

Gilded pills in the medical chest on board the warship *Kronan*

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Two glass jars containing organic matter sprinkled with gold flakes, a bundle of gold foil and a hemi-spherical wooden bowl with traces of gold adhering to its concave inner surface have been recovered from the wreck of the 17th century Swedish man-of-war HMS *Kronan*. The finds provide evidence of the medical use of elemental gold on board. The pharmaceutical and medical significance of the finds has been deduced from their positions relative to other objects of unequivocal character. Samples of metal fragments from all four objects have been shown to be gold by energy dispersive spectroscopy in a scanning electron microscope (EDS/SEM). The wooden bowl is the lower half of an apothecary's tool for gilding (or silvering) pills, a procedure described in mid-late 17th century European textbooks on pharmaceuticals that requires a supply of gold (or silver) foil. Such pills and other similarly confected medications, together with their contexts, are likely to be connected with a specific social stratum of persons of rank, possibly belonging to the aristocratic officers on board the ship. One may also argue that the homogeneity of the medical contexts recovered at the wreck site, reflects the professional structure of medicine as a science at that time.

Keywords: *Kronan*, energy dispersive spectroscopy, gilded pills, pharmacy, scanning electron microscope, social stratum

Introduction

On June 1, 1676, the Swedish Navy was hit by one of its greatest disasters ever, when the royal ship *Kronan* ('The Royal Crown') exploded and sank off the east coast of Öland in the Baltic Sea during a battle against an allied Danish-Dutch fleet. Designed by the English shipwright Francis Sheldon the elder (1610–1692), the *Kronan* had been built on Skeppsholmen in Stockholm between 1665 and 1668. It was one of the largest sailing vessels in Europe, carrying 110–126 guns and a crew of 850 men (Zettersten 1903:574) and with a calculated displacement of 2000 to 2300 metric tons (Glete 1999:18). She was lost together with 800 men. The *Kronan* constituted a floating society, in terms of both crew numbers and social structure,

during a period when there was rarely a clear distinction between military and civilian society (Einarsson 1997a:209).

Together with three associates, Anders Franzén discovered and identified the wreck of the *Kronan* on August 8, 1980, lying at a depth of 26 m in a position 3.4 nautical miles due east of the village of Hulterstad on southeast Öland. In the spring of 1981, Kalmar County Museum was appointed to head the marine archaeological investigations. The finds in the wreck had been untouched for more than 300 years, and thus provide an on-the-spot account of life on board. After 27 years of continuous investigations, 85% (680 m²) of the wreck site has been investigated and more than 30 000 objects have been recovered to date (Einarsson 2008:3).

