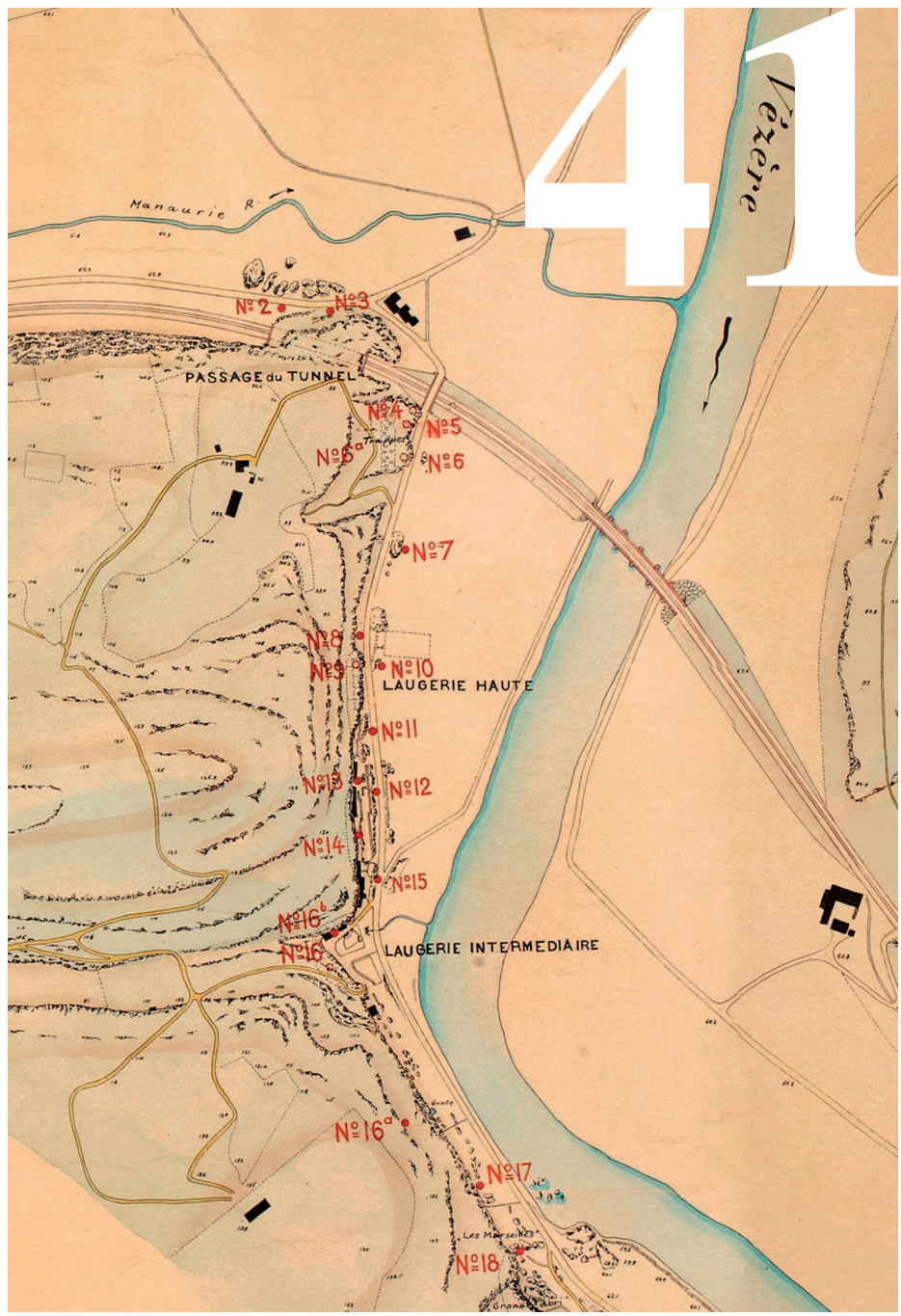
Analecta Praehistorica Leidensia 41 / Miscellanea archaeologica Leidensia

Roebroeks, Wil; Kamermans, Hans; Mol, Joanne; Turq, Alain; Kolfschoten, Thijs van et al.; Bakels, Corrie; Kamermans, Hans

ANALECTA PRAEHISTORICA LEIDENSIA

41



2009

Coffee, cacao and sugar cane in a shipwreck at the bottom of the Waddenzee, the Netherlands

Wim Kuijper
Martijn Manders

At the bottom of the sea east of the island of Texel (the Netherlands), a shipwreck was found dating from the second half of the 18th century AD. Botanical analyses have revealed the presence of coffee (in barrels) in the wreck. Also cacao and sugar cane (the latter used as a valve) were present. Apart from analysing the important cargo, we also investigated all other plant and animal remains in the botanical samples, including egg cases of cockroaches.

