SHIPBOARD LIGHTING: A.D. 400-1900

A Thesis

by

KENDRA LEEANNE QUINN

Submitted to the Office of Graduate Studies of Texas A&M University in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

December 1999

Major Subject: Anthropology
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Approved as to style and content by:

Donny L. Hamilton
(Chair of Committee)

David G. Woodcock
(Member)

Frederick M. Hocker
(Member)

Vaughn M. Bryant Jr.
(Head of Department)

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ABSTRACT

Shipboard Lighting: A.D. 400-1900. (December 1999)

Kendra LeeAnne Quinn, B.A., Colorado State University

Chair of Advisory Committee: Dr. Donny L. Hamilton

From A.D. 400-1900, illumination was gained by simply lighting a fibrous wick soaked in a burnable fuel. Yet, this basic technology played an integral part in the every day functioning of ships. Vessels which either sailed through the night or conducted evening meals and prayers by lamp or candle light, typically traveled longer distances in fewer days than those which limited all activities to day-light hours. After 1500, ships became increasingly larger which also elevated the amount of illumination needed for work below decks even when the sun was shining.

An understanding of how illumination was used on ships would give a clearer picture of how ship-board life was conducted. This thesis will, therefore, bring relevant material about lighting on ships together in a comprehensive analysis. Three main areas of interest will be examined using information from the archaeological and historical records: 1) technological developments and lighting trends throughout the period, 2) locations and types of the implements used, and 3) how sun-light may have been directed into the hold to reduce the risk of fire. With these details, another portion of ship-board life will come, as they say, to light.
ACKNOWLEDGMENTS

As with any thesis, mine would have been a lesser work without the efforts of my committee members; Dr. Donny Hamilton, Dr. Frederick Hocker, and Dr. David Woodcock who unselfishly gave their time and wise counsel. I also would like to thank Dr. Kevin Crisman who helped create the topic and pointed me in the appropriate direction. Through numerous verbal and email conversations with Eric Emery, Erich Heinold, Tom Oertling, Kevin Robinson, Norman Thomas, a number of interesting details were revealed, especially on the topic of deck-lighting. A special thanks goes to Kevin Robinson who donated photographs of natural lighting devices from the Discovery to my cause and to Norm Thomas for his optical analysis on the hexagonal deck-prism. Finally, none of this would have been possible without the loving support of my husband, Zane Warton who coddled, comforted, encouraged, prodded and lectured me through the whole process.
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INTRODUCTION

The specific and integral technology of lighting was an important part of seafaring from A.D. 400-1900 since it provided an opportunity for sailing after the sun had set. Ships which sailed both in the daylight and into the evening hours were able to traverse lengthy distances in fewer days. Even if the captain decided to anchor for the evening, a number of extra hours of sailing could be gleaned out of each day if activities such as food preparation and consumption were conducted without sunlight.

Yet, how was this accomplished? What types of lighting implements were used? How did they change throughout time? Were only certain crew members allowed to use them? Which parts of the vessel were illuminated? Was lighting not only functional but a sign of social status such as in the ward room or captain’s cabin? How were particularly hazardous areas, such as the powder room, lit? An examination of lighting technology and its uses on ships would answer these questions and lead to a better understanding of everyday life on board seafaring vessels.

To date, no other written work has brought together the relevant historical and archaeological material on ship-board lighting in a comprehensive analysis. This thesis adds to the current body of maritime knowledge and fills an existing information gap. The data gathered will act as a reference work on the subject of life aboard seafaring vessels for future researchers.

This thesis follows the style and format of the Society of Historical Archaeology.
Thesis Objectives

Pertinent material on lighting and seafaring vessels from A.D. 400-1900 will be used to meet the following objectives: 1) to briefly trace the development of each type of open-flame illumination, 2) discover which types of lighting implements were found on ships, 3) learn where in the vessels the implements were likely to be used, and 4) discover what implications can be made towards the topic of ship-board life. First, the Introduction will state the importance, objectives, limits and sources of the thesis and give a quick synopses of ship-board lighting practices before A.D. 400. The information will then be presented in three main sections titled Lighting Technology from A.D. 400-1900, Lighting and Ships, and Natural Lighting on Ships (see below). Lastly, the Conclusion will summarize the findings and give a portrayal of how the implements discussed in the separate sections were used in tandem to provide illumination for an entire ship during a twenty-four hour period.

The first section, Lighting Technology from A.D. 400-1900, begins by exploring the advantages and disadvantages of using an open-flame for illumination. Then, the simple technologies of lamps, candles, and lanterns will each be outlined and briefly discussed to discern which implements were available and most commonly used. This information not only provides a better understanding of the devices used, but explores why a ship's owner or captain might have chosen one type over another.

Lighting and Ships, the second section, deals specifically with how, when and why lighting implements were used on wooden vessels and the issues they created. First, the strict lighting regulations enforced on military, merchant and passenger vessels alike
will be examined since any ship which used an open-flame implement for light had to deal with the fire hazard it created. Changes in lighting on ships from A.D. 400-1900 will then be broken up into three segments: 400-1500 in which vessels used the oil-lamp exclusively, 1500-1800 when candles and lanterns were popular, and 1800-1900 as new innovations began changing ship-board illumination. Finally, there were uses of lighting which were specific to ships including the illumination of the ship's compass and powder-room. Each topic will be discussed with examples from historical documents and artifactual evidence.

The third section, Natural Lighting on Ships, will address how sunlight was directed into the inner portions of the ship. Due to the risk of fire involved with using an open-flame, natural light was considered highly desirable. There were basically two types of devices which provided natural lighting: 1) openings through the sides of the hull in the form of gun-ports, portals, sashes and stern-lights, and 2) those through the deck, glazed and unglazed, such as gratings, sky-lights and deck-lights. The development of each type will be traced and illustrated with examples from the historical and archaeological record.

Limits of Thesis

For the sake of brevity, this thesis will concentrate on those devices used on deck or inside the hull to provide illumination for the officers, passengers and crew. Signaling devices, which also used open-flame illumination, will not be considered here. The history and development of the signal-light is extensive and deserves individual
consideration; this includes: 1) stern lamps or very large lanterns, in use as early as 700 B.C., placed at the stern of the vessel to show the location of each ship in a convoy at night, 2) cressets or large baskets filled with burning pitch and pine used for communication between ships and night fishing, and 3) running-lights or colored lights placed along the vessel’s side, developed late in the nineteenth-century, which indicated which direction the ship was traveling to other passing vessels.

There are several forms of lighting popular from 400-1900 which were rarely, if ever, used on ships. Some items, such as the gas-lamp, will be considered in the Lighting Technology from A.D. 400-1900 section. They are an important part of the lighting technology story, yet were not widely used on ships because of the risk of fire, high expense, and/or inconvenience of installation. A few of the others, including torches, splinters, and rush-lights, will be briefly discussed below to explain why they were avoided on ships. Finally, lighting devices used only by a particular sect of people, at special occasions, or in a certain region were also not pursued by this thesis (below).

The torch and the splinter were two of the earliest types of lighting devices. The torch ranged from a simple length of resinous wood to twists of rag and rope ends soaked in pitch or resin. The splinter was simply a dried strip of resinous wood placed in a three-pronged holder or a clip holder. Both of these spewed embers when lit which created a great enough fire hazard that they were deemed unusable on ships (O’Dea 1958:13,68-70 and Robins 1939:12-13).

Another early form of lighting, first used by the Ancient Egyptians, was a peeled and dried rush dipped a few times in rendered animal fat called a rush-light or taper.
Rushes were known through the nineteenth-century as “the poor man’s candle” since a bunch sold for a mere half-penny and would burn for eleven hours or more (White 1789:197-99). Yet, they also provided less light than most candles or lamps, required a higher degree of maintenance, and created an oily mess while burning (Forbes 1966:129, O’Dea 1958:7,20,46, Robins 1939:4,14, Thwing 1984:13-14 and White 1789:198). For these reasons, rush-lights were rarely used on seafaring vessels.

Some lighting types were only used by a select group of people or for special occasions. For example, floating-wick lamps, or deep, bowl like containers where the wick floated on the surface of the fuel, were often found in Byzantine churches or palaces. Yet, they were not common among the populous or on ships since they tended to produce more smoke, required a more maintenance than spouted lamps, and could be doused when jostled (O’Dea 1958:6). Similarly, candelabra, chandeliers and sconces, or candle holders placed on a wall mounting, were used in wealthy households, churches, theaters, and during social events to provide decoration as well as illumination. These were, however, not placed on ships until luxury liners began installing gas and electric versions in the dinning rooms of their larger steamers at the end of the nineteenth-century. Space on a wooden vessels was limited and superfluous devices were avoided.

Other types of illumination were limited to a particular region. One example was the open-pan lamp or a wick placed into a shallow pan filled with viscous tallow. This lamp was popular in the Swiss and German Alps from the seventeenth to eighteenth centuries, yet it was rarely used outside of that area or on ships (M. Watkins 1984:22).
Sources Used

The information on ship-board lighting utilized in this thesis was obtained by a thorough search of several available resources. Both historical and archaeological archives were examined in addition to a few on site observations and personal communications with knowledgeable people. The archive research uncovered four types of sources: 1) texts on the development of lighting technology, 2) historical documents, 3) reports from excavated shipwreck sites, and 4) publications which give information about certain types of ships.

The first type of text, utilized in the Lighting Technology from A.D. 400-1900 section, were general histories of technology or specific texts on the development of lighting which provided valuable background information. Examples of these texts include: *A Short History of Technology* (Derry and Williams 1960), *The Social History of Lighting* (O’Dea 1958), and *Lighting in the Americas: From Colonial Rush-lights to Victorian Chandeliers* (Cooke ed. 1984). Understanding which implements were available and the characteristics each type possessed aide in discerning why certain items may have been chosen over others.

A large number of the sources used were historical documents. Some gave additional information on lighting innovations such as *The Repertory of Arts, Manufactures, and Agriculture* (Pellatt 1807) which listed patent descriptions. Others listed equipment typically found on ships like *The Sea-mans Dictionary* by Sir H. Manwayring (1644). Finally, written accounts of the sailors themselves, such as *Two Years Before the Mast* by R. H. Dana Jr. (1840) or *A year on a Monitor and the*
*Destruction of Fort Sumter* by A. Hunter (1862-63, Edited 1987), provided first hand accounts of how certain areas of a ship were illuminated.

Perhaps the largest portion of information came from reports of wreck sites which mention an oil-lamp, candle or lantern among the non-cargo artifact list. The most useful were completed site reports published as one work such as *The Loss of the Verenigde Oostindische Compagnie Jacht Vergulde Draeck, Western Australia 1656*, edited by J. Green (1977) and *Yassi Ada: A Seventh-century Byzantine Shipwreck* edited by G. Bass and F. van Doorninck (1982). Archaeological conference source books and professional journals, like the *International Journal of Nautical Archaeology and Underwater Exploration*, also provided excellent accounts of wrecks with lighting devices. *National Geographic* and other popular publications occasionally offered pieces with pertinent information. Rarely, articles were found which described similar lighting devices from several wreck sites in a region, such as K. Vlierman’s (1994) “A Note on Deck-lights, -glasses or -prisms from 19th Century Wrecks in Flevoland, The Netherlands.” These reports and articles not only prove a certain lighting type was used on a ship, but also provide clues as to where it was employed or stored.

The final source type of information, class of ship publications, were based on intensive research through naval archives or first-hand examination of a working craft. Examples of class of ship publications include: *The Arming and Fitting of English Ships of War 1600-1815* by B. Lavery (1987), *The Seventy-four Gun Ship* series by J. Boudriot (1986) and *The American Fishing Schooners 1825-1935* by H. Chapelle (1973). These texts often describe the type and number of lighting devices found on a particular ship.
type and where they were stored.

Ship-Board Lighting Before A.D. 400

Lighting on ships did not simply appear in the year A.D. 400, but was a part of a well established seafaring tradition extending as far back as the Bronze Age. During this time, oil-lamps were the lighting implement of choice and were often used on ships as proven by the non-cargo lamps found on ancient wreck sites. After examining numerous site reports, it appears that when an artifact assemblage was well preserved, an oil-lamp was likely to be found. Sixteen such sites dating from 1316 B.C. to A.D. 300 are listed in Table 1. After a brief description of each lamp type found in the table, patterns which emerged from the data will be outlined including utilization of lamps on ships, the low number of non-cargo lamps compared to the great sums typical in oil-lamp cargos, and the lack of candle use in the ancient world.

Ancient Lamp Types

The following three lamp types were found on ancient shipwrecks: saucer, Greek and Roman terra-cotta. The saucer lamp was merely a shallow, wheel thrown bowl with a portion of the rim pinched to form a nozzle or an angled channel in which the wick would be laid (Figure A-1). Rarer varieties had two to four nozzles for multiple wicks. Since they were easy to make, allowed for minor wick control, and could be easily hung in a corner or placed on a flat surface, saucer lamps were widely used across the ancient world from the Early Bronze II period (2650-2350 B.C.) to the end of the sixth-century

In the fifth-century B.C., Greek ceramicists designed and mass produced a new type of wheel thrown lamp. First, a bridge was placed over the wick channel of the saucer lamp which created a tunnel or spout which allowed for better wick and flame control. Then, other modifications occurred; the wick tunnel was elongated until it formed a long tube, the reservoir was deepened and the reservoir rim was turned inward until only a minor opening was left for refilling the lamp. These changes not only helped keep the fuel warm and clean, but also reduced spillage. Often a handle was placed opposite the spout to make the lamp more portable and/or a base was added for stability (Figure A-2) (Bailey 1972:9,17, Forbes 1966:153, Sussman 1982:7, and Sussman 1985:48). A number of Greek lamps were made with a raised hole through the center so the lamp could be mounted on a pointed stick. This variation, however, seem to be rarely used on ships since few have been found on ancient wreck sites.

The lamps favored throughout the Mediterranean from the first- to the third-centuries A.D., were similar to their Greek ancestors. Roman lamp had a round, flat reservoir with a slightly concave top, a small fill hole and a short nozzle (Figure A-3). Instead of being made on a wheel; however, these lamps were mass produced by pressing soft terra-cotta clay into soft lime-stone, soap-stone, or plaster molds. Molding allowed highly detailed, relief decorations which ranged from gods and myths to scenes of daily life (Forbes 1966:153,157, Israeli and Avida 1988:16,24 and Sussman 1982:8).
Table 1
Ancient Shipwrecks with Non-Cargo Lamps
Organized by Date

<table>
<thead>
<tr>
<th>Wreck Name</th>
<th>Date</th>
<th>Wreck Location</th>
<th># - Type</th>
<th># Used</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Gelidonya</td>
<td>1200 B.C.</td>
<td>Turkey</td>
<td>1 - Saucer</td>
<td>0</td>
<td>Bass 1961:267-76</td>
</tr>
<tr>
<td>Cap d'Antibes</td>
<td>625-575 B.C.</td>
<td>France</td>
<td>1 - Saucer</td>
<td>1</td>
<td>Livadie 1967:320-22</td>
</tr>
<tr>
<td>Giglio Campese A</td>
<td>600-590 B.C.</td>
<td>Italy</td>
<td>3 - Greek</td>
<td>2</td>
<td>Bound 1985:28-29</td>
</tr>
<tr>
<td>Zakynthos</td>
<td>450 B.C.</td>
<td>Greece</td>
<td>1 - Greek</td>
<td>Unknown</td>
<td>Gibbion 1991:354</td>
</tr>
<tr>
<td>Ma'agan Mikhael</td>
<td>430-390 B.C.</td>
<td>Israel</td>
<td>4 - Saucer</td>
<td>3</td>
<td>Lyon 1993:85-89</td>
</tr>
<tr>
<td>Porticello</td>
<td>415-385 B.C.</td>
<td>Italy</td>
<td>2 - Greek</td>
<td>Unknown</td>
<td>Eiseman and Ridgway 1987:28-29</td>
</tr>
<tr>
<td>La Madonnina</td>
<td>400-300 B.C.</td>
<td>Italy</td>
<td>1 - Greek</td>
<td>Unknown</td>
<td>McCann 1972:185</td>
</tr>
<tr>
<td>Kyrenia</td>
<td>300 B.C.</td>
<td>Cyprus</td>
<td>1 - Greek</td>
<td>Unknown</td>
<td>M. Karzev 1974:69-72</td>
</tr>
<tr>
<td>Grand Conglouë A</td>
<td>225-215 B.C.</td>
<td>France</td>
<td>3 - Greek</td>
<td>1</td>
<td>Long 1987:11-12</td>
</tr>
<tr>
<td>Madrug de Gien</td>
<td>60-50 B.C.</td>
<td>France</td>
<td>10 - Roman</td>
<td>0</td>
<td>Tchernia et al. 1978:16,18</td>
</tr>
<tr>
<td>Titan</td>
<td>50 - 45 B.C.</td>
<td>Levant</td>
<td>2 - Roman</td>
<td>Not Stated</td>
<td>Tailliez 1958:186,188</td>
</tr>
<tr>
<td>Baie de Cavallere</td>
<td>A.D. 50-150</td>
<td>France</td>
<td>3 - Roman</td>
<td>Not Stated</td>
<td>Charrin et al. 1978:35</td>
</tr>
<tr>
<td>Dramont D</td>
<td>A.D. 40-50</td>
<td>France</td>
<td>3 - Roman</td>
<td>0</td>
<td>Joncheray 1974:24,28-30</td>
</tr>
<tr>
<td>Plexandria B</td>
<td>A.D. 200</td>
<td>Sicily</td>
<td>4 - Roman</td>
<td>Unknown</td>
<td>Gibbion 1989:23-34</td>
</tr>
</tbody>
</table>
Utilization of Lamps on Ships

A lamp recovered from a wreck site is determined to have been utilized if the spout or nozzle displays charring or is blackened or sooty colored. While charring is a definite indication of lamp use, it is often difficult to discern. A previously charred spout might be chipped or broken or the soot color may be obscured by black glazes or dark grey slips. According to K. Vitelli (1982:189), several other circumstances might also limit the amount of residue on a nozzle. First, a well maintained lamp or one with minimal clay porosity might have only minor initial blackening. Second, hundreds of years in a sandy sea bed might have removed certain slips and their accompanying char marks. Third, it is possible that the lamps were cleaned just before the ship sank. Yet, this last scenario is unlikely as carbon blackening is tenacious and difficult to remove.

Of the fifty-six lamps listed in Table 1, thirteen displayed a definite charred wick-channel or spout, nine showed no discoloration but were likely non-cargo items due to their location on the wreck, fourteen were lamps with non-discernable spouts due to glaze color, breakage, or utilization was not discussed in the source text, and twenty were possible cargo lamps from the Uluburun and the Madrag de Giens wrecks (see below). Unfortunately, this leaves only twenty-two lamps, thirteen with charring and nine non-cargo lamps without, with which statistical data can be formed. With this small of a test group and all of the unknowns listed above, listing a percentage of utilized lamps vs. non-utilized lamps would be meaningless. While charred spouts are great indications of lamp use on ships, the location of the lamps and the number of lamps recovered should also be considered.
Although archaeologists are certain that oil-lamps were a part of an ancient ship’s equipment, when and how they were used on board remains speculative. Lamps were probably used in the living areas such as the galley or in one of the areas that housed the crew. Since a hanging lamp provided light over an extended area and prevented fuel spills as the ship rocked back and forth, an oil-lamp was likely placed in a dangling net or the wood and rope hangers used on land at the time. If such holders were used, however, they would not have survived the site formation process since they were made of organic materials and placed high in the hull where items quickly deteriorated.

One clue of how ancient crewmen used illumination comes from a curious lack of lanterns in the maritime archaeological record. While evidence exists of ceramic and metal lanterns on land, to the best of my knowledge, there is currently no evidence of them on ship-wreck sites. Oil-lamps were, therefore, more often used inside the vessel where the flame was protected from gusts of wind than on a breezy deck.

*Average Non-Cargo Lamp Counts vs. Large Lamp Cargos*

The number of non-cargo lamps recovered from a wreck site tends to be quite small (Gibbons 1989:19). Fourteen of the sixteen wrecks on Table 1 produced one to four lamps with an average of 2.1 per site. This limited number was probably all that was needed to illuminate ancient ships such as the Kyrenia wreck which had an estimated over-all length of 15 m or the Porticello wreck that was approximately 16.6 m long. Each only needed a handful of crewmen on board and a few lamps to illuminate evening activities (Eiseman and Ridgway 1987:13 and Steffy 1994:43).
Two sites on the table, the Uluburun wreck (1316-1318 B.C.) and the Madrag de Giens wreck (60-50 B.C.), had more than four lamps in the artifact assemblages. The Bronze Age wreck found off the coast of Uluburun, Turkey produced sixteen Syrian saucer lamps which can be divided into two types. Six had pronounced, pinched and blackened rims (Figure A-1) which indicate they were used by the crew. Yet, all six were not necessarily in use at once. A few may have been stored away until another lamp broke or perhaps were saved for special occasions such as votive ceremonies. The other ten saucer lamps had shorter wick-channels and displayed no signs of utilization. These were probably a part of the cargo since most were found inside a ceramic pithoi, or a man sized storage vessel, with other cargo ceramics (Bass 1986:281-82 and Pulak 1994:27).

The Madrag de Giens wreck also produced more than four lamps with ten Roman terra-cotta lamps recovered throughout the stern area. Not one of these displayed any clear evidence for utilization and were possibly a small tag-along cargo or placed on the ship as a small addition to the regular cargo (Tchernia et al 1978:16,18). Yet, these devices also could have been a part of the ship’s stores or owned by individual crewmen since the lamps were found in the stern where the stores and crewmen’s personal items were traditionally kept and ten lamps was a small sum for a cargo.

In contrast to the small number of non-cargo lamps recovered from ancient wrecks, great numbers of lamps have been found on sites where oil-lamps were definitely a cargo item (Gibbins 1989:20). Examples include such sites as the Luque B wreck (A.D. first-century) which produced over 250 Roman styled lamps, and the Grand Bassin C wreck (A.D. 120) with its cargo of over 2,300 lamps (Liou 1973:583 and Sabriè and
Sabrië 1981:94-113). According to W. Harris (1980:135), a single cart or two pack animals, could transport approximately 1,000 pottery lamps over land. Extending this estimation towards a ship’s cargo hold, D. Gibbins (1989:23) states “even a large batch of 4,000 lamps would occupy relatively little hold space in an average merchant ship, and could have been laden along side or among a dominant amphora cargo.” Most tag-along lamp cargo counts would have reached into the hundreds.

