas, Olaf Dieckhoff and David Dettweiler, whose skill and enthusiasm in all matters ROV are second to none. Important to all aspects of deep-sea shipwreck investigations and excavations are the navigators/survey team, and big thanks goes to Aaron Rodgerson, Kris Allen and Ryan Wells.

The relentless task of gathering and managing data was conducted by IT Manager Gerhard Seiffert and his team of dataloggers, Fred Fretzdorff, Dave Kamm and Tom Money. Their attention to detail and patience sets a benchmark for photomosaic production. None of the above would have been possible without the keen-eyed professionalism of Project Manager Ernesto Tapanes and his side-scan survey team of Dan Adams, Brett Hood and Zach Antonissen. A huge thanks goes to Captain Keith Herron and Captain Mike Wainman and their officers and crew for making everyone's stay on the *Odyssey Explorer* a safe and happy experience. Bob Stemm and John McNeilly assisted in the investigation and excavation of this shipwreck and were a welcome addition to the team.

The 2006 survey and excavation were conducted under the archaeological supervision of our good friend and colleague Hawk Tolson. The authors also acknowledge the generous professional advice of Stephen Johnston (Oxford Museum of the History of Science), John Sudbury, Bill Lindsey and John Batchelor for artefact identifications. For their constant enthusiasm and support at Odyssey Tampa, our ongoing gratitude is extended to Mark Gordon, Laura Barton and John Oppermann. Alan Bosel and Chad Morris patiently answered endless requests for photographs and data and Ellen Gerth generously offered research pointers. Special thanks are extended to Jason Williams (President, JWM Productions) and the Discovery Channel for helping bring the story of this shipwreck to life. Much appreciation to Alice Copeland for her proofreading prowess and a big thanks to Melissa Dolce for her layout work.

Notes

1. In addition to Odyssey's own detailed investigation of site 35F, Odyssey is aware that it was also inspected by another commercial offshore company using a small 'eyeball' ROV. A small number of artifacts were reportedly picked up from the site, but nothing has been published, and the whereabouts of any artifacts recovered is unknown.
2. MoLAS's discovery and excavation in 2005 of Sir Nicholas Crisp's early 17th-century glass bead factory along the riverbank at Hammersmith, England, for the manufacture of wares to be used in the slave trade between Guinea and the West Indies (until 1640) suggests that

some goods exchanged in West Africa were produced in Britain in the 17th century.
3. See: http://www.arq.de/english/projects_caboverde_cidadevelha.htm.
4. See: http://www.english-heritage.org.uk/server/show/nav.17487.
5. See: http://www.heritage-activities.nl/ancods/voc-zw.html.
6. See: http://www.arq.de/english/projects_caboverde_louisa.htm.

Bibliography

Alves, F.J.S., *The 16th Century Portuguese Shipwreck of Oranjemund, Namibia. Report on the Missions Carried out by the Portuguese Team in 2008 and 2009* (Lisbon, 2011).

Anozie, F.N., 'Cultural Prehistory in the Niger Delta'. In Alagoa, E.J., Anozie, F.N. and Nzewunwa, N. (eds.), *The Early History of the Niger Delta* (University of Port Harcourt & Hamburg, 1988), 141-86.

Atkinson, K., Green, J., Harper, R. and Intakosai, V., 'Joint Thai-Australian Underwater Archaeological Project 1987-1988 Part 1: Archaeological Survey of Wreck Sites in the Gulf of Thailand, 1987-1988', *International Journal of Nautical Archaeology* 18.4 (1989), 299-315.

Auer, J., 'Fregatten *Mynden*: a 17th-century Danish Frigate Found in Northern Germany', *International Journal of Nautical Archaeology* 33.2 (2004), 264-80.

Barber, V.C., 'The *Sapphire*, a British Frigate, Sunk in Action in Bay Bulls, Newfoundland, in 1696', *International Journal of Nautical Archaeology* 6.4 (1977), 305-313.

Bax, A. and Martin, C.J.M., *'De Liefde*. A Dutch East Indiaman Lost on the Out Skerries, Shetland, in 1711', *International Journal of Nautical Archaeology* 3.1 (1974), 81-90.

Beachey, R.W., 'The East African Ivory Trade in the Nineteenth Century'. In Z.A. Konczacki and J.M. Konckzacki (eds.), *An Economic History of Tropical Africa. Volume One. The Pre-Colonial Period* (London, 1977), 216-30.

Bednarz, T., 'The Wreck of a 16th/17th-century Sailing Ship Near the Hel Peninsula, Poland'. In L. Blue, F. Hocker and A. Englert (eds.), *Connected by the Sea. Proceedings of the Tenth International Symposium on Boat and Ship Archaeology, Roskilde 2003* (Oxford, 2006), 273-76.

