

An Examination of Sanitation and Hygiene Habit Artifacts Found Aboard *Vasa*

Health, Sanitation, and Life at Sea in Seventeenth-Century Sweden

by

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Vasa was a 64-gun Swedish warship in the service of King Gustav II Adolf (r. 1611 – 1632). The vessel sank on its maiden voyage in 1628, taking at least 16 of the approximately 150 persons on board to the depths of Stockholm Harbor. Amongst the cannon, figureheads, and skeletons were a collection of artifacts that can tell us about health and hygiene aboard *Vasa*. These artifacts include chamber pots, glass bottles, wooden enema nozzles, combs, and the ship's heads. This project seeks to examine the sanitation and hygiene artifacts recovered from *Vasa* and place them into the larger background of sanitary practices in Europe in the seventeenth century.

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By
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Dedication

For Katy, Bambino, and Bear.

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Chapter 1: Introduction

There is a significant lack of research into the lives of sailors in the centuries predating the great age of Nelson's Navy. While there are certainly more sources available to researchers who examine the navies of the nineteenth century, what about life on board *Vasa* (1628), *Kronan* (1676), or other vessels of the seventeenth century? How would the officers and crew have lived if *Vasa* had survived past its foundering in Stockholm harbor? The material culture found onboard *Vasa* provides the opportunity to see not only what personal effects the officers and crew found important enough from their life ashore to take to sea, but also how they may have lived while ashore. Items such as personal chests, game boards, eating utensils, combs, and chamber pots all tell archaeologists a little bit about the crew.

There is some information on the crew, who came from several economic backgrounds, in the records of the Swedish Treasury's Rikshuvudböcker or "national register" (Glete 2010:575). The regular seamen came from the lower levels of Swedish society, while the officers came from the middle and upper classes (Hocker 2006:51-52; Glete 2010:575-577). Based on artifact evidence from *Vasa*, the crew also consisted of various skilled laborers from trades such as rope making, carpentry, piloting, sail making, and skilled seamen (Hocker 2006:52).

Life onboard any ship in the seventeenth century was a rough and hazardous undertaking and injury or death due to disease, war, or the elements was a common occurrence. Even though *Vasa* met an untimely end, this does not mean it is impossible to determine how the crew was planning to live. The material culture associated with shipboard health and hygiene give a glimpse as to what items the officers and crew found important, but also provides insight into the hygienic practices of seventeenth century Sweden. Space onboard any vessel is limited, and

space for personal objects was at a premium, meaning the crew only brought what was important or necessary.

Among the items that crewmembers, officer and seaman alike, found important to bring aboard were sanitation and hygiene items. These objects were combs, chamber pots, personal medicines, ear-scoops, or even personal enema kits (prior to the invention of the clyster, these were some form of bag with a nozzle). A barber-surgeon would have had a kit, similar to what was recommended in John Woodall's *Surgeon's Mate* (1617), or what was found aboard *Mary Rose* (1545) (Gardiner and Allen 2013) for treating any injury or illness that occurred at sea within a designated space. These kits contained tools such as trepanning bits, scalpels, bone saws, and medicines believed to treat the wide range of illnesses the crew might encounter (Figure 1). Military vessels in later decades had a full-time surgeon who was either brought up through university or an apprenticeship. Surgeons tended to the health needs of the crew; however, personal hygiene was still the responsibility of the individual sailor.

Electuarium Diatrion piperion.	Pulvis re- string. mi- nus.	Ung. con- tra ignem.	Unguen- tum Mar- tium.	Vng. Dia- pompho- ligos.	Elect: Diafcor- dium.	Mel Depura- tum.	The lowest part of the Chest. The present appearance of the Chest, with the or- der of every Medicine as they are plac'd, is here demon- strated.	Lixivi- um capi- tate.	Syrupus Rosarum.	Balsa- mum ar- tific.	Oximel.	Acetum Rosarum.	Aqua Ab- sintii.	Aqua Ros- arum rub.									
Tberiac Diates.	Vnguentum Dialthea.	Axungia Cervi.	Vnguentum Egyptia- cum.	Vng. Au- renum.	Confer. Rosarum.	Rhabarb- elec.		Oleum Lilio- rum.	Oleum Limoni.	Mel Rosarum.	Oleum cha- momili.	Oleum Rosarum.	Aqua Angelica.	Aqua Plantag.									
Tberiac Lond:	Vnguentum Album.	Axungia Porcina.	Vnguentum Potabile.	Linam. Arcei.	Confer. Barbar.	Confer. Prunel- lorum.		Acetum Rosarum.	Oleum Tercint.	Ol. Lum- bricorum.	Oleum Sambuci.	Oleum Anethi.	Aqua Ly- moniorum.	Aqua Car- di bened:									
Terebinth Venetia.	Vnguentum Populeon.	Vnguentum Arragon.	Vnguentum Pectorale.	Oleum Lauri.	Confer. Cidonio.	Pulpa Tamarin- dorum.		Oleum Scorpio.	Syrupus Absinthii.	Diamo- bron.	Oleum Petreoli.	Oleum Vitrioli.	Oleum Succini.	Aqua Ci- namomi.	Succus Ly- moniorum.	Aqua Mentha.							
Vnguentum Basilicon.	Vnguentum Apostolorū.	Vnguentum Aureum.	Vnguentum Al. Campb.	Vnguentum nutritum.	Vnguentum Dialthea.	Vnguentum Populeon.	Vnguentum cont. ignē.	Vnguentum Pectoralc.	Vnguentum Potabile.	Vnguentum Arragon.	Vnguentum Martianum.	Linamen- tum Arcei.	Mel Sapo- nis.										
Vnguentum Egyptiac:	Syr. Rosa- rum.	Syr. Viola- rum.	Mel Rosa- rum.	Mi- thrida- ta.	Dia- fcor- di- um.	Conf. Ha- mech.	Crocus Mart.	Pilula Cecibia.	Pilula cambo- gia.	Note that the particulars mentioned on each side this place are usually to be found in the upper part of the Chest, The middle part, which cannot bee here expressed, I leave to the Surgeons experimental or- dering and view.				Rha- barba.	Ag- ricum.	Mum- mia.	Aloes.	Myr- rha.	Maf- tiche.	Cam- phora.	Troch- alban- dal.	Pul- Lique- ritia.	Vnguentum Dispan- pholigos.
Axungia Porci.	Syr. Papa- veris.	Syr. Lique- ritia.	Mel rosar- um.	Theri- aca. Ven.	Theri- aca. Londi.	Dia- pheni- con.	Conf. Alker- mes.	Pilula Agreg.	Pilula Ruffi.	Cam- bogia.	Scamo- nium.	Sper- maceti.	Terra Sigil- lata.	Mercu- Subli- mas.	Praeci- pit.	Eu- phorbi- um.	Pul- Bene- dictus.	Argen- tum vivū.					
Axungia Cervi.	Syr. Limo- nior.	Syr. Prunel- lorum.	Syr. Diam.	Elect. de ovo.	Laud. opiat Parac.	Dia- catbo- licon.	Elect. Diast- Pipe.	Pillu- Eupha.	Pilula Aurea.	Stibi- um.	Opium.	Crocus.	Bolus Averis.	Cina- brium.	Hiera- picra.	Sal Ni- tri.	Sal Absin- thii.	Titia T.T.	Vng. contra scorbuntum.				
Species Di- atrion pipe- rion.	Species Di- atefferon.	Terebinth: Clara.	Conserua Rosarum.	Conserua Antbos.	Conserua Barberorū.	Conserua Prunellorū.	Conserua Cidoniorum.	Pul. refrin- gens major.	Pulvis Arthreticus.	Pulpa Tamarind.	Succus Liquiritia.	Mithridat.											

Loving Reader, this explanation is more for putting the Artift in memory of what may be, then of what must be in his Chest; for although there may seeme many particulars, yet there wanteth at the least forty more, that may not in true method be omitted in a due proportion; as namely, all the instruments for manuall uses and operations, all the most usefull of which are expressed in an Index following the Pre- face in the beginning of the booke.

Place this Chest, betwixt Fol. 26 and 27.

Figure 1: List of herbal remedies included in a surgeon's chest. From John Woodall's *The Surgeons Mate*" (Wellcome Library Images)

While archaeologists continue to learn a great deal about the construction and operation of *Vasa*, there is still a gap in the knowledge about the officers and crew. This gap includes how the officers and crew took care of life's basic necessities, and how they went about their daily routines. One of the most basic of these necessities, and the most critical to preserving the health of *Vasa's* officers and crew, were the sanitary and hygienic practices. Most, if not all, of these questions can be answered through careful study of *Vasa's* material culture and the ship itself. This thesis will study the sanitation and hygiene artifacts recovered from *Vasa*, and will examine

the gaps in the knowledge of how the officers and crew of *Vasa* planned to function, live, and interact within their shipboard environment. This will be accomplished by material culture analysis on artifacts associated with shipboard sanitation and hygiene, as well as examining the design of *Vasa*. An examination of artwork associated with the period will also be conducted in order to interpret hygienic practices in the seventeenth century.

Research Questions

There are two primary research questions of this thesis. First, how did *Vasa* function as an instrument of health? An analysis of the interior of *Vasa*, the pumps, and the heads on the beakhead will determine if there was any concern for the sailors' health during the design and construction of *Vasa*. The second question is, how did the crew as a community maintain their health and hygiene on board? This question can be answered by a careful analysis of the material culture found during excavation, and by examining artwork depicting life in the seventeenth century. These questions will help explore an under-researched period of maritime history, and a function of shipboard life that is not only instrumental to preserving life, but efficiency as well. By examining the sanitation and hygiene artifacts against the larger picture of medical history of Sweden, a clearer image can emerge of Swedish society in the seventeenth century.

Organization

This thesis consists of five chapters. Chapter 1 will introduce the source material and the thesis. Chapter 2 is background history and will briefly cover the history of Sweden up to the sinking of *Vasa*, as well as the history of medicine, health, and sanitation up to the mid seventeenth century. This background is important because it is necessary to understand where the development of medicine was during the period in history that *Vasa* existed. Alongside the knowledge of where medicine was, it is important to understand why a vessel such as *Vasa* was

even necessary, and what geopolitical events drove the Swedish crown to improve the navy with such a vessel.

Chapter 3 will discuss *Vasa* as an instrument of health. Along with the artifacts that can be grouped together as hygiene artifacts, the ship itself can be considered as an instrument of health. *Vasa* has certain design features, such as pumps and heads, which are features that impact health onboard the vessel. While there is excellent scholarship on the development of external sanitary facilities, the facilities on *Vasa* provide a perfect starting point to begin this research due to their obvious, intended purpose.

Chapter 4 will discuss the crew as a community and the measures they would have undertaken to ensure their health, and how the artifacts found on *Vasa* reflect this. As mentioned previously, space onboard *Vasa* was at a premium. While the captain and officers had more leeway in regard to space, the regular seaman did not. This puts a special emphasis on the items that they brought onboard. The crew also had habits and daily practices that would have been undertaken to ensure the cleanliness of the ship and to preserve hygiene. Chapter 4 will also provide the conclusion and will address the answers to the questions posed by this thesis, as well as discuss future research that can be undertaken in this area. The first appendix will contain the artifact data in the form of Vasamuseet artifact forms, which were collected during research at the museum

Chapter 2: Background History

In order to understand how *Vasa* acted as an instrument of health and hygiene, and how the crew functioned as a community, it is important to understand the historical context of both *Vasa* and where the development of medicine was by 1628. This chapter's goal is to lay the historical foundation for *Vasa*, and to establish a general understanding of the history of medicine and surgical tools up to the seventeenth century. *Vasa* existed during Sweden's Great Power Era (1611-1732), a period which saw Sweden rise in regional and international influence, saw the reformation of many of its internal governmental offices, involvement in multiple military conflicts, and the rise Gustav II Adolf.

While the Great Power Era lasted well beyond the reign of Gustav II Adolf, the early part of his reign launched this period of reform and reorganization of the Swedish state and defines why *Vasa* was constructed. Sweden in 1628 existed in a time where humeral theory was the prevailing treatment and diagnostic medical theory, and where surgeons were seen as skilled craftsmen rather than medical professionals. Religion and traditional, or "folk," remedies colored how the basic Swede understood health and hygiene, while upper class members of Swedish society increasingly had access to foreign-born and foreign-trained physicians. The limited understanding of their health that the common sailor held impacted what items they brought on ship. In addition, space was a limiting factor in what the crew brought aboard, which meant that an item could be deemed important by the sailor, but it still had to "fit." By the time *Vasa* foundered in Stockholm Harbor, Gustav Adolf had instituted reforms to ensure more Swedes were receiving medical training in Sweden, and that guilds, such as the barber-surgeons' guild, received royal backing. Meanwhile, conflict had begun with Poland and their king, Sigismund III (r.1587-1632), who claimed the Swedish throne.

History of Sweden through 1628

In October 1611, upon the death of his father King Charles IX, seventeen-year-old Gustav II Adolf (r. 1611-32), grandson of Gustav Vasa, ascended to the Swedish throne (Lockhart 2004:22-23). At this time, Sweden's very existence as a nation state was perilous. War, constitutional crisis, and an alienated aristocracy were but a few of the troubles facing young Gustav (Lockhart 2004: 22-25). Indeed, the *Riksdag* wasted little time and although bound by a 1604 charter to recognize Gustav as the heir to the Swedish throne, they provided conditions to his confirmation in the form of the 1612 Charter (Lockhart 2004:23-24). This charter bound Gustav to obtain consent of the council before levying new taxes, acting on matters of foreign policy, conscripting troops, or passing new laws. In addition, membership on the council would be limited to native-born nobility (Lockhart 2004:23). Knowing that he required the support of the nobility, Gustav agreed to the charter. The result of this charter would not hamper the King, nor would it cause an unending period of bitterness and distrust between King and nobility. Instead, it would lead to what is known as the "Great Power Era." The Great Power Era was the period of time that Sweden was a European power of the first rank, despite being one of Europe's youngest monarchies, through the restructuring of its state into that of a fiscal-military state (Lockhart 2004:1-6).



Figure 2: King Gustav II Adolf (r.1594-1632). Artist Unknown. (Rijksmuseum Amsterdam)

In the Great Power Period, Sweden was able to conduct long wars on foreign soil with limited resources. In order to achieve this feat, Gustav Adolf had to reform vast sections of Swedish government to create an effective fiscal-military state, or a state whose economy is based on the sustainment of its military, often through high taxation (Glete 2002:2-5). In doing so, he would create an effective governmental body that would survive his untimely death in 1632, and well into the eighteenth century. The reforms focused on constitutional, military, and administrative areas (Lockhart 2004:28-30). Local government was reformed as well; by 1621

provinces were well defined and operated under the direction of local governors, rather than a monarch who travelled to enforce their edicts (Lockhart 2004:29). Before these reforms could be implemented within the boundaries imposed upon him by the coronation charter, Gustav Adolf needed a chancellor who could be counted on to enforce the will of the crown, and for Gustav Adolf this person was Axel Oxenstierna (1583-1654).