Lack of Candle Use on Ancient Ships

With the exception of the Early Egyptian conical, pressed wax candles used by priests, the candle was not known in the ancient world until the Romans began using them throughout their Empire in pagan ceremonies. Roman citizens, however, considered the candle an inferior light source and rarely used them outside of the rituals (O’Dea 1958:33). This sentiment was carried onto seafaring vessels. Among the artifact assemblages of the Roman wrecks I examined and in A. Parker’s (1992:522) more extensive research in Ancient Shipwrecks of the Mediterranean and the Roman Provinces not one candle holder was recovered. Ancient ship-board illumination was provided exclusively by the oil-lamp.
LIGHTING TECHNOLOGY FROM A.D. 400-1900

Households from A.D. 400-1900 were typically lit by open-flame illumination or when a wick was placed into a combustible fuel and one end was lit. This term includes lamps lit with oil or gas, candles made of wax or tallow, and holders such as lanterns. Each had its own history of development which will be discussed in detail below. First, however, a look at the similarities between these systems will provide an introduction to the characteristics of open-flame illuminants.

Lamps and candles were similar in three respects: 1) they produced roughly the same amount of light, 2) created a fire hazard and, 3) the frequency of their use was often determined by economics. A single wax candle or a single spout lamp burning olive-oil would each produce approximately one candela or one candle-power of illumination (Robins 1939:20). In terms of lumen, or the amount of light from a single candela source onto a square foot/30.5 cm² surface one foot/30.5 cm away, one flame emitted 12.57 lumen. In comparison, a new 60 Watt electric light bulb gives off 830 lumen or the equivalent brightness of 66 candles.

A single flame seems like a pitiful amount of illumination to those accustomed to extra bright modern standards. The human eye, however, is remarkably adaptable to a wide range of light intensities. Intensity of light is measured in either the foot-candle (fc) which is equivalent to one lumen, or in the metric form of the lux defined as the amount of light from a source of one candela on a square meter surface placed one meter away; where 1 fc = 10.76 lux. A person’s eye can adjust from the mere 0.01 fc or 0.11 lux it takes to find a safe route along a dark road, to the 12.57 fc or 129.12 lux a candle would
produce in a room, to the 10,000 fc or 107,600 lux found in an open park on a sunny day in June (Forbes 1966:124-25). With this adaptability, a single open-flame would have provided plenty of light for late night travelers or for evening activities in the home as long as the source of illumination was kept close by.

Another common factor among lamps and candles was the fire hazard each created. In the Mechanic’s Magazine of London, W. Baddeley (1847:340-50) reports a total of 776 non-arson fires with known causes in 1846 London. Of those, 274 or 35% were attributed to candles and lamps igniting bedding, window curtains, saw dust, spilled oil, etc. This was four percent more than the next two largest hazards combined; with faulty flues responsible for 126 or 16% and hearths/wood stoves spewing sparks or embers causing 113 or 15%.

Once started, especially in large cities made mostly of dry wood, a fire could burn for days destroying anything in its path. London historically gives poignant examples of ravaging fires. Between A.D. 1086 and 1135 the greater part of the city was consumed by fire three times (B. W. 1666). The greatest fire began on September 2, 1666 and raged for three days. When it was done the damage covered 350 of the city’s 460 acres with 12,000 houses, 87 churches, seven chapels, the Cathedral of St. Paul, the Exchange, the Guild Hall and the Custom House destroyed (Flagellum Dei 1668:10).

Cities in the U.S. had similar problems. Residents of Chicago, Illinois in 1871 used to joke that there was a fire every Monday and Thursday. Fires were such a regular occurrence that when one began on October 8, after a cow reportedly knocked over a kerosene lantern in the barn of Patrick and Catherine O’Leary, it caused little alarm.
Several citizens decided to walk on by and let the fire department quench the blaze.
Twenty-four hours later, 300 people were killed, 18,000 buildings were leveled, 1,687 acres were destroyed, and a third of the cities 300,000 inhabitants were left homeless (Sawislak 1995:1).

The final similarity all types of open-flame illumination shared was that economics played a large part in determining how frequently they were used. The type of economic system practiced in a region often encouraged the use of either the candle or the lamp. For example, an agricultural community with easy access to vegetable oils would be more likely to use oil-lamps while pastoral societies would find tallow candles made from sheep or cattle fat the less expensive source (Forbes 1966:125). Another economic factor was that lighting fuels were also sources of food. During periods of high economic hardship, vegetable oils and animal fats were more likely to be consumed or used for cooking than burned for light. Poorer families would regularly go without lighting in the evenings, especially during the long days of summer (White 1789:199). Even in the early 1800's, the Elder Brethren of Trinity House were concerned about light-house keepers who habitually ate some of the tallow candles provided in order to supplement their meager rations (Forbes 1966:125 and O’Dea 1958:3,222).

Lamps

Utilization of the lamp slowly changed through time. Similar to the eras before A.D. 400, oil-lamps continued to be the most common form of lighting throughout the Byzantine Era. Then, between A.D. 900 and 1200, the candle became popular and the
lamp began to take a secondary role in illumination. Yet, traditional slanted-wick lamps, where the wick laid in an angled wick channel or spout, continued to be used in homes across Europe and the Americas well into the 1800's.

It was not until the late 1770's that a new form of lamp arose, the upright-wick lamp where the wick was held vertically in a separate burner which allowed a completely sealable reservoir. This in turn led to other bright alternatives such as Argand’s lamp and new fuels including distilled coal gas. Gas soon became the lighting preference on land until the introduction of the electrical filament which marked the beginning of the end of open-flame illumination. Each type of lamp will be briefly discussed below with special attention given to those forms most likely to be found on wooden sailing vessels.

Slanted-Wick Oil-Lamps

Slanted-wick lamps, such as the Byzantine lamp, wheel thrown lamps, crusies, bettys, spout lamps, and peg lamps, were easy to produce and provided an efficient means of illumination. In an experiment conducted by W. O’Dea (1958:32), a single spouted lamp, with 20 fluid ounces (560 ml) of oil and an average sized wick, burned for thirty seven hours with the brightest possible flame and fifty hours with a less bright flame. This simple form of illumination, however, required maintenance. First, if the wick was allowed to burn down to the fuel line, the flame would extinguish and cause unwanted smoke. It was necessary to pick the wick or periodically pull it above the surface of the oil with a piece of wire, sharp thorn, stick, or small pair of tweezers sometimes attached to the lamp by a thin chain. Second, to ensure the flame would
remain as bright as possible, the charred end of the wick would occasionally need to be clipped off and discarded. A third problem was that many slanted-wick lamps made an oily mess. Since the burning end of the wick was placed immediately off the edge of the nozzle or spout, unconsumed oil would drip from the wick onto the table or surface the lamp was sitting on (Forbes 1966:155, O'Dea 1958:3,5,40 and Sussman 1982:1). To eliminate this problem, an internal wick support, such as a tube cut length-wise or a z-shaped piece, was often placed inside the nozzle which allowed the flame to burn freely while oil drips ran back into the reservoir (Figure A-4).

An oil-lamp wick was simply a twisted length of material fibrous enough to soak up fuel. It could have been made of flax, wool, hemp, asbestos, oakum, mullein, linen, castor plant, reed, or even papyrus (Bailey 1972:10 and Forbes 1966:126,156). Cotton was the favored material from the seventeenth to early nineteenth centuries, including twists of rags or yarn (M. Watkins 1984:19). While the type of wick used did not make a difference in oil consumption or flame brightness, thickness was an important factor. In an experiment conducted by D. Bailey (1972:10), a small caliber linen wick burned one fluid ounce (28 ml) of olive-oil in about three hours while a fat wick consumed the same amount of oil in half the time without an appreciable gain in light.

It was not until the eighteenth-century that developments in wicks would further improve the amount of light available from oil-lamps. The flat-ribbon wick, or cotton fibers woven into a flat, long strand, was available by 1773. As more fuel was consumed when using this wide wick, a larger and brighter flame was produced (O'Dea 1958:50). In 1825, cotton threads were woven into a solid cylindrical pattern, called a plafted wick,
which aerated the flame and minimized wick clipping. By this time, however, the gas mantle had revolutionized illumination and oil-lamps were only used in rural areas.

Fuel for a slanted-wick lamp could be as variable as the wick since any fatty liquid would do. Fish-oil, one of the earliest lamp fuels, was generally considered undesirable since it created a poor light, large amounts of smoke, and a disagreeable smell (Woodside 1984:17). Tallow was occasionally used in lamps, yet to remain viscous enough to be absorbed by the wick it needed to be constantly heated. The most widely used fuels were oils from vegetable sources including: olive, linseed, radish, castor berry, sesame seed, and various nuts. Of these, olive-oil was recommended since it burned bright and was nearly smokeless (Bailey 1972:10 and Forbes 1966:126,156).

From the later portions of the Medieval Period to the last half of the nineteenth-century, whale-oil was considered the best fuel for lamps. A single wick in oil from a Sperm Whale reportedly burned with the brightness of two tallow candles and could last 12-15 hours without trimming. Unfortunately, it was also very expensive and the more traditional fuel types continued to be used for daily purposes until other alternatives were found (Derry and Williams 1960:689, O’Dea 1958:87 and Woodside 1984:17).

Byzantine Molded and Wheel-Made Lamps

During the Byzantine Era, fourth to tenth centuries A.D., two types of oil-lamps were available; the molded lamp and wheel thrown varieties. Byzantine terra-cotta lamps were molded, had a pear-shaped body, a wide fill hole, a short nozzle which appeared to be a continuation of the body, and an occasional round base (Figure A-5).
Unlike earlier Roman versions, decorations tended to be simple consisting of floral, faunal and geometric designs, or, more rarely, Jewish, Christian or Samaritan symbols (Israeli and Avida 1988:144, Sussman 1982:10 and Sussman 1985:49).

Wheel-thrown ceramic lamps were re-introduced by Byzantine craftsmen sometime in the fifth-century. They had a wide body with high sloping walls, a tube extending from low on the body, and a large loop handle placed opposite the tube (Figure A-6). The only decoration placed on these lamps was an occasional ribbed body and/or whatever glaze the manufacturer brushed on. As the centuries passed, lamps made on the wheel became more popular until the Late Medieval Period when they fully supplanted molded varieties (Israeli and Avida 1988:12,177).

The Saucer Lamp

Sometime during fifteenth-century, ceramic lamps once again began to be made saucer shaped with the rim pinched for a nozzle or smaller variations of those used from the Bronze Age to the fifth-century B.C. (Israeli and Avida 1988:12). Often, the pinched saucer was placed on a tall cylinder in the center of a rimmed dish with a loop handle (Figure A-7). This combination produced a portable lamp whose flame was always above the work space, while the dish caught the oil drips. Other saucer lamps were hung with wire hangers looped through holes, or nubs with holes, on the sides of the lamp to provide convenient, overhead lighting (Taux 1984:30-31 and L. Watkins 1984:27-29).

The ceramic saucer was frequently replaced by more sturdy iron variations from the 1600's through the 1800's. The iron crusie, often called a slot lamp, had a shallow
dish type of reservoir with a nozzle or slot at one end and a hook on the other for hanging purposes (Figure A-8). Although single nozzle crusies were most common, several were made with as many as four slots. This practical lamp was employed throughout Western Europe and Colonial America, and the Basque used it exclusively until the advent of kerosene. A crusie cousin was the double crusie or phoebe lamp. In addition to the original reservoir, a second slightly larger reservoir was attached under the first to catch oil drips (M. Watkins 1984:19-20 and Woodside 1984:16-17).

Bettys and Spout Lamps

Another type of metal reservoir lamp, the Betty, was used from the fifteenth to the late nineteenth centuries in Eastern Europe, Italy, Germany, France, Belgium and the Americas. This lamp was similar in shape to ones used by the ancient Greeks. The reservoir was shallow and made of iron, brass, tin, copper or pewter. A short tube or half-tube was connected at an angle to the base to act as a wick support and a swinging wire handle was attached in the center (Figure A-9). While many of the Betty lamps were open, several had lids to keep the fuel clean and warm (M. Watkins 1984:20-22).

Extend the tube of the Betty and deepen the reservoir, and you have the spout lamp or a metal version of the Byzantine wheel-made lamp (Figure A-10). Brass spout lamps were extremely popular with the Dutch during the 1600's, while tin varieties were widely used in America after 1750. Lamps with multiple spouts were often used in pre-industrial revolution factories and, reportedly, on ships where they were referred to as hanging lamps (Hayward 1923:48, M. Watkins 1984:22-23 and Woodside 1984:18).
Unfortunately, I have found no archaeological evidence to suggest spouted lamps were used on seafaring vessels.

Peg Lamps

One variation of the slanted-wick lamp in use during the eighteenth and nineteenth centuries was the peg lamp (lampion to the French) or a cross between a candle and a lamp. The reservoirs were made of tin, brass or pewter and had a hinged lid, one to four spouts, and a handle on one side. The lamp was then mounted on a tubular piece or peg so it could be placed into the socket of a candle holder or inside a lantern base (Figure A-11). After the 1780's, peg lamps were often made with upright-wick burners (see below) which limited spills (Boudriot 1988:124-25, Hayward 1984:38, M. Watkins 1984:48 and Woodside 1984:50).

Upright-Wick Lamps

A new type of lamp came into use after the 1770's which used a burner that held the wick vertical or upright instead of at a slant. The earliest upright-wick lamps used cork-burners or one to three thin, tin tubes inserted through holes drilled into two metal discs with a cork stopper in between (Figure A-12). A wick was then threaded through each tube, and the burner was placed into a reservoir's fill hole. This created a nearly sealable oil-lamp which not only limited spillage and eliminated fuel drips, but also aided in flame control. Slots were often added to the tops of the tin tubes to more easily raise a burned wick-end. The only problem with the design was that the cork quickly
deteriorated since it was constantly removed and replaced during reservoir fillings (Woodside 1984:49-50).

A more sturdy burner using screw-threaded collars was patented by John Miles in 1787. One collar was soldered onto the outside of an all metal burner, while the other accompanying collar was cemented or soldered onto the inner rim of a reservoir. This allowed the burner to be securely screwed onto the reservoir opening which created the first air tight oil-lamp (Woodside 1984:51). Threaded burners kept the fuel warm and prevented spillage even if the lamp was overturned. Soon Miles' Patent Lamps and imitators marketed as "Agitable Lamps" became widely adopted. These lamps, however, were more commonly known as Whale-Oil Lamps since that was the fuel most preferred to use in them (M. Watkins 1984:47,51).

*Other New Innovations*

The upright-wick lamp was only the beginning of new lamp improvements. In 1783, Ami Argand created a hollow centered, cylindrical wick which delivered more fuel and air to the flame creating a brighter light. Argand then placed this wick into a new lamp complete with a cork-burner, a side mounted reservoir, gravity feed fuel tubes, a wick lifting mechanism, and a glass chimney. The resulting flame burned as bright as ten tallow candles and it soon became the standard by which all other light sources were compared. While Argand's lamps were popular among the wealthy, poorer families and ship owners were not inclined to use them since they were expensive and had a high rate of fuel consumption. A regular flame was usually sufficient to
complete any home or ship-board task (O'Dea 1958:50,55 and Shadel 1984:60).

New fuels intended to provide a bright yet inexpensive alternative to whale-oil were also developed. One example was developed by John Porter of Boston in 1834 as a mixture of alcohol, purified oil of turpentine, and quick lime. Porter’s mixture and similar fluids burned white, bright, odorless, and smokeless; but they were also extremely explosive. In an attempt to counteract this hazard fluid-burners or safety-burners were created. These were upright-wick burners set into screw-threads with thinner, longer wick tubes set at an angle to keep the flame from traveling down the tube and igniting the fluid. Unfortunately, safety-burners were not very safe. By 1850, several fire insurance companies had policy clauses which forbade the use of the burners unless a special permit was granted and additional fees were paid (Shadel 1984:60,63 and Woodside 1984:52-53). Due to the danger these fuels posed, they were universally avoided on ships. To date, no fluid-burner has been recovered from a wreck site.

*Gas-Lamps*

More practical fuels for lamps were gases derived from coal and crude-oil. William Murdock first introduced lamps lit with gas distilled from coal in 1792. He then worked to develop an appropriate gas-lamp for commercial use by 1805 which used the cockspur-burner or a metal tube with three holes at the end. Initially, gas-lamps were only used to light city streets and factories. Gas systems, however, were installed in most urban households by 1860 in Europe and after the Civil War in America (Derry and Williams 1960:508, Luckiesh 1920:55, O'Dea 1958:23 and Yarwood 1990:914).
A few improvements made the gas-lamp even more popular for use in the home.

In 1810 Samuel Clegg found a way to remove impurities in Murdock's fuel by adding lime to the water the gas passed through during instillation (Derry and Williams 1960:508, 510). Better gas-burners were invented in 1858 by William Sugg and in 1885 by C. A. Welsbach. Each burner was more corrosive resistant and caused less smoke than their predecessors (Derry and Williams 1960:513 and O'Dea 1958:22,55). In 1856, a second gas type, distilled from petroleum or shale-oil, was developed by Abraham Gesner called kerosene (Greek for wax) or paraffin. Kerosene was clean, safe, easy to manage, odorless, of modest expense, and was quickly adopted as a fuel alternative (Derry and Williams 1960:517 and O'Dea 1958:23).

**Introduction of the Electrical Filament**

Electrical lamps with carbon filaments were first made into practical lighting devices by Sir Joseph Swan in 1878 and soon after by Thomas Edison in 1879 (O'Dea 1958:23). These lamps were reliable, greatly reduced the hazard of fire, were maintenance free, and created no smell or smoke. Electrical power stations were in place as early as 1881, yet businesses and households continued using gas lighting through the early 1900's for several reasons. First, gas was the less expensive alternative until power plants became more numerous. Second, the expense of changing from gas lines to electric wiring was high. Finally, gas lights typically gave off enough heat to warm a cool room (O'Dea 1958:25,62).

In spite of these advantages, electric companies managed to steadily build a
customer base. The Pearl Street Power Plant had a mere 203 customers with 3,144 lamps in 1882, yet, twenty-six years later in 1908, the company had grown to 70,000 customers with 3 ½ million filament lamps and 54,000 arc lamps for street lighting. With the gradual accumulation of power plants, electric lighting became as inexpensive as it was useful and ascended as the undisputed king of illumination by the 1920's (Derry and Williams 1960:634 and O'Dea 1958:25).

Candles

Through the Byzantine period, the Roman tradition of using candles only for religious purposes continued. This link between ceremony and the candle was even incorporated into the Early Christian Church. During the fourth and fifth centuries, candles were depicted on tombs and altars and were listed in several Church accounts. Candles soon became an established part of many Christian ceremonies. The great Paschal candles, used at Easter, were introduced in the early portion of the fourth-century. In 542, Justinian established Candlemas throughout the Eastern Mediterranean. Soon after, the Roman Catholic Church in Western Europe re-named the ceremony the Purification of the Blessed Virgin and began using it as a replacement for the festival of Hypopante (Forbes 1966:140-41, O'Dea 1958:33,141-42 and Robins 1939:22).

Candles became a regular part of Roman Catholic practice as they began to be placed on altars during the tenth-century. The altar candle was so popular that Papal Bulls were created in the thirteenth-century to regulate their composition. A church candle could not be made out of any amount of animal fat. In addition, those used on the
High Altar were required to have 65-75% bee’s-wax, while lesser altars needed a minimum of 25% bee’s-wax. The candles thus became a church symbol with the wax representing the virgin body of Christ and the flame the divine light of the Lord (Forbes 1966:141, O’Dea 1958:141-42 and Robins 1939:22).

Candle use appears to have spread from churches to public buildings and households between A.D. 800-1200 (Forbes 1966:141 and Taylor and Singer 1956:370). During this time, they increasingly appear in tax documents and in several Medieval laws. The ceremony for excommunication included the snuffing of a candle. Those who were to pay for their crime with their lives were to carry a lit candle through the streets of town to their execution as a symbol of their lost soul. As early as the ninth-century, the candle was introduced as a means to measure time. During auctions of seized pirate ships or cargos, decayed vessels and old naval provisions, items were “sold by the candle” or to the highest bidder before a candle burned down to a certain level. Candle use was certainly well established by the end of thirteenth-century as France, then England, certified two guilds; one for wax chandlers and another for those who dipped tallow (Forbes 1966:141-42, O’Dea 1958:20, Robins 1939:18 and Tanner 1923:452).

Why did the candle become a popular illumination source after centuries of being known as the less desirable light? Technological advances were not responsible since the first innovation in candle production did not appear until the fourteenth-century when molding techniques were developed (Forbes 1966:138 and O’Dea 1958:39). Economics may have partially attributed to a candle emergence as animal husbandry was increasingly important in certain European communities making tallow more available.
Wax candle supplies, however, did not increase until 1484 when costs were lowered by a Royal decree (Robins 1939:18). Perhaps the popularity of the candle was linked to the growth of the Christian Church. Since the candle was used in ceremonies and symbolized Christian beliefs, as the Church grew in power and influence so did the approval of the candle. Whatever spurred its acceptance, candles were widely used from 1200 through the late 1800's.

Wicks

A candle wick could have been almost any twisted, fibrous material. The Romans, and probably the Byzantines, used the pith of a rush, strands of twisted flax or certain types of papyrus. These were often impregnated with sulphur for cleaner burning (Forbes 1966:139 and Pliny Natural History XVI.70 and XXIII.4). From the Middle Ages through 1820, wicks were typically made of twists of cotton or hemp cloth (O'Dea 1958:33 and Woodside 1984:16).

The problem with any of these wicks was that each needed to be constantly tended. As a candle burned, the wick-end was charred yet not completely consumed. The end would often bend or fall into the rest of the candle and cause guttering or the premature melting of the tallow/wax accompanied by large amounts of smoke and a great reduction in light. To prevent this, it was necessary to snuff the wick or clip off the burned end and remove it (Forbes 1966:134 and O'Dea 1958:343).

Snuffing was usually accomplished with a snuffer or a hand held, scissor implement with a small box attached to one blade (Figure A-13). While the candle was
still burning, the burned wick-end was cut off and dropped into the box where it could do the candle no harm. This may sound like a simple procedure, yet the flame was commonly doused instead of brightened. Today, the term “snuff out” means “to extinguish,” yet few know it refers to a mistake made while tending a candle (Hayward 1923:95). How often snuffing was required depended on what type of candle was being used. The poorer varieties of tallow were tended every 5-10 minutes, while good tallow candles called for snuffing every 20-30 minutes, and wax varieties could be left for one to two hours before the wick-end needed to be clipped (O’Dea 1958:3,43).