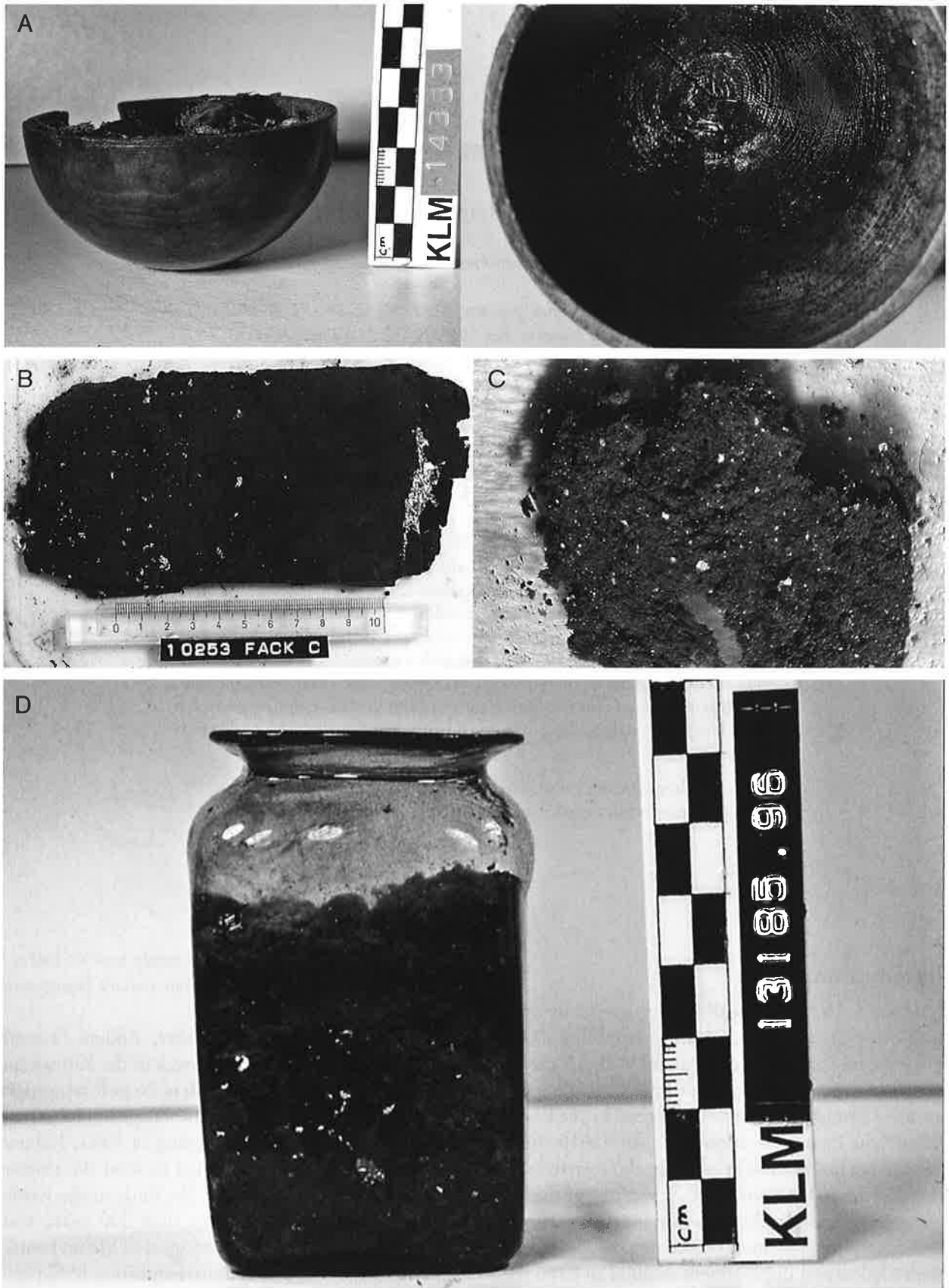


Figure 1. (a) The turned wooden bowl (scatula deauratoria), (b) The bundle of gold leaves. (c) Part of the contents of the isolated jar, (d) The jar from the medical chest with its contents. Photos by Max Jahrehorn, Kalmar County Museum.

Background to the present report

A significant potential exists in a shipwreck for coming as close as possible to the nature of the original object and its user. This potential is closely linked to the fact that a shipwreck often represents an unconditional deposit of information. No one has time to sift through carefully and purposefully what should be saved for posterity, and thus to consciously influence the image presented of the era in question. This is quite evident in the case of the Kronan (Einarsson 1990:279–297, 1997a:209ff). Although similar objects can be found in museums and private collections, they have often been manipulated and have undergone changes and modification, and the lack of context is often apparent. Shipwrecks are also mentioned as “microcosms”, societies in miniature. In order to determine the accuracy of the expression, it is important to first of all study the nature of the ship, and secondly the nature of the wreck. The study of the wreck itself should include one initial question: how representative is the wreck with its present material culture of the original ship and the society that produced it?

Among the findings from the 2004 excavations at the Kronan (Table 1) was a turned wooden bowl (Fig. 1a) with visible traces of what looked like gold in the bottom. Other discoveries of what appeared to be gold included a bundle of gold leaves (Fig. 1b) inside the remains of a partly fragmented medicinal chest discovered in 1996, an isolated glass jar (Fig 1c) recovered in 2002, and a second glass jar (Fig 1d) among the rich contents of a medical chest discovered in 2001. Both jars contained deposits of shavings that gleamed in the manner of gold. The wooden bowl (VI) was located on the orlop deck, without any apparent context, about 3 metres astern from where the medicinal chest of 2001 (III) had been discovered and approximately 2 metres forward of the partly fragmented chest of 1996 (I). The glass jar (V) was found less than 1 metre to one side of the medical chest (III), in which the second jar (IV) was located. A site plan showing the relative locations of the finds is shown in Fig. 2.