Detailed information is supplied on the ship itself, as well as the identifications and the history of some plants.

1 Introduction

In 1984, local divers discovered a shipwreck on the Burgzand in the Waddenzee, off the east coast of Texel (fig. 1), at a depth of 7 metres. They called this the Water barrel wreck as many large wooden barrels were found on the ship (Kley 1991[1]; Habermehl 2000), and it was believed that these barrels had been used for the transportation of water (so-called "*leggers*"). In the days that the roadstead of Texel was crowded with ships awaiting departure to distant destinations, water from the Weesputten (wells) on the island of Texel was transported to the ships by lighters. These were small shallow-draft boats which were also used to transport goods from and to ships from the warehouses in Amsterdam. The wreck was codenamed BZN 4.

During a first non-intrusive evaluation in 1999 and a subsequent intrusive evaluation with trial trenches, executed in 2000 by the Dutch Institute for Shipwrecks and Underwater Archaeology (Nederlands Instituut voor Scheeps- en onderwater Archeologie – NISA; presently the maritime research department of the State Service of Cultural Heritage), the story of the water barrel wreck was further examined.

2 The research

During the 2000 investigation, two trial trenches were dug to gain more insight into the construction and the cargo of the ship (fig. 2). In the centre of the ship, where the mast blocks of the main mast were expected, a 2 m wide and 8 m long trench was dug, perpendicular to the longitudinal axis of the wreck. This trial trench had a maximum depth of 1.60 m. A second trial trench was dug in the stern: 1.20 m deep and 4 m wide, following both sides of the ship and therefore ending in a triangle. In addition, a small trial trench was made in the bow. The finds from the ship only gave a rough indication of its age: 1700 to early 19th century.

Dendrochronological dating of a piece of wood with which most of the ship was made gave a more precise date of 1744 ± 6 (Hanraets 1999) as youngest date. The oak originates from central and northern Germany. The ship is 35 m long and 6 m wide. It was a heavily built ship, witness the riders on the ceiling (= inner planking of a vessel) that were found in the ship. These were probably already installed during construction and were meant to additionally strengthen the vessel across-ship. The ship has been preserved to just under the first deck. The stern was sheathed with copper sheets. As the construction is far too big and too solid to have been from a lighter, it was concluded that the BZN 4 is the wreck of a large 18th century seafaring merchant vessel (Manders 2007 a and b).

After the investigation of the ship by means of trial trenches, the wreck was covered with polypropylene nets. In some places in the ship, the findlayers are at least 1.5 m thick, and it may well be possible that in the future we would like to investigate these layers with more targeted questions.

During the investigation, much attention was given to the cargo of the ship. The position of the barrels was recorded, and samples were taken in different places for botanical investigation. In most cases these samples were taken from the barrels, and only in a few cases were stray samples taken in the ship but it is believed that these remains originated from barrels that lost part of their contents by having been crushed. All samples are contaminated by sediments and by botanical and animal material of local origin (Waddenzee). As a rule, the samples were taken underwater with resealable plastic bags. The samples were scooped up with these bags, and subsequently all excess water was very carefully squeezed out. Next the bags were sealed and transported to the surface. Only in the palaeobotanical laboratory of Leiden University were these bags opened again. From one barrel (TC 1), which was raised in its entirety, the whole contents was sampled and transported to the palaeobotanical laboratory.