_Tallow Candles_

Tallow was produced by rendering or repeatedly melting down and straining fat from sheep, cattle, pigs or even bears to remove excess protein matter. Candles made from mutton drippings were greatly favored as sheep fat produced a hard, white tallow. Rendered beef fat, however, made an inferior commodity that was soft and off-colored. There were four disadvantages to using a candle made from any type of tallow: 1) it produced a less brilliant flame than wax, 2) required a higher degree of maintenance, 3) would often melt in warmer weather and climates before they could be used, and 4) smelled like rotten meat if the fat was improperly processed. In spite of the problems, tallow candles were used on a daily basis by all sects of the population since they were widely available and priced considerably less on the market than wax varieties. Even the poorest families were able to produce light from ordinary kitchen grease any time of the year (Forbes 1966:135, O’Dea 1958:3,19-20,213 and Robins 1939:17).
Most tallow candles were made by dipping or drawing a wick repeatedly through viscous tallow. Wicks were looped over a tapered stick or held in sets of four in the hand, then lowered into a vat of melted tallow and pulled back out. After the first layer had dried, the procedure was repeated, and repeated again until the tallow was 3/4 to 1 inch (1.9-2.5 cm) in diameter (Cooke 1984:137 and Forbes 1966:138).

Another form of tallow candle production, developed in the fourteenth-century, was molding or the pouring hot tallow into a ceramic, copper or tin tube tapered to a rounded point with a wick suspended in the center (Figure A-14). Although molding produced a more standardized candle, it was only a secondary means of production until late in the nineteenth-century due to higher manufacturing costs. First, there were lengthy cooling and seasoning times. Second, only the best tallow could be used in molds as inferior tallow or wax stuck to the walls of the tubes which created a damaged product (Cooke 1984:137-38, Forbes 1966:138, Hayward 1984:38 and O’Dea 1958:39).

Wax Candles

Due to the higher melting point of wax, candles made of the substance were far superior to those made of even the best tallow. First, wax burned brighter. A candle made from bee’s-wax gave off fifteen to twenty percent more light than a good tallow candle of similar size. Second, wax candles lasted longer. Ninth-century time keeping candles weighing 2/5 oz. (11.34 grams) burned for about four hours, while a half-penny tallow candle, which was slightly larger, would last only two to three hours. Finally, wax required less snuffing (O’Dea 1958:217,219, White 1789:198 and Woodside
1984:17). Unfortunately, wax candles were typically three to four times the price of rendered fat varieties. The Church used wax candles only on altars, the rich saved them for social gatherings and holidays, and poorer families purchased them only for rare occasions such as weddings (O’Dea 1958:19,216 and Richardson 1984:84).

Wax candles were produced by pouring or dribbling molten wax over a wick to gradually build up the body. Multiple wick holders, such as ten to twenty wick hooks on a revolving wheel, and other techniques allowed a candle maker to pour more than one candle at a setting. While pouring is a simple idea, a good wax Chandler needed to develop the skill of matching of wicks or ensuring the correct size wick was used for the desired candle size (Forbes 1966:138-39, O’Dea 1958:6,39 and Robins 1939:22).

There were several sources for wax. The most popular wax type through the 1830's was extracted from honey-bee combs by repeatedly melting the combs in water and straining the remains. During this process, salt or soda could be added to whiten or yellow the wax respectively (Forbes 1966:135-36 and Pliny Natural History XXI.49).

Other waxes had vegetable origins. In Colonial America, berries were collected off the bayberry bush, boiled in water, then strained through a cloth bag into another kettle of hot water. As the second kettle of water cooled, a film of wax consolidated on the surface which was then collected and later poured into spicy scented candles. Bayberry wax was often mixed with tallow to create a cheap, yet durable, candle to be used during hot summer months (O’Dea 1958:218 and Robins 1939:22). Other plants which yielded wax were Coconut Palms, the West African Palm, and the Lisoea Tree found in the Punjab, Himalaya and Java regions which produced up to 500 candles per

From 1700 to the 1830's, spermaceti, or a substance skimmed from the top of cooled oil from the Sperm Whale, made the best quality of candles. Spermaceti candles cost nearly twice that of other wax varieties, but burned approximately fifteen percent brighter and needed less maintenance. While candles made with one hundred percent spermaceti were used to set the standard of the candle-power, most were made with a small percentage of bee’s-wax to keep the substance from crystallizing (Derry and Williams 1960:689, Matthews 1958:56, O'Dea 1958:219 and Robins 1939:20).

Improvements in Candles

Between 1801 and 1861, several improvements in molding techniques, wick production and wax consistency greatly improved the candle. First, innovations in the art of molding led to lower production costs. In 1801, Thomas Binns developed a water-cooled mold which hardened tallow more quickly and shortened manufacture time. Then, in 1823, Joseph Morgan created a machine with movable pistons that ejected the finished candles (O'Dea 1958:54). Later designs, available by 1834, also used a system for continuous wicking which produced 80-500 candles per hour (Forbes 1966:139). A final mold machine improvement appeared in 1861 when J. Fields developed a device that tapered candle bases so they would fit into almost any socket holder without shaving (O'Dea 1958:55).

During the same period, changes in wicks greatly reduced the need for candle maintenance. In 1825, a Frenchman named Cambacéres invented the plaited cotton wick
or several woven cotton fibers with one thread pulled tighter than the others. This wick twisted while it burned which kept the tip in the hot, outer portion of the flame where it was nearly incinerated instead of simply charred (Forbes 1966:138, O’Dea 1958:54, Richardson 1984:84 and Woodhead et. al. 1982:7). M. De Milly eliminated the guttering problem entirely in 1831 by impregnating the plafted wick with boric acid which raised the flame temperature and aided in full consumption of the wick-end (O’Dea 1958:54).

The largest contributions to the candle came in form of new types of waxes. In 1823, M. Chevreul and J. Gay-Lussac, discovered a method of producing stearin, also called stearic acid, or fatty acids separated from animal fat. Soon, the pair had patented the composite candle, a mixture of stearin and tallow. This mixture produced an inexpensive, molded candle that burned like bee’s-wax (Forbes 1966:138-39). Snuffless, composite candles were introduced in 1835 by Price’s Patent Candle Company when they created a candle with equal parts of stearic acid, hard fat from coconut-oil and De Milly’s plafted wick impregnated with boric acid (Forbes 1966:135 and O’Dea 1958:216). By 1857, candles made from paraffin, a petroleum product, were developed and placed on the London Market. These affordable, high quality candles burned approximately twenty percent brighter than spermaceti and could be used in the new molding machines. Paraffin candles soon replaced all other varieties (Forbes 1966:139).

*Candle Holders*

Irrespective of the candle type used, a holder was required. Since the introduction of the candle there were two types of holders: 1) the socket holder or a
small cup fixture placed onto a drip-pan or the top of a stem into which the bottom of a candle was inserted (Figure A-15), and 2) the pricket or an iron spike welded vertically on a plate like base or drip-pan onto which the candle was impaled (Figure A-16). The socket variety was favored by the Romans and the Byzantines. Then, during the Early Medieval Period, pricket designs were used almost exclusively. It was the Persians who began to use the socket type again in the thirteenth-century and are likely responsible for its re-introduction into Europe through Venetian merchants during the fourteenth-century. Socket and pricket were then used side by side until the first half of the seventeenth-century when prickets again became rare (Forbes 1966:133, O'Dea 1958:38, Richardson 1984:83 and Robins 1939:25,27).

The pricket holder may have been the more versatile of the two types since a tallow or bee’s-wax candle of any size was easily pushed onto the spike. Handles or projecting arms were often attached to the holder for portability and hanging purposes. Other differences were merely stylistic. In the twelfth-century, candlesticks were commonly in the form of animals. Designs from the thirteenth-century imitated Gothic Architecture and were tall and graceful. Enameled variations were then popular from 1300-1500 (Forbes 1966:133, O'Dea 1958:38 and Robins 1939:28).

Until candle bases were standardized in 1861, socket holders required the user to manually reduce or build up the base of a candle before it was inserted. This was not typically an arduous task since candles and sockets could both be produced close to a desired size. Dipped and poured candles in England usually sold eight-to-the-pound (113.4 gm per candle) making a general sized candle available to English consumers
(O’Dea 1958:38-39 and Robins 1939:27-29). Measurements of the socket diameter of six candle sticks; five from the English colony of Port Royal, Jamaica (1692) and one from the English warship the Maidstone (1747), range from 2.0 cm to 2.4 cm (De Maisonneuve 1992:25-26 and pers. observation). This small variation infers that shaving down or building up a candle could be accomplished in a short amount of time.

From the thirteenth to the beginning of the seventeenth-century, socket holders went through numerous style variations including: 1) the Persian trumpet-mouthed base with a drip pan, stem and socket on top, 2) the baluster stem or one that looked like it was turned on a lathe; plus an increase in the separation of the drip pan and the base, 3) the mid-drip stick with a collar half way up the stem, 4) the base-drip holder or one with a long stem and a wide flat base which acted as a drip-pan, and 5) the chamber stick which looked like a frying pan with a short tube sticking out of the center (Figures A-15 and A-17). Holder types became even more diverse from the seventeenth through the nineteenth centuries thanks to the introduction of glass candle-sticks in the 1660's, new bronze casting techniques developed in the 1670's, and an expansion of the iron industry from 1600-1700 (Hughes 1984:98, Richardson 1984:83,85-87 and Robins 1939:28).

Two general innovations made socket holders easier to use. During the fifteenth-century, a slot, and later a mere hole, was added to the side of the socket to help remove an expired candle end (Robins 1939:28 and Richardson 1984:83). Several holders from the sixteenth-century were made with a spring device inside a tube like socket which slowly pushed the candle up as it was consumed. This kept the flame at a constant level and ensured the area illuminated would not shift as the candle burned (O’Dea 1958:38).
One type of holder, available in the eighteenth century, was the iron spiked holder. This was simply a socket with one or two pointed iron projections and a loop for a handle. The projections could be stuck into woodwork, a barrel side, between containers, etc. which provided a holder that could be used in tight places. While these were popular in mines throughout the Western United States in the nineteenth century, they were also reportedly used on ships during the eighteenth century (O'Dea 1958:44). Unfortunately, the only other reference I found to spiked holders on vessels was a checklist used by the Dutch East India Company from 1740-1750 which includes candle holders with spikes as a part of the ship's equipment (Gawronski et. al. 1992:99).

Lanterns

For outdoor use, lamps and candles were often placed inside of lanterns or housings made of wood, ceramics, hardened leather (after 1517), iron, copper or tin (post 1750). Light was allowed to escape these housing through either an open slit, an open section, a transparent pane, or perforated holes. Lanterns protected a flame from weather and minimized the hazard of fire, but they typically projected an uneven and shadowy light. While this made lanterns undesirable for indoor use, they were ideal for travel on roads and ships.

From 400-1900, lanterns used in the Western World were similarly constructed. Bodies were either cylindrical or square with an access door, a loop for a handle, and either a candle holder or a raised rim for an oil-lamp attached to the base. The tops, sporting several ventilation holes, were typically conical or pyramidal, yet flat or domed
shaped tops on square bodies were also known (O'Dea 1958:73,75,88, Robins 1939:128
and Waterer 1956:184). Differences in lanterns appeared in how light was allowed to
escape from the housings including: 1) pane variations made from horn, mica, or glass,
and glass lenses and globes, 2) perforated lanterns, and 3) lanterns with manual control
over light access or dark-lanterns.

*Pane and Lens Lanterns*

Most lanterns dating from A.D. 400-1900 utilized a pane or lens of transparent
material. Four types of fixtures were in use throughout the period: thin horn, mica, glass
panes, and thick glass lenses. These forms eventually led to the use of glass globes
during the nineteenth-century.

Horn Panes

Panes made from horn were in use by the first-century A.D. Cow or bull horn
was split, soaked, heated, pressed, scraped and polished into thin, curved plates. These
were then placed into a skeleton frame of wood or bronze complete with an access door,
venting holes and handle. The complete assembly was called a horn-lantern or lanthorn
(Figure A-18a). Although processed horn was slightly opaque, it was light weight, non-
flammable and nearly unbreakable. With these qualities, horn-lanterns were widely
utilized through the end of the nineteenth-century (Forbes 1966:169, O'Dea 1958:71-72
and Wyant 1984:78).
Mica Panes

The second type of pane used in lanterns were made from thin, slightly opaque sheets of mica called muscovy glass. These panes, popular during the sixteenth and seventeenth centuries, provided an appealing glossy sheen, did not yellow with age like horn, and were less expensive than glass. Muscovy, however, was only available in 2.5 to 6 in (6.4-15.2 cm) diamond shaped pieces which had to be individually soldered together to create a large enough globe or window for light to escape. As this took, skill, time and money, muscovy glass became obsolete as larger and less expensive glass variations became available during the early portions of the eighteenth-century (O’Dea 1958:74, Robins 1939:130 and Sutherland 1729:255).

Glass Panes

For centuries, glass panes for lanterns came in two forms. The first, in use after the seventh-century, was plate-glass or small, thick, plates of cast glass which were ground smooth and polished. The second form, sheet-glass or thin, sheets of hand-blown glass, was made available during the sixteenth-century. Both pane types went through a number of developments which made them increasingly obtainable on the market and less expensive for lantern use.

Plate-glass was originally produced by pouring molten glass into a wooden frame on a cooling table and rolling the viscous material to an appropriate thickness. After cooling, the surface was stone-ground smooth and polished until the plate was transparent (Charleston and Angus-Butterworth 1957:237 and Forbes 1966:169).
Unfortunately, this lengthy process produced only small, expensive panes. After 1691, French glass workers began to manufacture larger plates in less time. The traditional casting methods were used, but on a much larger scale with greatly expanded cooling tables and mechanized, pouring stands, rollers, grinders and polishers (Angus-Butterworth 1958:372, Charleston and Angus-Butterworth 1957:238-39 and Derry and Williams 1960:595-96). As early as 1789, steam-engines replaced manual laborers in rolling, grinding and polishing, which greatly reduced production time and again lowered the cost of plate-glass (Derry and Williams 1960:595).

After its introduction in the sixteenth-century, sheet-glass was considered the superior form of pane glass. Since blowing required bringing molten glass to a higher temperature than casting, blown panes were thinner yet stronger than plate varieties. The method, however, took time and required highly skilled craftsmen which made sheets considerably more expensive than plates until late in the nineteenth-century (Charleston and Angus-Butterworth 1957:240).

The first method of producing sheet-glass was developed in Normandy. A hollow sphere was formed on the end of a blow-iron then flattened by spinning the sphere into a disk about 5 ft (1.52 m) in diameter. An unavoidable bulb or crown was left in the center of the sheet where the blow-iron was connected which gave the glass its name crown-glass (Charleston and Angus-Butterworth 1957:240, Angus-Butterworth 1958:366 and Derry and Williams 1960:594).

The second sheet-glass technique, the cylinder method, came into use in Lorraine and Germany late in the eighteenth-century. A hollow sphere was again blown on an
iron, but instead of spinning the shape, it was gently shaken which allowed gravity to lengthen the sphere into a cylinder. The cylinder was then sliced lengthwise on one side and laid flat to cool. The cylinder method produced sheets up to 30 by 50 inches (76.2 x 127.0 cm) with no pesky bulb in the center. This made them easier to use than the traditional crown-glass (Charleston and Angus-Butterworth 1957:240).

Innovations by W. Clark in 1857 made sheet-glass as inexpensive as any plate variation. Clark developed a method of drawing viscous glass directly from the furnace. A bait or flat piece of metal was dipped into molten glass and, as the bait was pulled across a cooling table, the glass was drawn into a sheet. Initially, the sheet was as wide as the bait yet it gradually narrowed as the glass quickly cooled. In 1901, this bottleneck effect was solved when J. B. Fourcault forced molten glass, under hydrostatic pressure, through a slit in a fire-clay float. As the glass was pushed through the slit, it was slowly drawn away from the furnace by a cooling belt which created huge sheets of glass of even width and thickness similar to panes used today (Douglas 1958:678-79).

Glass Lenses

Instead of a thin pane of glass, some lanterns used a thick, glass lens. Lenses could be round, oval, square or rectangular and sometimes had a bump or bulge in the center to concentrate the light that came out of the lantern. An early lens type, in use by the thirteenth-century, was semi-spherical shaped with a number of facets cut into the face called a crystal pane (O’Dea 1958:74). Another popular lens, used well into the eighteenth-century, was created by the bulb formed from hand-blown, crown glass.
These lenses tended to be oval and, when mounted, looked similar to a huge eye and thus were known as bulls-eyes. Many square bodied travel lanterns had bulls eyes mounted on three sides with a handle on the back (Figure A-18b). This configuration allowed light to be thrown onto the road and surrounding area but not into the carrier’s face which would interfere with night vision (O’Dea 1958:74).

Glass Globes

In 1783, Armi Argand discovered that a glass chimney surrounding the flame could be useful for three reasons: it aerated the wick, protected the flame from drafts, and limited the hazard of fire. It was not until the 1820’s, however, that lantern globes and glass chimney’s for lamps began to gain favor. The first globes were round in shape. Then, in the 1870’s, taller, cylindrical variations became the standard after the introduction of the kerosene burning hurricane lamp (O’Dea 1958:75-76).

Perforated Lanterns

Many lanterns did not use a pane or globe at all. The perforated lantern had a body which was punctured with numerous small holes through which the light escaped. This lantern was inexpensive, highly durable, yet still protected a flame from strong gusts of wind (Figure A-18c). Iron and tin variations of the perforated lantern were found in the twelfth-century cathedrals Aix-la-Chapelle and Hildesheim. Similar ‘wind-proof lanterns’ were available in southern Germany and Austria from the fifteenth to nineteenth centuries (O’Dea 1958:74). In Colonial America, perforated tin housings
were re-named the Revere Lantern after Paul Revere. The small holes, however, cast
light only a minimal distance and Revere's famous 1775 ride was more likely
accomplished with a typical horn-lantern (Cooke 1984:123).

Dark-Lanterns

A dark-lantern would cast no light until the user was ready. The lamp or candle
was fully encased in metal or wood until a hinged door or sliding shutter was opened
(Figure A-18d). One variation attached a sheet of metal tall enough to cover the glass
lens in the body to one side of a removable base. By twisting the base when it was in the
housing, the lens could be covered or uncovered producing the desired amount of
illumination (Figure A-19) (Boudriot 1986:175-76). These lanterns were used by thieves
and police officers alike from the 1700's to the early 1900's when dry-battery powered
torches, known in the U.S. today as flash-lights, became available (O'Dea 1958:75).
LIGHTING AND SHIPS

A whimsical account from the sixteenth-century describes ships as small wooden cities with their own urban landscape. The waist of the ship served as the central square, the bilge pump functioned as a foul fountain, and the masts on deck were “strange trees bearing stranger fruit.” Meanwhile, the captain and officers acted as the city’s municipal officers and the crew were its citizens who lived in lodgings located in the hold (Phillips 1986:155).

While this description is humorous, the comparison of terrestrial cities and ships does have some merit when it comes to lighting. First, each shared the hazard of fire created by the use of an open-flame. On a vessel, however, the results of a fire were more immediate and deadly as there was no safe place to which the inhabitants could escape. Strict ship-board lighting regulations were often set into place. Second, land sites and ships shared similarities in lighting preferences. The period in question can be broken up into three segments according to which lighting implements were in use: 1) from A.D. 400-1500 when there was a continued reliance on the oil-lamp, 2) 1500-1800, candles were favored over lamps, and 3) 1800-1900 when technological innovations began changing lighting practices on land and ships alike.

There were two uses for illumination on ships that were not used in cities. The first was the binnacle or a lit housing for the ship’s compass. While sailing at night did not require any other lighting device, illumination of the compass to steer the ship by was essential. The second use, found on any ship armed with cannons, were light-wells and light-rooms or a space opposite the powder-room where light from lanterns could
shine through a glazed opening in the bulk-head. The use of these spaces ensured no flame would accidentally reach and ignite the stores of gun-powder.

Fire and Ships

Statistically, fires did not account for a large portion of lost vessels. Between 1793 and 1815, the Royal Navy lost a total of 101 ships to accidents, ten (9.9%) of which were due to fire for an average of one ship every 2.2 years (Lewis 1960:348). Numbers from North America give a similar picture. Off the Port of New York there were a total of 602 distressed vessel reports dating from 1614 to 1900. Of this number, 61 (10.1%) were due to fire incidents caused by carelessness with a flame and 23 (3.8%) were attributed to blown steam engines or the rare lightning strike (Rattray 1973:241-63). According to statistics from troubled ship calls along the U.S. Atlantic and Gulf Coasts in 1906, a ship was roughly 2.6 times more likely to become stranded or 3.4 times more likely to be involved in a collision than to catch on fire (Ritchie 1996:42).

Although fires did not occur as often as other ship disasters, an out of control flame was considered dangerous since it could burst into a blaze that would engulf the entire ship in a very short time. This is shown by examples from archaeological sites, historical documents, and contemporary ship lore. One of the earliest wreck sites in North America, the Red Bay wreck of 1565 probably met its demise through fire. Some of the ship’s timbers were charred and valuable instruments were left behind that would not normally have been forgotten (Grenier 1988:79). In 1614, the Dutch exploration vessel Tijger burned to the water-line as it sat loaded with furs in a bay next to what was
to become New York City (Rattray 1973:1-2). The English flagship *Sovereign of the Seas* was lost to fire in 1697 after a candle was upset (Lavery 1987:185). Similarly, when the Lake Champlain steamer *Phoenix* was razed in 1819 a candle was blamed as the culprit (Simmons 1988:191). In 1848, a lit candle dropped into flammable material ignited a fire that killed 176 of the 380 people on board the *Ocean Monarch* as the 1,300 ton immigrant packet ship sat quietly off the coast of England (Ritchie 1996:151). Worse casualty rates occurred in 1850 when a blaze started in the hold of the Lake Erie steamer *Griffith* ended with the loss of 295 of the 321 people on board (Ritchie 1996:94).

Captains of military vessels had reasons to fear fire even more than their merchant counterparts since they carried more men and large amounts of gun-powder. During a voyage on the Atlantic in 1825, the British troopship *Kent* caught fire when a lantern fell into spilled whiskey. Although the captain had the lower decks flooded to give the 500 men on board time to escape, when the flames reached the magazine 81 people were killed by the resulting explosion (Ritchie 1996:110).

Vessels supposedly safe in port were often at a higher fire risk than those at sea. First, due to proximity, an accidental fire on one docked ship could easily spread to others. For example, the clipper *Great Republic* was sitting at dock at the Port of New York in December of 1853 when a fire sparked in its hold. Before the blaze was contained, it had fully consumed the *Great Republic* as well as the clipper *White Squall* and the packet *Joseph Walker* (Rattray 1973:245). A second problem was that older wooden ships, which were likely to be lost at sea by other means, were often ignited on purpose by their owners so the insurance money could be easily collected.
While the vessel was at sea, however, both the owner and the captain took fire safety seriously. Better fire-fighting techniques were developed as ships became larger and more lighting instruments were used on board. Bilge pumps were often utilized to bring water to the location of an errant flame (Oertling 1996:23,54-55). Other fire fighting equipment, in use by the 1650's, included hardened leather or canvas buckets on long lanyards which were kept on deck for drawing water (Green 1977:373-74 and Jennings 1843:59). During the eighteenth and nineteenth centuries, the officers and crew were typically assigned a ship-board fire station. If each man was at his station using the pumps and buckets when a blaze threatened the ship, the fire might be extinguished before it engulfed everything on board (Lavery 1987:185).