Oxenstierna was the chief author of the coronation charter, and from one of the most distinguished conciliar families in the Swedish aristocracy (Lockhart 2004:25). In his selection for chancellor, Oxenstierna showed that Gustav Adolf was serious about addressing the concerns that the *Riksdag* held after the previous kings (Lockhart 2004: 24-25). Oxenstierna and Gustav Adolf worked well together, with neither going out of the way to enforce their will or use their access for personal gain, and this provided a level of stability that was sorely lacking in other European courts (Lockhart 2004:25). This reconciliation between the King and nobility proved beneficial to Gustav Adolf, and once he began to reform parts of the Swedish state, the nobility was willing to go along with the reforms.

In order to be successful as a nation-state, the state has to be able to wage war, oftentimes away from the state. Likewise, the state has to be able to easily replace losses, and supply armies, while on campaign. Gustav Adolf worked to reform the entirety of the Swedish state, and it started with greater involvement of the nobility in civil offices and governing bodies, which was part of the requirements laid out in the 1612 Charter (Lockhart 2004:23-24,28). These reforms changed the Council from simply being a way to guarantee noble privilege, to a governing body made up of dedicated civil servants in the service of the Vasa state (Lockhart 2004:30). Reorganizing and clearly defining the *Riksdag* into four estates (nobility, clergy, burghers, and peasantry), and setting a clear procedure for joint meetings allowed for the *Riksdag*

to be more effective than it had been under the previous Vasa kings (Lockhart 2004:31). Not ceasing with the *Riksdag*, the clergy came under reform from the King, who used the clergy as a way to spin royal decrees with a positive note, as well as entrusting the local parishes with collection of local demographic information in order to remain effective at taxation and conscription (Lockhart 2004:31-32). An effective taxation and conscription scheme was critical if Sweden was to be successful in war. Reforming the clergy also gave Gustav Adolf a means to communicate his policies to the masses. Lutheran clergy would speak positively about what the king was directing and urge support from the masses, many of whom would be paying the price in taxes and blood (Lockhart 2004:32).



Figure 3: Axel Gustafsson Oxenstierna (1583-1654). Copy after Michieal Jansz van Mierevelt (Sweden National Museum of Art and Design)

Even with royal propaganda, Gustav Adolf required more than public support for an effective nation-state. At the national level, the past Vasa kings had relied on foreign administrators due to a lack of native Swedes who had the necessary education to hold office. Concerned that a significant percentage of Swedish government workers and diplomats lacked the language skills and rhetorical reasoning necessary to their posts, he enacted an extensive reform of Swedish education. Until Gustav Adolf's reforms, the responsibility for education fell

upon the Lutheran church (Scott 1988:196). Lacking the support of past Vasa kings, Uppsala University had suffered and was lacking in an ability to provide a quality education, forcing many who had the means to attend university to do so outside of Sweden (Lockhart 2004:30). Gustav Adolf, who sought to increase the standard of education out of a sense of national pride, poured more money in order to fix the university, and he established secular secondary schools for Swedes seeking careers with the state (Scott 1988:196-197; Lockhart 2004:30). Gustav Adolf sought to have a citizenry that was educated not just in Christianity, but reading, writing, arithmetic, herbs and healing, geography, history, law, and astronomy (Scott 1988:198).

These new secondary schools taught more specialized material to their students, such as ethics, Hebrew, Greek, and other subjects chosen by the local bishop (Scott 1988:197). With many of the students coming from low to middle income families, this provided a means of upward mobility while also increasing the literacy and education of the Swedish population. While students from noble families still had an advantage for attending university, many lower or middle income students still found their way into university, using the summer singing and begging tour, or *sockenång*, to raise money until the practice was banned in the nineteenth-century (Scott 1988:197). Like many of Gustav Adolf's reforms, the benefit of this reform was felt after the passing of the king in 1632, although it would take longer for Gustav Adolf's dream of Swedish educated public servants to mature.

Sweden's fiscal apparatus and economy were also reformed by the king and his chancellor. Recognizing a need for a treasury board with independent authority, Oxenstierna instituted reforms in 1618 which gave the Swedish treasury a degree of authority independent of the *Riksdag*, and further changes, such as double-record bookkeeping, led to a vastly improved state financial apparatus (Lockhart 2004:29). Oxenstierna also saw that the Chancery was

reformed, so that it could function in his absence, which was often as Gustav Adolf spent most of his reign on campaign which left Oxenstierna to handle duties outside the kingdom after 1626 (Lockhart 2004:29). Gustav Adolf saw the move from a natural economy to a money economy, and he would create different taxation schemes, such as the special tax to finance the ransom of Älvsborg or the toll on all edibles brought to market, all paid in cash (Scott 1988:191). Sweden continued to export minerals, chiefly copper and iron, and military weapons and armor (Scott 1988: 188-189). The importance of centralized manufacturing was not lost on Gustav Adolf, who encouraged the growth of cities and guilds, passing laws in 1618 and 1621 (Scott 1988:188-190). The guild ordinance, which required three to four years of apprenticeship and two years as a journeyman before one could become a master, impacted barber-surgeons as well as apothecaries, craftsmen, and many other skilled professions (Scott 1988:190-191).

With all the reforms that Gustav Adolf instituted, he was first and foremost a soldier. During his reign, he spent considerable time changing the Army and Navy in order to make it an efficient fighting force capable of waging war away from their homeland for long periods of time. In order to achieve this, Gustav Adolf changed how troops were conscripted by placing the responsibility on the local parishes who acted as “draft boards” since they maintained parish registers vital to taxation and conscription (Lockhart 2004:32-33). Tactically, Gustav Adolf made changes in how Swedish infantry were organized, and in the types of weaponry they used. At Breitenfeld, the Swedes abandoned the Spanish massed *tercios*, which was 50 men across and 30 deep, for a formation that was linear and only 6 men deep, while interspersing musketeers with cavalry (Cederlund and Hocker 2006:38; Scott 1988:177). Infantry used more muskets while being supported with lighter-weight copper artillery pieces, which allowed for greater mobility during battle (Scott 1988:176-177).

These innovations impressed other generals in Europe, with Wallenstein using the Swedish system at Lützen in 1632 (Scott 1988:177). It would be on the field of battle at Lützen where Gustav Adolph, King of Sweden and Lion of the North, met his untimely end on 6 November 1632. During the battle, Gustav Adolf moved over to assist the left, where he was hit in the arm by shot from a musket, then in the back by pistol shot (Scott 1988:181). Falling from his horse, face down in the mud, he was dispatched by a shot to the back of his head (Scott 1988:181). Although the Swedish army would rally and defeat Wallenstein, the Swedish military intervention in the Thirty Years War soon came to an end without its charismatic leader.

Medical History through 1628

As important as it is to understand the historical context of Sweden leading to the 1630s, it is equally important to understand the history of medicine and human health. The history of human health starts with the settling of humans into small collectives in order to cultivate agriculture. These early settlements began to be afflicted with illnesses that traditional hunter-gatherers were not exposed to. These diseases, such as anthrax, typhus, influenzas, and parasites came from the domesticated animals and their waste that humans were now living near, and sometimes, in. As civilizations advanced certain members of the community began to be recognized as having an ability to cure people from their afflictions. Often, these abilities were thought to be supernatural acts brought on by offerings and prayers to a specific deity.

As society advanced, so too did medicine. One of the earliest medical accounts, dating to 2400 B.C., is a cuneiform Sumerian tablet called “The Treatise of Medical Diagnosis and Prognosis” (Porter 1997:45). This treatise contains around three thousand entries across forty tablets and describe all manner of ailments, many of which can be recognized in modern illnesses (Porter 1997:45). These tablets provide an insight into how early cultures interpreted

illness. Seeing disease as something supernatural, Assyrians framed disease as bad omens, and mixed religious rites with empirical treatments (Porter 1997:45). Indeed, Mesopotamian cultures saw the supernatural as factors in the cause of all illness. Factors such as spirit invasion, malicious sorcery, demonic possession, or the breaking of taboos were all reasons that a person became ill (Porter 1997:46).

By the Babylonian period, medicine had begun to be regulated by laws. The Code of Hammurabi (1728-1686 B.C.) included medical instructions, fee tables, awards and punishments for treatment success (or failure), as well as empirical treatments and remedies for many ailments (Porter 1997:45-46). Alongside the developing structure of Mesopotamian medicine, Egyptian medicine was advancing along similar lines with supernatural religious healing coupled with empirical surgery and drug treatments. Two papyri, the Edwin Smith and Georg Ebers texts, give detailed accounts of Egyptian medical practices and date to 1550 B.C. Case reports discussing injuries and illnesses, along with surgical instructions such as bone setting, wounds, and abscess treatment are covered (Porter 1997:46-47). These papyri show that medicine in Egypt, much like Mesopotamia, evolved around an empirical-supernatural understanding, and treatments reflected as much (Porter 1997:45-50).

The understanding of the human body continued to advance along with supernatural beliefs and natural balance. In Greece, written texts from the fifth century B.C. first mention medicine, and show supernatural causes for illness. Greece also started examining the human body alongside nature, and placing the body into their understanding of geometric shapes and natural harmonies (Porter 1997:51). Greek deities associated with health, hygiene, and healing were invoked to treat sufferers. The most popular was Asclepius, who eventually became a cult figure and patron of physicians in Greece. It is also from Asclepius that the modern caduceus,

the medical symbol of two snakes intertwined in a double helix on a winged staff, originated (Porter 1997:52). Despite the supernatural beliefs, Greek medicine would advance beyond the supernatural and into a realm of empirical reason under Hippocrates of Cos (c. 460-377 B.C.), who moved the art of healing away from the supernatural and into the natural (Porter 1997:52). This natural philosophy decried the divine origins of illness, and dismissed traditional folk healers as pretenders and charlatans (Porter 1997:53). Hippocratic medicine also espoused the superiority of the learned physician over that of traditional healers, and sought to bring the physician away from being an intermediary with the gods and instead be a bedside friend of the sick (Porter 1997:53). At this time, medicine moved away from being a regulated trade and into the sphere of philosophy and practice in public.

Hippocratic medicine sought to explain health and sickness by applying reason and an understanding of nature. Sickness was not caused due to angering a deity, but rather because the body was thrown out of balance with nature (Porter 1997:56-57). Hippocrates argued that what kept the body in balance were the bodily fluids, or humors. A body in balance with nature would not produce excesses of the humors, but when out of balance the body would produce excess humors, such as mucus from a cold, vomit from a stomach illness, or runny feces from dysentery. The four humors consisted of blood, phlegm, yellow bile, and black bile. These paired with the four primary elements of fire, air, water, earth; as well as the four primary qualities of hot, dry, cold, and wet (figure 4) (Porter 1997:56-57). This humeral system of health extended to the natural elements, and locations also contributed to a person being in balance, such as pale, phlegmatic people from the North, who were seen as inferior to the Greeks who lived in the equable climate of the Mediterranean (Porter 1997:56-57).



Figure 4. The four elements, four qualities, four humors, four seasons, and four ages of man. Airbrush by Lois Hague, 1991 (Wellcome Library)

Of the four humors, blood was seen as the most important. Blood was thought to carry life through the body, and it was associated with hotness and dryness. Eating foods that were viewed as “hot” in excess was thought to throw the body out of its state of equilibrium. Hot foods, such as meat, being eaten when the weather was hot and dry was considered a contributing factor to an excess of blood, although men were naturally believed to be heavier in blood than women (Porter 1997:56-58). Fever, being quick to anger, and redness of the skin

were some of the indicators to humeral physicians that the sufferer had an excess of blood, and the treatment was therefore to relieve the person of blood by a process called “bloodletting”. Bloodletting was viewed as the principal means of bringing a person suffering from an excess of blood back into equilibrium with nature, since the body could naturally expel excess blood, such as bloody noses or menstruation (Porter 1997:57-58). Since a person who loses blood becomes cool to the touch, it is easy to see how this treatment was thought to work (Porter 1997:57).

Phlegm was associated with wetness and cold, and the production of mucus by someone who was sick was seen as an abundance of phlegm. The sufferer would show symptoms involving coldness and wetness, such as sweating, nasal discharge, or coughing up mucus; even epilepsy was thought to stem from an overabundance of phlegm choking the body (Porter 1997:56). Treatment involved the eating of hot foods, such as meats and stews, and the changing of the person’s routine to become more active (Porter 1997:56-58). Yellow bile was associated with vomiting and diarrhea, and was also associated with fevers and fluxes. Black bile was thought to be related to an overabundance of effluvia in the body, and a vigorous regimen of purgatives and laxatives was prescribed to the sufferer in order to cleanse their system and bring it back into balance. The four humor system provided an easy to comprehend method of understanding health in relation to the environment and the cosmos (Porter 1997:57). These treatments were first detailed by Galen of Pergamon (A.D. 129 - c. 216), one of the most prolific writers on medicine and health.

Galen of Pergamon wrote more on medicine than perhaps any other author in his era. His works survive even to this day and we have more examples of his work than any other medical theorist; Galen wrote around 350 works on all manner of topics (Porter 1997:73). Galen gained notoriety as the personal physician to many Roman senators and dignitaries, as well as emperors.

Galen sought to perfect Hippocratic medicine by unifying the clinical and the theoretical (Porter 1997: 75). His works were detailed, instructing physicians to let blood from their patients, with the amount varying on constitution, the current season, location, and the weather (Porter 1997:75). Galen wrote on almost every subject in medicine in his time, and his theories, such as his theory that the human body was governed by three organs, the heart, brain, and liver, which regulated *pneuma* (air) through three alterations in the body, were generally accepted as indisputable facts, even as late as the seventeenth century (Porter 1997:76-77). Galen's theories lasted well into the Renaissance period, and indeed the humeral theory of disease endured into the eighteenth century. Galen's theories began to be challenged during the Renaissance, when dissection of human bodies began to be allowed.

Galen attempted to frame the theories of health and medicine with that of logic and reasoning concerning the natural order of things. Galen saw life as operating in a balanced system, and that this system carried over from species to species. According to Galenic theory, the internal organs of a dog or a primate were the same as what could be found in a human. Galen had limited opportunities to dissect humans; his only experience was treating the wounds of gladiators, which did give him a small window into the human body. As Christianity became the dominant religion in the west, the Catholic Church put a prohibition on the dissection of corpses. This led to a stagnation in medicine, and physicians suffered a loss of prestige alongside the clergy when the Black Death struck Europe in 1347, leading to the loss of 30-60 percent of Europe's total population (Alchon 2003:21).

The Christian outlook on health was influenced by earlier religions and put health and disease as a supernatural occurrence, prizing the human soul over the body (Porter 1997:84-85). Severe illness was seen as a direct result of a person's lifestyle and spiritual habits. If a person

was a sinner, then God may afflict that person with an illness as punishment for their transgressions. The more severe the illness, the greater the sufferer's sins and these illnesses could only be cured by God (Porter 1997:84-85). Despite this attitude, a healing tradition developed within Christianity and the Catholic Church, who sought to win over converts who were suffering from illnesses, and the church sought to show Christ as the "physician of the soul" (Porter 1997:87). Poor houses, hostels, and compounds for lepers were set up, old pagan healing cults were replaced with Christian saints, and the values of charity towards the sick and poor were championed (Porter 1997:85-88). These attitudes continued up through the Protestant Reformation.