In total 41 samples were investigated with a combined volume of more than 19 litres. Separate samples were

Figure 1 shipwreck BZN4, findspot in the Waddenzee (the Netherlands)

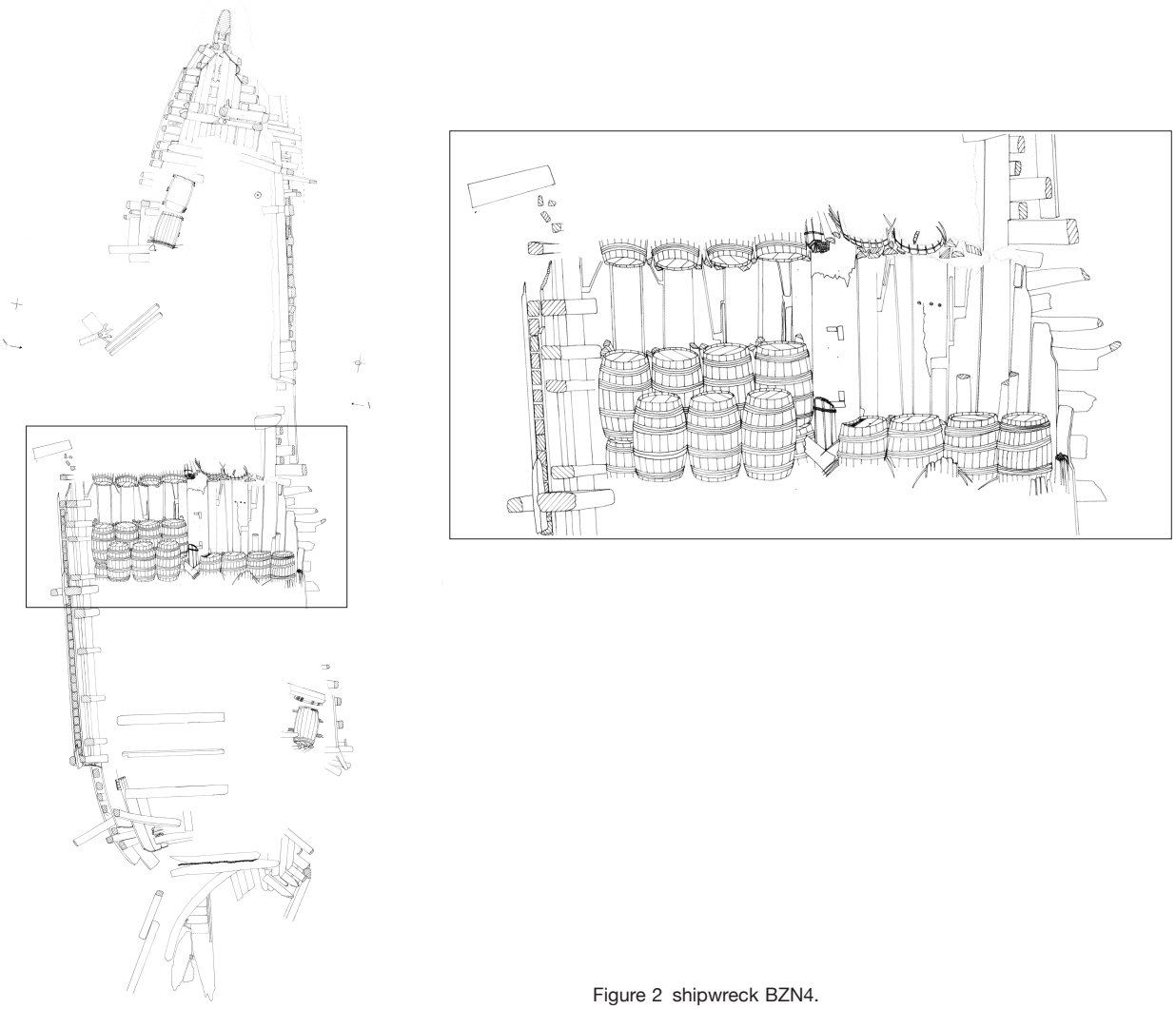


Figure 2 shipwreck BZN4.

collected from 7 places in the vessel. The material was gently rinsed with tapwater on sieves with a 0.5 mm mesh. A small part of the samples was sieved on 0.25 mm but this did not supply additional information. The sieve residue was examined in water under a microscope.