**Lighting Regulation**

The best way to fight a fire was to be sure one never started. Preventive measures on ships came in the form of strict regulations which controlled where lights were allowed, who distributed the lighting supplies, and who would be able to use them. As military vessels housed explosive substances and a great number of men, lighting regulation was essential. Two different naval entities, the Spanish Navy in the seventeenth-century and the English Royal Navy in the eighteenth-century, had several common traditions when it came to controlling illumination. Many of these same rules were also used on vessels from the private sector as shown by personal accounts and stories of life on board during the nineteenth-century.
Spanish Galleons in the Seventeenth-Century

In *Six Galleons for the King of Spain*, Carla Phillips (1986:119-80) describes the position and responsibilities expected from the captain, officers and crew on seventeenth-century Galleons from Spain. Concerning illumination, there was only one official duty assumed by the captain. After the evening meal, he was to order his men, except those on watch, to go below deck and turn in to minimize lamp and lantern use. Unfortunately, force was sometimes necessary to ensure this order was carried out since grown men didn’t like to be told when to go to bed (Phillips 1986:153).

Beyond that, lighting was largely in the hands of four men. The first was the master who was ultimately responsible for the distribution of food, drink and supplies in addition to ship maintenance. While in port, he obtained ample supplies including three types of candles: 1) small wax candles for the officers, probably used in uncovered holders in their cabins and on the captain’s table, 2) tallow candles for the lanterns used by the crew, and 3) large wax hachotes weighing 1 ½ to 2 pounds (0.68-0.91 Kg) for religious ceremonies and the poop-lantern. The master also ensured there were plenty of lanterns on the ship and each was in proper working condition (Phillips 1986:127-28).

While at sea, many of the Master’s duties fell to a second man, the contra maestre or master’s assistant. In addition to other provisioning and maintenance duties, he inspected the rigging before the sun set to ensure each line was in its proper place. This allowed the sailors to make quick adjustments even in the dark and limited the need for emergency deck lighting. Also, after the captain had ordered his men to bed, the contra maestre saw to it that the cooking fire was fully extinguished and all unnecessary candles
were blown out before retiring himself. As the cooking fire would not be left burning for any of the passengers, they were encouraged to cook and eat at the same time as the rest of the crew or eat a cold meal in the dark (Phillips 1986:134-36,166).

The third man, one of the contra maestre’s assistants called the guardian, ensured that lighting implements were being properly used. Before turning in for the evening, he checked to see if the pages, or young boys, had set out and supplied with candles the lanterns that might be needed during the night. He then looked in on the appointed teenaged apprentice to be sure the young man was satisfactorily maintaining the light in the compass housing (Phillips 1986:143-44).

The final person in charge of lighting was another assistant to the contra maestre, called the dispenser, who gave out the supplies and provisions to the crew. He held the keys to all the locked storage-rooms and the grates and hatchways leading to the hold. If a candle or lantern was needed, the dispenser retrieved the item and kept a close account of what remained. Only the dispenser was allowed to carry a covered light into the store-rooms as the supplies could be easily ignited (Phillips 1986:135-36).

The Royal Navy in the Eighteenth-Century

In the eighteenth-century, an English captain’s role in illumination was similar to those in command of the earlier Spanish Galleons. After the evening hymn or in the early part of the evening, British captains ordered all unnecessary lights extinguished (O’Dea 1958:85). To ensure the order was maintained, one of the lesser officers, such as the master-at-arms or the mid-ship-man, patrolled the decks once an hour and
extinguished any re-lit device (Lavery 1987:185). Exceptions to this rule were often made for officers or gentlemen. Although it was recommended that these men use a covered light or a lamp trimmed with oiled water, they often used candles in open holders (O’Dea 1958:85).

The purser, a non-commissioned officer appointed by the Admiralty, was the man responsible for the allocation of candles and lanterns as well as other provisions and supplies. Each month, the purser was allowed to collect a certain amount of “necessary money” from each crew member to purchase coal, wood, candles, lanterns and Turnery-ware or wooden table ware. Then, he would determine how these items were distributed. His reign over candles was so complete that the sailors often referred to the tallow lights as “pusser’s glims” (Love 1735:126 and Pope 1987:151,158).

It was the steward, appointed by the purser, who was responsible for delivering the appropriate supplies to the crew (Blanckley 1750:127 and Falconer 1769:pum-pur,ste-ste). To accomplish this task, he was given an assistant and could be aided by other crew members. For example, before the crew’s meal was served, the steward’s assistant delivered the appropriate number of candles to each mess-group, each were then placed into a horn-lantern that was monitored by the head cook. The candles were then re-collected by 6 am by steward’s assistant and his boy who cleaned and trimmed them (Lavery 1990:207, Pope 1987:151,158 and Smith 1627:36).

To aid in the smooth functioning of an English naval vessel, several people were allowed to have their own lanterns. The navigator was given two dark-lanterns which lit his way to the steerage (Blanckley 1750:29,89-90). Gunners were also equipped with a
dark-lantern in addition to a primer, a lint stock, a horn-touch box, and a pair of compass callipers (Smith 1627:36). Meanwhile, the boatswain and carpenter were responsible for a few “hand-lanterns” which were probably small horn-lanterns. These provided light for work done in the ship’s hull (Blanckley 1750:29,89-90). Finally, the crew who hung their hammocks on the gun deck were often afforded a few large horn-lanterns for minimal illumination during the early evening hours.

Ships from the Private Sector in the Nineteenth-Century

There is, unfortunately, less information available about regulations on private vessels. This is due, in part, to the different rules each ship maintained as expressed by its charter and how it was interpreted by the captain. When it came to lighting, however, it appears the merchant vessels and public transports used similar practices to those found on naval ships as shown by a few contemporary documents and accounts from the nineteenth-century.

Although Lt. Edward Jennings (1843:59) was a naval officer, he lists numerous safety precautions he strongly recommends to every ship’s captain. First, hearth fires were to be doused at 8 pm and all other lights put out at 9 pm except those required for the compass housing and on deck. When all of the flames had been snuffed, the officer of the last dog-watch was to report “fire extinguished” to the captain. Second, to ensure these lights remained out, each man relieved from the wheel was to examine below and report “all well” to the officer of the watch. Third, no naked light was to be permitted, “let either lanthorns (horn-lanterns) or lamps (with glass globes) be used.” Fourth, the
only form of illumination allowed below decks was a lantern. Fifth, naked lights were not to be allowed near a spirit cask and, for added protection, the casks should be drawn off on deck during the day. In addition, Jennings warns against allowing lit pipes or cigars below decks and insists that certain items, like medical chests with chemical bottles or cargos of cotton, be fully inspected and carefully stowed (Jennings 1843:59).

From personal accounts and fictions written by experienced sea-men, it seems many companies and captains took these regulations to heart. One example is Two Years Before the Mast which relates the personal account of R. H. Dana Jr’s 1834-36 experience on two merchant vessels. On the merchant brig Pilgrim, there was a code against any light in a store room. Dana’s first berth was located next to the steward in the steerage which also held numerous supplies such as “coils of rigging, spare sails, old junk, and ships stores.” Due to the proximity of the equipment and stores, the men in this area “were allowed no lamp to find anything with,” and Dana found himself stumbling in the dark the first few evenings of his long voyage (Dana 1841:12,52).

Sailors in the forecastle of the same ship, however, were given minimal light to see by in the early evening hours. Months after disembarking from Boston, Dana requested and received permission to move from the steerage to forecastle where a “dim, swinging lamp shed its light over the dark hole in which we lived,” (Dana 1841:52-53,100). Even this single flame was regulated. The young scholar found he could not read during the night watches as “lights were not allowed after eight o’clock,” (Dana 1841:172). The second ship Dana lived on, the Alert, also awarded its forecastle sailors one lamp in the evenings as crewmen gathered around the single “lamp, which swung
from a beam," to make clothing for the cold voyage back to Boston (Dana 1841:216-17). A similar picture is painted in the fictional story *The Nigger of the Narcissus* by Joseph Conrad (1897) who had twenty years experience on seafaring vessels. The forecastle of the *Narcissus* was lit by two tin, oil-lamps which were hung from the beams with string (Conrad 1897:2,39,85).

Public transports were also stringent about illumination practices. Eighteenth- and nineteenth-century vessels carrying prisoners, slaves, emigrants and passengers from Africa and Europe to America and Australia rarely allowed an open-flame below decks. Slaves and prisoners spent the entire voyage, up to 60 days in the winter, in complete darkness (Lubbock 1925:103). Meanwhile emigrants and lower class passengers were allowed only minimal illumination in the form of a few horn-lanterns. Those that could afford it often purchased a personal travel lantern like the hand-sized, iron, lockable Emigrant’s Safety Lantern made available by Price’s Patent Candle Company in the 1850's (O’Dea 1958:85). Voyages were brighter for those who paid an upper-class passage. Lamps and/or candles were provided in the cabins, saloons and dining areas where reliable servants were paid to tend to the wicks and fuel (O’Dea 1958:85).

**Lighting on Ships: A.D. 400-1500**

How and when lighting was used on Byzantine and Early Medieval ships is difficult to discern as there is a minimal amount of contemporary documentation and archeological evidence from this era. The ten wreck sites listed on Table 2 date from 400-1100 and represent the available material. While numerous Northern European sites
predating 1500 have been excavated, most have little in the way of cargo or small finds
as the vessels were either derelicts or deliberate burials.

Unfortunately, not a single site dating from A.D. 1100-1500 is represented on
Table 2. Considering this was when land populations were switching from lamp to
candle use, this lack of information is troublesome. There is, however, enough data
available to understand that Medieval sailors followed many of the same traditions
established by ancient seafarers including a continued reliance on a small number of oil-
lamps, where lamps were found on wrecks, and how they might have been used.

Only A Few Lamps

Reflecting centuries of ship-board lighting tradition, only oil-lamps were
recovered from sites dating from A.D. 400-1100. Although tax and law documents from
800-1100 suggest a rise in the use of candles on land, there were no candle holders
recovered from any of the wrecks on Table 2. When candles were introduced onto
seafaring vessels is unknown. Perhaps future excavators will be able to answer this
question as more sites dating from 1100-1500 are uncovered.

Another similarity between Ancient and Byzantine/Medieval wreck sites, was the
low numbers of lamps recovered. Table 1 (p. 10) lists fourteen ancient wreck sites
which produced one to four lamps or 2.1 per wreck. On Table 2, one to four lamps were
also recovered from seven of the sites for an average of 2.0 lamps per wreck. Although
ship building methods were slowly changing, vessel size remained small. The 15 m,
fourth-century Yassi Ada wreck and the 15.36 m Serce Liman wreck from the
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<tr>
<td>Grazel B</td>
<td>631</td>
<td>France</td>
<td>1 - bronze lamp w/ Christian symbols</td>
<td>Not Stated</td>
<td>Solier et al 1981:26</td>
</tr>
<tr>
<td>Yassi Ada - 7th-Century</td>
<td>600-700</td>
<td>Turkey</td>
<td>24 - Byzantine</td>
<td>8</td>
<td>Vitelli 1982:189</td>
</tr>
<tr>
<td>Bozburun</td>
<td>800-900</td>
<td>Turkey</td>
<td>1 - Byzantine</td>
<td>1</td>
<td>Personal On-site Observation 1998</td>
</tr>
<tr>
<td>Tantura B</td>
<td>800-900</td>
<td>Israel</td>
<td>1 - Arab</td>
<td>0</td>
<td>Wachsman 1997:8,21</td>
</tr>
<tr>
<td>Plane C</td>
<td>900-1000</td>
<td>France</td>
<td>3 - wheel thrown with long sprouts</td>
<td>Unknown</td>
<td>Ximenes 1976:142,149</td>
</tr>
<tr>
<td>Serce-Liman</td>
<td>1000-1100</td>
<td>Turkey</td>
<td>1+ - Byzantine</td>
<td>1</td>
<td>Bass 1979:89,91</td>
</tr>
</tbody>
</table>
eleventh-century were both close in size to the Kyrenia wreck dated to 300 B.C. (Steffy 1994:79,87). One to four lamps would have provided plenty of illumination for the handful of crewmen who sailed these vessels.

There are, of course, exceptions to the low-lamp-count rule. Three of the wreck sites listed in Table 2 produced more than four lamps. The largest assemblage came from the Yassi Ada seventh-century wreck with twenty-four lamps; sixteen which had no charring and eight which were obviously utilized due to blackened spouts. Although this vessel was approximately five meters longer than those discussed above (Steffy 1994:80), eight is a high number of utilized lamps.

Why did the crew need the extra lamps? Perhaps lighting was afforded to more of the crew or the galley needed several lamps for proper illumination. A more likely answer was that some of the lamps were used to provide light for, or used in, religious ceremonies conducted on board. Indications that Byzantine Christians were on board were given by a steelyard inscription stating the ship’s captain was also a priest (Sams 1982:213), an incense-burner with a cross on top found in the area of the ship’s stores (S. Katzev 1982:266), and Christian symbols on a number of the lamps (Vitelli 1982:190-201). Although candles were becoming popular in Early Christian ceremonies on land, they were obviously still avoided on ships. Oil-lamps had been used in offerings and rituals since 1600 B.C. and were considered by many cultures to be a symbol of goodness and godliness (Bailey 1972:12, Forbes 1966:155 and Sussman 1982:2). Lamps, therefore, could have easily been substituted for candles in ship-board services.

The sixteen, non-utilized lamps pose a different problem. Considering the large
numbers of lamps in cargos of previous centuries, sixteen was a small number even for a
tag-along cargo. Additionally, the lamps were found in or near the galley area and not in
the hold where the other cargo was stored. Karen Vitelli (1982:189) offers a multi-
leveled explanation stating lamps were an “inexpensive and useful commodity that were
purchased when a ship was in port for use on board, as souvenir items with potential
trade value, and to have on hand for dedication at shrines along the way.” On this ship,
then, it appears that a few lamps were used daily, a number were set aside for on board
religious ceremonies, and several more were stored away for later novelty trade and/or
votive purposes.

The other two wrecks with more than four lamps were the Bataiguier wreck
which yielded eight and the Port Vendres A wreck which produced twelve. As the
Bataiguier wreck also carried other ceramic goods, both sets of lamps may represent
small cargos. Unfortunately, this is difficult to say with certainty as utilization was not
discussed in either source text and, again, eight and twelve lamps does not reflect the
great numbers of previously known cargos. Perhaps these lamps were stored and used in
much the same manner and those carried by the seventh-century Yasi Ada vessel
discussed above. Until the relationship between cargo and lamps for this period can be
more clearly defined, these two wrecks should be remembered when considering ship-
board illumination.

*Where Lamps Were Found On Sites*

One of the strongest indications that the lamps in Table 2 were used on board was
that they were often found either in the galley or other living areas. This is exemplified by three wrecks found off the Turkish coast: the seventh-century Yasi Ada vessel, the Bozburun wreck, and the Serce-Liman wreck. Twenty-two of the twenty-four lamps produced by the seventh-century wreck at Yassi Ada were recovered from the galley area in the stern along with numerous hearth tiles and cooking utensils. In this location, they would have been easily available to provide light for meal preparation, grabbed for religious ceremonies, handed out to the captain and the crew for personal use, or sold as souvenir items in port. The other two lamps, one of which was utilized, were recovered slightly forward of the galley. This area, possibly a cabin or dining area, could have been illuminated by the lamp(s) or perhaps the two specimens had merely settled away from the galley after the ship sank (Vitelli 1982:189).

The Bozburun wreck, dated to the ninth-century, produced only one lamp with a clearly blackened spout. It was found in close proximity to the ship’s steel-yard and balance weight which were located just forward of the stern galley area. The position of the lamp and weighing devices seems to indicate that they were stored above the galley floor and tumbled forward when the ship sank and broke up.

The eleventh-century wreck at Serce-Liman also produced one utilized lamp. Instead of in the stern, however, it was found amidships in a living area beside a cooking grill and a number of ceramic cooking vessels (Bass 1979:89,91 and Green 1979:1). As all three examples of lamps appear near hearths or grills, cooking areas seem to have been the center of daily life and illumination on ships from 400-1500. It also indicates that lamps were most often used to provide illumination for meal preparation and
consumption, while a few may have been used in personal quarters in the stern.

*How the Lamps Were Used*

The location of lamps on sites indicates where the lamps were used, yet little is known of how they were used beyond the probable types of fuel and wicks discussed in the Brief History of Lighting Section. Was a lamp simply placed on a shelf or other flat surface to be lit only when cooking or eating a meal? Or was it set into a lantern or a hanger for safe keeping? A lantern would have provided safe illumination in the cargo hold and protected the flame while on deck during breezy evenings. A hanger would have placed the lamp in an out of the way place, offered overhead illumination, and limited fuel spills. Unfortunately, to date, no evidence of either of these items have been recovered from a Byzantine/Medieval wreck site. Since lanterns and hangers were made from thin metals and/or organic materials and placed high in the hull, if they were used they would have been unlikely to survive the site formation process.

**Lighting on Ships: A.D. 1500-1800**

Compared to the Medieval period, the era between 1500-1800 contains a veritable wealth of historical and archaeological information as indicated by the thirty-four ships on Table 3; thirty of which were wreck sites while the other four were taken from historical references. Ships from this period were progressively larger due to a number of innovations in ship-building techniques. One of the first advances was the gun-port, or sections removed from the hull large enough to allow a cannon muzzle to
protrude through, developed in France from 1495-1500. Among the first vessels with ports were the Sovereign of the Seas, rebuilt in 1510, and the Mary Rose, finished in 1511, with sixteen ports each (Barnaby 1860:149, Lavery 1987:139 and Salisbury 1961:90). These new openings allowed ships to carry more guns, which meant additional decks and crewmen. This, in turn, created more dark spaces and people who required illumination. Another trend, according to eighty-eight inventories and eleven Dutch wrecks dating from 1600-1900, was an increase of living/sleeping space on private vessels which increased the need for evening illumination (Van Holk 1996:264). In addition, many of the smaller trade vessels, especially after 1700, began to house families on board whom also needed extra lighting devices (Van Holk 1996:265).

Although the size of seafaring vessels and the number of lighting implements used onboard increased, the average number of those devices recovered from wreck sites remains quite low. Excluding the possible cargo candle holders on the 1659 Vergulde Draeck (thirty-six) and the 1749 Amsterdam (nine), the thirty wreck sites on Table 3 produced a total of eighty-seven lighting and lighting related items (candle snuffers, snuffer holders and lamp hangers). The resulting average, 2.9 items per wreck, is not a great jump from the 2.1 and 2.0 averages obtained from the previous Ancient and Byzantine/Medieval wreck tables (pp. 10 and 55).