Brown, J., *The Description and Use of the Carpenters-Rule together with the Use of the Line of Numbers (Inscribed Thereon) in Arithmatick and Geometry* (London, 1656).

Brown, J., *The Description and Use of a Joynt-Rule* (London, 1661).

Brown, W.A.B. and Kelly, K.I.M., *Indian and African Elephant Ivory: Elephas Maximus and Loxodonta Africana* (1987).

Bud, R. and Warner, D.J. (eds.), *Instruments of Science: an Historical Encyclopedia* (New York, 1998).

Cates, M. and Chamberlain, D., *'Stirling Castle,* 1703. In M. Bound (ed.), *Excavating Ships of War* (Oswestry, 1998), 125-41.

Corbin, A., *The Material Culture of Steamboat Passengers. Archaeological Evidence from the Missouri River* (New York, 2000).

Davey, P., *The Archaeology of the Clay Tobacco Pipe. 1. Britain: the Midlands and Eastern England* (BAR British Series 63, Oxford, 1979).

Davey, P., *The Archaeology of the Clay Tobacco Pipe. 3. Britain: the North and West* (BAR British Series 78, Oxford, 1980).

Davey, P., *The Archaeology of the Clay Tobacco Pipe. 6. Pipes and Kilns in the London Region* (BAR British Series 97, Oxford, 1981).

Davey, P., *The Archaeology of the Clay Tobacco Pipe. 9. More Pipes from the Midlands and Southern England* (BAR British Series 146, Oxford, 1985).

Davies, G., *A History of Money. From Ancient Times to the Present Day* (University of Wales Press, Cardiff, 2002).

Davies, K.G., *The Royal African Company* (London, 1957).

de Maisonneuve, B., 'Excavations of the Maidstone, a British Man-of-war Lost off Noirmoutier in 1747', *International Journal of Nautical Archaeology* 21.1 (1992), 22.

Dickson, K.B., 'Trade Patterns in Ghana at the Beginning of the Eighteenth Century'. In Z.A. Konczacki and J.M. Konckzacki (eds.), *An Economic History of Tropical Africa. Volume One. The Pre-Colonial Period* (London, 1977), 132-46.

Einzig, P., *Primitive Money in its Ethnological, Historical and Economic Aspects* (London, 1949).

Ericsson, C.F., 'The Instruments from Her Imperial Majesty's Frigate *Nicholas', International Journal of Nautical Archaeology* 4.1 (1975), 65-71.

Flecker, M., *The Archaeological Excavation of the 19th Century Intan Shipwreck* (BAR Int. S1047, Oxford, 2002).

Flecker, M., 'The Thirteenth Century Java Sea Wreck: a Chinese Cargo in an Indonesian Ship', *Mariner's Mirror* 89.4 (2003), 388-404.

Geary, W.N.M., *Nigeria Under British Rule* (London, 1927).

Gibbard, P.L. and Lautridou, J.P., 'The Quaternary History of the English Channel: an Introduction', *Journal of Quaternary Science* 18 (2003), 195-99.

Goddio, F., 'The Wreck on the Lena Shoal'. In F. Goddio, M. Crick, P. Lam, S. Pierson and R. Scott, *Lost at Sea. The Strange Route of the Lena Shoal Junk* (London, 2002a), 1-42.

Goddio, F., 'Other Artifacts'. In F. Goddio, M. Crick, P. Lam, S. Pierson and R. Scott, *Lost at Sea. The Strange Route of the Lena Shoal Junk* (London, 2002b), 235-55.

Green, J.N., 'The Wreck of the Dutch East Indiaman the Vergulde Draeck, 1656', *International Journal of Nautical Archaeology* 2.2 (1973), 267-89.

Green, J.N., *The Loss of the Verenigde Oostindische Compagnie Jacht Vergulde Draeck, Western Australia in 1656* (BAR Int. Series 36(i), Oxford, 1977).

Green, J.N., 'The Survey of the VOC *Fluit Risdam* (1727), Malaysia', *International Journal of Nautical Archaeology* 15.2 (1986), 93-104.

Grey, R.F.A. and George, S.P., 'Manillas', *The Nigerian Field* 16 (1951), 52-66.

Grochowski, N.T.L., Collins, M.B., Boxall, S.R. and Salomon, J.C., 'Sediment Transport Predictions for the English Channel, Using Numerical Models', *Journal of the Geological Society* 150 (1993), 683-95.

Gunter, E., *De Sectore & Radio. The Description and Vse of the Sector in Three Bookes. The Description and Vse of the Cross-Staffe in other Three Bookes* (London, 1623).

Hamblin, R.J.O., Crosby, A., Balson, P.S., Jones, S.M., Chadwick, R.A., Penn, I.E. and Arthur, M.J., *The Geology of the English Channel* (London, 1992).

Herry, N., 'Report on Finds from the Saint-Quay-Portrieux Wreck, France', *International Journal of Nautical Archaeology* 33.1 (2004), 96-105.