3 The barrels and their stowing

The barrels were found in the ship starting at 4 m from the stern. Probably all these barrels had been stowed in the hold, lying directly on the ceiling, secured and supported by stowage blocks (fig. 3). Two layers of barrels were found in the trial trench in the centre of the wreck. Along the keelson of the wreck, so-called sheaves were discovered: barrels that had been taken apart and the staves of which having been tied together into more compact parcels for transport. A total of 20 barrels have been investigated, while probably over a hundred barrels had been present in the ship[2].

The barrels are 120 cm high, with a length of 110 cm between the grooves for the heads. The diameter of the heads is 56 cm, and the diameter of the bulge is 90 cm. This would result in a capacity of about 500 litres.

The barrels are marked with both scratch marks and brand marks. An in-depth study has not yet been undertaken of these markings, but we do know that scratch marks were often applied to barrels by merchants and that brand marks could have to do with the quality control of a brand master. Two of these brand marks show a warehouse and the letters SD. At the moment we assume that these letters stand for Santo Domingo, the capital of the Dominican Republic in the Caribbean, which would tally with their contents (see below) which was coffee. The Dominican Republic is an important coffee producer. This is an interesting detail as the wood from which the barrels were made comes from the northeastern part of South America (Luckers 2002). The

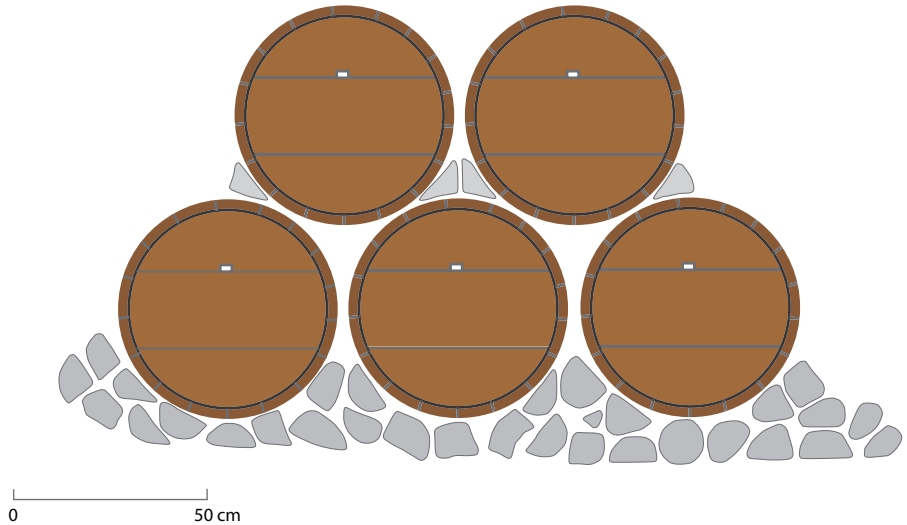


Figure 3 BZN4, reconstruction of the stacking of barrels with stowage wood

wood variety Wallaba (*Eperua falcata*) is present in the investigated barrels (staves) and would be ideal for barrels for liquids because of its split-fastness and oil-secretion. Other types of wood also found such as Bacuri (*Platonia insignis*) would also have good properties. The two other types of wood used proved to be Vinhatico (*Plathymenia reticulata*) and Andiroba (*Carapa* sp.) (Luckers 2002).

The stowage blocks have also been examined. Twenty-seven samples were taken from the about 150 pieces of wood recovered, which consisted of branches and treetrunks of about 1 metre long and with a maximum diameter of 20 cm. The 12 different identified types of stowage blocks seem to have had no other qualities than to serve for stowage and burning.

A total of 79 samples has been investigated, resulting in 21 wood species[3]. Nearly all these species can be found in the northern Amazon basin. An exception is *Plathymenia reticulata* which at present does no longer grow that far north. Possibly this was different 250 years ago, perhaps it is a remnant of an earlier South America trip (Brazil), or it came on board during embarkation in a different way.