An idea of how many items were actually used on board a vessel vs. how many survived to the present can be taken from a study conducted by Jeremy Green (1977: 350,352-54) on the Dutch East Indiaman Vergulde Draeck (1653-1656). The 38.8 meter merchantman was capable of carrying 260 tons of cargo, 24-32 guns, and 350 crew.
<table>
<thead>
<tr>
<th>Ship\Wreck</th>
<th>Ship Type</th>
<th>A.D.</th>
<th>Lighting Implements</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Bay Wreck</td>
<td>Basque Whaler</td>
<td>1565</td>
<td>burn marks on the binnacle probably from an oil-lamp</td>
<td>Grenier 1988:79</td>
</tr>
<tr>
<td><em>Girona</em></td>
<td>Armada Galleasses</td>
<td>1588</td>
<td>3+ silver candle holders.</td>
<td>Stenuit 1974:123</td>
</tr>
<tr>
<td><em>La Trinidad Valencera</em></td>
<td>Armada Transport</td>
<td>1588</td>
<td>1 pewter candle holder, 1 brass candle stick base, 1+ lanterns, wooden w/ linen and horn panes.</td>
<td>Bingeman 1984:346,Marin 1979:19 and Rodriguez-Salgado 1988:189</td>
</tr>
<tr>
<td><em>Sea Venture</em></td>
<td>English Flagship</td>
<td>1609</td>
<td>1 pewter-candle holder w/ candle.</td>
<td>Wingood 1982:343.345</td>
</tr>
<tr>
<td><em>Witte Leeuw</em></td>
<td>Dutch East Indianman</td>
<td>1613</td>
<td>1 brass, gimbaled oil-lamp w/ three wicks.</td>
<td>Stenuit 1978:569</td>
</tr>
<tr>
<td><em>Cayman</em></td>
<td>Dutch East Indianman</td>
<td>1627</td>
<td>1 brass candle stick, 1 copper candle holder.</td>
<td>McBride &amp; Whiting 1985:23-24</td>
</tr>
<tr>
<td><em>Wasa</em></td>
<td>Swedish Galleon</td>
<td>1628</td>
<td>1 brass candle stick (found in stern, used by captain or officers)</td>
<td>Kleingardt 1972:14-15</td>
</tr>
<tr>
<td><em>Batavia</em></td>
<td>Dutch East Indianman</td>
<td>1629</td>
<td>2 brass candle sticks (1 w/wax), 4 brass gimbaled oil-lamps w/ 3 wicks (one w/ wick remains).</td>
<td>Stansbury 1974:19-21</td>
</tr>
<tr>
<td><em>Los Tres Reyes</em></td>
<td>Spanish Galleon</td>
<td>1634</td>
<td>candle use - stores of were replenished while in Indies.</td>
<td>Phillips 1990:55</td>
</tr>
<tr>
<td><em>La Concepcion</em></td>
<td>Spanish Galleon</td>
<td>1641</td>
<td>1 silver candle stick - in a wealthy passenger's wooden chest.</td>
<td>Smith 1988:93.97</td>
</tr>
<tr>
<td><em>Monte Cristi Wreck</em></td>
<td>Dutch Merchantman</td>
<td>1656</td>
<td>1 brass candle holder. 2 brass lamp hangers. 3 pair brass lamp wick tweezers?</td>
<td>Hall 1996:185-89</td>
</tr>
<tr>
<td><em>Vargulde Drueck</em></td>
<td>Dutch East Indianman</td>
<td>1656</td>
<td>1 brass chamber stick. 1 pr. brass candle snuffers. 1 gimbaled oil-lamp w/ 3 wicks, 36 brass candle sticks - cargo?</td>
<td>Green 1977:186-93</td>
</tr>
<tr>
<td><em>Kennemerland Wreck</em></td>
<td>Dutch East Indianman</td>
<td>1664</td>
<td>1 chimney to gimbaled oil-lamp? brass with copper rim.</td>
<td>Price &amp; Muckelroy 1974:264</td>
</tr>
<tr>
<td><em>Sacramento</em></td>
<td>Portuguese Galleon</td>
<td>1668</td>
<td>1 pewter candle stick.</td>
<td>De Mello 1979:223</td>
</tr>
<tr>
<td>Ship/Wreck</td>
<td>Ship Type</td>
<td>A.D.</td>
<td>Lighting Implements</td>
<td>Source</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------</td>
<td>------</td>
<td>----------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 wooden lantern w/ shell panels.</td>
<td></td>
</tr>
<tr>
<td>La Belle</td>
<td>French Exploration</td>
<td>1687</td>
<td>1 brass, gimbaled oil-lamp with 3 wicks.</td>
<td>Pers. Observation Aug. 1999</td>
</tr>
<tr>
<td>Wreck from Philip's Fleet</td>
<td>New England Milliary</td>
<td>1690</td>
<td>1 lead, four-wicking hanging oil lamp.</td>
<td>Bernier 1997:74</td>
</tr>
<tr>
<td>Con Dao Wreck</td>
<td>Oriental Merchantman</td>
<td>1690</td>
<td>2 saucer oil-lamps found forward of midships.</td>
<td>Flecker 1992:221-44</td>
</tr>
<tr>
<td>Sovereign of the Seas</td>
<td>English Warship</td>
<td>1697</td>
<td>candle used burned to waterline.</td>
<td>Lavery 1987:185</td>
</tr>
<tr>
<td>Goodwins Wreck</td>
<td>English Warship</td>
<td>1703</td>
<td>1 brass portable candle holder, 1 pr. brass candle snuffers, 1 brass hanging lamp.</td>
<td>Lyon 1980:339-41</td>
</tr>
<tr>
<td>Slotterhooge</td>
<td>Dutch East Indiaman</td>
<td>1724</td>
<td>2+ brass candelsticks</td>
<td>Green 1980:127</td>
</tr>
<tr>
<td>Curação</td>
<td>Dutch Warship</td>
<td>1729</td>
<td>1 brass candelstick.</td>
<td>Sténuit 1977:115,118</td>
</tr>
<tr>
<td>San José</td>
<td>Spanish Merchant Nao</td>
<td>1733</td>
<td>2+ brass candelsticks.</td>
<td>Smith 1988:102</td>
</tr>
<tr>
<td>Hollandia</td>
<td>Dutch East Indiaman</td>
<td>1743</td>
<td>1 brass partial pr. candle snuffers, 3 silver candelstick fragments. 6 brass candelstick fragments. 1 brass wick trimmer/tongs. 2 gimbaled oil-lamp pieces. 1 four-cornered, hanging slot-lamp.</td>
<td>Gawronski et. al. 1992:283,429-32.</td>
</tr>
<tr>
<td>Maidstone</td>
<td>English Warship</td>
<td>1747</td>
<td>1 brass candle w/ candle remains, 1 pr. brass candle snuffers.</td>
<td>De Maisonneuve 1992:25-26</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>Dutch East Indiaman</td>
<td>1749</td>
<td>1 brass candle stick designed to be nailed into a wooden surface. 9 brass candle holders - cargo?</td>
<td>Marsden 1972:73-96</td>
</tr>
<tr>
<td>Le Machault</td>
<td>French Fleet Flagship</td>
<td>1760</td>
<td>3 brass candle holders (1 w/ tallow), 1 brass chamber stick w/ tallow. 1 pr. brass candle snuffers. 1 brass snuffer holder. 3 tallow candles.</td>
<td>Sullivan 1986:93 and Woodhead et. al. 1984:6,12,19,22,28.</td>
</tr>
<tr>
<td>Estafit</td>
<td>Russian Transport</td>
<td>1780</td>
<td>1 copper candle holder.</td>
<td>Sténuit 1976:222</td>
</tr>
<tr>
<td>OE 14</td>
<td>Netherlands Cargo Vessel</td>
<td>1790</td>
<td>1 spout-lamp.</td>
<td>Van Hol 1996:87</td>
</tr>
<tr>
<td>NB 6</td>
<td>Netherlands Cargo Vessel</td>
<td>1790</td>
<td>1 spout-lamp fragment.</td>
<td>Van Hol 1996:87</td>
</tr>
</tbody>
</table>
A requisitions list, created for the *Vergulde Draeck* before its first trip to the Indies in 1653, states that the steward's chest contained, among other items, two dark-lanterns, six lamps two brass powder-lanterns. Meanwhile, twelve wooden lanterns, probably glazed with horn, hung in the mess (Green 1977:350,352-54). While that was the extent of the requisition records of the *Vergulde Draeck*, other contemporary records from similar ships suggest that additional lighting equipment would have included candlesticks, iron lantern hangers, and numerous other lanterns such as the eighty brass horn-lanterns for the guns. From these records, it can be assumed that when the *Vergulde Draeck* sank off the coast of Australia in 1656, it carried a rough total of 14 lamps, over 100 lanterns, and numerous candle holders (Green 1977:342-45,373-74).

Few of these items were recovered from the wreck site. Of the fourteen recorded lamps, only a single brass, gimbaled lamp was found and there was absolutely no evidence of the 100 plus lanterns on board. In addition, only one non-cargo candle holder and a pair of brass snuffers was recovered from the wreck to indicate any ship-board candle use (Green 1977:186-93). Multi-decked vessels of this period obviously carried an ample amount of lighting devices. Yet, after a larger ship sank, a greater portion of the hull would have been exposed to the harsh marine environment where it would have quickly deteriorated. This included areas where lighting implements would have been hung or stored. As a result, a low percentage of the implements have survived to the present.
**Candle Use and Holders**

Unlike previous eras, candles were favored over the oil-lamp on both land and ships from 1500-1800. The only two household items continually listed in eighty-eight contemporary inventories of Dutch cargo vessels was the candlestick and the spoon (Van Holk 1996:263). The favored status of the candle is also reflected in their frequent appearance on Table 3. Of the thirty-four ships listed on Table 3, indications of candle use appeared on twenty-five, while fourteen provided evidence for lamps and five produced examples of both.

A few examples of candle use appeared in historical accounts. For example, the fire which destroyed the *Sovereign of the Seas* (1697) was reported started by a candle (Lavery 1987:185). Several were wreck sites with a single candle holder like the pewter example with candle remains from the wreck of the *Sea Venture* (1609) (Wingood 1982:343,345). Others sites produced more than one type of holder such as the silver and brass remains recovered from the wreck of the 1743 Dutch East Indiaman *Hollandia* (Gawronski et. al. 1992:283,429-31). The grandest assemblage was recovered from the wreck of the French flagship at the Battle of Restigouche, *Le Machault* (1760), with four holders, a pair of snuffers, an upright snuffer holder, and eight tallow candles (Sullivan 1986:93 and Woodhead et. al. 1984:8,12,19,22,28).

As the discussion on ship-board regulations revealed, candles in lanterns were used in most places on board a vessel while uncovered candles in holders were reserved for officers or influential passengers. Further evidence of this attitude comes from wreck sites where holders are found in the stern such as the single brass holder recovered from
the 1628 Dutch warship Wasa and the silver-plated stick of the 1687 San Antonio de Tanna (Kleingardt 1972:14-15 and Piercy 1981:110,116). Historical accounts also support the use of candles in the stern. One example is the story of an officer who was using a candle in the stern of the 1774 exploration vessel Resolution. Unexpectedly, water from a large wave broke over the ship and entered the cabin through the skylight above. The deluge drenched the man and doused the flame (Beaglehole 1969:317).

Wax or Tallow?

Whether wax or tallow candles were used on a ship appears to have been subject to what was available when it was last provisioned. Royal Navy Admiralty requisition records often refer to tallow, but only rarely to wax which points toward a tallow preference (O’Dea 1958:83). With the large amount of animal husbandry conducted in England and the resulting high availability of tallow, it is easy to see why tallow candles were favored by the British Navy. In contrast, eighteenth-century French war-ships largely depended on candles made from yellow wax; a less expensive variety than traditional white. French hand- and dark-lanterns were typically lit with yellow wax candles that weighed eight-to-the-pound (56.7 gm each), while the battle-lanterns were filled with the larger four-to-the-pound (113.4 gm each) candles (Boudriot 1986:175-76 and O’Dea 1958:84). The wreck of Le Machault (1760), however, only produced tallow candles (Sullivan 1986:93). This is not surprising since the ship was last provisioned in North America where wax candles were rare.

A feel for how much wax and/or tallow was used on board can be extrapolated
from records made by the Dutch East India Company in the 1650's. Fifteen months
worth of provisions on a Jacht like the _Vergulde Draeck_ included 80 pounds (36.3 Kg) of
tallow candles, 80 pounds of candles made from wax, and 80 pounds of candles that were
a blend of wax and tallow (Green 1977:375-76). If the candles weighed the typical four-
or eight-to-the-pound (56.7 or 113.4 gm per candle), then 320 to 640 of each type would
have been loaded into the hold for a total of 960 to 1,920 candles. Per month, the ship
would have used 64 to 128 candles for stern-, battle-, horn-, and dark-lanterns, as well as
lanterns for the powder-room and holders in the officers quarters.

_Oil-Lamps_

Although there is indisputable evidence for use of open-flame lamps on land
throughout the period of 1500-1800, if and when certain types of lamps were used aboard
ships remains speculative. One example of uncertain lamp usage comes from trying to
determine if the iron crusie was a means of ship-board illumination during the sixteenth
and seventeenth centuries. From historical and archaeological evidence, it is known that
crusies were brought over to the New World by Spanish conquerors and early settlers of
the Dutch and English. These lamps also may have been utilized on the ships that carried
the voyagers across the Atlantic. Lamp descriptions from the _Mayflower_ of 1620 sound
like the slot and hook of a crusie (Cooke 1984:34 and M. Watkins 1984:20). During the
same period, the Basque used crusies exclusively for illumination on land (until the
1850's) and could have easily utilized them on the whaling vessels they operated. Not a
single example of a crusie, however, has been recovered from a Basque wreck including

There are two solid examples of crusie type lamps recovered from wreck sites. The first comes from the site of a 1690 New England military vessel from Phip’s Fleet. This lead lamp had four slots for wicks and two flanges with holes for hanging, or a multi-wicked crusie (Bermier 1997:74). The second example, a brass artifact recovered from the 1743 Dutch East Indiaman Hollandia, is very similar. It has four slots for wicks and two sets of holes on opposite sides for a wire hanger (Gawronski et. al. 1992: 283,432). A third possible example is the brass lamp on a wire hanger from the Goodwins wreck, an English battleship which sank in 1703 (Lyon 1980:339-41). Unfortunately, which type of lamp this was is not stated in the source text.

Other sources also suggest oil-lamp use without indicating the type of lamp. On the site of the 1656 Monte Cristi wreck, a Dutch merchantman, no examples of lamps were recovered. There were, however, two brass lamp-hooks and three brass tweezers which may have been used as wick-picks (Hall 1996:185-89). A requisitions list for the Vergulde Draeck (1656) included six lamps for the sick. While the type of lamp used by the ship’s practitioners is not stated, these devices were probably crusies or bettys (Green 1977:350). A century later, the steward’s chest on a typical Dutch East Indiamen continued to hold a number of oil-lamps as indicated by company check lists dated from 1740-1750 (Growronski et. al. 1992:191).

Late in the eighteenth century, Dutch cargo vessels may have favored the spout-lamp as a means of illumination. Two wrecks from The Netherlands, dated to 1790, each produced remains of a lamp with a spout called “snotneus.” While only a fragment was
recovered from NB 6, an intact specimen was found on OE 14 (Van Holk 1996:87,89).

Lamps on Gimbals

Instead of hanging a lamp from a beam, lamps from 1600-1900 were sometimes placed into gimbals or a holder that would pivot on two pins. First, a lamp was fitted into a circular brass ring. The ring was then connected to the ends of a u-shaped fitting with pins which allowed the lamp to swing back and forth. Finally, the arm of a wall mount was connected to the curved portion of the u-piece and the entire assembly was attached to a vertical surface (Figure A-20). To keep the lamp from rotating fully around, the base was often weighted. This system maintained the advantages of hanging, yet limited the distance the lamp could swing.

The Dutch East India Company favored a brass version with three wick-supports, a central fill hole which could be corked or covered with a screw cap, and a weighted base. In addition to the single example from the 1656 Vergulde Draeck (Green 1977:188-89), the best preserved example came from the 1613 wreck the Witte Leeu (Stenuit 1978:569); while another four were found on the 1629 Batavia (Stanbury 1974:19,21). The VOC used these lamps well into the eighteenth century. Company check lists dating from 1740-1750 included the lamps; plus the 1743 wreck of the Hollandia produced a gimbal ring and a handle (Gawronski et. al. 1992:96,283,432).

These brass lamps may have been used with chimneys as six were listed on the 1653 requisitions list for the Vergulde Draeck. A description of the chimneys was lacking and none were recovered from the wreck site. Yet, they were likely perforated
brass cylinders which rested on top of the gimbal-ring/lamp connection (Green 1977:188-89). One possible example of such a chimney was found on a fourth Dutch East India vessel, the Kennemerland wreck of 1664. The item, as described by R. Price and K. Muckelroy, was a “circular, brass, tray-like object with a copper rim 9.5 cm in diameter and 2-3 cm high,” (Price and Muckelroy 1974:264). While they speculate that the artifact was used on a lantern, it may have been placed on one of the gimbaled lamps favored by the VOC.

The Dutch were not the only ones to use a three wicked, brass, gimbaled oil lamp on their vessels. A similar lamp was found inside a barrel, along with iron tools and nails, from the wreck of La Belle; one of Sieur de La Salle’s 1687 exploration vessels recovered off the coast of Matagorda Bay, Texas. The location of the barrel and the accompanying artifacts suggests the lamp probably belonged to the Bos’n and provided illumination for internal ship repairs (Helen Dewolf, CRL at Texas A&M University and Pers. Observation, August 1999).

*Lanterns*

Evidence of lanterns is rare on wreck sites. Of the thirty wrecks listed on Table 3, only three produced evidence of lantern use with a single wooden example from each. The earliest was found on the 1545 English warship, the *Mary Rose*. It had a round base, a body with space for five rows of panes (probably horn), and a domed top with the hanging ring missing (McKee 1982:134). A similar lantern, with panes of oiled linen and horn, was recovered from the wreck site of the 1588 Armada transport *La Trinidad*
Valencera (Bingman and Bingman 1984:346). The final lantern, a nearly intact artifact, was found on the Portuguese San Antonio de Tanna (1687) in an area that was probably the bos'n's store. The body was octagonal measuring roughly 8 inches (20.3 cm) wide at the base and 13 inches (33.0 cm) high at the neck. It had shell panes, an access door in the back, a domed top with ventilation holes, and a hanging ring (Piercy 1977:336,338).

In contrast to the small amount of information gleaned from wreck sites, contemporary descriptions list large numbers of lanterns on ships. William Falconer (1769:lan-lar) describes horn-lanterns as “a well known machine, of which there are many used in a ship.” This is exemplified by the 100 plus lanterns which were reportedly on the Vergulde Draeck in 1653. Similarly, check lists for Dutch East Indiamen between 1740-1750 have spaces for several types of lanterns including battle-lanterns, those which used multi-wicked peg-lamps, small and large hand-lanterns and dark-lanterns. Additional hand-lanterns were also found in the steward’s locker; while dark-lanterns were stored in the master-at-arms’ locker (Gawronski et. al. 1992:95,190,205).

Vessels of war also carried great numbers of lanterns with a large portion related to the cannons. On a French seventy-four-gun-ship in the 1780's, the gun-room lantern was brass, square based, glazed with glass, and lit by a peg-lamp with four wicks. It measured 10 inches (25.4 cm) square at the base and was 14.5 inches (36.8 cm) high at the neck (Boudriot 1986:125-26). The gunner was also responsible for the placement and maintenance of numerous other lanterns; each made of tin plate, painted with a red ochre and lit with yellow wax candles (Boudriot 1986:125-26). First, he was to maintain the twenty-four horn or battle-lanterns on the gun-deck. These measured 10 inches (25.4
cm) square and 12 inches (30.5 cm) high at the neck. Second, he and his crew were given eight circular hand-lanterns, called clear-lanterns, which were 7 inches (17.8 cm) in diameter, 10 inches (25.4 cm) high, and glazed with horn. Finally, the gunner controlled the use of three dark-lanterns which measured 5 ½ inches (14.0 cm) in diameter, 8 inches (20.3 cm) high and had twisting bases and bulls-eye lenses (Boudriot 1986:175-76).

Texts written by officers of the Royal Navy describe what some of the British lanterns looked like. Hand-lanterns were made of tin plate and horn, with a cylindrical body and a conical top with ventilation holes and a loop at the peak for easy carrying. The larger sized hand-lanterns were 7 inches (17.8 cm) in diameter, 14 inches (35.6 cm) high at the neck and could be bought for 1L 10s per dozen in 1729 (Blanckley 1750:15, 29, 89 and Sutherland 1729:255). Other lanterns were made for specific places in the ship such as the triangular lantern placed in the bulkhead between the boatswain’s and carpenter’s store-rooms which illuminated both areas. Each side measured 11 inches (27.9 cm) wide and 1 foot 9 inches (53.3 cm) high and was glazed with four panes (Blanckley 1750:89-90 and O’Dea 1958:84). The historical accounts of numbers and descriptions of ship-board lanterns prove that the housings provided the majority of the daily illumination on vessels from 1500-1800.

Lighting on Ships: A.D. 1800-1900

During this period of great technological development, many older styled lighting implements were used alongside the new. On the nineteen ships listed in Table 4, devices ranged from lard-lamps and candles, to upright-wick lamps, to electric lighting.
Table 4
Ships with Illuminants: A.D. 1800-1903
Organized by Date

<table>
<thead>
<tr>
<th>Ship/Wreck</th>
<th>Ship Type</th>
<th>Date A.D.</th>
<th>Lighting Implements</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH 49</td>
<td>Netherlands Cargo Vessel</td>
<td>1810</td>
<td>1 wall mounted spout-lamp. 1 possible candle holder.</td>
<td>Van Holk 1996:90</td>
</tr>
<tr>
<td><em>Turtle Shell Wreck</em></td>
<td>Gunboat</td>
<td>1820's</td>
<td>Paul Revere lantern in port storage compartment.</td>
<td>Hollingshead 1981:203</td>
</tr>
<tr>
<td><em>Kent</em></td>
<td>English Troopship</td>
<td>1825</td>
<td>lantern use - dropped into spilled whiskey caused fire.</td>
<td>Ritchie 1996:110</td>
</tr>
<tr>
<td><em>Pilgrim</em></td>
<td>English Merchantman</td>
<td>1834</td>
<td>oil-lamp use - in forecastle</td>
<td>Dana 1841:52-53,100</td>
</tr>
<tr>
<td><em>Alert</em></td>
<td>English Merchantman</td>
<td>1834</td>
<td>oil-lamp use - in forecastle</td>
<td>Dana 1841:216-17</td>
</tr>
<tr>
<td><em>Ocean Monarch</em></td>
<td>English Sailing Packet</td>
<td>1848</td>
<td>candle use - dropped into flammable material caused fire.</td>
<td>Ritchie 1996:151</td>
</tr>
<tr>
<td><em>Donald McKay</em></td>
<td>U.S. Sailing Packet</td>
<td>1850's</td>
<td>1 brass oil-lamp, gimbaled with glass globe.</td>
<td>Woodside 1984:52</td>
</tr>
<tr>
<td><em>USS Kearsarge</em></td>
<td>Union Battleship</td>
<td>1860's</td>
<td>1 lantern with lard oil-lamp.</td>
<td>Hayward 1923:57</td>
</tr>
<tr>
<td><em>CSS Alabama</em></td>
<td>Confederate Kilder</td>
<td>1864</td>
<td>1 gimbaled oil lamp with a weighted base.</td>
<td>Guerout 1994:78</td>
</tr>
<tr>
<td><em>HL Hunley</em></td>
<td>Confederate Submarine</td>
<td>1864</td>
<td>candle use - for illumination of the compass and steerage.</td>
<td>Murphy 1998:92</td>
</tr>
<tr>
<td><em>De Zeehond</em></td>
<td>Netherlands Cargo Vessel</td>
<td>1880</td>
<td>1 oil-lamp.</td>
<td>Van Holk 1996:91</td>
</tr>
<tr>
<td><em>SS Columbia</em></td>
<td>Steamboat</td>
<td>1880</td>
<td>electric-lamps, Edison style.</td>
<td>O’Dea 1958:87</td>
</tr>
<tr>
<td><em>City of Richmond</em></td>
<td>Steamboat</td>
<td>1881</td>
<td>electric-lamps, Swan style.</td>
<td>O’Dea 1958:87</td>
</tr>
<tr>
<td><em>Latina</em></td>
<td>Netherlands Cargo Vessel</td>
<td>1888</td>
<td>1 flat candle stick 1 cheap- or lard- lamp 1 oil-lamp 1 pr. lamp tweezers</td>
<td>Peirce 1955:226</td>
</tr>
</tbody>
</table>
with in a span of only twenty years. Unfortunately, only seven of the ships were wreck
sites while the rest were indicated by brief, and often inconclusive, historical references
When the nineteenth-century becomes more distant to our modern eyes, the supply of
archaeological resources for this era will grow. Until that time, clues of ship-board
illumination can be taken from the available historical texts and documents.

Candles, Lanterns, and Slanted-Wick Oil-Lamps

With the technological advances in waxes and wicks developed between 1800-
1900, candle use on ships would have been even more desirable than in any other
previous century. Maintenance concerns were practically eliminated by affordable
composite and paraffin candles with snuffless wicks. Yet, proof of these items on ships
is often rather thin. It is known that candles were used on certain vessels as they were
implicated in the fires that destroyed the steamer Phoenix (1819) and the immigrant
packet Ocean Monarch (1848). Only two wreck sites on Table 4 produced solid
evidence of candle use on private vessels during the nineteenth century. Both were cargo
carriers from Flevoland, The Netherlands. The wreck NH 49 (1810) produced one
possible candle holder; while excavators found a single flat holder on the site of De

Military vessels also continued to use candles as an economical light source. This
is exemplified by two Confederate wreck sites. First, the submarine vessel the HL
Hunley was known to run with a single candle to illuminate the compass, steering wheel
and diving lever. A candle also provided a means to monitor oxygen levels when the
vessel was submerged (Murphy 1998:92). The second wreck was the blockade runner CSS *Ella* which produced a single brass chamber stick. Keeping with seafaring tradition, the item was likely used by the ship’s officers or captain (Watts and Bright 1973:134-35).

The trail of information for lanterns is also scarce. It begins with a nearly intact, perforated, tin lantern found in a port storage compartment on the Turtle Shell wreck, an 1820's American gun-boat (Hollingshead 1981:203). Since these vessels were small and open, a perforated style lantern was a good choice. It not only protected a flame from strong gusts of wind, but was also small enough for easy storage. The historical record gives a few indications of lantern use from this period as well. One example is the lantern blamed for the fire that destroyed the 1825 British troopship the *Kent*. Finally, private antique collections hold a number of historic lanterns including the brass horn-lantern taken off the 1865 English merchantman *Mathilda* (Haws 1975:156) and the brass "Magazine Safety Lantern" from the Union battleship USS *Kearsarge* which had a large bulls-eye lens and a copper, broad wicked, lard lamp (Hayward 1923:57).