Hillis, R.R., Gatliff, R.W., Day, G.A. and Edwards, J.W.F., *The Geology of the Western English Channel and its Western Approaches* (London, 1990).

Holman, R.G., 'The *Dartmouth*, a British Frigate Wrecked off Mull, 1690. 2. Culinary and Related Items', *International Journal of Nautical Archaeology* 4.2 (1975), 253-65.

Ingelman-Sundberg, C., 'Preliminary Report on Finds from the Jutholmen Wreck', *International Journal of Nautical Archaeology* 5.1 (1976), 57-71.

Johansson, S-O., *Nigerian Currencies. Manilas, Cowries and Others* (Skolgatan, 1967).

Johnson, M., *Ivory Trade and the Economic Development of Pre-Colonial West Africa* (London, 1978), 12.

Johnston, S., 'The Carpenter's Rule: Instruments, Practitioners and Artisans in 16th-century England'. In G. Dragoni, A. McConnell and G.L'E. Turner (eds.), *Proceedings of the Eleventh International Scientific Instrument Symposium* (Bologna, 1994), 39-45.

Johnston, S., 'Reading Rules: Artefactual Evidence for Mathematics and Craft in Early-Modern England'. In L. Taub and F. Willmoth, *The Whipple Museum of the History of Science. Instruments and Interpretations, to Celebrate the Sixtieth Anniversary of R.S. Whipple's Gift to the University of Cambridge* (Whipple Museum, 2006), 233-53.

Johnston, S., 'A Note on the Wooden Carpenter's Rule from Odyssey Shipwreck Site 35F'. In G. Stemm and S. Kingsley (eds.), *Oceans Odyssey 2. Underwater Heritage Management & Deep-Sea Shipwrecks in the English Channel & Atlantic Ocean* (Oxford, 2011), 39-50.

Jones, G.I., 'Native and Trade Currencies in Southern Nigeria during the Eighteenth and Nineteenth Centuries'. In Z.A. Konczacki and J.M. Konckzacki (eds.), *An Economic History of Tropical Africa. Volume One. The Pre-Colonial Period* (London, 1977), 274-83.

Karklins, K., 'Beads from the Mid 17th Century Manilla Wreck, Bermuda', *International Journal of Nautical Archaeology* 20.1 (1991), 33-42.

Kist, J.B., 'The Dutch East India Company's Ships' Armament in the 17th and 18th Centuries: an Overview', *International Journal of Nautical Archaeology* 17.1 (1988): 101-102.

Knight, R., 'The Carpenter's Rule', *Newsletter of the Tools and Trades Society* 20 (1988), 12-19.

Knight, R., 'A Carpenter's Rule from the Mary Rose', *Tools and Trades* 6 (1990), 43-55.

Kuntz, M., Ferguson, J., Iduma, V., Kuzava, R. and Benvenuto, M., 'Chemical Compositions of African Trade Bracelets (Manillas) via Energy Dispersive X-Ray Fluorescence', *American Journal of Undergraduate Research* 1.1 (2002), 29-38.

Larsonneur, C., Bouysse, P. and Auffret, J-P., 'The Superficial Sediments of the English Channel and its Western Approaches', *Sedimentology* 29.6 (1982), 851-64.

L'Hour, M., 'The Wreck of a Danish Merchant Ship, the *Sainte Dorothea* (1693)', *International Journal of Nautical Archaeology* 22.4 (1993), 305-22.

L'Hour, M. and Veyrat, E., *Un corsaire sous la mer. Les épaves de la Natière, archéologie sous-marine à Saint-Malo. Volume 3. Campagne de fouille 2001, l'épave Natière 2* (Edition Adramar, 2002).

Law, R., *The English in West Africa 1681-1683. The Local Correspondence of the Royal Africa Company of England 1681-1699, Part I* (Oxford University Press, 1997).

Law, R., *The English in West Africa 1685-1688. The Local Correspondence of the Royal Africa Company of England 1681-1699, Part 2* (Oxford University Press, 2001).

Law, R., *The English in West Africa 1691-1699. The Local Correspondence of the Royal Africa Company of England 1681-1699, Part 3* (Oxford University Press, 2006).

Manders, M.R., 'The Mysteries of a Baltic Trader'. In C. Beltrame (ed.), *Boats, Ships and Shipyards. Proceedings of the Ninth International Symposium on Boat and Ship Archaeology, Venice 2000* (Oxford, 2003), 320-28.

Marsden, P., 'The Dutch East Indiaman *Hollandia* Wrecked on the Isles of Scilly in 1743. 3. Archaeological Report', *International Journal of Nautical Archaeology* 4.2 (1975), 278-97.