One purpose of this article is to argue that the artefacts and the materials they contain constitute a closed spatial context that was a functional one related to medical and pharmaceutical purposes. Moreover, the context is likely to reveal a connection with a specific social stratum on board the ship.

The use of gold and silver in medical preparations goes way back in history. The practice was already noted by Pliny around AD 60 and the inclusion of gold in

the Arab apothecary’s art was later nourished by the close connexion between pharmacy and alchemy. The “philosopher’s stone”, if ever discovered, was thought both to transmute base metals into gold and to provide the elixir of life (Chambers 1728:170–171; Cowen & Helfand, 1990:45).

Although ascribed to Avicenna (AD 980–1037) the practice of coating pills with precious metals is evidently of a much later date, as maintained in a recent article by Bela (2006:1–10). It was first mentioned in a non-medical book in 1626, while the earliest reference in the professional literature seems to have appeared only in the second half of the seventeenth century (de Bergeries 1673:117; Schröder 1693:344; Léméry 1697:433). The procedure of gilding/silvering pills and the tools used (*scatula deauratoria s. argentaria*) together with gold and silver leaves (*aurum et argentum foliatum*) are later described in standard textbooks such as *Lehrbuch der Apothekerkunst* (Hagen 1797:392–393).

Gold was included in pharmaceutical preparations either in its solid form (as a powder or shavings), or as dissolved salts, and preparations fortified with its powder or shavings were used during the 16th and 17th centuries mainly against syphilis and “the King’s evil” (*scrofula*, tuberculosis of the lymph glands). Gold leaves, *liminarum auri* or *aurum foliatum*, are found among the official substances in the two earliest Swedish pharmacopoeas, the *Pharmacopoea Holmiensis* of 1686 and *Pharmacopoea Svecica* of 1775 (*Collegium Medicum* 1686:163; *Collegium Medicum* 1775:6), in the latter case despite Linnaeus’ hesitations.

In the early eighteenth century it was questioned whether gold had any real medicinal properties

Table 1. Summary of finds.

Sample record KLM identification No	Denoted in the text as	Artefact	Year of Discovery
KLM 10253:1 Kr	I	fragmented chest	1996
KLM 10253:24 Kr	II	bundle of leaves	1996
KLM 13185:1 Kr	III	medicinal chest	2001
KLM 13185:96 Kr	IV	glass jar in chest	2001
KLM 13461:1 Kr	V	isolated glass jar	2002
KLM 14383 Kr	VI	wooden bowl	2004