Also found in the wreckage was a loose piece of wood with processing traces of coopering, and was identified as *Manilkara* sp. (possibly *M. bidentata*). No barrel parts made of this wood were found though. The hoops that surround the barrels have also been investigated. Most of them were made of a tough type of tropical liana. These could however not be determined to species level. However, willow hoops (*Salix* sp.) were also found in the wreck, sometimes still encircling the barrels, sometimes as waste in the stern. Evidently the barrels were partly repaired with Northwest European material. In the trial trench of the stern were also found, apart from cut hoops, wood shavings, split wood, semi-finished barrel parts, and tools, which all point to the repair of barrels on board ship. Also the method of attachment with the so-called "fish mouth method" (Dutch: vissenbekjes) is a typical (Northwest) European custom (Manders 1996).

The processing traces on the barrel staves and heads paint an interesting picture. These were made following the prevailing North European tradition. However, because the wood had properties to which the crew was not accustomed, many barrels were never watertight, let alone airtight. Also the fact that the barrel staves were finished in such a way that sapwood was still present, thereby negating the high durability of the wood, seems to confirm the unfamiliarity with the wood.

4 The contents of the barrels and other finds

The largest part of the ship's cargo consisted of large wooden barrels filled with unroasted coffee beans (table 1). Apparently the ship was on its way with a largo cargo of coffee. The remains of coffee beans were abundantly present in the wreck. In addition there were cacao beans, dispersed and in small numbers. Other cultivated types found were a single grain of buckwheat, remains of a possible broad bean, two fragments of a pod of peanut and chaff of oat.

4.1 Coffee (Coffea arabica *L.*) – fig. 4

The plant

Wild coffee is a shrub that can reach a height of 15 to 20 metres. Coffee varieties (genus *Coffea*) belong to the Rubiaceae family. After flowering, red fruits appear after

several months. These almost 2 cm long fruits are egg-shaped, and are also called berries. Two seeds will develop in a fruit, with their flat sides touching. Occasional there is only 1 seed in the berry, this seed is then egg-shaped. Every seed lies in a sturdy horn-like hull (= endocarp, seedcase, parchment). Its wall consists of clear, irregular pentagonal (4-6) cells. These cells measure on average 30×50 μm, the cell walls are straight and thin (1-2 μm thick). Between the seed and the parchment is a silverskin, which is the silver-like seed coat (epidermis) with stone cells. These cells are oblong in shape, pointed or rounded at the ends, and have dozens of perforations. Their slightly undulating walls run parallel and are c. 5 μm thick. The cells have a clear light yellow colour. On average the measurements of these cells are 30×255 μm. After removal of the berry, seedcase and silverskin, we can see the well-known coffee bean (Robbrecht 1995).

The finds

Due to their long stay in the water, the seeds no longer had their well-known coffee bean shape but were transparent, flattened skins: the epidermis (fig. 4d). Only a few beans in the cargo had retained their original shape (figs. 4a and b). This shape retention was caused either by the complete outer hard layer (parchment) still enveloping the bean or by the bean having been lightly mineralized, thus preventing the seed from having been flattened. Small fragments of the hard outer layer were regularly found in small numbers (fig. 4c). Rarer were finds of some unripe berries and fragments of berries.

The measurements in mm of the whole beans were:

– with parchment

11.9×8.8×5.0; 10.7×8.1×5.0; 13.0×8.0×4.8; 9.0×6.5×5.5; 14.2×7.6×4.7; 11.7×7.0×6.9; 12.7×7.9×4.5; 12.7×9.0×5.0; 6.5×5.5×4.9 (from a 1-seeded berry); 11.9×8.5×6.0; 12.3×9.0×5.1; 9.7×6.9×3.9; 9.3×6.7×4.2; 8.8×6.0×3.0; 12.0×8.0×4.0; 10.4×7.5×7.0

13.0×flat; 12.3×flat; 12×flat.

– without parchment

8.8×7.0×4.6; 9.3×7.0×4.0; 11.4×7.9×4.0; 10.5×8.3×4.9; 8.5×5.9×4.9; 10.0×7.4×4.3; 9.0×6.0×6.2.

The cargo

From one of the barrels (TC 1), the whole contents has been collected in order to ascertain how much coffee there was in one barrel. In total 25 litres of silt-containing sand with plant remains was recovered from this barrel. Of this sediment small samples were taken from different places, and analysed. Thus a total of 1 litre has been carefully examined.