The arguments of Renaissance medical thinkers can be described as ancients (Aristotle/Hippocrates) versus moderns (Galen) (Debus 1998:70). In the renaissance period, there was a belief that the ancients were more advanced than the current generations and that they possessed knowledge that had been lost and was waiting to be rediscovered in the ancient texts (Porter 1997). Thanks to the invention of the printing press, these newly translated works could be consumed by anyone who could afford them. The new translations of Galenic texts served to reinforce the idea that the ancient medical practices were the truest practices and that it was up to Renaissance scholars to protect and interpret them (Porter 1997:170-171).

While the desire to prove Galenic medicine as the truest and most accurate understanding of illness and health, not all Renaissance scholars were convinced. Through the birth of a new study of the human body, anatomy, some scholars saw the errors that Galen had made, and began to publish books in an attempt to disprove him (Porter 1997:176-179). Chief among these anatomists was Andreas Vesalius (1514-1564), whose opus *De humani corporis fabrica* [On the Fabric of the Human Body] accurately portrayed the human skeletal and muscular structures,

thanks to his acquisition of the remains of several recently executed convicts (Porter 1997:179-180).

Fabrica laid down the foundation of observation based anatomy, and it showed that Galen had not dissected any human cadavers, but instead based his observations on animals (Porter 1997:179-180). After Vesalius died in 1564, anatomy became a larger part of medical instruction with the publication of more books on the human body, many correcting errors in some of Vesalius' works (Porter 1997:182). While anatomists still supported Galenic medicine, even at their exposing of errors in Galen's work, they sought to legitimize anatomy within the field of medicine as the only way to see and experience through the senses. However, many physicians believed that anatomy could never be the foundation of medicine, only philosophy could (Porter 1997:185). Along with advances in anatomy, new frontiers began to open which would have an everlasting effect on medicine and health.

New ideas and discoveries concerning circulation, digestion, and reproduction arose during this period. As the new scientific ideas clashed with old, more written material to support and disprove became available. Medical instruction changed as Galenism began to die out, replaced with new interpretations such as mechanical philosophy, which stated that nature functioned like mechanical objects and that living things also functioned

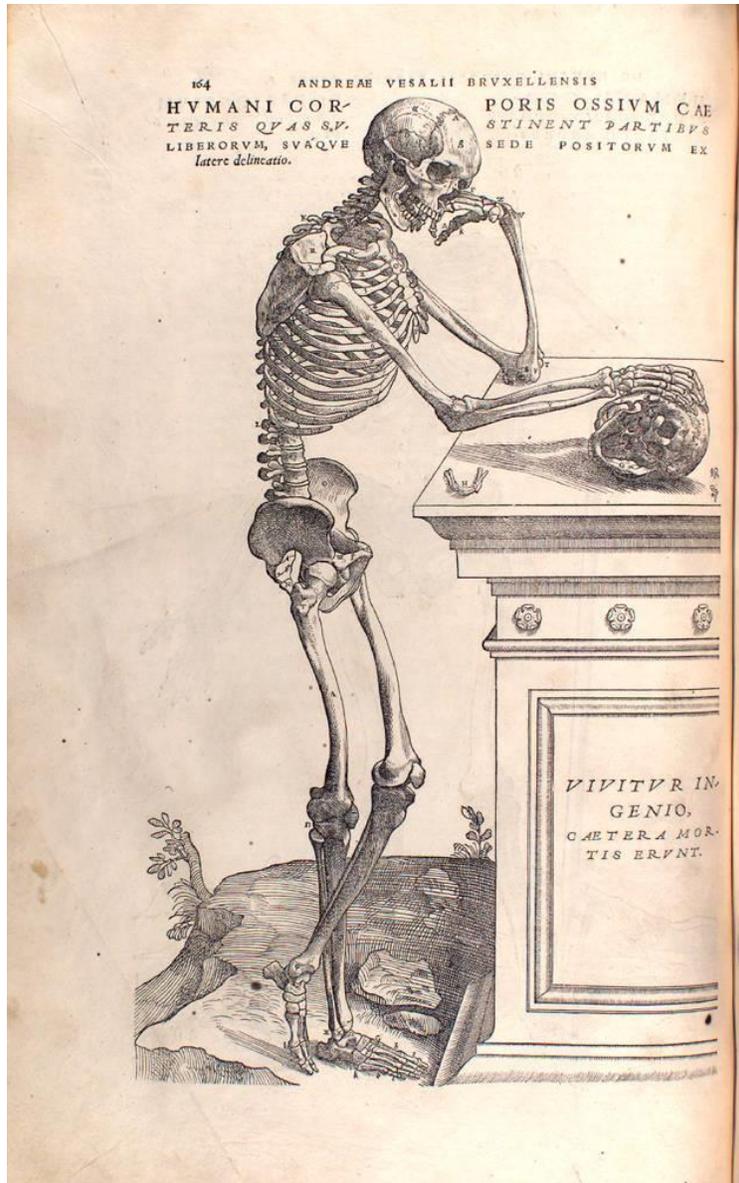


Figure 5: Illustration from *De humani corporis fabrica*. Illustration by Jan Stephen van Calcar. (Internet source. <http://quod.lib.umich.edu/w/wantz/vesd1.htm>)

The Old World began to merge with the New World after Christopher Columbus landed on Hispaniola in 1492. The New World was exposed to the ravages of Old World diseases. Smallpox, measles, and typhus burned through all the lands that Europeans landed on. Central America and Mexico, land of the Aztecs and Mayans, were hammered by waves of diseases,

weakening cities and resistance to the Spanish Conquistadors while Native Americans in North America were weakened by contact with European settlers (Crosby 1976:289-99). There is debate on the population and how quickly viruses spread, but the virus certainly assisted the conquistadors in their conquest (Crosby 1976:289-99; Brooks 1993). The Old World benefited from the New World by way of the “Columbian Exchange,” which provided new lands that were exploited for valuable resources and labor. The goods from the New World filled the markets of Europe with new produce, and expanded the pharmacopeia available to medicine.

The Columbian exchange provided an expansion to the pharmacopeia in Europe by introducing new herbs, medicine, and spirits to Europe, which greatly expanded what apothecaries could use in their treatments of diseases (Porter 1997:190). It also brought new illnesses into Europe, chiefly syphilis, which ravaged the continent, and later the world, until a cure was found in the twentieth century, and tropical diseases such as yellow fever and malaria killed thousands of European settlers in the Caribbean and Africa. The settlement of these colonies led to a need for more doctors, surgeons, and apothecaries which led to the founding of more institutions for the learning of the medical arts, as well as hospitals to treat the inform returning from the New World.

Within medicine, there have been many ways to practice the art of healing. Bone setters, folk healers, physicians, barber-surgeons, apothecaries, and herbalists are but a few. As medicine advanced, physicians began to push out “quackery,” or any medical practitioner who was not as learned as they were. Before the establishment of medical institutions and universities, the art of healing was passed down through an apprenticeship system, usually requiring the prospective healer to study and learn from an older, experienced healer for five to seven years (Porter 1997:287). Medicine in this time lacked any formal regulation, and all that

was necessary to practice was admission into a physician's guild (Porter 1997:287). As the practice of medicine evolved, the apprenticeship system for physicians began to be replaced by university training, especially among societal elites (Porter 1997:287-288). While physicians saw themselves at the medical elite, beneath them were surgeons and apothecaries. If physicians were the intellectual elite, requiring logic and reason to diagnose and cure, surgeons were tradesmen who worked with their hands like a common carpenter.

Surgery started first with bone-setters, who would set broken bones for a nominal fee, and evolved into barber-surgeons. Barber-surgeons were responsible for bleeding, amputations, cutting hair, cupping, lancing, and any other task that involved cutting or piercing the body. Surgery was seen as being beneath physicians because surgeons worked with their hands, and were not seen as intellectual or social equals, but rather as a skilled craft (Porter 1997:186). Surgery operated in an apprenticeship system and was organized in a guild system (Porter 1997:186). Many barber-surgeons would work in the service of king and country by serving with the army or the navy.

Hippocrates had advised "he who wishes to be a surgeon should go to war," and war was the best school a surgeon could attend (Porter 1997:187-188). The development of gunpowder led to an increase in the frequency and severity of battlefield injuries, and the surgeon would often be left with little choice but to amputate and hope for the best (Porter 1997:186-187). Improvements in warfighting technology, such as iron cannon, bar and chain shot, and lead musket balls left open wounds that left the sufferer prone to infection when the shot carried large fragments of clothing into the wound, unlike swords and arrows, which carried smaller fragments (Porter 1997:186-188).

The massive loss of life from battlefield injuries spurred development of surgical techniques and tools in an attempt to save the lives of more soldiers. Ambroise Pare, an *aide-chirurgien* to the Paris hospital Hotel Dieu, spent much of his time serving as a surgeon to the French Army (Porter 1997:188). During his service in a French military campaign in Italy, he was forced to improvise after the traditional treatment for gunshots, cauterizing the wound by filling it with burning oil, ran out (Porter 1997:188). Pare improvised by applying a salve of egg white, rose oil, and turpentine which, much to his surprise, had a more beneficial effect on the wounded than the hot oil (Porter 1997:188-189).

Surgery at sea, always a difficult endeavor in the best of circumstances, became increasingly standardized by the end of the seventeenth century. Surgeons are recorded as far back as Roman times as members of the crew of seagoing vessels, and were increasingly present on non-military expeditions (Druett 2000:10-13). During the British expeditions to West Africa in the sixteenth and seventeenth centuries, there are substantial records of surgeons accompanying the vessels in order to treat the tropical diseases and scurvy likely to be encountered by the crews (Alsop 1990:215-221). The treatments at sea were not much better than the treatments provided ashore, and sometimes the absence of a barber-surgeon on board left treatment up to the captain or master. The British East India Company took a proactive step and in 1613 appointed an experienced and well-trained barber-surgeon as its first surgeon-general, John Woodall.

John Woodall (1569-1643) is widely considered the father of sea-surgery (Druett 2000:10-12). Woodall was the first surgeon-general of the East India Company, and his responsibilities included the recruitment of qualified barber-surgeons to sail with the company ships, as well as the fitting, furnishing, and inspection of the medicine chests and surgical

instruments sent out with each vessel (Druett 2000:15). His list of accomplishments while company surgeon-general is impressive, but the publishing of *The Surgeons Mate* in 1617 is perhaps his crowning achievement.

The Surgeons Mate was meant to accompany the medical chests sent out with the company vessels. The text provides a young barber-surgeon with recommendations on treatments for various illnesses that may be encountered by the vessel, as well as treatment instructions for various injuries. The book also described, in detail, the various tools and medicines included with the chest, as well as detailed analysis on scurvy and “fluxes of the belly” (Woodall 1617; Druett 2000:19-25). This volume was published in three revisions in 1639, 1653, and 1655; the work was so popular that only eleven copies remain of the initial 1617 edition.

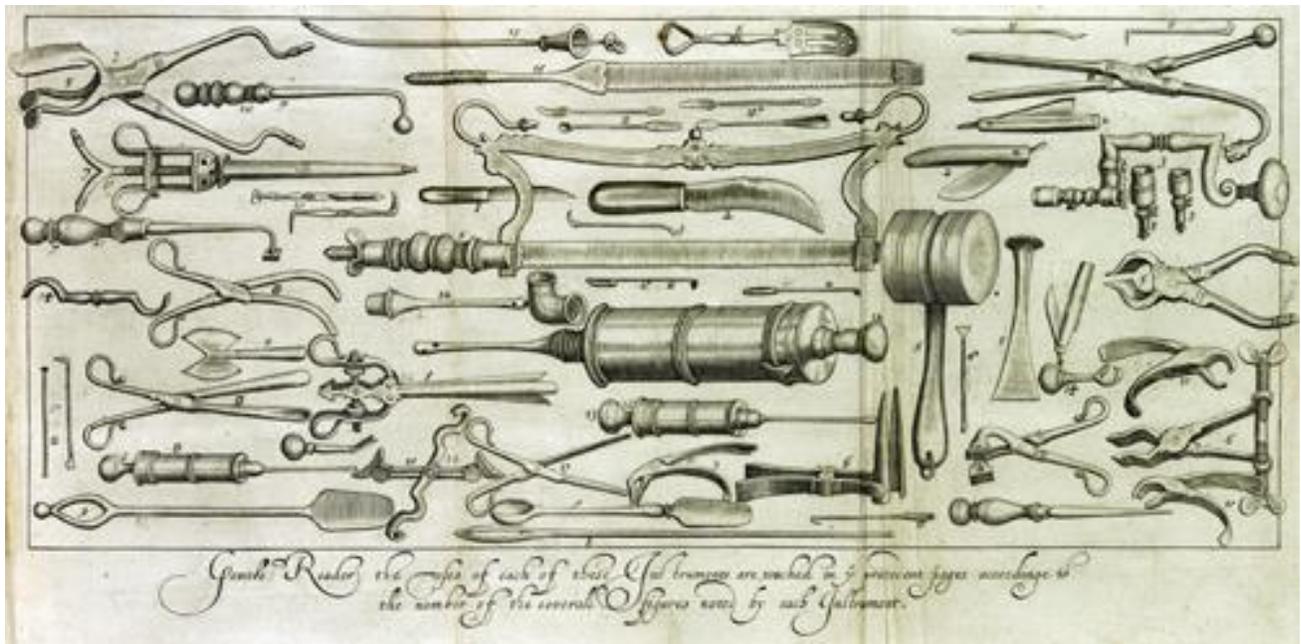


Figure 6. Surgical tools included with the medicine chest as seen in *The Surgeons Mate* (University of Bristol Library)

Humeral treatment regimens remained as important at sea as they were ashore. Bleeding remained a common treatment for most tropical and non-tropical diseases, and various dietary remedies were attempted by many surgeons to defeat scurvy which, due to a lack of ascorbic acid (vitamin C), caused a sailor's teeth to fall out, gums to swell and bleed, fingers to blacken, old bone breaks to re-break, foul breath, fatigue, heart failure, and eventually, death (Alsop 1990:219; Porter 1999:295-296; Herman 2005:163-164). While at sea, the ship's surgeon would be faced with an ever-increasing assortment of diseases and injuries depending on the journey. Tropical diseases stalked the coastlines of Africa and the Caribbean, rough seas saw the crushing of hands, digits, and the snapping of bones, combat at sea saw injuries by shot, shrapnel, and sword.

At sea, the ship's surgeon was responsible for treating these injuries in whatever space was set aside. Some vessels, such as the *Mary Rose* (1545) had a purpose-built cabin in the vessel with enough room for the barber-surgeon and his assistant. *Mary Rose*, like most vessels, would have designated a space below deck that would be used as a sick bay or treatment ward at sea, during, and after battles. Surgeons were responsible for administering the medicine chest, which was filled with various remedies intended to treat a wide range of illnesses, but once the surgeon was ashore they could not treat any illnesses with medicines as this was administered by physicians.