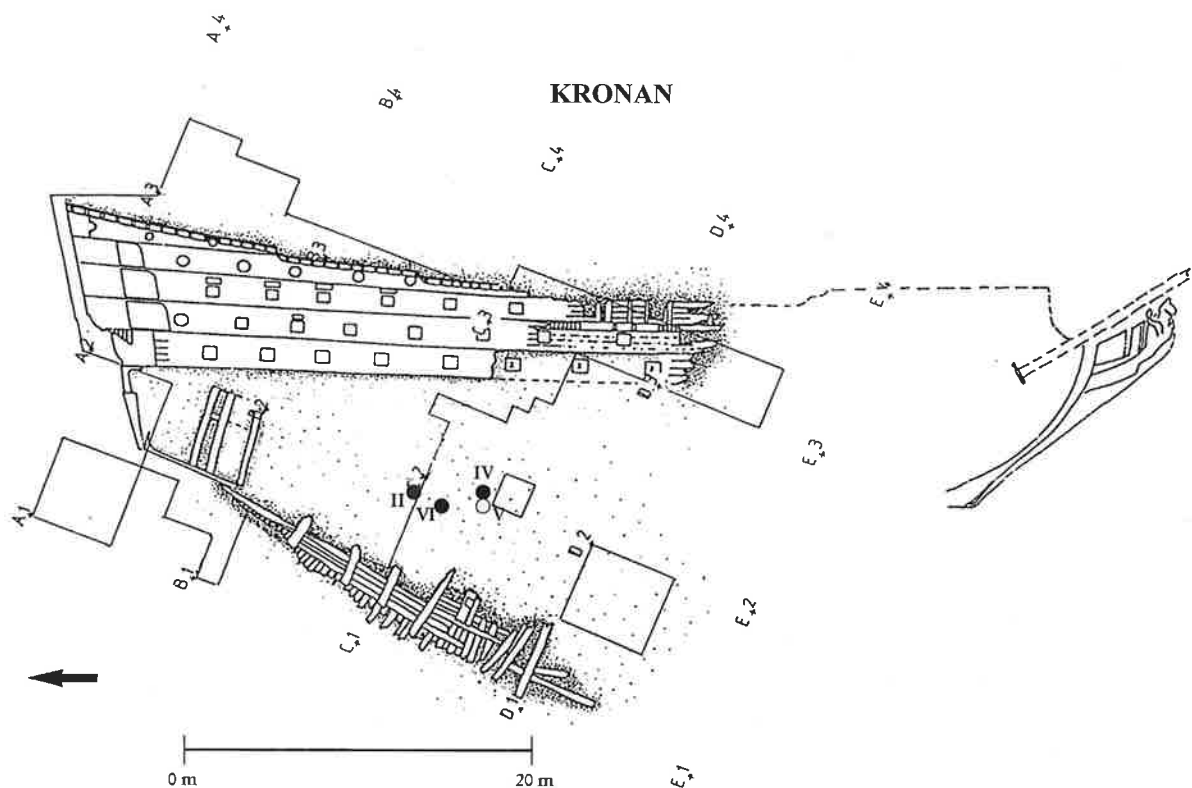


Figure 2. Site plan of Kronan, showing the distribution and relative location of the medicinal finds dealt with here. Drawing: L. Einarsson/Kalmar County Museum.

(Chambers 1728:170–171), and Linnaeus, in his *Materia medica in regno lapideo*, was later very sceptical about the usefulness of silver and gold (“vis = politica, usus = oeconomicus”, i.e. social characteristics but no medical ones) (Linnaeus 1752:22).

The modern reader may find it significant that Schröder considered only one of 33 pill compositions worth gilding, namely pills against hypochondria (pülulæ hypochondriacæ, Schröder 1693:344).

Materials

The wooden “bowl” constituted a hollow half-sphere, with inner and outer diameters of 77 and 84 mm, respectively. It had a dent on the edge, which graded to a minor crack towards its bottom, with traces conforming to gold adhering to the wood. This “gold” remained intact after preparation (cautious cleaning and treatment with 10% PEG-400), followed by freeze-drying.

The bundle of gold leaves, recovered in the summer of 1996, was found five years prior to the discovery and rescue of what was to be recognized as the major medical chest. The gold leaves were packed in a case 165×78×13 mm, made up of four thin wooden sheets, and the whole was included among the contents of a smaller, smashed chest, that otherwise contained a lump of a material resembling wax (weight 236 g), fragments of bottles and some ceramic jars. The glass jar was one of several similar square-bottomed green jars found in the medical chest. It measured 47×49.5×76 mm and had a volume of 120 ml. When recovered from the chest it was filled with a soft, fluffy, greyish material (of an organic nature), spiked with shavings that gleamed like gold. The other glass jar was recovered from the wreck site in the summer of 2002. Although found outside the medical chest, it was very similar in appearance to the first one, albeit considerably larger, measuring 92×93×182 mm, with a volume of 798 ml. Its contents comprised a fluffy,

greyish material, with a deep-red zone at the bottom, within which shavings, apparently of gold, were deposited. There was also a small wooden spatula left in the bottle.

Investigations

Energy dispersive spectrometry/scanning electron microscope analysis (EDS/SEM) was performed at the Glass Research Institute (Glafo) in Växjö, Sweden. The analyses were run on a Jeol JXA 840A scanning electron microscope equipped with an energy dispersive spectrometer and an Inca 300 analytical system (Oxford Instruments). Two to four squares (approx. $10 \times 15 \mu\text{m}$) of each sample were analysed and the results were normalised to 100%. The precision levels of the individual SEM analyses are given in Table 2.