This sample of 1 litre contained 0.52 lt of plant remains after sieving on a 0.5 mm mesh. It was estimated that 95% of this over half a litre of plant remains consisted of coffee bean skins, which constituted the remains of 5471 beans. Extrapolation leads to 25×5471 = 136,775 coffee beans in the barrel. The dimensions of some whole beans correspond with those of modern coffee beans. This enabled us to calculate an approximation of the volume.

In a modern pack of roasted coffee beans (100% Arabica) were 1960 beans, which filled a space of 650 ml. Returning to our barrel, the beans would have required a space of (136,775 : 1960)×650 ml = 45.359 ml = well over 45 litres.

To give an indication of the weight, we weighed some unroasted beans: c. 0.15 gram per bean. Forty-five litres would then weigh over 20 kg.

A second quantity of roasted coffee beans from a different brand resulted in: 220 gr = 600 ml = 1670 beans. In this case the beans would require a space of (136,775 : 1670)×600 ml = 49,141 = well over 49 litres.

The barrel involved was also measured. It was about 110 cm high with – in the middle – a diameter of c. 90 cm. This would give a volume of c. 3.14×(40×40)×100 = 500 litres.

With rounding off and some assumptions, the calculated numbers and measurements made above give an indication of the volume. The difference (of a factor 10) between the calculated volume of the coffee and the barrel contents is however so large that we assume that a lot of coffee beans have disappeared through the slits between the staves and at the head while lying on the seabed or during the raising of the barrel.

Although many uncertainties played a part in the calculation of the total quantity of coffee in the vessel, we can give an indication here:

a. Assuming the presence of about 100 barrels on board, and assuming that the contents of the one intact examined barrel (TC 1) represented the entire contents, we are dealing with 100×136,775 beans = 13,667,500 beans.

b. If the barrels were filled entirely, we are dealing with a maximum of 10 times as many beans.

In the latter case, full barrels, the barrels could contain a maximum of c. 220 kg. If 100 barrels had been on board, there would have been a cargo present of about 22,000 kg coffee.

The historical background

One of the questions raised with such a find is where this coffee originated from. Hence a brief history.

The species comes originally from the highlands in Ethiopia (formerly known as Abyssinia), and has been cultivated for centuries in the rest of this country. From the Arab world, coffee spread to the rest of the world. Arabic texts from c. 900 already mention the effect of coffee. But when the custom of coffee consumption began will probably always remain unknown (Robbrecht 1995).

findno.	sample volume in cm3	**Coffee** (*Coffea arabica*)				**Cacao** (*Theobroma cacao*)		**Buckwheat** (*Fagopyrum esculentum*)	**cereals** (Cerealia)	**bean** (Fabaceae)
		seed epidermis, flattened	parchment fragment	seed not flattened	berry fragment	seed complete	seed fragment	seedcoat fragment	seedcoat fragment	seedcoat fragment
202	50	xxx	–	1	-	2	xx	-	-	-
516	6000	xxxx	xx	–	–	x	xx	2	–	–
562	250	xxx	1	–	–	3	xx	–	–	–
563	100	37	–	–	–	–	–	–	–	–
564	150	10	–	–	–	3	xxx	2	–	–
565	100	2	–	–	–	–	x	–	–	–
566	50	–	–	–	–	–	xx	–	–	–
605	200	xxx	3	–	–	9	xxx	–	–	–
606	500	xxxx	6	1	2	3	xxx	1	–	1
706	100	–	–	–	–	3	x	–	–	–
717	150	xxx	–	–	–	–	x	1	–	–
748	500	xxx	xx	–	1	–	–	2	–	2
760	500	xxxx	xx	–	1	–	1	1	–	1
778	250	x	–	–	–	10	xx	–	–	–
781	200	–	–	–	–	–	–	–	–	–
782	400	xxxx	xx	3	x	–	–	–	–	x
806	500	xxxx	xx	–	1	9	x	–	–	1
909	500	xxxx	xx	–	1	–	1	2	–	3
924	500	xxxx	xx	1	–	–	x	–	–	–
953	300	xx	2	–	–	18	xxx	–	–	–
957	500	xxxx	1	–	2	–	–	2	–	1
995	500	xxxx	xx	1	8	–	x	4	–	–
1072	500	xxxx	3	–	–	–	–	–	–	5
1134	25	xx	–	–	–	–	–	1	–	–
1242	250	xxx	xx	–	–	1	–	1	–	–
1252	200	–	–	–	–	–	–	–	–	–
1253	500	xxx	1	–	–	25	xxx	–	–	–
1286	500	xxxx	xx	–	–	1	–	3	–	–
1314	500	xxxx	xx	–	2	3	xx	1	–	1
1340	500	xxx	xx	–	1	2	x	1	–	–
1414	500	xxx	xx	3	x	1	xx	1	–	–
1415	400	xxx	x	–	–	–	x	1	–	–