Figure 7: Artifacts related to barber-surgeon found during excavation of Mary Rose including a pewter syringe, bloodletting bowl, and brazier (courtesy of the Mary Rose Trust)

With the establishment of trade between the New and Old Worlds during the Renaissance period, new botanical medicines were developed. Guaiac wood, tobacco, sarsaparilla, coca, and spices were brought over and used to treat many different ailments, such as syphilis. Many of these botanicals were observed being used by indigenous peoples to treat similar ailments, and the location of “cures” so close to the perceived epicenters of disease supported a renaissance theory that God placed cures near the sources of disease (Porter 1997:191-193). Apothecaries became more accepted as views towards pharmacy, and were even recognized as special members of the Grocers’ Company in England before separating and forming their own company.

Advances in medical learning, and a society more accepting of medical authority (real or perceived) led to new laws that required judges to consult with physicians and midwives, patronage, both royal and municipal, helped to grow medical institutions of learning. The invention of the printing press allowed for medical works to be printed and distributed to those who could afford them, while Protestant crusading led to the dissolution of monasteries, religious orders, and charities that ran medieval hospitals. As the Renaissance drew to a close, medicine began to reform. Instead of focusing on the ancients, medicine would begin to build a more scientific base with medical practitioners such as Paracelsus, William Harvey, and Rene Descartes, who would challenge Renaissance medical thought and long-held beliefs. New technology such as the microscope would allow scientists to see protozoa, spirogyra, and human spermatozoa for the first time, challenging the belief of spontaneous generation by lower order animals (Porter 1997:223-226).

Along with this new approach to medicine, the seventeenth century brought new technologies as well, especially in the evolution of the warship. Although it would not be successful in its service to the Swedish crown, *Vasa* pushed the limits of ship construction toward the eventual multi-decked warship and changed the face of naval warfare in the age of sail.

Chapter 3: *Vasa* as an Instrument of Health and Hygiene

A ship is more than a mass of wood, nails, and sailcloth. A ship is a living community, with different personalities that have their own wants and needs. Uniform across the board is a need to relieve oneself of bodily waste. Onboard a vessel, especially one the size of *Vasa*, you could not have crewmembers relieving themselves anywhere and everywhere. The same can be said of any embarked soldiers and/or passengers. The general health of the crew would have relied on many variables, from the quality of victuals and how well they were stored, airflow within the ship, and of course, access to spaces for disposal of waste. When designing *Vasa* the master shipwright, Henrik Hybertsson, had to take this fact of life into account as a ship that did not provide at least a basic means of sanitation could be taken out of service if the crew is struck with disease.

This chapter will discuss how the ship designers implemented sanitation and hygiene into their design, and whether the implementation would have been sufficient. By examining the features worked into the design of *Vasa*, specifically the two seats-of-ease, or “heads” located on the beakhead, and the primary and secondary pumps, the efficiency of these measures can be examined. There is a noticeable lack of material on the personal conduct of sanitation and hygiene as it was something that most writers did not discuss. Fortunately, there is excellent work on the subject of external sanitary facilities of vessels up to the nineteenth century by Joe J. Simmons, III which gives a solid starting point for examining the facilities on *Vasa*. This chapter will also briefly touch on the design and construction of *Vasa*; however, it will not go into detail as extensive scholarship is available on the subject.

Construction of *Vasa*

Prior to the 1620s, Sweden was a navy of small ships, consisting of mostly single-decked warships with 12-pounder muzzle loading smoothbore cannon (the weight referring to the weight of the iron shot) (Cederlund and Hocker 2006:39). As part of the reformation of the Swedish Navy, Gustav II Adolf contracted new vessels for the Swedish Navy, seeking to shift from smaller single-decked combatant vessels to warships with multiple gun decks and uniform armament. During his reign, Gustav II contracted five large, two-decked vessels to be built at state shipyards: *Vasa*, *Äpplet*, *Scepter*, *Kronan*, and *Göta Ark* (Cederlund and Hocker 2006:39). The Swedish crown owned several shipyards throughout Sweden, and these yards were supplied with raw materials from the crown's resources (Cederlund and Hocker 2006:39-40). The shipyards also recruited workers and craftsmen from outside Sweden in order to obtain the necessary skillsets and experience for the construction of larger vessels (Cederlund and Hocker 2006:39).

The shipyard responsible for the construction of *Vasa* was the Stockholm shipyard, located on an island called Skeppsholmen ("Ship Island"), and it was the largest employer in Stockholm (Cederlund and Hocker 2006:39-40). Under the *arrende* system, civilian entrepreneurs were given control of a state-owned facility, and were expected to repair and maintain a specific number of ships, or to supply a quota of material (Cederlund and Hocker 2006:40-41). The contract awarded by the crown in 1625 to Henrik Hybertsson covered the construction of five new ships, and a second contract covered the sails and rigging (Cederlund and Hocker 2006:40-42).

The contract gave some general specifications about the size of the vessel to be built, specifying a keel length of 64 *aln* (128 feet or 38m) in the 10 January 1626 contract (Cederlund

and Hocker 2006:42). There was some disagreement between Hybertsson and Gustav Adolphus regarding the dimensions of the larger and smaller ships that Hybertsson was contracted to build, and this disagreement was further enhanced by loss of 10 ships in a storm on 20 September 1625 (Cederlund and Hocker 2006:42-44). This caused Gustav Adolphus to change the dimensions of the vessels in the contract, and after several letters between the king and the shipyard master, construction began (Cederlund and Hocker 2006:42-43)

Item	<i>Tre Kronor</i>	Gustav Adolf's New Specification	<i>Vasa</i>
Keel Length	108 feet	120 feet	130 1/2 feet
Keel moulded	21 inches	21 inches	23-24 inches
Keel sided	21 inches	21 inches	23-24 inches
Bottom breadth	24 feet	Not given	26 1/2-28 feet
Plank thickness	4 inches	4 inches	4 inches
Wale thickness	7 inches	7 inches	8 inches
Keelson thickness	9 inches	9 1/2 inches	10 inches
Keelson width	29 inches	29 inches	30 inches
Ceiling thickness	3 1/2 inches	3 1/2 inches	4 1/4 inches
Beam moulded	14 inches	14 inches	14 or 18 inches
Beam spacing	3 1/2 feet	3 1/2 feet	4 feet
Floor timber moulded	12 inches	12 inches	15 inches
Rider moulded	16 inches	16 inches	18 inches

Table 1. Scantling specifications from the two ships discussed in correspondence. From

Cederlund and Hocker 2006:44.

The shipwrights did not use drawings when constructing *Vasa*, instead they built the vessel from the bottom up (Cederlund and Hocker 2006:46). This was accomplished by laying the planking to the turn of the bilge, then setting up the frames on the base (Hocker 2004:82-84; Cederlund and Hocker 2006:46). This method of ship construction was cheap, however it

required a master that knew how he wanted the ship to turn out rather than reliance on models or drawings (Cederlund and Hocker 2006:46-47). This method of construction saved labor and material requirements, however *Vasa* would still require immense quantities of oak, ash, and alder. The hull was made from oak harvested from the royal forests in Sweden and purchased from Riga, Königsberg (Kaliningrad), and Amsterdam (Hocker 2011 41-43). Alder was used to make the pump shafts as the wood is tolerant of wet conditions, and ash was used for the rigging hardware (Hocker 2011 41-43).

In 1626 Hybertsson became too ill to continue his duties as shipyard master, so he turned over responsibility for construction of the new ship to Hein Jacobsson, who would see *Vasa* finished and outfitted for its maiden voyage on 10 August 1628. The intricate wooden carvings that adorn *Vasa* from stem to stern were completed by the master craftsmen in the shipyard. In the spring of 1628, the ship was towed around Skeppsholmen to the Tre Kronor palace, where the royal armory was located, and was loaded 64 cannon of varying size including 24 pounders, 3 pounders, howitzers (*stormstycken*), and 1 pounder falconets (Cederlund and Hocker 2006:47-51). Shot and powder were taken onboard, as was the provisions and equipment the ship required in order to sail to Älvsnabben, where *Vasa* was to take on a complement of soldiers, its remaining crew members, and to join with the reserve fleet stationed there (Cederlund and Hocker 2006:52-53).

The rest of *Vasa*'s story is well known as the ship had a troublesome stability test, which showed Admiral Klas Fleming and Captain Söfving Hansson, that the ship was dangerously unstable (Cederlund and Hocker 2006:53). The king required *Vasa* and the fleet from Älvsnabben in Poland, so the ship made ready to sail. Disaster struck *Vasa*, and the ship

foundered in the harbor and sunk in 18 fathoms of water, coming to rest on the harbor bottom at a high list (Cederlund and Hocker 2006:54-55).

Heads

Aboard *Vasa* there are two designed sanitation elements that are worth discussing in any significant detail. The two heads located on the beakhead, and the primary and secondary pumps, are features of the ship which serve a dedicated sanitation and hygiene function.

On board *Vasa* are two seats-of-ease, located on the beakhead. Their purpose is to allow a crewmember to expel bodily waste in a location which would have been cleaned by the crashing action of waves breaking over the beakhead. Seats-of-ease are part of a long line of shipboard sanitary innovation. Sailors from the earliest of times have had a need to dispose of effluvia while on the water (Simmons 1997:4-11). A ca. 600 B.C. ivory plaque from the sanctuary of Artemis Orthia, Sparta shows an individual squatting on a projecting piece of timber while a shipmate fishes in the “baited” water (Simmons 1997:5). Like many external sanitary accommodations, including the seats-of-ease on *Vasa*, this would have been a fair-weather use. As ship construction advanced and new designs came about, sanitary accommodations advanced from a board or projection that one could use, to steeping tubs and gardorobes in order to combat the increasing complexity of waste disposal at sea.

The advent of multi-decked ships created more concerns about the health of the crew at sea. Unlike the officers, who were berthed in private or 2 person berthing spaces and often had the advantage of a chamber pot, ordinary sailors were berthed where space was available. This created an effect that Joe J. Simmons calls the “birdcage effect,” where sailors berthed on decks above would dispose of waste where convenient and it would then trickle down on the sailors berthed below (Simmons 1997:6-9). Even if the sailors were issued a bucket or something to

collect and then use to dispose of waste, this item would often be split between multiple sailors, and if the weather is inclement or the sailors indisposed due to illness or injury, it would not be emptied over the side (Simmons 1997: 11).

The failure to maintain a degree of cleanliness led to an unbearable stench, often referred to as a “pestilential funk” which made life below decks unbearable (Simmons 1997:7-8; Oertling 1996:6-7). This issue was caused by bacterial and fungal growth on the ballast, and the collection of debris and waste in the bilge, and if severe enough it would become necessary to “rummage” the vessel (Simmons 1997:7-8). Rummaging is described as “heaving her down on some convenient beach, throwing all ballast overboard so that the tide would cleanse it, scraping the horrible gunk off the inside of the hold, spraying it with vinegar, and replacing the ballast with clean stones, sand or shingle” (Simmons 1997:7). If the bilges were not kept clean, then disease and vermin could multiply and wreak havoc on a crew, although if the rats became plentiful enough it provided a nice supplement to the daily rations.

For the crew of *Vasa*, key-holed seats of ease were the main method of waste disposal. The earliest record of key-holed seats-of-ease is on a ca. 1380 Hanse Cog found in the Bremen basin (Simmons 1997:14-15). During recording of materials recovered from the Bremen Cog site, archaeologists identified a seat of ease that was located at the stern (Kiedel 1985:77-78). A single, key-holed box seat was found built into a box behind the starboard cabin, most likely for use by the captain or other officers as the crew would have had to rely on buckets or simply hanging over the side of the vessel (Kiedel 1985:77-78). Social hierarchy was much less defined on merchant vessels than military vessels, so it is plausible that this seat served the relatively small crew of the cog. As seafaring technology in Southern and Northern Europe advanced, changes in sanitary accommodations changed as well. Steep-tubs, privy-boxes, and garderobes

all became a part of a ship's structure, sometimes mirroring what was seen in castle design (Simmons 1997:19-23).

As ship design and construction evolved, so too did sanitary facilities. As cogs and carracks faded into obscurity, so too did the built up forecastle. The "galley spur," appearing first sometime during the reign of King Henry VIII of England, evolved into the beakhead as the need for a ram dissipated (Simmons 1997:29-31). This evolution in ship design allowed for sanitary facilities to be placed in an open air location, although in anything other than calm weather using the facilities would have been a risky endeavor. The heads on *Vasa's* beakhead are a continuation of the advances in ship design in the seventeenth century. As the 1600s went on, beakheads continued to change shape and became a natural location for sailors to relieve themselves. While *Vasa* only has two seats present, ship models of vessels from the latterhalf of the seventeenth century show as many as six seats-of-ease located on the beakhead.



Figure 8: *Vasa* port side seat-of-ease, facing forward.

Unlike steep-tubs and garderobes, which were impractical, locating sanitary facilities on the beakhead of the ship allowed for ease of cleaning. Waves breaking over the beakhead would

clean any waste matter in the boxes or on the beams underneath. Cleaning the seats was still reserved as a punishment for sailors who were caught lying, but the natural, cleansing action of the waves would have kept things fairly cleaned out as opposed to sanitary facilities located at the stern, which were kept clean by the officer's stewards (Simmons 1997:30-31). *Vasa* does not have an example of a stern galley, garderobe, or roundhouse, and officers had other means to relieve themselves, such as chamber pots, rather than using the facilities on the beakhead with the sailors.

Vasa's sanitary accommodations for its crew, despite being in line with ships of its era, are lackluster at best. Two seats would have served a crew of 145 sailors, and 300 embarked soldiers. However, this number of seats compared to the number of embarked crew and soldiers, was not uncommon. The reconstruction of the Dutch VOC ship *Batavia* (1629) show two seats of ease located on the beakhead, as well as a toilet located at the stern for officers. *Batavia* had a crew of 341 sailors and passengers, compared to the 145-man crew and 300 embarked soldiers that would have been aboard *Vasa*. This difference in crew size could mean that the shipwrights felt that two seats of ease were suitable for a crew in excess of 300. Because there are no line drawings or construction plans surviving from late sixteenth and seventeenth-century Dutch ships, the heads could be conjecture (Van Duivenvoorde 2008).

Presently, there are few archaeological examples of heads mounted on the beakhead. When a ship sinks, the beakhead is usually one of the earlier sections that deteriorates and falls into the sediment. Its location above the protective sediment and exposure to biological and chemical degradation usually is enough to ensure that very little unburied wood survives. In some cases, the breaking up of the beakhead can cause pieces to be preserved underneath sediment. *Vasa* benefited from unique conditions in Stockholm harbor which allowed for the

vessel to be recovered mostly intact; however, even *Vasa*'s beakhead fell into the sediment due to the corrosion of the bolts that held it in place.

Nicolaes Witsen, a Dutch diplomat and scientist, mentions in his 1671 work on Dutch shipbuilding that “on men-of-war the largest beakheads are required: they serve the quarters of the sailors, for cleaning, washing, urinating, and for one’s relief” and that the captain’s privy was located in the bench inside his cabin (Hoving 2012:123-154). Witsen also gives mentions of the “pisbak,” which referred to the hawseholes, troughs located inside the ship to catch water that came in through the haws during inclement weather (Hoving 2012:135). According to Witsen, these served a dual purpose, and functioned as a urinal for sailors during inclement weather as well. While Witsen’s work was completed much later than *Vasa*, it is likely that the placement of the heads on *Vasa* were influenced by the Dutch shipwrights. Since there were Dutch shipwrights involved in the design and construction of *Vasa*, it makes sense that the ship would carry features over from Dutch-built and designed ships. Practicality is another influencing factor in the placement of heads onboard a vessel. As noted earlier, placing the heads on the beakhead allowed for natural cleansing and washing of the seats and grating.