Preparation of the samples for the EDS/SEM analysis comprised isolation, cleaning and fixation of the gold shavings. Loose shavings in the water container in which find II was stored were trapped and transferred to a small vessel containing a solution of 95% ethanol, excess ethanol was removed, and the sample (denoted A) was dried. The shavings with the appearance of gold in jar IV were isolated (denoted D) and similarly cleaned with 95% ethanol. Isolation of the shavings from find V was more difficult, as they stuck to the red substance, and therefore some of the material was boiled in diluted HCl (1:10), decanted and repeatedly cleaned with distilled water. A solution containing small, cleaned particles (denoted B) was finally sucked up into a pipette, deposited on a glass slide and dried. In the case of VI, a few gleaming "dandruff" particles were extracted from the bottom of the wooden bowl after its treatment with polyethylene glycol (PEG-400) and freeze-drying. Material from each sample was mounted on double-adhesive carbon tape and covered with a thin carbon layer prior to EDS/SEM analysis. All the samples were treated similarly in this respect.

Results

The results of the EDS/SEM analysis are summarised in Table 2. Gold was the most abundant element in all the samples, at amounts in the range 78% (VI:A) to 90% (IV:D), or 19–22 carats. Of the other metals, only small amounts of silver and copper, about 2–4%, were present in all of the samples. In terms of atomic ratios, oxygen stands out as the most abundant element (II:A and VI:A) or second most abundant element

(IV:D and V:B) in the samples, although its presence must relate to admixtures from secondary sources. The focus in planning the EDS/SEM analyses had been on determination of the metals present, primarily gold, and little attention was paid to carbon. Consequently, carbon was used in the fixation of the samples (cf. Investigations, above) and it was considered important to treat all the samples in the same manner. In a second set of calculations, in which carbon was also included in the analysis of the "dandruff sample" from the bowl (VI:A), which had the highest oxygen level, carbon can be seen at levels well above the background (i.e. those of V:B). Moreover, comparison on a molar basis showed the increase in carbon (2 atomic %) to be roughly twice that in oxygen (0.9 atomic %), which is consistent with contamination with PEG-400.

The material of the "bowl" is assumed to be birch wood. In view of the pharmaceutical-medical context of much of the recovered material at the actual wreck site, the "bowl", with its traces of gold is compatible with one half, probably the lower half, of a capsule for gilding pills, a process in which they were poured into a spherical receptacle, consisting of two hemispheres made of wood or horn, leaves of gold were added and the closed receptacle was then shaken (Hagen 1797:392–393). This would have been one possible purpose for the gold leaves of find II. The wooden sheets between which the gold leaves were packed had originally been covered with some sort of fabric (Fig. 1b).

The two glass jars containing sediments and organic material mixed with gold shavings, may originally have contained gilded pills that had disintegrated, or other pharmaceutical preparations of which gold was an integral part, or both.

Discussion

The turned wooden bowl of 2004, identified as a *scatula deauratoria* for making gilded pills, was discovered on the border between the Kronan's orlop deck and the hold, approximately 16 m from the ship's stern. It was an isolated find, with no apparent context when discovered (Einarsson 2005:15ff), but it became evident upon studying the contextual surroundings that it could be connected with the original contents of the fragmented medicinal chest (I) discovered in 1996 approximately 2 metres astern of the position of the wooden bowl (Einarsson 1997b:16). This assumption is based upon the observation of a general forward distribution of finds in the wreck, connected with the

Table 2. Scanning Microscope Analyses. The precisions of the individual SEM analyses at the levels given were as follows: O $\pm 3\%$, Al $\pm 0.2\%$, Fe $\pm 0.1\%$, Cu $\pm 0.2\%$, Zn $\pm 0.3\%$, Ag $\pm 0.3\%$ and Au $\pm 2\%$.