Although the old fashioned, slanted-wick lamps were not as common as candles during this century, they were still used in many regions as an affordable means of illumination. As such, they also may have been used on merchant vessels. Several contemporary accounts, including those tales related by R. Dana Jr. and J. Conrad described above, state that one or two oil-lamps were used by crewmen in the forecastles. Unfortunately, the type of oil-lamp used was not an important enough detail for either author to describe. While these lamps may have been upright-wick variations, it is also likely that companies would have utilized the most inexpensive means of lighting for the
crew and used a slanted-wick lamp.

There are four ships with artifactual remains of open lamps on Table 4. The first was the lard-lamp found in the lantern of the USS Kearsarge. Since lard would have created a large amount of smoke and required a high degree of maintenance, it is difficult to believe that this type of lamp was used by the Union on a regular basis, especially in a lantern for the magazine. Lard was, however, easy and cheap to obtain and the use of this lamp may indicate a cost cutting measure taken by the Union Navy.

The other three vessels with open lamps were all wrecks from Flevoland, The Netherlands. The wreck NH 49, an 1810 cargo vessel, produced a wall mounted spout-lamp or “wandsnoteus.” From the site of the cargo carrier De Zeehond, dated to 1880, a single oil-lamp was recovered (Van Holk 1996:90-91). The largest illumination collection from this period was found on the site of the cargo vessel Lutina (1888). In addition to lamp tweezers, a “slush-lamp” (lard-lamp) and a hanging oil-lamp were uncovered. Since a candle holder and two deck-light lenses were also found on this wreck, it can be assumed that the captain/owner’s living space was continually well lit (Reinders 1985:92).

New Inventions in Lighting

Many of the lighting innovations developed were quickly adopted on ships from 1800-1900. The first, the upright-wick burner, was quite popular on vessels throughout the century. Often the burner was placed in gimbals with a weighted base and topped with a glass globe. These gimbaled lamps were frequently used by sailing packets and
clipper ships of the 1850's such as the *Donald McKay* (Woodside 1984:52). From 1857-1872, owners of vessels on the Ohio River were able to purchase similar lamps from Howan and Company of Cincinnati for a wholesale price of twelve dollars per dozen (Knittle 1984:26). Military vessels also found use for upright-wick lamps in gimbals. One was recovered from the 1864 blockade runner CSS *Alabama*, minus the glass globe. Due to its location, this lamp probably illuminated the captain's cabin (Guerout 1994:78).

The next set of lighting innovations was rarely, if ever, used on ships. Fuels which were more volatile than whale-oil were universally avoided for obvious fire safety reasons. This reluctance was often extended toward coal gas. Although gas lighting was available commercially by 1805, only the larger steam ships on the Great Lakes, Mississippi and Hudson Rivers, or great passenger liners similar to the 1843 SS *Great Britain* used gas-burners. On Lake Champlain, they were not used at all until 1888 when the first gas-lamps were installed in the luxurious state-rooms of the steamer *Chateaugay* (Hill 1976:249).

In contrast, electrical lamps were installed on ships soon after Swan and Edison perfected the filament. The first was the 1880 SS *Columbia* which used a small number of Edison lamps. The following year, sixty Swan lamps were placed on the Inman Company's *City of Richmond* to provide general lighting for the steamer (O'Dea 1958:87). The 1903 *Vermont III* was the first vessel on Lake Champlain fully illuminated with electricity (Hill 1976:250). Electric lighting quickly became popular on ships for several reasons. Ships with steam engines already had a built-in power source for generating electricity which made the system easy and affordable to install. Also,
electric-lamps needed no tending, were safer than an open-flame, and were reliable in all kinds of weather. The success of the electrical filament lamp on those first ships encouraged other shipwrights and owners to install the lamps on their own ships which marked the end of open-flame illumination on seafaring vessels.

Binnacles

To ensure a ship maintained its proper course, it was vital that the compass was visible to those in the steerage day and night. The compass was, therefore, set into a box with its own lamp or candle and placed before the helm. This housing was called a binnacle or, by English sailors through the eighteenth-century, bittacle which was a probable bastardization of the French word “habitable” for small habitation (Falconer 1769:bil-bin). Since iron would foul the compass, the binnacle was made entirely of wood and/or brass with a small window set in one side for viewing the compass. Placing a lamp or candle inside the box next to the compass accomplished two things. First, the flame was protected from wet and windy weather. Second, while the compass card was fully illuminated, only a limited amount of light was allowed into the rest of the steerage where it could interfere with the helmsman’s night vision (Blanckley 1750:9, Falconer 1769:bil-bin, Manwayring 1644:9, O’Dea 1958:86 and Smith 1627:11).

From the fifteenth through the seventeenth centuries, the binnacle was merely a small, wooden box with a hole in one side. One passenger on a Spanish merchantman observed that the housing resembled a stand for a gentleman’s chamber pot (Phillips 1986:155 and Phillips 1990:12). The binnacle recovered from the stern of the 1565 Red
Bay wreck roughly fits this description. The wooden box had a non-glazed window with a notch in the upper edge which acted as a lubber’s point. Other marks included a chess board pattern incised in the top and a charred area inside from the flame of what was likely a whale-oil lamp (Grenier 1985:63,65 and Grenier 1988:79).

On Spanish vessels in the sixteenth-century, lighting the binnacle lamp or candle was not only part of the daily routine, but was treated as a type of ritual. After the evening meal, one of the pages brought a light to the compass housing intoning, “Amen and God give us good night, good voyage, good passage for the ship, sir captain and master and good company.” Two other pages would then recite the evening prayers (Phillips 1986:160). Through the night, one of the apprentices was charged with keeping the binnacle light burning (Phillips 1986:143).

Seventeenth-century vessels were also concerned with ensuring the compass remained lit. Four compass lamps were listed on the 1653 requisitions list of the Vergulde Draeck (Green 1977:350). While only one lamp would have been used at a time, illuminating the compass was important enough to carry extras. This apparently became a tradition since numerous compass lamps remained a regular part of the ship’s equipment and the steward’s chest on Dutch East India vessels as shown by VOC check lists from 1740-1750 (Gawronski et. al. 1992:96,191). Captains of English vessels reportedly favored lamps filled with the best whale-oil for the binnacle since the fuel burned bright and only needed trimming every twelve hours (O’Dea 1958:87).

During the eighteenth-century, binnacles were often made with two compasses to further guarantee the ship was heading in the proper direction. The double-binnacle was
a small cabinet with three inner compartments which were separated by thin, wooden, glass glazed frames which slid into place from the top. The two outer compartments each held a gimbaled compass, while the middle section held a small, upright-wicked lamp also set in gimbals. When the lamp was lit, the light shone through the glass panes onto both compass cards. These cabinets often had drawers and sections in the sides to store log-glasses, watch-glasses, log-books and other important papers (Boudriot 1988:123 and Falconer 1769:bil-bin).

By the beginning of the nineteenth-century, the British Navy began using a binnacle with a sealable, upright-wick lamp inside a small, ventilated compartment that was attached to the outside of the housing above the compass. Light shone down onto the compass through a small, glazed window. In the 1850’s, a condenser lens or a thick semi-spherical piece of glass, often replaced the flat, glass pane which amplified the amount of light the compass received (O’Dea 1958:86-87). After 1880, safe, reliable, and maintenance free electrical illumination began to be installed on ships and the binnacle was probably one of the first places to receive an electric-lamp.

Light-Rooms and Light-Wells

Due to the explosive nature of gun-powder, special care was taken to store the substance on board any vessel which carried cannons. During the seventeenth-century, the powder was placed in a separate store-room as far from the use of fire as possible, typically in the bow. Often a separate place to fill the cartridges or filling-room was also created. These rooms were sparingly lit by a single candle in a horn-lantern (Falconer
After 1702, a better solution was developed. An opening was cut into the bulkhead of the magazine, glazed with a thick pane of glass, and sealed with putty. A large lantern was then placed before the bulk-head window on the opposite side of the powder-room. The space where the lantern was kept was called a light-room, which was large enough to allow a person but could be of most any size and shape, or a light-well, which was a small indentation in the bulk-head much like a bay window. Light-rooms and -wells provided safe illumination for the powder-room from a completely separate compartment; this allowed the men to fill kegs or cartridges without any explosive results (Lavery 1987:146).

Eighteenth-century ship-wrights of the Royal Navy typically installed a light-room in the bow and on the deck above the magazine. This placed the light-room window high on the magazine wall which not only kept the flame far from the powder, but also evenly dispersed the light throughout the magazine. Later examples of light-rooms were triangular in shape and had two windows; one to port and one to star-board. A double windowed light-room allowed illumination to both sides of a large magazine or a filling-room on one side and the magazine on the other (Goodwin 1987:124, Lavery 1987:146 and Ollivier 1737:147-49).

French and the Dutch war vessels usually placed their magazines in the stern and lit them through light-wells. The window in the well was glazed with glass 2 inches (5.1 cm) thick, sealed with putty, and protected from accidental breakage by a grate of cross-hatched, brass dowels. A lantern was then placed on a shelf or hung on a hook in front of
the glass. This system allowed the lantern to light the passage to the magazine on one side and the magazine itself on the other (Boudriot 1986:57 and Ollivier 1737:147-49).

Occasionally, special lanterns were used in to illuminate the spaces where powder was stored. A powder-room lantern, described by T. R. Blanckley (1750:90) of the Royal Navy, was six sided and glazed with four stone-ground glass panes per side. To catch any wayward sparks, the lantern was placed over a water filled cistern lined with lead. From 1740-1750, ships working for the Dutch East India Company used a large octagonal, powder-room lantern made of copper. Mirrors were mounted inside the lantern which reflected back additional light into the room; plus a lead pan filled with water was placed beneath the lantern for added safety (Gawronski et. al. 1992:184). In French warships of the late eighteenth-century, the light-well lantern was tin, square, glazed with glass, and lit with a square, four-wicked peg-lamp filled with olive- or fish-oil. Each side of the base measured 12 inches (30.5 cm) and the neck was 18 inches (45.7 cm) high. When not in use, the lantern was kept in a wooden box with a sliding lid (Boudriot 1986:125-26).
NATURAL LIGHTING ON SHIPS

The growing demand of illumination on multi-decked vessels built after 1500 was answered not only by the increase of lighting implements, but also by the use of natural lighting or sunlight directed into the ship through openings in the deck and hull. Since natural lighting reduced the danger of fire, it was considered very desirable as long as the openings could be covered or sealed against harsh weather. William Sutherland (1729:255) aptly summed up the situation:

“Glazing is rather for conveyency to accomodate places, than any ways for strength or service, to make houses conspicuous and delightsome, which otherwise would be dark and obscure, provided the weather, as wet and cold, was kept out.”

There were basically two types of natural lighting: 1) openings, glazed and unglazed, through the sides of the hull in the form of gun-ports, scuttles, stern-lights and portals, and 2) those placed into the deck such as gratings, sky-lights, and deck-lights.

Openings in the Hull: Gun-Ports to Portals

Although it was not developed as a source of natural illumination, an open gun-port was the first means of letting sunlight into the interior of a ship beyond an open hatch-way. Gun-ports were relatively simple to construct. A hole, approximately 30 inches square (76.2 cm), was cut through the side of the hull at least 9 feet (2.74 m) above the water. The ship's frames were used as the sides, or munitions, of the port while horizontal timbers, or sills, were inserted as the top and bottom edges. A solid, wooden lid was fit snugly into the port when it was not in use (Barnaby 1860:149-50, Howard
While these ports would have added ventilation and illumination during battle, they were also often left open in non-combat situations. Between the sixteenth and eighteenth centuries, port-lids were considered unnecessary in fair weather on all but the lowest deck. Gun-ports located in officers’ cabins or the ward-room were typically covered with special double-door lids or a lid cut in half horizontally which opened outwards and was kept open by a hook and eye-bolt. A few of these lids had a circle cut out of the center where the two halves met so it would close around the cannon barrel. These special port-lids allowed the occupants easy access to light and air while still maintaining security for the ship (Boudriot 1986:50, Goodwin 1987:189 and Ollivier 1737 LXXXVIII:92).

Eventually, crew members were also given the benefit of easy access to natural illumination. In 1778, the Royal Navy Admiralty ordered hinges, hooks and eye-bolts placed on every port lid on the gun-deck. In addition, small ventilation scuttles, holes with a sliding metal covers, were also installed into the lids. This proved so effective that in 1789 hinges and scuttles were placed on gun-port lids throughout the ship (Howard 1979:181). There was even an attempt to bring sunlight into the gun-deck while the lids were securely in place. In 1809 thick, semi-spherical, glass lenses called Illuminators (discussed below) were placed into the lids of British vessels beside the ventilation scuttles (Lavery 1987:139-40). Yet, glass and cannon balls did not mix and the use of lenses in port-lids was short lived.
Sashes

After 1700, the split gun-port lids in the ward-room and the great cabin were replaced with sashes or two removable frames, one glazed with glass and the other covered with a wooden shutter. Sashes were not only pleasant to look at, but they allowed officers to choose between a fully open port which let in light and air, a port that let only light through when only the glazed frame was in place, or protection against rough weather when both frames covered the hole.

Two methods were used to keep a sash open. The first was the traditional hinge, hook and eye-bolt method which secured the open frames to the deck-head or other ship's timber. The hinges were placed either at the top of the frames so they would swing inwards and upwards, or on each side which allowed them to swing inward and to the sides (Lavery 1987:176-77 and Ollivier 1737 CLXVII:158-59).

The second opening method, the sliding sash, was used by the Royal Navy as early as 1737. For each frame, a cord was strung through a channel cut into the munion. Counter balanced, lead weights were then attached to the cord ends which allowed the coverings to slide up and down. By the end of the century, the sliding sash was also used by other navies such as the French who placed them in the great cabins of war-ships in the 1780's. Sashes began to fall out of favor after the beginning of the nineteenth-century. As the guns were permanently removed from the officer's rooms, the openings were either made into fixed-lights, glazed and sealed openings, or mock-lights, solid hull sections painted over to look like fixed-lights (Boudriot 1986:66, Boudriot 1988:45-47, Goodwin 1987:190, Lavery 1987:176-77 and Ollivier 1737 CLXVII:158-59).
Scuttles

After gun-ports became an accepted ship construct, other sections of the hull, especially in the stern, began to be removed to admit air or sunlight. One example was the large ventilation scuttles which were unglazed and covered with a solid, hinged lid. While the main function of a scuttle was to allow air into the hold, many were large enough to let in light as well. In 1737, British scuttles measured 2 feet (61.0 cm) long and 10 to 13 inches (25.4-33.0 cm) high while French versions tended to be slightly larger. Both the British and the French had scuttles placed in the port and starboard sides of the ward-room, great cabin, and dining-room. (Ollivier 1737 CLXVII:159).

Stern-Lights

The first holes cut into the hull of a vessel specifically for natural illumination may have been glazed openings in the transom or stern-lights. A stern-light began as an opening cut between the transom supports which were planked over with pine and rabbetted to accept an oak frame. Panes of muscovy or glass were then set into surrounds of lead or tin-plate, tacked into the frame, and sealed with strips of glued paper. Since water sometimes splashed against a stern-light, gutters and a small hole were carved into the base of the frame and lined with lead to allow any trapped moisture to escape (Boudriot 1986:45,66). During bad weather or high seas, stern-lights were often guarded with dead-lights or wooden covers which fit into the openings to block waves which might break into the cabin or ward-room (Falconer 1769:dea-dea).

As muscovy was less expensive than plate-glass until after the 1690's, stern-lights
of the sixteenth and seventeenth-century were typically glazed with the small, diamond shaped, mica sheets. A few rare ships did use glass such as the Katerine Pleasaunce built in 1519 for Henry VIII and Katerine of Aragon. The lights in this vessel took 112 feet (34.14 m) of sheet-glass, eighteen window bars or small, thick, glass plates and two panes of the King's Arms or stained glass panels (Friel 1985:78). The use of this much glass, however, was unique and reflected the opulence of one king.

After 1691, the availability and the size of plate-glass grew steadily. Yet, until glass production again improved in the late 1800's, smaller panes were still used in stern-lights. As the ship rolled over the waves, the lights were placed under constantly changing pressure. The panes needed to be thick and small enough to endure the strain. If a ship-wright wished to double the width of each pane, he would have to purchase plates that were also twice as thick if the panes were to survive when the ship was out on the open sea. This amounted to four times the amount of glass which meant more than four times the purchasing cost. In 1729, a glass pane 9 inches (22.9 cm) square cost 1s 3d, while another 18 inches (45.7 cm) square and twice as thick was as much as 11s 9d (Sutherland 1729:257).

How many stern-lights were placed in a transom depended on the size of the vessel. British first or second rate vessels of the eighteenth-century had three decks each with five to six stern-lights and two mock-lights in front of the galleries. Meanwhile, 60- and 74-gun-ships had two decks with four to five stern-lights plus two false windows, and 40-50 gun-ships had only four lights per deck (Falconer 1769:ste-ste, Haws 1975:111 and Ollivier 1737 CLXVII:158-59). These lights measured 20 inches (50.8
cm) square and were installed to provide illumination for the great cabin, the captain’s
day cabin and the ward-room (Falconer 1769:ste-ste and Ollivier 1737 CLXVII:159).

Stern-lights on French vessels of the same century were smaller in size, but
similarly placed (Ollivier 1737 CLXVII:159). A war-ship capable of carrying 74 guns
had six stern-lights and four mock-lights for each of its two decks along the transom. On
each side of the aft portion of the vessel, three additional sections per deck were installed
which looked like stern-lights. In the captain’s cabin and the day cabin of the upper
deck, the forward most of these sections were mock-lights, the middle ones were fixed-
lights, and those furthest aft were doors for access to the gallery balcony. On the lower
deck, each side of the ward-room had two mock-lights, one fore and one aft, while the
upper half of each middle section was glazed and opened like a sash (Boudroit 1986:50).

Portals

During the nineteenth-century, small openings placed into the sides of the hull or
a deck structure were called port-lights or portals. There were two basic types of
portals: 1) a flat glass lens fixed permanently into the side planking, and 2) a set of
hinged doors, one glazed and the other solid, similar to the larger gun-port sashes. Fixed
portals, owing their introduction to the Illuminator in 1809 (see Deck-Lights below),
were popular on many private vessels including American fishing schooners where they
were placed on each side of the main cabin. A glass lens, measuring 6 to 7 inches wide
(15.2-17.8 cm) and 1 inch (2.54 cm) thick, was set into a hole cut into the side planking
that was rabbeted and lined with white lead to help seal the opening. The lens was then
secured by a wooden frame tacked to the remaining planking. In the early portions of the
century, schooners used square or rectangular lenses similar to those used in the decks of
fishing and cargo vessels found off the coast of Flevoland, the Netherlands (see below).
After the 1870's, round and octagonal shaped lenses came into use and were fitted with
frames of iron instead of wood. Hinged port-lights, which let in air as well as light, did
not appear on fishing schooners until after 1895 and then were used only occasionally
(Chapelle 1973:570).

In contrast, passenger and merchant vessels often used an opening portal. There
was a hinged port-light for almost every out-board cabin of the SS *Great Britain*, a 322
foot (98.15 m) long passenger liner built in 1843 (Ball and Wright 1981:16-19, Blake
sixteen round port-lights each 9 inches (22.9 cm) in diameter with one glass and one
solid cover hinged on the same side (Figure A-21). These covers could either be
proped open or securely shut with a latch (Roberts 1982:32-41 and Tom Oertling,
Galveston Seaport Museum 11/3/5 pers. comm).

Openings in the Deck: Gratings, Sky-Lights and Deck-Lights

Similar to the first openings (gun-ports) in the side of the hull, natural lighting
through the deck was first achieved by openings designed for other means. Hatches and
companion-ways each allowed in a certain amount of light, especially when the sun was
directly over head. The benefits of natural lighting were not disregarded by ship-wrights.
First, they utilized the openings that were already present by placing gratings, or a lattice
of flat wooden battens, over open hatches. Later, other natural light openings were placed into the deck in the form of sky-lights and deck-lights

*Gratings*

Sir Henry Manwayring (1664:46) describes gratings as “small ledges laid over one crosse another like a portcullisse or a prison gate.” This arrangement allowed the crew to walk over the hatch area yet still admitted air and light to the area below. As such, gratings were especially popular over the gun-deck where fired cannons created large amounts of smoke. A tarpawling, or piece of tarred canvas, was often stretched over a grating during foul weather or rough seas to keep the lower decks dry (Blankley 1750:168, Manwayring 1664:46 and Sutherland 1729:78,285).

Construction of a grating was simple. Squared slats of wood or ledges were tacked laterally onto a slightly crowned, rectangular, wooden frame. Notches were cut into the ledges to accept the longitudinal wooden strips or cross battens which were also tacked into place. The finished frame was then set into a recess in the coaming, or a raised border 3 to 12 inches (7.6-30.5 cm) high around the edge of the of the hatch which kept water running on the deck from pouring into the hold (Blankley 1750:40,66, Howard 1979:112,187,190, Lavery 1987:185,238-40 and Smith 1627:7).

The width of the spaces between the cross battens and ledges was the subject of a minor debate during the eighteenth-century. In 1731, Dutch and English vessels had spaces measuring approximately 4 inches (10.2 cm) square while the French had spaces no larger than 2 ⅜ inches (6.4 cm) square. The larger width, English and Dutch ship-
wrights claimed, provided the hold with more illumination and fresh air. Yet, the master
ship-wright to the King of France, Blaise Ollivier (1737 CVII:101-02), declared that the
differences in light and ventilation was minimal and the smaller spaces were more
comfortable to walk on. The British stood by their gratings and kept the spacing roughly
4 inches (10.2 cm) until the nineteenth-century when they were reduced to an average of
3 inches (7.6 cm) (Blanckley 1750:66 and Lavery 1987:238-40).

Sky-Lights

Sky-lights appeared on the decks of ships early in the eighteenth-century and
were soon known by two basic terms. The first was the companion or a long, wooden
rectangular box with panes of glass set into the top or sides which sat six to twelve
inches (15.2-30.5 cm) above the level of the deck. Companions were typically placed in
the stern of the main deck, often over the captain’s cabin. The second sky-light type was
the box-light which came in two forms. The first was literally a small box (roughly 36
inches or 91.4 cm square) with a glazed top or sides which was placed on the roof of a
deck structure. The second box form was much larger, often measuring 4 x 6 x 3 feet or
1.22 x 1.83 x 0.91 m. These lights had glass panes or lenses in the top and were located
on the decks of many non-military vessels.