While *Vasa* does lack a dedicated privy for the captain or admiral, there are spaces which could serve a secondary purpose for officers and crew. While more or less lacking a designed privy, the officers would have made use of their personal chamber pots to relieve themselves. For the sailors, there was also the possibility of using the chainwales on the larboard side as a sort of improvised facility. The sailor would need to brace themselves tightly with the rigging lines, and it would be much more uncomfortable than using the heads and the sailor would likely not be able to keep as dry as they might like. It is also likely that, despite the best efforts of the officers

and higher ranking crewmen, corners and other spaces within the ship would have been used if a sailor needed to urinate and did not wish to use the beakhead grating or communal bucket.



Figure 9: Forward view of *Vasa* showing beakhead and forward gun ports.

Pumps

Thomas Oertling (1996) writes that “pumps were the most important pieces of equipment on a ship.” All wooden ships leak, and *Vasa* would not have been any different. The constant

forces acting on *Vasa*'s planking would have loosened caulking or slightly torqued planking and caused leaks to occur. Also, as previously mentioned, sailors would have illicitly used dark corners to urinate, and rain or crashing water from the Baltic would have deposited water inside the ship. Pumps provided the main defense when a vessel took on water by providing a method to remove water from deep within the vessel. Removing this water not only acted as a way to prevent the spread of disease, but it often meant the difference between a vessel sinking or staying afloat. There are many stories of crewmembers and passengers alike manning the pumps for hours on end in order to save their afflicted vessel (Oertling 1996:7-9).

Additionally, leaky seams mixing with human waste would be a cause for concern. If the vessel lacked a means to deal with this buildup, then the potential for loss of crew and vessel drastically increased. Rats would feed and breed, providing a breeding ground for fleas and lice which would spread diseases, such as typhus, throughout the ship. Also, in later human history it was believed that the odors emanating from within the bilge was the vector by which disease was transmitted, leading to several interesting methods in drying out wooden ships. These methods included burning brimstone on the decks in order to produce smoke, and scrubbing the decks with vinegar (Brown 2003:16).

Bilge pumps have existed in some form or another dating back as far as the Renaissance (Oertling 1996:16-21). The earliest pump was the "Burr Pump" which featured a burr valve, which was a leather cone, that was drawn up a tube to remove water (Oertling 1996:16-17). An example of this pump type was recovered from the Basque whaler *San Juan* (1565). Pumps, like other materials and equipment used in sailing ships, evolved. *Vasa* utilized what was, for its time, an advanced bilge pump and three other secondary pumps (Hocker 2006:324-325). Chain pumps were also seeing use in Europe, mostly in mining, and were in widespread use by the

eighteenth century although their origin may date as far back as Roman times (Oertling 1996:56-59). Chain pumps were considered to be superior to suction pumps as one crewmember could move more water from a ship more effectively and chain pumps proved easy to repair while at sea (Oertling 1996:58-59).



Figure 10: Main bilge pump on *Vasa*.

The four pumps on *Vasa* were common or “suction” pump known at the time as “box” pumps, which use barometric pressure to suction water up a pipe or tube in order to remove it from the bilge (Oertling 1996: 24-29; Hocker, pers. comm.). The main pump on *Vasa* was made from Alder, which grows in marshy, wetland type areas and is a member of the birch family and

was noted for its durability in wet conditions (Oertling 1996:10). The secondary pumps on *Vasa* consisted of lead piping and were operated by the use of “T” handles.

The main pump on *Vasa* from the frames to the top of the pump handle measures 9.8m. Suctions pumps are limited in size due to the physical laws of barometric pressure and the ability to create the suction needed in order to draw the water up the tube and out to the scuppers (Oertling 1996:23). The main pump on *Vasa* had a fixed valve at the bottom of the pump, and a movable “box” with the valve attached to the handle (Fred Hocker pers. comm.). The brass “cap” affixed to the end of the alder log had holes punched into it, which acted as a screen to prevent objects in the bilge from clogging the pump.

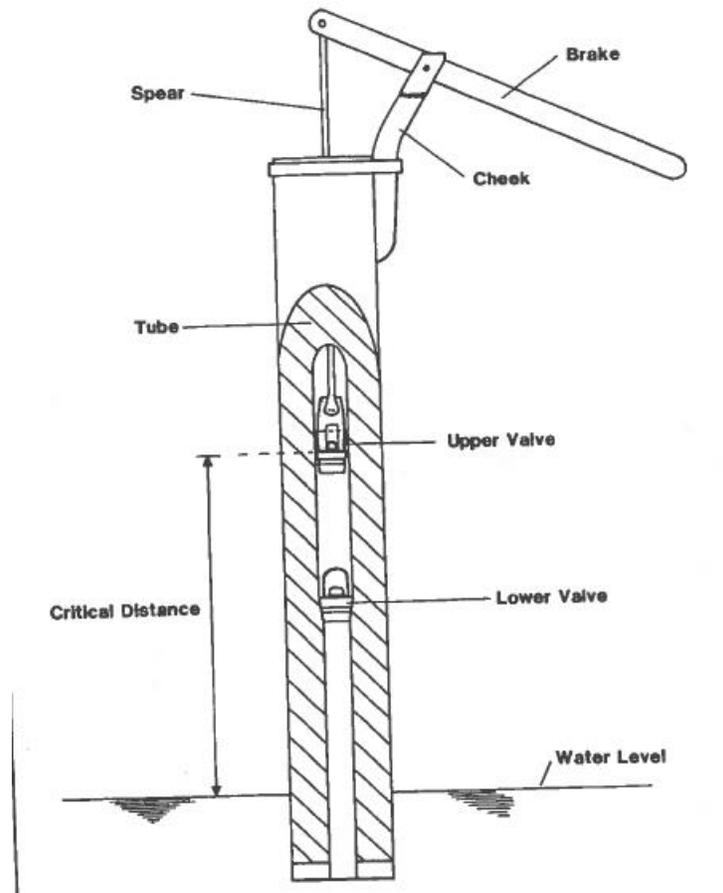


Figure 11: Example of a suction bilge pump, with parts labeled. From Oertling 1996:24.

In order to determine how effective the pump was, the equation for finding the volume of a cylinder, $V=\pi r^2h$, is used. In this context, “r” is the internal radius of the bored hole in the main bilge pump and “h” is the length of a single stroke. In the equation, “r” equaled 200mm and “h” equaled 700mm. The result shows that, for every full stroke of the brake, 87,964,594.30mm³ of water was moved.

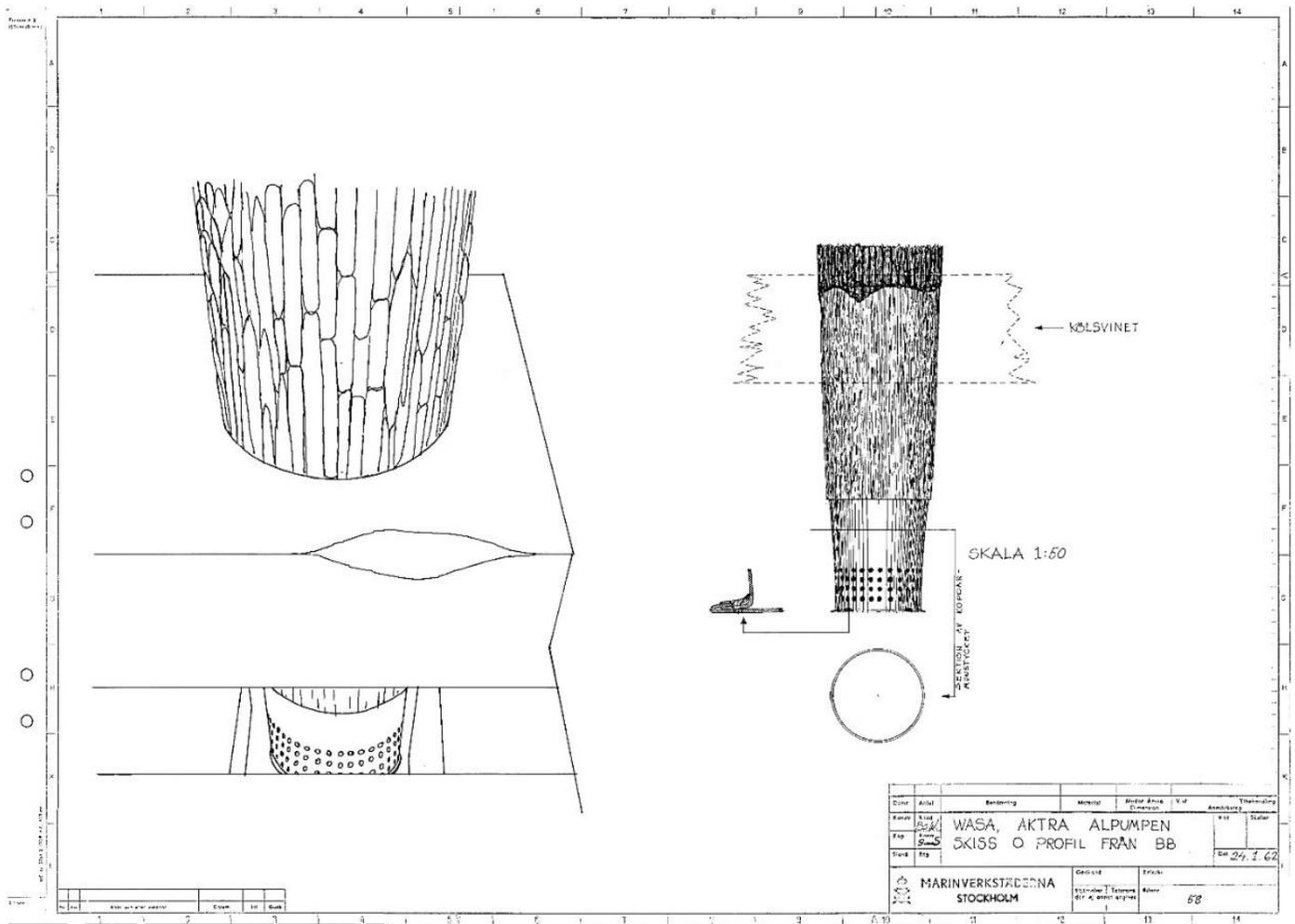


Figure 12: Lower portion of the main bilge pump (Vasamuseet 1962)

The second pump (Figure 13) was located abaft of the mainmast, and consisted of a complex structure of lead pipes set below the deck (Hocker 2006:325). Like the main bilge pump, this was also a suction pump; but was smaller than the main pump and likely would not have been able to draw as much water. This was due to the difference in handles; where the main bilge pump had a long brake, the second pump used a t-handle brake which would have made more work for the crewmember operating the pump. The tubing was made with lead dales and started with bifurcated pipe before becoming a single pipe which ran down between beams 15 and 16 (see Figure 13). The stroke for the pump would have been limited by the length of straight section, which would have impacted its effectiveness (Hocker, pers. comm). The outlet for this pump was located on the upper gundeck, but the fittings came up through the lower gundeck and were mounted to the aft side of beam 15 (Cederlund and Hocker 2006:351).

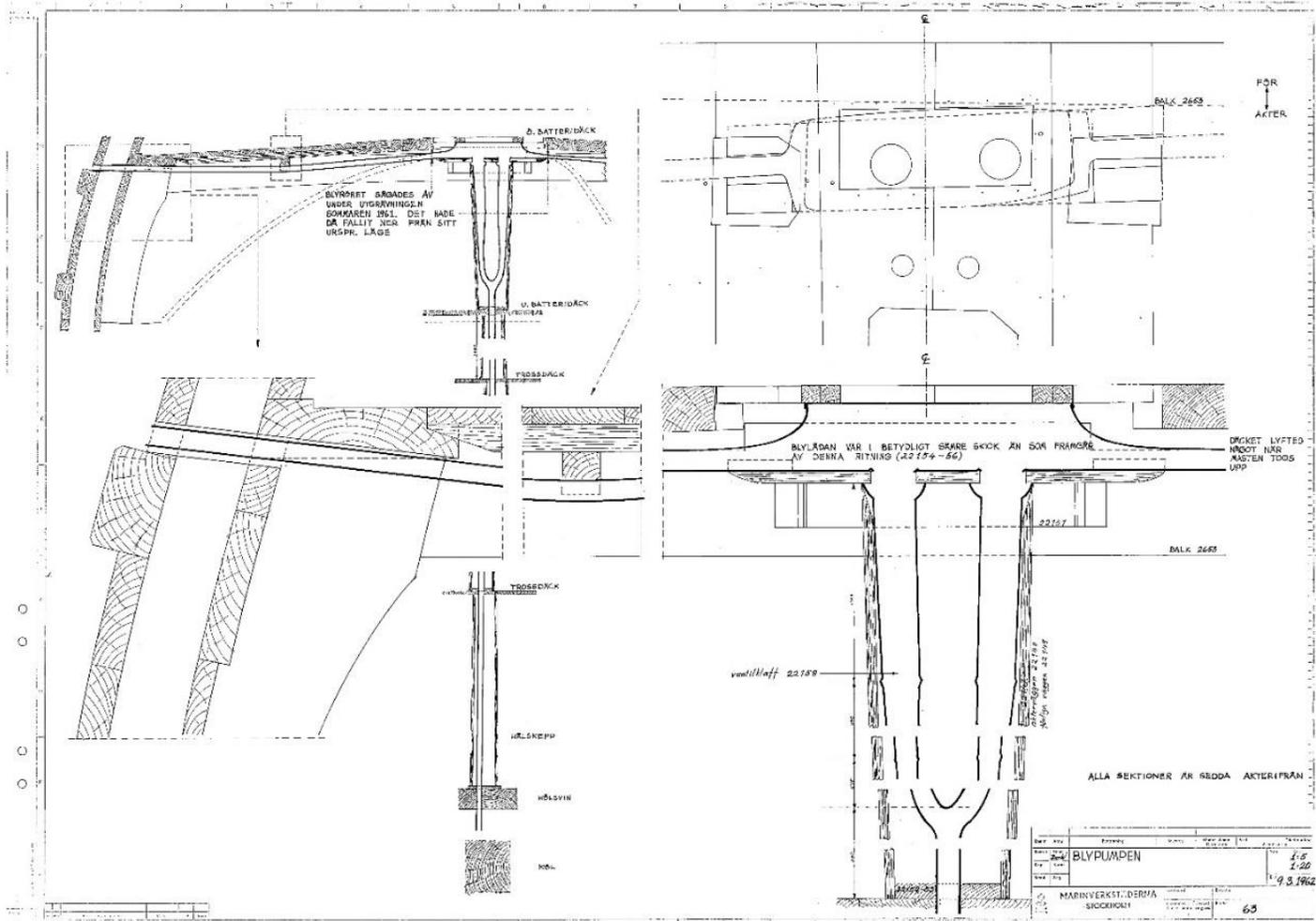


Figure 13: Detail of the secondary pump from Vasa. Courtesy Vasamuseet

The third set of pumps are located on the lower gundeck, and are split between port and starboard, 15.3m back from the foremast. These pumps consist of lead piping that follows the turn of the bilge, ending beneath the hold. These pumps also would have utilized a ‘T’ handle, and the water would have exited the top of the pump and flowed off the ship through a scupper located nearby (Figure 14).