Martin, C.J.M., 'The *Dartmouth*, a British frigate Wrecked off Mull, 1690. 5. The Ship', *International Journal of Nautical Archaeology* 7.1 (1978), 29-58.

Martin, C.J.M., 'The Cromwellian Shipwreck off Duart Point, Mull: an Interim Report', *International Journal of Nautical Archaeology* 24.1 (1995), 15-32.

Martin, C.J.M., 'The *Adelaar*: a Dutch East-Indiaman Wrecked in 1728 off Barra, Outer Hebrides, Scotland', *International Journal of Nautical Archaeology* 34.2 (2005), 179-210.

McBride, P. and Whiting, D., 'The Wreck of the Dutch East Indiaman *Campen* on the Needles Rocks, Isle of Wight, 1627-Part 1. Artefacts', *International Journal of Nautical Archaeology* 14.1 (1985): 15-31.

McKearin, H. and Wilson, K.M., *American Bottles and Flasks and their Ancestry* (New York, 1978).

Molaug, S., 'The Excavation of the Norwegian Frigate *Lossen*, 1717'. In M. Bound (ed.), *Excavating Ships of War* (Oswestry, 1998), 164-5.

Moore, D.D. and Malcom, C., 'Seventeenth-Century Vehicle of the Middle Passage: Archaeological and Historical Investigations on the Henrietta Marie Shipwreck Site', *International Journal of Historical Archaeology* 12 (2008), 20-38.

Morgan, K. (ed.), *The British Transatlantic Slave Trade, Volume 2. The Royal African Company* (London, 2003).

Morgan, R., *Sealed Bottles. Their History and Evolution (1630-1930*) (Burton-on-Trent, 1980).

Parthesius, R., Millar, K. and Jeffery, B., 'Preliminary Report on the Excavation of the 17th-century Anglo-Dutch East-Indiaman *Avondster* in Bay of Galle, Sri Lanka', *International Journal of Nautical Archaeology* 34.2 (2005), 216-37.

Petersen, B-M., 'The Dutch Fluitship *Anna Maria*, Foundered in Dalaro Harbour in 1709', *International Journal of Nautical Archaeology* 16.4 (1987), 293-304.

Price, R. and Muckelroy, K., 'The Second Season of Work on the *Kennemerland* Site, 1973. An Interim Report', *International Journal of Nautical Archaeology* 3.2 (1974), 257-68.

Smith, C.E. and Maxwell, C.V.H., 'A Bermuda Smuggling-Slave Trade: the 'Manilla Wreck' Opens Pandora's Box', *Slavery & Abolition* 23.1 (2002), 57-86.

Sténuit, R., 'Early Relics of the VOC Trade from Shetland. The Wreck of the Flute Lastdrager Lost off Yell, 1653', *International Journal of Nautical Archaeology* 3.2 (1974), 213-56.

Sutton, J., *Lords of the East. The East India Company and its Ships* (London, 1981).

Svalesen, L., *The Slave Ship Fredensborg* (Kingston, 2000).

Tripati, S., Gaur, A.S., Sundaresh and Vora, K.H., 'Shipwreck Archaeology of Goa: Evidence of Maritime Contacts with Other Countries', *Current Science* 86.9 (2004), 1238-45.

Tripati, S. and Godfrey, I., 'Studies on Elephant Tusks and Hippopotamus Teeth Collected from the Early 17th Century Portuguese Shipwreck off Goa, West Coast of India: Evidence of Maritime Trade between Goa, Portugal and African Countries', *Current Science* 92.3 (2007), 332-39.

Tyler, K. and Willmott, H., *John Baker's Late 17th-Century Glasshouse at Vauxhall* (MoLAS Monograph 28, London, 2005).

Van den Bosche, W., *Antique Glass Bottles. Their History and Evolution (1500-1850). A Comprehensive, Illustrated Guide with a World-wide Bibliography of Glass Bottles* (Suffolk, 2001).

Wade, G., *The Pre-Modern East Asian Maritime Realm: An Overview of European-Language Studies* (Asia Research Institute Working Paper Series No. 16, Asia Research Institute, National University of Singapore, 2003).

Walker, J.F., *Ivory's Ghosts. The White Gold of History and the Fate of Elephants* (New York, 2009).

Walker, P., 'Tools of the *Mary Rose', Tools and Trades History Society Newsletter* 2 (1983), 20-30.

Webster, J., 'Slave Ships and Maritime Archaeology: An Overview', *International Journal of Historical Archaeology* 12 (2008), 6-19.

Wingate, E., *The Use of the Rule of Proportion in Arithmetique and Geometrie* (London, 1645).

Wingood, A.J., *'Sea Venture*. An Interim Report on an Early 17th Century Shipwreck Lost in 1609', *International Journal of Nautical Archaeology* 11.4 (1982), 333-47.

Young, R.A. and Glover, T.J., *Measure for Measure* (Littleton, CO, 1996).