1574	100	xxx	x	1	–	1	x	–	–	–
1575	500	xxxx	x	3	2	2	x	–	1	6
1632	500	xxx	1	–	–	1	x	2	–	–
1673	150	xxx	x	–	x	–	–	4	1	1
1674	100	xxx	x	–	–	–	–	–	2	–
1674b	200	–	–	–	–	20	xxx	1	x	–
1675	200	xxx	x	–	1	–	–	1	1	1
1731	250	x	–	–	–	–	xxxx	–	–	–
x	1000	xxxx	xx	3	4	2	20	2	–	2

As well: in 1340 – **oat** (Avena sp.) 1 chaff; 516 – **peanut** (Arachis hypochaea) 2 podfragments
Legend: x = some, xx = some to many tens
xxx = some to many hundreds, xxxx = some to many thousands

Table 1. Shipwreck BZN4. Waddenzee, the Netherlands. Cultivated plants in the samples.

Figure 4 BZN4, various forms of coffee
a. Original form, flat side
b. Original form, convex side
c. parchment
d. epidermis

After the Arabs became acquainted with coffee, they took it across the Arabian peninsula. Especially in Yemen did the coffee (arabica) grow well. Coffee was traded from the port city of Mocha (Mokka). Around 1500 there were coffee houses all over the Arabian world. But the use of coffee also encountered opposition. After various developments, there is a first report from 1552 by a European on the drinking of coffee by the Turks.

Pieter van den Broecke had seen black beans in Mocha in 1616, from which 'black water' was made which was drunk hot (Godee Molsbergen 1939). In the 17th century coffee drinking became known in the western world, and the first European coffee house was opened c. 1645 in Venice. The first Northwest European coffee house was opened in The Hague around 1663, and subsequently coffee houses were started in many large cities. From the 18th century coffee was a much consumed stimulant, first as a luxury article, later by all strata of society.

From c. 1660 the Dutch East India Company (VOC) became interested in the coffee trade, but the trade was entirely in the hands of the Arabs. The Dutch broke this Arabian monopoly of the trade in and cultivation of coffee (*Coffea arabica*).

With some difficulties plants were obtained. When Johan van Hoorn, as director-general, consulted with Adriaan van Ommen, resident in Suratte (Southwest India) on the production of indigo, they were also negotiating coffee. In 1696 Van Ommen sent some coffee plants from Cananoor (Southwest India) to Batavia (modern Jakarta). Van Hoorn had them planted out, but they were washed away in the earthquake of 1699 and the associated floods. Zwaardecroon who was commissioner on the Malabar coast (Southwest India) brought coffee plants to Batavia again, and Van Hoorn had these planted out in his garden. The cultivation succeeded, and Van Hoorn gave some as a curiosity to some devotees, a.o. to Nicolaas Witsen in Amsterdam, though this was against the order of the Heeren XVII (the board of the VOC). One plant, having been sent on by Witsen, who was commander of the West India Company, became the ancestor of the coffee cultivation in Surinam.

From 1707, coffee plantations were established by the VOC in the mountain areas of Java and later Sri Lanka. Already in 1720 did the VOC bring many cargos of coffee to Europe (Amsterdam).