Figure 14: Starboard set of bilge pumps and scuppers, lower gundeck.

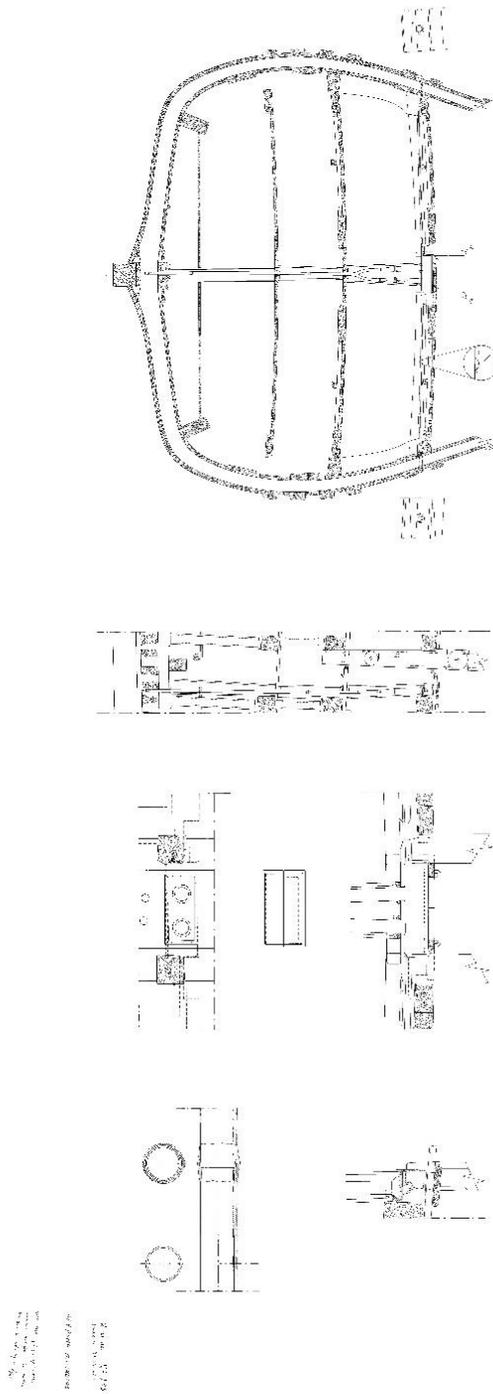


Figure 15: Cross-section and drawings of main pump from *Vasa*. Courtesy Vasamuseet

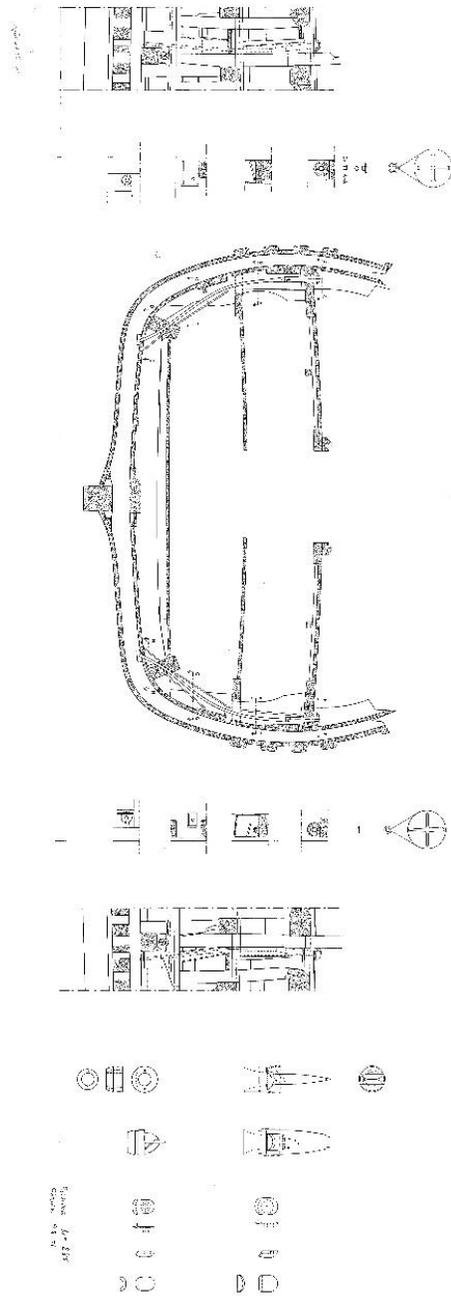


Figure 16: Third set of pumps on *Vasa*. Courtesy Vasamuseet.

Conclusion

The question remains if inclusion of facilities means that the shipwrights took shipboard hygiene into account when designing and constructing *Vasa*. As mentioned earlier, *Vasa* shares some similarities with hygienic facilities found onboard Dutch or Dutch-built vessels. In addition, *Vasa* was built with additional pumps that were meant to be worked alongside the main pump. While the additional pumps would have been a great asset in the effort to keep water from building up, the heads are inadequate to meet the needs of the 350 plus individuals aboard. While the crew would have been able to use the beakhead to relieve themselves, only two individuals could utilize the seats of ease at a time. If the seats were occupied, then the unfortunate crewmember would have to either wait, defecate through the grating, or try and brace themselves while hanging their posterior over the larboard chainwales. Officers too would have had to utilize the seats of ease, although they had the benefit of chamber pots should nature call while in their berthing.

The crew would have found their own ways to get around cramming on the beakhead. Sailors would have used the corners rather than the beakhead, or the gun crews might have had a communal bucket that they could have utilized. When the ship would have had the soldiers embarked onboard, the situation would have worsened. One can only imagine the “birdcage effect” on the lower gundeck as hundreds of soldiers and crewmembers, unable to use the beakhead, went where it was convenient.

Chapter 4: *Vasa*'s Crew as a Community: Health and Hygiene Material Culture

In addition to the sanitation and hygiene features built into the ship, *Vasa*'s crewmembers brought various items onboard. These items are important to understanding some of the most basic life functions at sea, and contribute to the principal task of material culture studies which is “to know what can be known about and from the past and present creations of humankind” (Schlereth 1985:7). To appreciate the following objects, it is important to understand the substance, what the artifact is made of, before understanding the form, or what the object was used for. It is the material that makes an object, as well as defines it and can ascribe a value to the culture. A wooden bucket and a pewter chamber pot can both be used in the collection of human waste on ship; however, the material each item is made from gives it a degree of value, though how much value an item has is wholly dependent on the individual.

Wood, as a material for crafting items, can be expensive or cheap depending on the type of wood, and its intended use. Wood for a bucket would not require much seasoning, and it would not be prohibitively expensive. The low-cost material would make ownership of the bucket accessible to a broad spectrum of individuals. Pewter, however, requires more skill and thus costs more money. Once an understanding of the artifact's form is attained, then the function of the artifact can be examined. Objects generally have more than one function, and the artifacts examined for this thesis are no different; however, there were some organizational hurdles that had to be overcome in researching these objects.

Methodology

Generally, when examining artifacts based on their function the artifacts are made of the same or similar material. A researcher who is examining specific items, such as clothing, eating utensils, or barrels generally have artifacts that are made from the same materials and have the

same function. In this study, the artifacts are made from various materials, ranging from pewter to wood, and the items also have varying functions. A chamber pot is (usually) only used for the collection of urine, while the brazier is primarily used for heating food but can also be used during surgery to heat cauterizing irons. The function of these items also determines what material the artifacts themselves could be made of, as one would not want to have a silver chamber pot due to how silver reacts to urine.

The material that the artifacts are made from presented some difficulty in logically grouping them for study. The artifacts are grouped based on the logical function of the artifacts, and on the context of the artifact find. The context of the artifacts is as important as the artifacts themselves, as it helps to determine what the function is. A brazier found by itself could have different interpretations of its use, but a brazier found with other artifacts corresponding to eating or cooking food would support that its primary function was related to food preparation. On the contrary, if a brazier was found with medical instruments it could signify its use as being related to the barber surgeon

The artifacts which have a primary, definite use for sanitation and hygiene, and have contextual data that supports that use, are examined first. Artifacts that may have multiple functions are examined second. Each object was examined and basic data such as height/length, width, and depth were recorded in metric units. The objects were drawn on Vasamuseet forms, and a selection of artifacts were photographed. Once compiled, the data was then processed into the museum's artifact database, Primus, and the artifact data was put into a spreadsheet. In order to best present the data, it is necessary to first examine the material that the artifacts are made of before delving into the artifacts themselves.

Likely Sanitation and Hygiene Artifacts

In the artifact collection from *Vasa*, there are many artifacts that can be grouped under the category “metal,” such as coins, fasteners, and drinking vessels. For this thesis, the artifacts were limited to objects which have a sanitation and hygiene function, or artifacts which could be related to the barber surgeon. The artifacts directly related to sanitation and hygiene are two pewter objects. Pewter is mostly comprised of tin, and has varying amounts of antimony, copper, and lead (Rodgers 2004:128; Robinson 1998:63-64). Pewter, if covered rapidly, can survive underwater; however, the high tin content can cause it to undergo selective galvanic corrosion (Rodgers 2004:128). The pewter artifacts of interest for this thesis, artifact numbers 21250 and 00488, are two chamber pots, which were found outside the ship in the remains of the collapsed great cabin by the divers working the site (Hocker pers. comm.).

Chamber pots were used to collect liquid waste and they afforded a means to dispose of the waste away from the bed chamber. Chamber pots have been found on historical sites spanning centuries, and they have been made from a wide range of materials. Like many objects, the material denotes some level of status for the owner, although simply having “a pot to piss in,” and a gunport to toss the waste out of, was in and of itself a luxury to some. Cheaper chamber pots were made from fired clay, while more expensive chamber pots were made from pewter, copper, or other metals. *Vasa* has two chamber pots that were found in the remains of the great cabin, located outside the vessel. There are additional examples of chamber pots found on shipwrecks, such as the metal chamber pot found onboard *Mary Rose* (1545), where officers were quartered in the sterncastle (Mary Rose Trust).

Artifact 21250 is the best preserved of the two chamber pots, likely due to burial in sediment which prevented exposure to the currents of the harbor and preserved it in an anaerobic

environment. The artifact measures 121.5 mm in height, 120 mm in depth, and has a diameter of 173 mm. The artifact is silver in color, and has two hallmarks on the handle (figures 17 and 18). The mark on the left side of the handle is a crescent moon, two five-pointed stars, and the letters "E" and "A" (Figure 19). The right hallmark is a single, three-pronged crown. The artifact is in good condition, with two dents on the exterior of the chamber pot being the only damage.



Figure 17: Artifact 21250, a pewter chamber pot.



Figure 18: Artifact 21250, opposite view.



Figure 19: View of hallmarks on handle of Artifact 21250. Mark on the left is a crescent moon, Two five-pointed stars, and the letters "E" and "A." Right hallmark is a three-pronged crown.

Artifact 00488 is another chamber pot that was located outside the ship, found in the collapsed stern by the divers, near artifact 21250 (Vasamuseet records 1963). The artifact measures 121 mm in height, 180.2 mm width, and the best section for measuring thickness was 15 mm. This chamber pot is in poor condition, with most its structural integrity having been

corroded away by exposure to the moving water column (Figures 20 and 21). The chamber pot is heavily degraded, with small holes forming in the base and on the sides of the artifact, making it very fragile. There are no identifiable hallmarks or maker's marks on the artifact, though it has similar features to the other chamber pot recovered from *Vasa*.



Figure 20: Artifact 00488, a pewter chamber pot.



Figure 21: Artifact 00488, opposite view.

The two chamber pots, based on their location, likely belonged to officers on *Vasa*. The officers' higher status and better financial standing, as well as more space in their berth, would have allowed them to bring aboard items for personal relief. The location of the *Vasa* chamber pots, in the wreckage of the great cabin, is similar to where the *Mary Rose* chamber pot was found. The *Mary Rose* chamber pot was located by divers in a scour pit underneath the sterncastle, near where officers were berthed (Gardiner and Allen 2013:161-162). Much like on *Vasa*, the officers likely did not want to use the same facilities as the common sailor unless they had to. Chamber pots provided them that luxury.

In addition to the chamber pots, additional items related to personal hygiene were found. Nit combs, which were used to remove nits and lice from hair or a wig, were usually made from wood or bone. Nit combs have two ends, one with teeth that are closer together and one side with teeth that are further apart, referred to as “fine” and “coarse” toothed (Figure 22) (Dirks and Vos 2010:65). These combs would have been carried by individuals, such as many of the combs on *Mary Rose* (Castle *et al* 2005:218) Lice can carry diseases such as typhus, which can rapidly spread through the ships’ crew making personal hygiene important, especially in the days before standardized uniforms, when conscripts on board a ship was wearing whatever they had when they were conscripted, which often led to an infestation of lice aboard the ship.



Figure 22: Close-up of woman having her hair combed. Notice the two types of teeth on the comb. From "Allegory of Vanity" by Jan Miense Molenaer (1610-1668). From the collection of The Toledo Museum of Art.

On *Vasa*, artifact number 14048 (figure 23) is the best preserved of the two combs examined. It is likely made from either boxwood, a wood used in making combs since Roman times and known for its resistance to splitting, or pine (Dirks and Vos 2010:55-56). The presence of combs suggests that the sailors on *Vasa* had some concern about their personal hygiene, or at the very least simply did not want lice taking up residence on their persons. Similar combs were found on *Mary Rose* in clothing and personal possessions during excavation, as well as in the barber surgeon's cabin (Figure 24). As the individual charged with the responsibility of barbering the crew, the barber surgeon had an assortment of combs, personal hygiene tools (such as an ear wax scoop), and razors and shaving bowls. Combs were also found during the excavation of *Kronan* (Figure 25). With the exception of combs, no other items related to barbering were found onboard *Vasa*.



Figure 23. Boxwood comb recovered from *Vasa*.



Figure 24: Combs recovered from *Mary Rose*. (Courtesy Mary Rose Trust)



Figure 25: Comb found during excavation of Kronan. Multiple combs and hygiene objects were found during excavation.

Artifacts with Multiple Functions, Including Sanitation and Hygiene, or Surgery

The brass brazier (figure 26) was located in the hold, on the port side between beams 23 and 24. The artifact is lathe-turned, with holes punched into the neck under the bowl to facilitate air flow for the coals. Holes are also punched higher up in the bowl, and the top of the bowl has three 13 mm tall rounded extensions for setting a metal bowl on to warm food. The stand and the bowl are two separate pieces, joined by a fastener. Two handles on the artifact allowed for the brazier to be transported by hand. The brazier has a height of 113 mm, and a diameter of 205 mm at the top of the opening, while the base has a diameter of 118 mm. A brazier is among the artifacts found in the barber-surgeon's cabin on *Mary Rose* (Figure 27) (Castle *et al* 2005:203-206). The brazier from *Mary Rose* measures 165 mm in diameter at the rim, and is 85 mm in height, and was found near the barber surgeon's chest; use of a replica found that it was only suitable to use for heating food if the pot was suspended above it (Castle *et al* 2005: 203-206).