Companions

Before 1746, the term companion referred to a structure on the quarter deck of a
small number of English ships that gave the helmsman a view of the sail. Then, when
the captain's cabin was moved from the upper deck to the quarter deck and a sky-light was placed over the cabin, the term began to be used to indicate the new light. As any sky-light took up valuable deck space, entities like the Royal Navy Board were initially reluctant to use them. The convenience of natural lighting prevailed, however, and the Board ordered companions placed over the steerage on all frigates and before the mizzen mast on all 300 ton sloops in 1779 (Lavery 1987:243).

Two early examples of sky-lights, installed on English war-ships by 1737, appear to be forerunners to the companion. The first was a wooden box 1 foot (30.5 cm) high with a row of glass panes in the aft side placed over the opening above the galley (Ollivier 1737 CLXVII:158). The second sky-light was placed over the dining-room and was a cross between a grating, as B. Ollivier (1737 CLXVII:159) called it, and a sliding sash-light. The ship-wright further describes the light as being made by “window frames glazed with panes of glass which slide between two munions in such a manner that they can be removed if required.” These two versions, one fixed and glazed on the sides and the other glazed on top and opening to allow in air, were mimicked on later war vessels.

The most popular type of companion from the latter portion of the eighteenth-century through the nineteenth-century was a rectangular box which measured 3 ft x 5 ft x 7 in (91.4 x 152.4 x 17.8 cm). The top was flat and solid, while three of the sides each held five fixed panes (Figures A-22 and A-23). This arrangement not only let light into the area below, but also allowed officers or sailors to utilize the space by stepping on top of the box. Occasionally, the fixed panes were placed into the top of the box. While this meant less available deck space, more light was let into the cabin on the lower deck and
the structure was able to sit closer to the deck.

A few companion variations also provided ventilation. The top of a box, with similar dimensions as the one above, was split length-wise and made into two glazed, hinged doors which could be propped open. Alternatively, the cover was split in half diagonally then hinged together in the center which enabled the panel to fold open (Lavery 1987:16,243).

Merchant vessels of the eighteenth and nineteenth centuries also used companions. In 1769, William Falconer (1769:com-com) defines companion as “a sort of wooden porch placed over the entrance or stair case of the master’s cabin in a merchant-ship.” An example of this can be seen on the 1877 barque the Elissa. Its companion has a flat wooden top and panes on three sides which illuminated the stair and entry way to the officers’ cabins (Figure A-23).

Many merchant vessels and passenger liners, such as the Elissa and the 1843 SS Great Britain, also had tall versions of the companion set over the main stair-wells called companion-way covers. A cover was tall enough to admit an average sized person into the stair-well, while panes of glass set into each side allowed sunlight to safely illuminate the passage (Figures A-22 and A-24) (Roberts 1982:32-41 and pers. observation 10-15-96). As stair-way covers were large and bulky structures on a deck, they do not appear to have been used on military vessels.

Box-Lights

While companions lit areas in the stern on warships and stairways on merchant
vessels and passenger liners, box-lights were used everywhere else. Nineteenth-century America fishing schooners often used the smaller box type. A single small wooden box-light was placed on top of the main cabin 3 feet (91.4 cm) from the fore end of the roof. This light was 36 inches (91.4 cm) square with solid sides and a slanted top. Two panes of glass 1/4 inch (0.6 cm) thick were set into the top and protected by a set of quarter inch (.06 cm) brass or iron rods (Chapelle 1973:615). After 1865, ship-wrights of schooners began installing a box-light with a solid, sightly crowned top and rectangular glass panes in the port and star-board sides that were protected by metal rods running fore and aft. Some of these lights had glass panes on all four sides, while others sported hinged lids that could be propped open for ventilation (Chapelle 1973:615).

Large wooden box-lights were often used on passenger ships and, occasionally, on exploration vessels during the nineteenth and into the twentieth-century. A prime example is the well-known 1843 passenger liner SS Great Britain which carried twenty large sky-lights; eleven in the after portion of the vessel and nine in the bow and the area over the engine (Ball and Wright 1981:16-19, Blake 1989:88 and Corlett 1990:68-71). Most of these were rectangular in shape measuring 4 feet by 6 feet (1.22 x 1.83 m) and sat approximately waist high on the weather deck. The sides were solid sides and the tops were glazed with glass panes.

Directly below each stern sky-light, in the promenade and saloon, was a large wooden frame with the same dimensions as the box-light above called a light-well (similar to the magazine wells on French and Dutch war-ships as they both let light through from one space to another). Instead of glass in the top, the frames of the wells
were cross-hatched with brass bars. This not only kept passengers from toppling over to the deck below but also allowed air and light to continue further down into the dining-room. This sky-light/light-well system gave illumination to passageways, cabins on the promenade deck, and the dining-room tables on the lower deck (Ball and Wright 1989:88, Blake 1981:16-19 and Corlett 1990:68-71).

Similar box-lights may have been used on the American steamer *Central America*. In 1857, the ship foundered off of the coast of Savannah, Georgia while carrying 600 passengers and $1,600,000 worth of cargo. The crew of a Swedish bark were first on the scene and found sixty survivors. These lucky few had been able to cling to a floating sky-light, a few doors, and other bits of debris (Sherman 1875:135-36).

Large sky-lights were also used on exploration vessels such as the *Discovery* which braved portions of the Antarctic. When the ship was built in 1901, a number of box-lights with solid sides were installed over the galley, engine-room and the wardroom. Some of the tops were slanted and others were flat, but each had a hinged lid fixed with as many as fifteen circular, glass lenses (Figures A-25 and A-26). Unlike other sky-lights, these were placed under a light deck structure to keep off heavy snow which would dampen the light and make ventilation difficult. As supplies on such a mission would have been limited, the more natural light used the better (Kevin Robinson pers. comm. 10-27-95 to 11-15-95).

*Deck-Lights*

One of the most innovative developments in natural lighting did not appear until
early in the nineteenth-century in the form of the deck-light or a glass lens placed into a hole in the deck. This innovation was introduced as the “Illuminator” in 1807 when Apsley Pellatt of London received a patent. Since that time, deck-lights have been used on board wooden vessels in many shapes and sizes. Several have even appeared as a part of a removable fixture for ventilation purposes.

The Illuminator

Pellatt described his Illuminator as a solid piece of glass with a circular flat base and a convex top, or basically a large lens approximately 5 inches (12.7 cm) in diameter and 1 inch (2.5 cm) thick in the middle. The semi-spherical glass was placed convex side up into a square or circular frame made of wood or metal, then sealed with glaziers' putty or other type of cement. This frame/lens assembly was then set into a rabbeted deck or side plank (Figure A-27) (Pellatt 1807:321-23).

The convex side of the lens was intended to protrude slightly above the plank in order to catch the rays of light from the sun. Pellatt warns that one side of the lens should remain unpolished to prevent it from becoming a "burning glass" when rays from the sun were concentrated through it. The inventor’s vision was that the Illuminator would be placed as a sealable fixture into the previously solid lidded ports and scuttles, sky-light sides or tops instead of glass panes, and closed decks. He even suggests placing hinges on the frames so that they might be opened to admit air (Pellatt 1807:321-23). This vision has proven to be amazingly accurate.

This new innovation was not called the Illuminator for long. By 1812, the
assembly was referred to as the "Patent-light" alluding to the fact that the lens had been officially patented. By that year, the wooden/metal frame was often omitted. Instead, the lens was placed (still convex side up) directly onto the rabbet. Then a brass or copper collar was placed around the lens and tacked to the deck to keep the lens in place (Figure A-27). This arrangement was often nick-named the "Bull’s Eye Light" since the shape of the lens and the surrounding metal rim was reminiscent of a large eye (Crisman 1992:50 and Vlierman 1994:319).

Another change in the Patent-light appeared around 1818. Certain ship-wrights began installing the deck-lights with the lens inverted so the convex side was placed down into the planking. This allowed the fixture to lay flush with the deck which was a great improvement. A protruding lens often made footing tricky for deck hands (Crisman 1992:50 and Preston 1818:358).

As with many new innovations, the military was the first to utilize the Illuminator/ Patent-light. The English navy placed them in gun-ports in 1809 and, soon after, used them as portals and deck-lights in several war-ships (Lavery 1987:139-40). The British schooner Tecumseth (1815-27), built for the War of 1812 and recovered in 1953 from Georgian Bay of Lake Huron, was fitted with at least two deck-lights. While Erich Heinold of Texas A&M University was carefully going through the artifact assemblage recovered from the wreck, he found two semi-spherical lenses. The lenses were 4 3/4 to 5 inches (12.1-12.7 cm) in diameter and 1 3/8 inches (3.5 cm) thick. Each base was stone-ground and wear marks suggest they were placed convex side up into the deck. One lens had the British arrow stamped in it. Documents used for the vessel’s
construction indicate the lenses were probably placed over the magazine to safely illuminate that area during day-light hours (Heinold pers. comm. 10/1/1997).

On the other side of the war, the young United States navy also found use for the Patent-light. In 1814, at least three U.S. warships had decks with the lenses: the brigs Jefferson and Jones, and the row galley Allen. During excavations of the U.S. brig Jefferson, built by Henry Eckford on Lake Ontario, two pale green glass lenses and a copper collar were recovered in the vicinity of the main mast. The lenses were flat on one side, convex on the other, and measured 5 3/4 inches (14.6 cm) in diameter and 1 3/4 inches (4.5 cm) thick. Due to the copper collar and the wear marks on the glass, the lights were installed by the bulls-eye method or convex side up with the collar secured to the planking by brass tacks (Crisman 1992:50).

According to historical documents, six Patent-lights were also issued to the brig the Jones, the sister ship of the Jefferson. Two of these were used to cast sunlight into the binnacle. In addition, the commander of the lake squadron, Captain Isaac Chauncey, ordered six dozen Patent-lights from his agent in New York City in February of 1814. Since at least three kegs of the lights were delivered to Sacket’s Harbor that spring, several more vessels built that year on Lake Ontario were probably furnished with Pellatt’s invention (Crisman 1992:48-50).

Other U.S. ship-wrights also used Patent-lights. Excavations of the row galley Allen, built by Noah Brown on Lake Champlain in 1814, produced a single thick green glass fragment similar to the lenses recovered from the Jefferson (Emery 1996:134). This lens was probably located over the magazine to provide safe, day-time illumination
to the powder stores. As the quarters on a gunboat were extremely tight; however, a
deck-light, which eliminated the need for a bulky lantern, would have been useful in
several places on the Allen (Eric Emery 1995 pers. comm.).

The semi-spherical lenses were also popular on private vessels during the
nineteenth-century. In Two Years Before the Mast, Dana (1841:168) describes the
forecastle of the merchantman Alert as large, clean and "tolerably well lighted by bull's-
eyes...it was far better than the little, black, dirty hole in which I had lived so may
months aboard the Pilgrim." Since his inspection was carried out during the day and the
Alert crew was only allowed one lamp at night, the bull's-eyes were obviously deck-
lights using Patent lenses and copper collars.

Ship-wrights of fishing vessels also found the Patent-light useful. A semi-
spherical, glass lens with beveled and ground edges was recovered near the stern post of
a fishing vessel wreck (post 1875) located off the coast of Flevoland, the Netherlands
(Figure A-28a). Use wear indicates the convex portion of the lens protruded above the
level of the deck, plus the word "Patent" was stamped into the flat underside (Vlierman
1994:322). A smaller, semi-spherical lens, with no "Patent" markings, was found on
another wrecked fishing vessel at Flevoland, the 1876 De Twee Gebroeders. This lens
was recovered amidships on the port-side and, according to wear marks, set in the deck
convex side up (Figure A-28d) (Vlierman 1994:321-22 and Vleirman 1995:152,158).
By this time, however, other shapes of lenses were also being used such as the flat,
square lens (see below) also found on the De Twee Gebroeders.
Flat Lenses

After the Patent-light began to be inverted so the entire assembly laid flush with the deck, a semi-spherical shape was no longer necessary. All that was required was a flat, thick piece of glass. One of the earliest examples of a flat lens comes from the 1864 Confederate submarine HL Hunley. Five pairs, round in shape, were used in the top of the hull between the snorkel box and the aft hatch. Each lens was 2.5 inches (6.35 cm) in diameter and placed 5.0 inches (12.7 cm) on either side of the center-line of the vessel. The aft-most, port light was complete with an 0.5 inch (1.25 cm) collar. As it is unlikely that this lens was the only one installed with a collar, the other nine probably had them also (Murphy 1998:80). These "dead-lights" would have provided the crew with shafts of sun-light while the Hunley was on the surface of the water. They may also, however, have been the vessel's undoing. Light from a candle, which illuminated the compass and acted as an oxygen gauge, could be seen shining through the aft-most lights while the vessel was underway. This allowed enemy ships to target the vulnerable vessel even when it was completely submerged (Murphy 1998:92,103).

Several other examples of flat lenses were found among the wrecks at Flevoland. One was a circular lens with two flat sides recovered from a 1876 cargo vessel named the Koopmans Welvaren. One side, presumably the side facing up in the deck, had a raised checkered pattern (Figure A-28b) which was probably an attempt to create a safer deck-light. When the smooth surface of a regular glass lens was wet it became extremely slippery. A checkered surface could have provided a sailor additional traction in wet conditions (Vlierman 1994:322 and Vleirman 1995:152,158).
Square, flat lenses were probably developed after shipwrights discovered that a better seal could be made for a deck-light fixture if it was placed into a single plank instead of multi-planks. Since a square shape fits into a single plank more easily than a circle, square lenses appeared. An intact example of a square lens was found in situ in the forward port-side of the deck on the 1876 Flevoland fishing vessel De Twee Gebroeders. The light was laid flush with the deck and snugly placed into a single plank (Figure A-28c) (Vlierman 1994:321-22 and Vleirman 1995:152,158).

If keeping the lens in one deck plank was beneficial, then the best way to increase the size of the lens with out risking more leaks was to make it longer instead of wider. Thus, the rectangular lens was created. Not only did a rectangular shape let in more light, but it reputedly broke less often than square ones. A good example of a flat, rectangular lens was found in the star-board berth of another cargo vessel at Flevoland, the Lutina, dated 1888 (Figure A-28e). The second lens from the Lutina, found amidships, was a rectangular deck-prism (Figure A-28f); the next step in deck-light evolution (Vlierman 1994:322 and Vleirman 1995:152,158).

Prism Deck-Lights

In the middle of the nineteenth-century, it was found that a lens with a faceted under side (perhaps first tried on the convex portion of a Patent-light) created a prism effect which would refract rays of sunlight into the far corners of the hold below. Prism deck-lights came in two shapes. The first, more popular version, had a hexagonal top with a base of six slanted triangles laid side to side which converged to a point at the
distal end (Figure A-29). The second prism had a flat rectangular top with an elongated, inverted pyramid base such as the recovered example from the *Lutina* (Figure A-28f).

Deck-prisms were more efficient at capturing light than other lens types for two reasons: 1) they were able to cast light further into the recesses of the hold and 2) they were effective at catching rays of light even when the sun was low in the sky. In November of 1995 Norm Thomas of the Lawrence Livermore National Laboratory conducted an optical analysis on a replica of one of the hexagonal deck-prisms from the *Charles W. Morgan* (1841). He found that when the sun was at an angle less than 38 degrees to the lens, the light was reflected nearly vertically into the hold. When the sun was at an angle greater than 38 degrees to the lens, however, the light was bounced into the hold back in the general direction of the sun (Norman Thomas 1995, pers. comm.).

Exactly when the hexagonal prism came into use is unknown. Currently, the earliest example comes from the whaler *Charles W. Morgan*, built in 1841, which had several prisms placed in its deck. Each measured 4 in (10.2 cm) across the top, 4 in (10.2 cm) high and weighed approximately 3 lbs (1.36 Kg). Like their predecessors, the prisms were set into rabbets in the deck and held in place by copper frames screwed into the planking (Leavitt 1973:3,58). After 1850, the hexagonal prism became popular on other vessels such as American fishing schooners (Chapelle 1973:438).

The rectangular shaped prisms may not have been as popular as their hexagonal cousins, yet they were utilized on many nineteenth-century vessels and were also efficient at reflecting rays of light below the deck. During the 1978-82 restoration of the 1877 *Elissa*, at least ten rectangular prisms were found which had been installed in the
stern over the officers quarters (Figures A-22 and A-30). Since moon-light refracted through the prism was bright enough to keep the officers awake, each cabin with a prism was also furnished with a sliding, wooden panel to cover the glass during sleeping hours (Tom Oertling and the Texas Seaport Museum Staff, Galveston 1996, pers. comm.).

Ventilating Deck-Lights

In 1818 another type of deck-light appeared known as the ventilating deck-light. In that year, Grant Preston received a patent (1819:141) for an innovation he called the Portable Deck-Light which expanded Pellatt's original idea of combining a fixed lens with ventilation. Preston suggests placing a screw-rim, or a brass or copper tube with interior threading, into the deck as a fixture. A semi-spherical, glass lens would then be set, convex side down, into a slightly smaller screw-rim with threading on the outside so it could be twisted into the first. Finally, a vent with a safety grate was fixed into an additional threaded collar and mounted below the glass. The lens and the vent were each "made to screw either right or left, so that when the glass is wanted to be taken out for air, it only rests with the person or persons below to take hold of the handles and unscrew it; it may then be hung on a hook, to prevent rolling about," (Preston 1819:141).

This form of deck-light was praised soon after its introduction by people who tried it on their vessels. They complimented the design as being easy to use, watertight even in rough weather, and able to provide sufficient ventilation in fair weather (Preston 1818:358-60). Evidence suggests, however, that the ventilating deck-light was not widely used on sea going vessels in the first half of the nineteenth-century.
One of the earliest known examples of Preston's innovation dates to nearly fifty years after its introduction on the USS Monitor built in 1862. Construction plans for the Monitor show that deck-lights provided the primary source of natural illumination. There were nine rectangular lenses placed in the stern and sixteen round lights in the bow (Peterkin 1985:61). Since the deck sat near the waterline, these lights would have let light into the interior portions of the ship, yet still kept out any water that would inevitably wash over the hull. Although the rectangular lights were probably fixed prisms, the round ones seem to have been the Portable Deck-Light variety. During an early reconnaissance of the vessel, divers located a round deck-light in a brass frame. The glass of this fixture appeared flat on top and the rim was raised above the deck in the same fashion as Preston described. Also recovered from the vessel was a deck-light cover which was used to protect the light and crew during battle (Watts 1981:32,100).

Ventilating deck-lights were apparently considered a success on the Monitor since they were used on later monitor-class vessels. An account by Alvah Hunter, who served aboard the Nahant in 1862-63, describes "two score of dead-lights" or forty lights. They were, Hunter states, circular windows that gave light to the state-rooms, the great cabin, the ward-room, and the berth-deck. Each light was made of a circular plate of thick glass with a beveled edge. A rubber gasket was placed around the bevel, then the glass was enclosed by a metal frame. Instead of being screwed in and out of place for ventilation, the frame was hinged on one side so it would swing open. It was then held in position by a large thumb-screw on the other side. When the ship went into battle, the lights were anchored into place from below by "hooking a stout hook into an equally
stout eye-bolt." The vibration from the guns, however, caused many lights to loosen and Hunter and his crew mates had to tie each hook into its eye-bolt with piece of rope to ensure they remained closed. To protect the glass lenses from being shattered from the outside, circular covers, made from two inch (2.54 cm) thick iron plates, were placed over the lights before the vessel went into action (Hunter 1987:17-18).

According to Hunter, the illumination produced by these deck-lights was pleasing to the eye. As water washed over the deck it made for a

"very curious and interesting lighting effect in the rooms beneath. The water twisted about and boiled in the dead-light cavity, and, being more or less charged with air bubbles, the constantly changing shades of green light were a pleasure to study" (Hunter 1987:17-18).

The green color of the light suggests that green colored glass was used in the deck-lights reminiscent of the lenses used in the Jefferson fifty years prior.

Although not as popular as fixed lights, the ventilating deck-light was in use as late as 1901. In that year, twenty-eight circular deck-lights were placed on the arctic exploration vessel the Discovery so that each could be opened from below deck with a screw fitting (Figure A-31). In many of the individual cabins, the deck-light was the only source of natural light and ventilation. The crew of the Discovery called these lights "ankle-biters" since they sat a good 10 to 15 centimeters above the level of the deck, just the right height to catch ankles. While these deck-light/ventilators were a bit taller than Preston proposed in his patent, they seemed to have a similar type of screw/ventilation mechanism (Kevin Robinson 1995, pers. comm.).
CONCLUSION

By utilizing pertinent material from the historical and archaeological record, this thesis has briefly traced the development of lighting from oil-lamps to candles to lanterns to the various means of natural illumination. The types of implements and where they were used on ships was also discussed. Through it all, there have been glimpses of how illumination added to daily life on sea-faring vessels.

Until this point, the subject of illumination has been looked at in pieces with the evolution and use of each genre considered separately. How, then, were these items used as an entire ship-board illumination system? After a brief summary of the lighting practices used on ships through A.D. 400-1900, a look at how one type of ship used open-flame and natural lighting together through a twenty-four hour period will provide an over-all picture of illumination on a seafaring vessel.

Summary of Ship-Board Lighting Practices Through Time

Previous to the year A.D. 400, oil-lamps were used exclusively on land and ships alike. As vessel size was small, only a few lamps were needed to provide light for the crew in the evening hours. Through the centuries between A.D. 400-1900 this slowly changed from a continued reliance on lamps until 1500, to a preference for candles between 1500 and 1800, to the use of new innovations including the electric filament lamp from 1800-1900.
A.D. 400-1500

During the centuries from A.D. 400-1100, the lighting implement of choice on ships was the ceramic oil-lamp which followed over a thousand years of lighting tradition. The average 2.1 lamps recovered from wreck sites dated to this period were usually found in the galley or other living areas; plus many had charred nozzles which indicate they were used before the ship sank. Although there has been no evidence of lantern housings or hanging devices recovered from these sites, both items were probably used for safety and convenience. Natural lighting on vessels from this period was limited to those rays which found their way into the hold through open hatches such as the ones typically over the galley and the cargo hold.

From 1100-1500, there was little historical and archaeological evidence of shipboard illumination available. During this period there was a change in terrestrial illumination practices from a reliance on the oil-lamp to an over all popularity of the candle. When this attitude was adopted onto ships is unknown. Future wreck excavations from these centuries will hopefully provide important clues in this mystery.

A.D. 1500-1800

Between 1505 and 1510, gun-ports were added to vessels which created increasingly larger ships, both military and private, which in turn enlarged the need for illumination below decks. As shown by historical documents, large numbers of lighting implements were used on ships built between 1500 and 1800. On some vessels, over a hundred lanterns were used by they crew while candles in holders were reserved for the
officers. Lamps, meanwhile, were reserved for specialized uses such as hanging lamps for the sick or those placed in gimbals for the steward or in the compass housing. Only a small percentage of these items, however, were recovered from wreck sites. Although ships were larger, the devices would have been placed high in the hull where they would have rarely survived the site formation process.