Sample	Element							Sum	Carat
	O	Al	Fe	Cu	Zn	Ag	Au		
Relative atomic mass	16.0	27.0	55.9	63.6	65.4	107.9	197.0		
II:A									
weight %	11.0	0.9	0.5	1.7	<0.2	4.2	82.0	99.8	20
atomic %	56.0	3.0	0.8	2.3		3.3	35.0	100.0	
IV:D									
weight %	5.0	<0.2	0.4	2.2	0.6	1.7	90.0	99.9	22
atomic %	39.0		0.8	4.2	1.0	0.2	56.0	100.2	
V:B									
weight %	6.0	<0.2	<0.2	1.8	<0.2	2.8	89.0	99.7	21
atomic %	43.0			3.2		2.9	51.0	100.3	
VI:A									
weight %	17.0	0.7	<0.2	1.9	<0.2	1.8	78.0	99.4	19
atomic %	<0.1	1.6		2.0		1.1	26.0	99.9	

sinking of the vessel, which would thus have allowed the contents of the chest to fall out and move forward to the position where the bowl was discovered. Also among the contents of the damaged chest was the bundle of gold leaves (*aurum foliatum*). Gold leaves might have had a number of uses on board a man-of-war, the other items surviving from the contents of the chest – the sizeable chunk of wax-like material and a large quantity of broken glass and ceramic ware – was clearly related to the work of an apothecary. Various variants of beeswax (*cera flava*, *cera alba* and *cera citrina*) are ingredients of 28 out of 34 poultices and 15 out of 27 ointments described in the *Pharmacopoea Holmiensis* (Collegium Medicum 1686:64–77, 143–152), for example. Thus use as a *scatula* may be suggested on contextual grounds as a plausible explanation for the purpose of the object with its traces of gold. This suggestion is also backed up by the presence of two apothecary's jars containing the shavings that gleam in the manner of gold. One, find V, recovered from the wreck in the summer of 2002 (Einarsson 2003:12ff), was found in the sediment, together with a handful of other scattered objects of a pharmaceutical nature, less than 1 metre away from the most significant medical chest, found the previous year (Einarsson 2002:12ff). Although a contextual relation to the medicinal chest seems obvious, it cannot be regarded as feasible to try to determine whether the original content of these bottles was gilded pills – which then disintegrated in the course of more than 320 years on the sea bed – or one of a couple of medical formulations in which gold

shavings constitute one of the ingredients.

Although all the objects discussed were located within an area of the wreck site for which a pharmaceutical and medical context has been established, this area also contains finds of high social status, several of them directly referable through initials and tokens to the admiral general of the Swedish Navy at that time, Baron Lorentz Creutz, who was on board the *Kronan*. As in many other cases examined at the site, one may argue that these objects should be related to wider contexts involving him, but where medical contexts are concerned, there are reasons to assume that they should be referred to professional circumstances rather than personal ones. As opposed to other closed finds such as an officer's chest with rich contents, the medical chests point to a strikingly homogeneous context. They point exclusively to substances of a medicinal nature. Medicine as a science was already highly structured and clearly defined in terms of education and practice by the time (Nilsson & Peterson 2000:75), and it should be noted that the collective medical elite of the navy – the chief admiralty doctor, Peter Gripenflycht, the surgeon Herman Fuchs, and the chief admiralty apothecary, Alexander Steckert – were all on board the ship and perished in the disaster. These individuals represent an exceptionally high and relatively well established social as well as professional stratum of society.

Why *gilded* pills on board the warship *Kronan*? The law of 1667, signed by Charles XI, and its subsequent amendments of 1685 (Carl then Elffte 1668) clearly

stated that the ships of the royal fleet should be provided with an ample selection of applicable medicinal drugs, but this was hardly meant to include gilded pills. In view of the notion that the gilding of pills appears in the professional literature only in the second half of the seventeenth century (de Bergeries 1673:117; Schröder 1693:344; Léméry 1697:433; Bela 2006:1–10), it can be envisaged that this was in fashion among the aristocracy around 1670. Were these people simply adhering to the fashion of the time? When Linnaeus, in his *Materia medica in regno lapideo*, (1752:22) looks back at the previous use of gold in medicine, he is very sceptical and ascribes *social* rather than medical properties to the element. Gilded pills fit in well with the luxurious context, which is so conspicuous in the functional entity formed by the wreck of this warship, and reflect in turn the almost mandatory need for exuberance among the up and coming nobility of the period (Lappalainen 2007:250–256). The material culture of the Kronan yields further dimensions of information in addition to data on shape and function. The objects often had a symbolic value as well. The study of material culture of the Kronan reveals a strident ambition of that time on the part of the social elite to constantly manifest its social and material superiority (Englund 1989:70ff). In a wider context one might even say that the crew members themselves became symbols of their time and space.

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