Brass occurs when a metallurgist combines copper with zinc to create an alloy that is malleable and easy to work (Rodgers 2004:108). Brass can also contain lead, tin, nickel, or iron with amounts varying on the quality of the brass and its intended use (Rodgers 2004:108). This study examined a single brass artifact, a brazier that was found in the hold between beams 23 and 24. This artifact does not serve a sanitation and hygiene purpose; however, it highlights the multiple uses that artifacts can have. It is one of the artifacts that is important to answering the question of whether a barber surgeon was on board *Vasa* at the time of the wrecking event, which will be discussed further in this thesis.



Figure 26: Brass brazier (artifact number 12495) found onboard Vasa.



Figure 27: Brazier/chafing dish recovered from the barber surgeon's cabin on *Mary Rose* (courtesy Mary Rose Trust)

Glass is a common artifact on historic and underwater archaeological sites. It was used for all manner of products that crossed many economic lines; glass was used for fine drinking vessels, stern castle windows, and for cheap trade bottles. Glass bottles were also valuable because they could be reused for various purposes. A case bottle might have originally been purchased for its contents; but once the bottle was empty, it could be used to hold homemade medicine or to carry water. Even when glass was broken, it was not necessarily discarded. Glass fragments, called cullet, have been found on ship wrecks such as the 11th-century A.D. Serçe Limani vessel, where archaeologists believe the cullet was being transported from the Levant to

Byzantine Anatolia in order to be melted down and made into other items (Matthews and Ledo 2009:254-256).

In order to produce glass, the glass maker needs three main ingredients: silica, alkali, and a stabilizer. Silica, usually in the form of sand in the seventeenth century, was the base ingredient (Jones *et al* 1989:10). Silica requires extraordinarily high temperatures to melt, and these temperatures were not feasible to achieve, so an alkali was added to the silica to lower its melting point (Jones *et al* 1989;10). The source for this alkali in Sweden was plant ash and created what is known as potash-lime glass (Jones *et al* 1989:10-11). Finally, a non-alkaline base stabilizer had to be added in order to stabilize the glass (Jones *et al* 1989:10). This stabilizer can be in the form of lime or lead (Jones *et al* 1989:10). Potash-lime glass is a soft green color as a result of impurities present in the glass, and this glass was commonly used for windows, drinking vessels, and bottles (Jones *et al* 1989:10-12). Most of the glass found onboard *Vasa* during excavation was of the potash-lime variety.

Glass production in Sweden can be traced to the mid thirteenth century (Ihr 2014). Previously, it was thought that Gustav Vasa brought glass making to Sweden with the inviting of two prominent glassmakers from Italy and Germany. Glassworks were established outside of Stockholm in order to serve the demands of the Swedish nobility for fine glass products. Drinking vessels and bottles were the primary products produced by the early Swedish glassworks, and with Sweden's ample forests and plenty of sand, glass works soon sprung up in other parts of the country. While the multitude of glassworks meant that glass was easy to acquire in Sweden, it was still treated as a commodity to re-use.

Art work from the period shows examples of this re-use by apothecaries, who used glass bottles to store medicines or for storing fluids such as urine for uroscopy. Figures 28 and 29

show two different apothecaries at work. In both images, various types of glass containers are shown. Storage containers make up the primary use for glass and the apothecaries would have stored liquid medicines in these containers for dispensing and transport.



Figure 28 *The Surgeon* by David Teniers the Younger (1610-1690), oil on canvas, showing the re use of glass and pottery. (Courtesy Chrysler Museum of Art)

When *Vasa* sank in 1628, it took to the bottom hundreds, if not thousands, of glass bottles with it. These bottles would have carried all manner of liquids, from water to aquavit and other assorted alcohols. Some of the bottles could have contained medicines, as many of the herbal cures would have been in some form of a liquid, usually high in alcohol, and glass bottles would

have made the transportation and storage easier. The bottles themselves would have varied in size, from smaller, square shaped and hand blown “vials,” which would have held small doses, to larger “case” bottles which could hold more readily available, and likely cheaper, medicines.



Figure 29: A barber-surgeon extracting stones from a woman's head; symbolizing the expulsion of 'folly' (insanity). Watercolor by Jacob. Cats (1741-1799), 1787, after B. Maton (Wellcome Images)

Transporting the medicines in case bottles would have ensured that the bottles did not break in rough seas since case bottles were shipped in cases with partitions designed to snugly fit the bottles. Case bottles were made by hand-blowing glass into a mold which shaped the glass into the desired shape. Case bottles came in varying sizes, but all were designed to be wider at the top than the bottom, so that they would fit better within the partitions. Glass bottles were often re-used, and broken glass was often re-melted to be used in making new glass.

The glass fragments from *Vasa* were of varying sizes, ranging from small fragments to larger intact pieces of case bottles. There were three primary colors in the glass: green, brown, and clear. The majority of the glass was green, ranging from an olive green to a brighter green. According to the museum database, most of the glass was found on the port side of the vessel, which is consistent with how the vessel listed to port before foundering. *Vasa* listing hard to port caused items that were not fastened down, or that were poorly fastened, to slide towards the port side of the hull. The impact of the cases against the bulkhead likely caused a breakage of bottles, and once the vessel listed a second time and sunk, more bottles broke.

It is likely that the bottles examined were not related to a barber surgeon, due to the significant number, general ubiquity, and location of the bottles. The only bottle that has a likelihood of medical or sanitary use is artifact 14033 (Figure 29). 14033 is a small, clear glass vial that was found in a box of personal possessions. With this vial, a possible enema nozzle with a plug was also found. The bottle has a height of 62 mm, a width of 29 mm, and a depth of 29 mm. It was made by blowing molten glass into a shaped mold, which gave the bottle its shape. There are no ownership markings; however, one side of the shoulder is misshapen where the glass went over the mold edge. Also present are bubbles, located near the finish, showing the

direction that the glass blower turned the bottle as they were blowing it into the mold. There are no pontil marks present underneath the bottle.



Figure 30: Artifact 14033. Clear glass vial. The right shoulder is misshapen from glass going over the mold.

As mentioned previously, found in the trunk with artifact 14033 was a suspected enema nozzle with a plug, artifact number 14048 (figures 30 and 31). The box was located on the lower gundeck, starboard between beams 3 and 4. The nozzle and plug are both wood, possibly Alder, with the nozzle showing evidence of having been turned on a lathe while the plug was worked by whittling. Another example of this kind of nozzle was found on *Vasa*, artifact number 11755,

which is in worse shape than 14048. Artifact 11755 split during conservation, and was missing the nozzle when recovered and also has a plug (figure 32).



Figure 31: Artifact 14048, a suspected enema nozzle.



Figure 32: Plug for the suspected enema nozzle. The curve of the point matches the boring in the nozzle, which would have created a seal.

Enemas were a common treatment when medical understanding was steeped in humoral theory. The goal was to introduce cures rectally in order to purge the body of excess humors. In Sweden, the indigenous Sami used enemas as a cure, with pouches made from animal stomach and reindeer bone nozzles (Display at *Medicinehistorikamuseet*, Uppsala). Enemas became the cure of choice in Europe, particularly in France, where King Louie XI became an enthusiastic proponent of the curative enema in the late 15th century (Friedenwald and Morrison 1940:95-96). During the late seventeenth and eighteenth centuries, enemas and clyster syringes featured

prominently in satirical artwork, often targeting apothecaries and surgeons who were quick to prescribe the clyster as a treatment (Dixon 1993:28-29).



Figure 33: Artifact 11755, a suspected enema nozzle. Artifact is missing the nozzle, which was broken off before the artifact was recovered.

The two suspected enema nozzles are similar to another artifact recovered from *Kronan*. The suspected enema nozzle from *Kronan*, 16268KR, is of a similar shape to artifact 14048; however, 16268KR was not found with a plug.



Figure 34: Artifact 16268KR, a suspected enema nozzle recovered from *Kronan*.

Also present on *Kronan* was an apothecary kit, complete with over 70 glass bottles and wooden containers of medicine, to include pills that were gilded in gold leaf (Lindeke *et al* 2009:28-31). *Kronan* is unique in that its status as the flag ship called for the presence of senior admiralty officials, such as the chief barber surgeon and fleet apothecary. Individuals such as these were not present on *Vasa* when it set sail in 1628; only the Grand Admiral was aboard.

Found in the context of kitchen cooking utensils was a wooden mortar and pestle, artifact numbers 15561 and 15560. A mortar and pestle is a tool used to grind grains or spices into a powder, and they are made from a range of materials ranging from stone, wood, or even ceramic.

The mortar and pestle recovered from *Vasa* was made from wood, likely alder or birch, and was recovered from the hold, on the starboard side between beams 23 and 24. The mortar, artifact 15561, has a height of 255 mm, and a width of 116 mm. The pestle, artifact 15560, has a length of 308 mm, and a width at the widest point of 43 mm and is also made from wood. The mortar shows evidence of being worked on a lathe, with decorative work in the middle that was done by hand. Both the mortar and pestle have iron staining, and are in a good state of preservation. The mortar is cracked, likely from the freeze-drying, and the pestle's wood has become "spongy."

Additionally, other artifacts related to the galley were also recovered. These artifacts include whisks, pewter bowls, ceramic drinking vessels, earthenware jugs, stoneware jars, wooden eating utensils, and wooden bowls. It has been theorized by Katarina Villner that there are finds which can be classified as barber's equipment, and that rather than viewing the objects as traditional barber surgeons' equipment, the artifacts are akin to an "emergency kit" (Villner 2014). Based on the finds' context and the lack of additional artifacts related to barbering, these artifacts are most certainly related to the cook, and not a barber surgeon. There is the possibility that these objects could have been used, if required, by the surgeon but the context of these objects places these objects with the cook.

These artifacts are all pieces of a larger narrative about *Vasa* and the crew. Each artifact acts as a puzzle piece to connect us with the larger story of life in the seventeenth century. These artifacts in particular tell us that members of the crew, like fellow European sailors, saw fit to carry personal hygiene equipment out to sea. These artifacts are not ornate, there are no flashy combs or gilded chamber pots, but utilitarian objects which serve a purpose. Some of these objects, such as the brazier or the mortar and pestle, have multiple uses. It may not even be

possible to completely ascertain what use each and every artifact had, and if that use is exactly what was theorized; but based on each object's context, we can get a fair idea.

In addition to the finds from *Vasa*, *Mary Rose*, *Kronan*, and other shipwrecks contained similar objects and help to show the uniformity of the kinds of items sailors brought to sea. Items such as the combs are commonplace; even shipwrecks in Australia from the Dutch East India Company (*Verenigde Oostindische Compagnie*) have combs of similar shape and design as those found on *Vasa*, *Mary Rose*, and *Kronan*. These items show that the sailors onboard *Vasa*, like sailors across Europe, thought enough about their personal hygiene to bring aboard necessary items. Life at sea is hard enough, but one can imagine how much worse it could be without a means to remove the lice from your hair, or a means to remove the urine and excreta from inside the ship.

Equally important is what artifacts were not found. The most substantial absence is that of a barber surgeon's chest (Figure 35), which would be the clearest indicator that he was on board. Examples of barber surgeon equipment survives on many shipwrecks, many of them discussed in the preceding chapters. Those artifacts show that an individual was onboard whose purpose was to treat and look after the health of the officers and crew. There is no doubt that *Vasa* would have had such a crewmember; what is in doubt is whether or not he was on board as *Vasa* set sail in 1628. There are no artifacts that can be linked to a barber surgeon. Villner sees the presence of some common galley objects as evidence for the presence of the barber surgeon. Unfortunately, the context of these finds lacks any real evidence that they belong to, or were for

the use of, the ship's surgeon and instead their locations, as previously mentioned, suggest that they were for the use in preparation of meals for the crew.

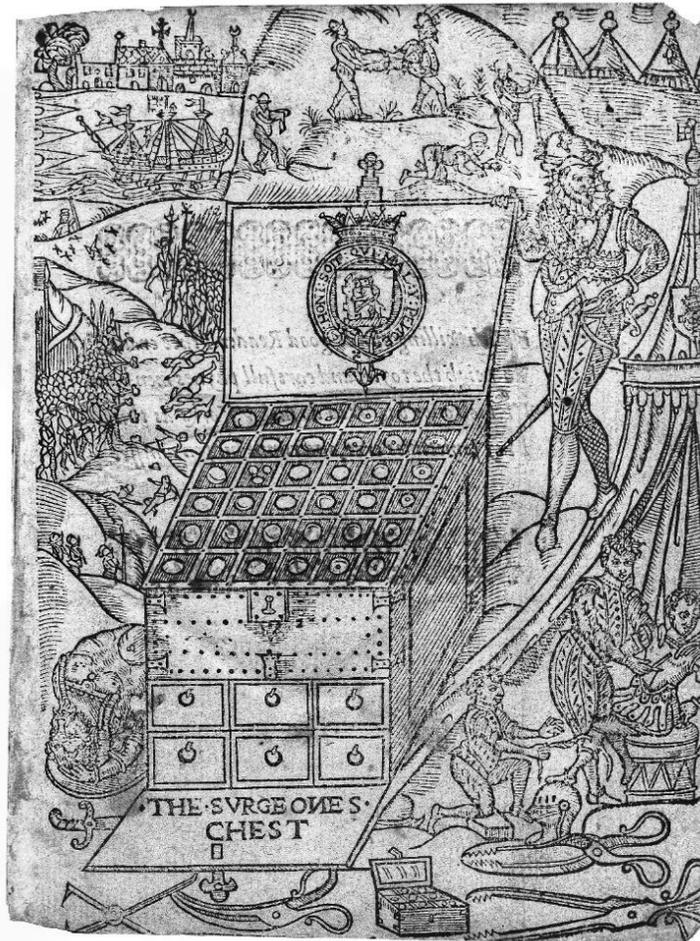


Figure 35. An army barber surgeon's chest, with associated tools, none of which were found on *Vasa*. Navel chests were similar, often identical, to army chests. From *A proved practice for all young chirurgians* (1588) by William Clowes. (Wellcome Trust, London)

If the barber surgeon was on board, he would have come aboard with an extensive kit. Tools for surgery, trepanning, administering medicines, and barbering would have been present. Razors, whetstones, bleeding bowls, syringes, cupping bulbs, and scissors are just some of the objects that are missing. The artifacts that Villner writes about include “a whisk, wooden ladles,

a very well preserved wooden mortar and pestle, a grater, a beer tap, a pewter flask, a pillbox and a stoneware jar” (Villner 2014). These artifacts could be linked to the ship’s cook, who would have used them in the preparation of the meals for the crew, or to an apprentice apothecary, as some of the objects could have been used in the preparation of medicines based on the recommendation of the barber surgeon onboard. Based on the lack of objects directly related to a barber surgeon, it is almost certain that one was not on board when *Vasa* sank in 1628.

As it was previously stated, the external sanitary accommodations on *Vasa* were put in as an afterthought, and this is likely due to the Dutch shipbuilding influence of the master shipwright. Two seats of ease would not have been enough to handle the waste that 450 sailors and embarked soldiers would have produced. The beakhead provides enough space that crew and soldiers could have disposed of liquid waste via the grating. The chamber pots found in the remains of *Vasa*’s great cabin show that at least some of the officers made arrangements of their own; however, *Vasa*’s voyage was cut short before the full complement of crew and soldiers could be taken aboard.