Another change in ship-building came in the form of the intentional use of natural illumination. Allowing sunlight into the inner portions of the hold not only cut the costs of lighting during the day, but also reduced the risk of fire. Although lidded gun-ports and gratings over pre-existing hatches were the first means of letting natural light into the hull, by 1519 stern-lights were installed in the transoms of ships while scuttles, glazed sashes and various sky-lights were in use by the early 1700's.

To further limit the hazard of fire, a ships' officers strictly regulated how lighting was conducted. This included limiting the distribution of lighting devices and supplies, where the devices were allowed, and who was to use them. Typical rules included the restriction of any unguarded light below decks, the exclusion of any type of light in a storage area, a general lights out after the evening meal, regular checks to ensure the lights remained out, and the assignment of specific fire-stations if an accidental blaze did start. On a ship that carried cannons, lighting was also carefully governed in the magazine where explosive gun-powder and shells were kept. The creation of light-rooms and light-wells after 1702 fully separated the powder-room from its light source, a large lantern, by a bulk-head with a window glazed with a thick pane of glass. Another specialized use of lighting on ships was the lamp or candle placed inside the binnacle
which illuminated the ship's compass throughout the night. This ensured the vessel always remained on its proper course.

A.D. 1800-1900

The century between 1800-1900 witnessed numerous innovations in lighting technology. With the exception of those lamps which burned more flammable fuels, such as Porter's Fluid or even coal gas and kerosene, these innovations were quickly placed on ships. The upright-wick burner was popular on commercial and military vessels alike as it allowed for a sealable reservoir which could be set into gimbals. Advances in candle waxes and wicks eliminated maintenance concerns and produced a high quality product for less money. While these candles were probably used on ships, their remains have yet to be found on a wreck site.

The introduction of the Illuminator, in 1807, gave natural lighting on ships a great boost. This semi-spherical lens and frame/collar combination was placed into decks as a fixed or ventilating deck-light, hull sides as a fixed or hinged portal, and the tops of large sky-lights. Fixed lights were sealed with putty or cement which kept out any unwanted water, while lenses fit into a hinged cover or screw-collar allowed fresh air into the ship as well as sunlight. In time, circular, square and rectangular flat lens shapes were also utilized in fixtures for portals or the deck. After 1841, numerous deck-lenses were made with a prismatic base; either hexagonal with six slanted triangles converging to a point as a base or rectangular with a pyramid base. These prisms would direct light into cabin corners even when the sun was low in the sky.
Electrical filament lamps were placed on ships as early as 1880. As 1900 approached, more and more vessels opted for electrical illumination since it was safe, clean and maintenance free. This was especially true on steamers which were able to use their engines to generate the necessary power. Soon, electric lighting replaced all forms of open-flame illumination on land and on ships.

*A Day and a Night in the Illumination of a Ship*

A ship of war needed to illuminate the powder-room and the gun-deck in addition to carrying most of the open-flame and natural lighting devices discussed. As such, a Western European war vessel from the beginning of the nineteenth-century gives a great example of how all forms of lighting were used together on a typical ship. On a peaceful day when the sun was shining, everyone had plenty of light to work and live by. The captain’s cabin and day-cabin had two doors which opened to the gallery balcony, two glazed sliding sashes, four to six stern-lights and the companion above. On the deck below, the officers’ cabins and the ward-room were also well lit with two opening scuttles, numerous sliding sashes over the gun-ports, and four to six stern-lights. Crewmen working on the gun-deck could take advantage of sunlight streaming in from the openings through the gratings over the hatches and any open gun-port. In the magazine, sailors may have been able to see to their work more efficiently due to a number of well placed deck-lights. While sailors were rarely in their berths during the day, those in the fore-castle may have been provided extra illumination with deck-lights placed in the bow.
When the weather turned foul or as the ship went into battle, ventilation and illumination were both greatly diminished. During the initial stages of a storm, the captain and officers could close the doors, sashes and scuttles, but would still benefit from light through the glazed stern-lights and sashes. As conditions worsened, all of the glass panes would have been covered with dead-lights or wooden shutters leaving the areas dark yet dry. With the exception of a few possible deck-lights, there were no glazed openings for the rest of the crew. Sailors had to either cover the open gun-ports with solid lids and the hatch ways with a large tarpawling or get wet as the storm raged.

During battle, any glazed opening was covered with its dead-light. Meanwhile, the gun-ports were left open for the cannon muzzles and scuttles were left open for ventilation. As smoke from the cannons typically filled the gun-deck, however, an opening would only minimally improve lighting or ventilation conditions while the guns were being used.

Activities conducted below deck was done with the aid of lanterns lit by tallow or yellow wax candles. These were controlled by the purser and distributed by the steward and the steward’s assistant. While the carpenter and the boatswain would work on deck when possible, each had lanterns to conduct repairs needed inside the hold. In addition, their individual store-rooms may have been lit by a lantern placed in an unglazed opening in the bulkhead between the rooms. The ship’s surgeon also needed illumination during the day since the sick-bay was below the fore-castle. Hanging or gimbaled oil-lamps were favored since they provided a bright, steady light for patient diagnosis and mixing prescriptions. If a deck-light was not available over the magazine,
the crew would use the light from a multi-wicked lamp in a lantern placed in the adjoining light-room or light-well as they filled cartridges and moved powder kegs. Finally, the gunner’s crew was assigned eight hand-lanterns which would have added illumination to the battle-lanterns already on the gun-deck when the enemy was engaged.

As evening fell, the officers gathered at the captain’s table for the evening meal then retired to the ward-room or their cabins using the bright flame from an unprotected candle in a brass holder. Meanwhile, illumination for the crew’s meal was supplied when the steward’s assistant distributed candles to the mess groups who placed them in the horn-lanterns hanging in the mess. After dinner, the crew was able to relax a bit under the light of a few lanterns on the gun-deck and one or two hanging lamps for those berthed in the fore-castle. At 9 pm, by order of the captain, all lights in unnecessary lanterns were extinguished, excluding candles being used by the officers, and all hands not on watch turned in to their hammocks. Each hour or after each watch, the master-at-arms or the mid-ship-man would tour the ship to ensure the lights were still out and report an “all’s well” to the steerage.

A number of ship-board lanterns were used throughout the night. Hand or horn-lanterns were available for those on deck responsible for the night watches. Plus, the navigator and the gunner were each given two dark-lanterns which allowed them to make their way to the steerage or gun-room as necessary. The navigator would also ensure the whale-oil lamp placed between the two compasses in the ship’s double-binnacle remained lit through the hours of darkness.

When the sun once again rose over the horizon, the lanterns on deck and the oil
lamp in the binnacle were extinguished. The candles from the officer's quarters, the
captain's table and the mess were collected and cleaned by the steward's assistant, and
lanterns were placed back into their boxes. Meanwhile, covers over the natural light
openings were removed and another day at sea began.

After 1500, lighting on ships was not limited to one device or item, but was
provided by numerous methods. Oil-lamps, candles, lanterns and openings through the
deck and hull for sunlight each brought light to different portions of the vessels during
different portions of the day. Together, enough illumination was provided for officers
and crew to work and live by during their long journeys at sea.
REFERENCES

ANGUS-BUTTERWORTH, L.M.

BADDELEY, W.

BAILEY, D.

BALL, ADRIAN AND DIANA WRIGHT

BARNABY, NATHANIAL

BASS, GEORGE
1986 A Bronze Age Shipwreck at Ulu Burun (Kas); 1984 Campaign. American Journal of Archaeology 90:269-96.

BASS, GEORGE AND FREDERICK VAN DOORNINCK JR.

BEAGLEHOLE, J. C. (Editor)

BENOIT, M. FERNAND
BERNIER, MARC-ANDRÉ

BINGEMAN, JOHN AND JANE BINGEMAN

BLAKE, JOE

BLANCKLEY, THOMAS RILEY
1750 A Naval Expositor Shewing and Explaining the Words and Terms of Art Belonging to the Parts, Qualities and Proportions of Building, Rigging, Furnishing, and Fitting a Ship for Sea. Printed by E. Owen, Warwick Lane, London.

BOUDRIOT, JEAN
1986 The Seventy-four Gun Ship II. Naval Institute Press, Annapolis Maryland.

BOUND, MENSUN

BOWEN, DANA THOMAS

B. W.
1666 A True and Exact Relation of the Most Dreadful and Remarkable Fires that Happened Since the Reign of King William the Conqueror to this Present Year 1666, in the Cities of London and Westminster and Other Parts of England. Printed by B. W. in Little S. Bartholomews Court in West-Smithfield, London.

CHAPELLE, HOWARD

CHARLESTON, R. J. AND L. M. ANGUS-BUTTERWORTH
CHARLIN, GEORGES, JEAN-MARIE GASSEND AND ROBERT LEQUÉMENT
1978 L'Épave Antique de la Baie de Cavalière (le Lavandou, Var).
Archaeonautica 2:35. Centre National de la Recherche Scientifique.

CHEVALIER, YVES AND CLAUDE SANTAMARIA

CHRISTIE'S

CONRAD, JOSEPH

COOKE, LAWRENCE (Editor)
1984 Lighting in America; From Colonial Rush-lights to Victorian Chandeliers. Main Street Press, Pittstown, New Jersey.

CORLETT, EVANS

CRISMAN, KEVIN

DANA, RICHARD HENRY, JR.

DE MAISONNEUVE, BERNARD

DE MELLO, ULYSSES PERNAMBUCANO
1979 The Shipwreck of the Galleon Sacramento 1668 off Brazil. IUNA 8.3:211-23.

DERRY, T., AND T. WILLIAMS
DOUGLAS, R. W.

EISEMAN, CYNTHIA AND BRUNILDE RIDGWAY
1987  The Porticello Shipwreck. Institute of Nautical Archaeology, Texas A&M University, College Station, Texas.

EMERY, ERIC
1996  "Gallies are Unquestionably the Best Description for the Northern Parts of this Lake." The Excavation and Study of the USN Row Galley Allen on Lake Champlain. SHA Underwater Archaeology 1996:134-139. S. James and C. Stanley, editors.

FALCONER, WILLIAM

FORBES, R. J.

FLAGELLUM DEI
1668  Flagellum Dei or a Collection of the Several Fires, Plagues and Pestilential Diseases that Have Happened in London Especially and Other Parts of this Nation from the Norman Conquest to this Present, 1668. No stated author. Printed for C. W., London.

FLECKER, MICHAEL

FRIEL, EIAN

GAWRONSKI, JERZY, BAS KIST AND ODILIA STOKVIS-VAN BOETZELAER
GIBBINS, DAVID

GINSBURG, BENJAMIN

GOODCHILD, R. G., AND R. J. FORBES

GOODWIN, PETER

GOWER, R. H.

GREEN, JEREMY (Editor)

GREEN, RICHARD
1979  The Lamp of Serce Liman. Unpublished Paper. Nautical Archaeology Library of the Anthropology Department, Texas A&M University, College Station, Texas.

GRENIER, ROBERT
GUEROUT, MAX

HALL, JEROME
1996  A Seventeenth-century Northern European Merchant Shipwreck in Monte Cristi Bay, Dominican Republic. Dissertation, Texas A&M University, College Station, Texas.

HARDEN, D. B.

HARRIS, W. V.

HAWS, DUNCAN

HAYWARD, ARTHUR

HEATHORN, T. B.

HILL, RALPH NADING
1976  Lake Champlain; Key to Victory. Countryman Press, Woodstock, Vermont.

HOLLINGSHEAD, KENNETH R.
HORTON, FRANK

HOWARD, FRANK

HUGHES, G. BERNARD

HUNTER, ALVAH

ISRAELI, YAEL AND URI AVIDA
1988 Oil-lamps from Eretz Israel; The Louis and Carmen Warschaw Collection at the Israel Museum, Jerusalem. Israel Museum, Jerusalem.

JENNINGS, EDWARD
1843 Hints on Sea Risk; Containing Some Practical Suggestions for Diminishing Maritime Losses Both of Life and Property; Addressed to Merchants, Ship-owners, and Mariners. Printed for R. B. Bate, London.

JONCHERAY, JEAN-PIERRE

KATZEV, MICHAEL

KATEV, SUSAN WOMER

KLEINGARDT, BRIDGET (Editor)
KNITTEL, RHEA

LAVERTY, BRIAN
1984 The Ship of the Line II. Naval Institute Press, Annapolis, Maryland.

LEAVITT, JOHN

LEWIS, MICHAEL

LIUO, B.

LIVADIE, C.

LONG, LUC

LOVE, JAMES
1735 The Mariner's Jewel or a Pocket Companion for the Ingenious. Printed for A. Bettesworth and C. Hitch at the Red Lion, London.

LUBBOCK, BASIL

LUCKIESH, M.
LYON, D. J.

MANWAYRING, SIR HENRY
1644 *The Sea-mans Dictionary or an Exposition and Demonstration of All the Parts and Things Belonging to a Ship, Together with an Explanation of All the Terms and Phrases Used in the Practice of Navigation*. Printed by G. M. for John Bellamy, London.

MARSDEN, PETER

MARTIN, COLIN J. M.

MATTHEWS, L. HARRISON

McBRIDE, P. AND D. WHITING

McCANN, ANNA MARGUERITE

McKEE, ALACANDER

MURPHY, LARRY E. (Editor)
1998 *HL Hunley Site Assessment*. National Park Service, Naval Historical Center, South Carolina Institute of Archaeology and Anthropology.

O’DEA, WILLIAM

OERTLING, THOMAS J.
1996 *Ship’s Bilge Pumps; A History of Their Development, 1500-1900*. Texas A&M University Press, College Station, Texas.
OLLIVIER, BLAISE
1737  *18th Century Shipbuilding; Remarks on the Navies of the English and Dutch from Observations Made at Their Dockyards in 1737 by Blaise Ollivier Master Shipwright of the King of France*. D. Roberts translator, Jean Boudriot Publications, East Sussex, England.

PARKER, A. J.

PELLATT, ASPLEY

PETERKIN, ERNEST

PHILLIPS, CARLA RAHN
1986  *Six Galleons for the King of Spain*. John Hopkins University Press, Baltimore, Maryland.
1990  *The Short Life of an Unlucky Spanish Galleon; Los Tres Reyes 1628-1634*. University of Minnesota Press, Minneapolis.

PIERCY, ROBIN,

POPE, DUDLEY

PRESTON, GRANT
PRESTON, GRANT (con't)

PRICE, RICHARD AND KEITH MUCKELROY

PULAK, CEMAL
1994 The Uluburun Shipwreck. Institute of Nautical Archaeology, Texas A&M University, College Station, Texas.

RATTRAY, JEANNETTE EDWARDS

REINDERS, REINDER

RICHARDSON, JOHN KIRK

RIDGELEY-NEVITT, CEDRIC

RITCHIE, DAVID

ROBERTS, DICK
1982 The Elissa Sails Again. Texas Highways 29.11:32-41
ROBINS, F. W.

RODRÍGUEZ-SALGADO, M. J. (Editor)

RULE, MARGRET

SABRIÈ, MARYSE AND RAYMOND SABRIÈ

SALISBURY, W.

SAMS, G. KENNETH

SAMUDA, J. D'AGUILAR

SAWISLAK, KAREN

SHADEL, JANE

SHERMAN, WILLIAM T.
SIBELLA, PATRICIA

SIMMONS, JOE J.

SOLIER, YVES AND G. F. LAVAGNE

SOLIER, YVES ET AL.

SMITH, JOHN

SMITH, ROGER C.

STANBURY, MYRA
1974 The Batavia Catalogue. Department of Maritime Archaeology Western Australia Museum, Perth, Western Australia: 19, 21.

STEFFY, J. RICHARD

STÉNUIT, ROBERT
SULLIVAN, CATHERINE
1986 *Legacy of the Machault: A Collection of 18th-century Artifacts*. Minister of Supply and Services Canada, Quebec, Canada.

SUSSMAN, VARDA

SUTHERLAND, WILLIAM
1729 *Britains Glory or Shipbuilding Unvail'd; Being a General Director for Building and Compleating the Said Machines*. Printed for A. Bettesworth at the Red Lyon, London.

TAILLIEZ, PHILIPPE

TANNER, J. R. (Editor)
1923 *Catalogue of the Pepysian Manuscripts; A Descriptive Catalogue of the Naval Manuscripts in the Pepysian Library* IV. Navy Records Society, London.

TAYLOR, F. SHERWOOD AND CHARLES SINGER

TCHERNIA, A. ET AL.

THWING, LEORY

TRUAX, WILLIAM J.
VAN HOLK, A. F. L.
1996 *Archeologie van de binnenvaart: Wonen en werken aan boord van binnenvaartschepen (1600-1900).* Scheeparcheologie IV. Nederlands Instituut voor Scheeps- en onderwaterArcheologie / ROB (NISA).

VINDRY, GEORGE

VITELLI, KAREN

VLIERMAN, KAREL

WACHSMAN, SHELLY
1997 *National Geographic Society Grant 5766-96. Exploration of Tantura Lagoon; Four Millennia of Seafaring; Final Report.* Institute of Nautical Archaeology, College Station, Texas.

WATERER, JOHN W.

WATKINS, LURA WOODSIDE

WATKINS, MALCOLM
WATTS, GORDON

WATTS, G. P., AND L. S. BRIGHT

WHITE, GILBERT

WINGOOD, ALLAN J.

WOODHEAD, E. I., C. SULLIVAN AND G. GUSSET
1984 *Lighting Devices in the National Reference Collection, Parks Canada.* Minister of Supply and Services Canada, Quebec.

WOODSIDE, CHARLES

WYANT, L. B.

XIMENES, SERGE

YARWOOD, DOREEN

ZACHARCHUK, WALTER
APPENDIX

FIGURE 1. A saucer-lamp from the Uluburun wreck (Drawing by C. Pulak).

FIGURE 3. Roman styled terracotta lamp from the wreck under the Tantura B wreck (Drawing by P. Sibella).

FIGURE 4. An open lamp with a z-shaped wick support. Not to scale.
FIGURE 5. An Arab lamp from the Byzantine period from the Tantura B wreck (Drawing by P. Sibella).

FIGURE 6. Sketch of a Medieval wheel-thrown lamp with a tubular spout and a loop-handle. Not to scale.

FIGURE 7. Sketch of a ceramic saucer-lamp on a pedestal with a drip-pan base and loop handle. Not to scale.
FIGURE 8. A single nozzled crusie with a wick. Not to Scale.


FIGURE 11. Peg-lamp with a hinged lid and a handle. Not to scale.

FIGURE 13. Pair of candle snuffers. Not to scale.


FIGURE 15. Socket holders: A) 13th century, Persian style-holder with a drip pan directly above a “trumpet” base, B) 14th century holder with a flared trumpet base, C) 17th century, “mid-drip stick” with a collar placed along the “baluster” or bubbled stem as a small drip pan, D) 18th century holder with the drip-collar on the rim of the socket, E) 18th century holder with a large drip pan in the base. Not to Scale (After Ginsberg 1984:92).
FIGURE 16. Sketch of a simple pricket candle-holder with a flat handle. Not to scale.

FIGURE 17. A typical chamber-stick, also called a hand-sconce. Not to scale (After Woodhead et al. 1984:21).

FIGURE 18. Four lanterns: A) horn-lantern, B) tin travel lantern with bulls-eye lenses, C) perforated tin lantern, and D) a dark lantern with a swinging door. Not to scale (After O'dea 1958: 73).
FIGURE 19. A dark-lantern with a twisting base and a bulbous lens. Not to scale.

FIGURE 20. A gimbal for a lamp including: ring, U-shaped piece, pins and wall mount. Next, a lamp would be mounted into the ring. Not to scale (After J. Green 1977:188).

FIGURE 22. View of the deck in the stern of the *Elissa*; deck-prisms shown on the port side, the companion to the left of the photo and a companion-way cover in the background (Photo by K. Quinn).
FIGURE 23. Port side of the Elissa's companion which illuminated the passage to the officer's cabins below (Photo by K. Quinn).

FIGURE 24. Companion-way cover on the Elissa (Photo by K. Quinn).
FIGURE 25. Flat-topped box-lights with fixed circular lenses on the deck of the *Discovery* (Photo by K. Robinson).

FIGURE 26. Slanted-topped box-lights under a protective covering on the *Discovery* (Photo by K. Robinson).
FIGURE 27. A semi-spherical lens placed in a rabbet in a deck and secured with a copper collar.

FIGURE 28. Six deck-light lenses from four wrecked ships off the coast of Flevoland, the Netherlands. A) Patent-light lens from a post 1875 fishing vessel, B) Flat, circular lens with checkered top from the 1876 cargo vessel Koopmans Welvaren, C) Flat, square lens found in situ on the 1876 fishing vessel De Twee Gebroeders, D) Semi-spherical lens also from the De Twee Gebroeders, E) Flat, rectangular lens from the 1888 cargo vessel Lutina, F) Rectangular deck-prism also from the Lutina (After Vlierman 1994:320).
FIGURE 29. Scaled drawing of a replica of the hexagonal deck-prisms found on the whaler *Charles W. Morgan*.

FIGURE 30. A rectangular deck-prism with a copper rim in the stern of the *Elissa* (Photo by K. Quinn).
FIGURE 31. A row of ventilating deck-lights or "ankle-biters" on the Discovery (Photo by K. Robinson).
VITA

KENDRA LEEANNE QUINN
1857 W. TENNESSEE
DENVER, COLORADO 80223

In December of 1990, I obtained a B.A. in Anthropology with a minor in History from Colorado State University. The next three years were spent gaining valuable field experience from various contract firms as a terrestrial archaeologist including:

- Geo-Marine, Inc., Plano, TX - crew member/lab personnel.
- Espey, Huston and Associates Inc., Austin, TX - crew member/scientific diver.
- Texas Archaeological Research Lab at University of Texas - crew member.
- Historic Sites Research, College Station, TX - crew chief/co-author of report.
- Northwestern State University, Alexandria, LA - crew chief/co-auth. of report.

I also was fortunate enough to gain experience working underwater: first at the submerged city of Port Royal, Jamaica (1692), second on a survey for wreck sites in the Galveston/Houston Ship Channel and, third on a mapping project of the freighter *Utina* (1910-1920) in the Corpus Christie Ship Channel, and fourth as an artifact photographer and INA Dive Master for the Bozburun Project (ninth century) off the Turkish coast.

Besides the two project reports I co-authored, a paper I wrote appears in the 1997 SHA Underwater Archaeology Conference proceedings titled “The Development of the Deck-Light During the Nineteenth Century.” The information in that work also appears in the final section of this thesis in an expanded and clarified version.

With a solid archaeological background, training in underwater excavation techniques, and a grasp of ship technologies, I hope to continue to work on underwater sites and add to the current body of knowledge on seafaring technology and ship life.