The abrupt end of the voyage also meant that many of the hygienic practices simply did not happen. There is not an abundance of artifacts from *Vasa* that are directly related to sanitation and hygiene, and the lack of those objects impacts the interpretation of life on board. Coupled with this absence of material, is the absence of the barber surgeon. Without the surgeon’s chest, and the clear context of those artifacts, it is difficult to say with any certainty where Sweden and its navy was in the development of shipboard medicine. What is evident is that some crewmembers were concerned enough about their hygiene to bring aboard combs, chamber pots, and possibly even enema hardware.

Conclusion

Health and sanitation at sea prior to the nineteenth century is an area ripe with research opportunities, especially in the Baltic Sea where conditions exist that allow for excellent preservation of shipwrecks. While excellent scholarship on external sanitary accommodations, and ships' bilge pumps exist, more detailed studies on specific ships and time periods are needed. There are several shipwrecks that cover a range of time periods and perhaps would cover different stages in the evolution of shipbuilding in regard to sanitary accommodations and bilge pumps. Exploring vessels such as *Mars* (1564), *Svärdet* [Sword] (1676) and the "Spökvraket" ["Ghost wreck"] could assist the researcher in examining the evolution of external sanitary accommodation on Swedish warships.

In addition, more historical scholarship on the development of health and sanitation in the Nordic region could help in the global understanding of how medical practices and knowledge developed world wide. There is extensive academic work on the medical histories of England, France, Italy, and Belgium, but not Scandinavia prior to the mid-nineteenth century, and what is written focuses primarily on psychology, and the establishment of socialized medicine in Sweden. Since ships are the pinnacle of technology for the seventeenth through the twentieth century, they are perfect objects to examine in order to trace how sanitary practices developed.

Additional scientific research on the items in the collection from *Vasa* could yield further details. With the multitude of glass shards found onboard, analysis of the shards using X-ray fluorescence could provide information about the elemental constituents present in the glass without destroying the sample (Janssens 2010:80). A positive identification of the suspected enema nozzle would assist in our understanding of the items members of the crew brought aboard and help to ascertain the purpose.

The artifacts alone are unable to tell the complete story of *Vasa*'s crew and their hygienic practices. When combined with how their ship functioned as an instrument of sanitation and hygiene the answer becomes somewhat clearer. With accommodations onboard not sufficient for the size of the crew, sailors and embarked passengers were forced to improvise. As the previous chapters show, the shipwrights who built *Vasa* treated sanitation and hygiene as an afterthought. Two seats of ease and slats on the beakhead were not sufficient to handle what 145 officers and sailors could produce, let alone the addition of 300 embarked soldiers. The pumps were needed to move more than human waste from the bilges, and were added to keep the ship afloat.

What *Vasa* and its associated artifacts do show is a desire for comfort and familiarity. An officer brought aboard their chamber pot in order to relieve themselves from the comfort of their berth, rather than the uncomfortable, crowded beakhead. Sailors brought combs to remove lice from their hair and beards which made their short, rough lives a little more bearable. It is entirely possible that someone also brought aboard an enema kit, possibly with a homemade medicine for some unknown ailment. With no barber surgeon aboard at the time of its sinking there is a large gap in piecing together where Sweden was in its development of medical care, sanitation, and hygiene.

Bibliography

Adams, Jonathan, and Rönnby, Johan (editors)

2013 *Interpreting Shipwrecks: Maritime Archaeological Approaches*. Southampton Monographs in Archaeology New Series Number 4, Södertörn Academic Studies 56. Highfield Press, Southampton.

Alsop, J. D.

2013 Sea Surgeons, Health and England's Maritime Expansion. In *The Mariner's Mirror* 76:215-221.

Ashenburg, Katherine

2008 *The Dirt on Clean: An Unsanitized History*. North Point Press, New York, NY.

Bass, George F., Lledo, Berta, and Matthews, Sheila

2009 *Serce Limani, Volume 2: The Glass of an Eleventh-Century Shipwreck*. Texas A&M University Press, College Station.

Brooks, Francis J.

1993 Revising the Conquest of Mexico: Smallpox, Sources, and Populations. In *The Journal of Interdisciplinary History* 24:1-29.

Brown, Stephen J.

2005 *Scurvy: How a Surgeon, A Mariner, and a Gentlemen Solved the Greatest Medical Mystery of the Age of Sail*. Thomas Dunne Books, New York.

Bruijn, Iris

2009 Ship's Surgeons of the Dutch East India Company: Commerce and the Progress of Medicine in the Eighteenth Century. Leiden University Press, Leiden.

Bryon, Reginald

1994 The Maritime Household in Northern Europe. In *Comparative Studies in Society and History* 36:271-292.

Cederlund, Carl Olof, Fredrick Hocker

2006 *Vasa I: The Archaeology of a Swedish Royal Ship of 1628*. National Museum of Sweden, Stockholm.

Conrad, Lawrence I.

1995 *The Western Medical Tradition: 800 B.C. to AD 1800 Volume 1*. Cambridge University Press, Cambridge.

Cockayne, Emily

2007 *Hubbub: Filth, Noise and Stench in England*. Yale University Press, New London.

Crosby, Alfred W.

1976 Virgin Soil Epidemics as a Factor in the Aboriginal Depopulation in America. In *The William and Mary Quarterly* 33:289-299

Csikszentmihaly, Mihaly

1993 Why We Need Things. In *History from Things: Essays on Material Culture*, Steven Lubar and W. David Kingery, editors, pp. 20-29. Smithsonian Institution Press, Washington, DC.

Cunningham, Andrew

2001 Protestant Anatomy. In *Religious Confessions and the Sciences in the Sixteenth Century*, Jürgen Helm and Annette Winkelmann, editors, pp. 44-50. Leiden University, Leiden.

D'Agostino, Mary Ellin

2000 Privy Business. In *Archaeology* 53:32-37

Debus, Allen G.

1998 Chemists, Physicians, and Changing Perspectives on the Scientific Revolution. In *Isis* 89:66-81.

Derks, Ton and Vos, Wouter

2010 Wooden Combs from the Roman Fort at Vechten: The Bodily Appearance of Soldiers. In *Journal of Archaeology in the Low Countries*. 2:53-77

Dixon, Laurinda S.

1993 Some Penetrating Insights: The Imagery of Enemas in Art. In *Art Journal* 52:28-35.

Doyle, Derek

2005 Per Rectum: A History of Enemata. In *Journal of the College of Physicians Edinburgh* 35:367-370.

Dungworth, David and Colin Brian

2009 Late 17-Century Crystal Glass: An Analytical Investigation. In *Journal of Glass Studies*. 51:111-215.

Eginton, Coral Am-Erika

2014 Health and Disease on the Dutch High Seas: An Analysis of Medical Supplies from *Batavia*, *Vergulde Draak*, and *Zeewijk*. Master's Thesis, Texas A&M University, College Station.

Friedenwald, Julius and Morrison, Samuel

1940 The History of the Enema, With Some Notes on Related Procedures. In *Bulletin of the History of Medicine* 8:239-276.

Gandulla, Stephanie

2014 The Swedish Sailor's Table: A Study of *Vasa's* Wooden Tableware. Master's Thesis, East Carolina University, Greenville.

Gardiner, Julie (editor) and Allen, Michael J.

2013 *Before the Mast: Life and Death Aboard the Mary Rose*. Oxbow Books, Oxford.

Glete, Jan

2000 *Warfare at Sea, 1500-1650: Maritime Conflicts and the Transformation of Europe*. Routledge, Abingdon, Oxon.

2002 *War and the State in Early Modern Europe: Spain, the Dutch Republic, and Sweden as Fiscal Military States, 1500-1660*. Routledge, London.

2010 *Swedish Naval Administration 1521-1721*. Koninklijke Brill, Leiden.

Helm, Jürgen

2001 Religion and Medicine: Anatomical Education at Wittenberg and Ingolstadt. In *Religious Confessions and the Sciences in the Sixteenth Century*, Jürgen Helm and Annette Winkelmann, editors, pp. 44-50. Leiden University, Leiden.

Hocker, Fred

2011 *Vasa: A Swedish Warship*. Medströms Bokförlag, Stockholm.

Hocker, Fred, and Ward, Cheryl (editors)

2004 *The Philosophy of Shipbuilding: Conceptual Approaches to the Study of Wooden Ships*. Texas A&M University Press, College Station.

Hodder, Ian

2000 The Interpretation of Documents and Material Culture. In N. K. Denzin and Y. S. Lincoln, editors, pp. 703-716. *Handbook of Qualitative Research* Sage, Thousand Oaks, CA.

Hoving, A.B.

2012 *Nicolaes Witsen and Shipbuilding in the Dutch Golden Age*. Texas A&M University Press, College Station.

Ihr, Anna

2014 *Becoming Vitrified: Kilns, Furnaces and High Temperature Production*. Doctoral Dissertation, Department of Historical Studies, University of Gothenburg. Gothenburg, Sweden.

Jones, Olive

1971 Glass Bottle Push-Ups and Pontil Marks. In *Historical Archaeology* 5:62-73.

Jones, Olive and Catherine Sullivan, George L. Miller, E. Ann Smith, Jane E. Harris, Kevin Lunn

1989 *The Parks Canada Glass Glossary*. Canadian Parks Service, Ottawa.

Jütte, Robert

1989 A Seventeenth-Century German Barber Surgeon and His Patients. In *Medical History* 33:184-198.

Kent, Neil

2008 *A Concise History of Sweden* Cambridge University Press, Cambridge.

Kiedel, Klaus-Peter

1985 *The Hanse Cog of 1380*. Förderverein of the Deutsches Schiffahrtsmuseum, Bremerhaven.

Lindeke, Björn, Bo Ohlson, Lars Einarsson, Max Jahrehorn

2009 Gilded pills in the medical chest on board the warship *Kronan*. *Journal of Nordic Archaeological Science* 16: 25–31.

Lockhart, Paul

2004 *Sweden in the Seventeenth Century*. Palgrave Macmillan, New York, NY.

Martin, Colin J.

2017 *A Cromwellian Warship Wrecked Off Duart Castle, Mull, Scotland, in 1653*. Society of Antiquaries of Scotland, Edinburgh.

McKenzie, Dan

1932 Alfred Higginson and His Syringe: With a Side-Glance at the Clyster. In *Proceedings of the Royal Society of Medicine* 25:633-638

Moberg, Vilhelm

1970 *A History of the Swedish People I: From Prehistory to Renaissance*. Norstedt and Soners, Stockholm.

1973 *A History of the Swedish People II: From Renaissance to Revolution*. Norstedt and Soners, Stockholm.

Muckelroy, Keith

1978 *Maritime Archaeology*. Cambridge University Press, Cambridge.

Oertling, Thomas J.

1989 A Suction Pump from an Early-16th-Century Shipwreck. In *Technology and Culture* 30:584-595.

1996 *Ships' Bilge Pumps: A History of Their Development, 1500-1900*. Texas A&M University Press, College Station.

Parker, Charles H.

2014 Defiled Souls: Corporality and Religious Difference in the Reformation. In *Renaissance Quarterly* 67:1265-1297.

Porter, Roy

1997 *The Greatest Benefit to Mankind: A Medical History of Humanity*. W.W. Norton & Company, New York, NY.

2002 *Blood and Guts: A Short History of Medicine*. W.W. Norton & Company, New York, NY.

2003 *Flesh in the Age of Reason: The Modern Foundations of Body and Soul*. W.W. Norton & Company, New York, NY.

Porter, Roy (editor)

2006 *The Cambridge History of Medicine*. Cambridge University Press, Cambridge.

Prown, Jules David

1982 Mind in Matter: An Introduction to Material Culture Theory and Method. In *Winterthur Portfolio* 17:1-19.

Qvarsell, Roger and Sundin, Jan

1995 The Social and Cultural History of Medicine and Health in Sweden. In *History and Philosophy of the Life Sciences* 17:315-336

Ratcliffe, John E.

2012 *The Casks from Vasa*. Master's Thesis, East Carolina University, Greenville.

Ray, Eric

2009 *Fire in the Hold: Construction and Use of the 1628 Swedish Warship Vasa's Galley*. Master's Thesis, East Carolina University, Greenville.

Robinson, Wendy

1998 *First Aid for Underwater Finds*. Archetype Publications Ltd. London, and Nautical Archaeology Society, Portsmouth.

Rogers, Bradley A.

2004 *The Archaeologists Manual for Conservation: A Guide to Non-Toxic, Minimal Intervention Artifact Stabilization*. Kluwer Academic/Plenum Publishers, New York.

Rose, Kelby James

2014 The Naval Architecture of *Vasa*-A 17th- Century Swedish Warship. Doctoral Dissertation, Texas A&M University, College Station.

Rowell, S.C.

2001 The Face Beneath the Snow: The Baltic Region in the Seventeenth and Eighteenth Centuries. In *The Historical Journal* 44:541-558.

Schreiner, Manfred

1991 Glass of the Past: The Degradation and Deterioration of Medieval Glass Artifacts. In *Mikrochimica Acta* 2:255-264.

Scott, Franklin

1988 *Sweden: The Nation's History*. Southern Illinois University Press, Carbondale.

Simmons III, Joe J.

1997 *Those Vulgar Tubes: External Sanitary Accommodations aboard European Ships of the Fifteenth through Seventeenth Centuries* Texas A&M University Press, College Station, TX.

Smeeks, Jessica D.

2014 *Characterizing the Deceased Mariners of the Swedish Warship Vasa: An Analysis of Personal Possessions Found in Association with Human Remains*. Master's Thesis, East Carolina University, Greenville.

Smith, Virginia

2007 *Clean: A History of Personal Hygiene and Purity* Oxford University Press, Oxford.

The Guardian

2009 The Mary Rose ship reveals a haul of old treasures. *The Guardian* 12 May, 2009. London, England <<http://www.theguardian.com/artanddesign/gallery/2009/oct/12/mary-rose-treasures#/?picture=354149536&index=1>>. 1 April, 2014

Van Duivenvoorde, Wendy

2008 *Dutch East India Company Shipbuilding: The Archaeological Study of Batavia and Other Seventeenth-Century VOC Ships*. Texas A&M University Press, College Station.

Vilner, Katrina

2012 *Under Däck*. Thomas Magnusson Medströms Bokförlag, Stockholm.

2014 "And of scurvy the teeth fall out of them." Hektoen International Journal <<http://hekint.org/and-of-scurvy-the-teeth-fall-out-of-them/>>. Accessed 15 July 2017.

Watt, James

1983 Surgeons of the *Mary Rose*: The Practice of Surgery in Tudor England. In *The Mariner's Mirror* 69:3-19

Woodall, John

1617 *The Surgeon's Mate or a treatise discoursing faithfully and plainly the due contents of the surgeons chest, the use of the instruments, the virtues and operations of the medicines, the cures of the most frequent diseases at sea.* Nicholas Bourne, London.

Wright, Lawrence

1962 *Warm and Snug: The History of the Bed.* Sutton Publishing, Gloucestershire.