In the meantime, also the French had managed to get hold of some coffee plants, via Amsterdam (in 1714). They started cultivation on Martinique. Soon thereafter, coffee cultivation began in the Caribbean and Central and South America. In 1718 the first coffee plants were shipped to Surinam (Thorn 1999), and the first cargo of Surinam coffee was traded in the Netherlands in 1723. Around 1750 this coffee constituted already 50% of the market share in coffee in the Netherlands. Towards the middle of the 19th century, Indonesia, Sri Lanka and Brazil were the most prominent coffee producers. Other well-known producers were Cuba, Haiti, Santo Domingo (Dominican Republic) and the Congo. Because of the boom in the trade in coffee in the 18th century, coffee was soon also available to the less well-off (McCants 2008), especially in France (Montanari 1994). It became the symbol of the rationalism of that time, of its pursuit of clarity, shrewdness and freedom of thought. However, in the Netherlands and England tea had already mainly superseded coffee (Montanari 1994).

It was Linnaeus who first described the variety scientifically in 1753. After the discovery of the well-known coffee – *Coffea arabica* – various other wild coffee varieties were discovered in Africa. Certainly mentioned should be robusta coffee – *Coffea canephora* – (discovered in Gabon in 1897) and liberica coffee – *Coffea liberica* – (discovered in Liberia in 1876). These varieties were also cultivated.

Possible origins for the cargo of coffee of BZN 4 are Central America, northern South America and the Caribbean. This is based on the origin of the stave wood.

Other archaeological finds

Coffee is a rare find in archaeological investigations. Only a few reports are known to the authors. There is a find of *Coffea arabica* beans in a cannon on the seabed off Padstow in England. The bronze had ensured the good conservation of the seeds. The cannon is dated to the 17th century, the beans themselves have not been dated (Greig 1991). In Bremen (Germany) four coffee beans were discovered in the filling of a cesspit. The beans were not roasted, and are dated to the end of the 18th century (Rech 2000). In Amsterdam (Netherlands) coffee beans were also found in an 18th century cesspit (H. van Haaster pers. comm. 2007).

Fruit and seeds (beans) were common in a shipwreck at the bottom of the Red Sea (Sadana Island) in Egypt. The cargo is dated to c. 1765 (Ward 2001).

4.2 Cacao (Theobroma cacao *L.*) – fig. 5

Regularly but usually in very small quantities we found seeds of cacao among the coffee beans. From the stern, stray finds were made of 5 seeds and some fragments, and an iron concretion was found with about 10 seeds.

It is possible that these seeds have become dispersed in the wreck over the centuries. It is thought that the cacao possibly came along in (burlap?) sacks and was stored on the first (and lost) deck (Wennekes 1996).

The plant

Cacao is a tree that reaches a maximum height of c. 15 m but that on plantations is pruned and thus reaches only 6 m.

Figure 5 BZN4, cacao (find no. 516)

On the trunk large fruits grow which each contain 20-40 seeds (the cacao beans). The seeds are oblate spheres with a length of 16-22 mm, a width of 10-19 mm and a thickness of 3.5-10 mm. More than half the weight of these beans consists of a waxy solid (cacao butter). Apart from the raw material for our chocolate, cacao beans contain a.o. theobromine, which is toxic for small animals (insects).

The finds

The beans are oblate spheres and about 25 mm long, 15 mm wide and 10 mm thick. A seed consists of 2 cotyledons with lobes. Fragments of the contents were regularly found in the samples. The fragile beans were probably broken during the sampling and recent transport. The seed wall is thin, and impressions of veins are visible on its surface. Remarkable is that the contents of the seeds is still present. This was probably caused by the high fat content of the seeds. Dimensions (in mm) of (whole) cacao beans that could still be measured are:

28×17×10; 27×15×10; 26×14×8; 23×16×10; 23×15×11; 23×15×10; 23×14×11; 22×16×11; 22×15×11; 22×11×11; 18×12×9.

(highly) oblate seeds (length×width):

27×16; 24×14; 24×12; 23×13; 23×13; 22×14; 22×13; 20×12; 20×11; 19×14; 19×12.

The historical background

Originally the plant comes from the tropical rain forests of the Amazon and Orinoco Basins in South America. Very small quantities of theobromine in pots excavated in Belize (Central America) indicate that the Mayas possibly already drank cocoa in 600 BC (Hurst *et al*. 2002). During the Spanish conquest of Central America, it was noticed that the local people drank a liquid with cocoa. In 1528 Hernando Cortez brought the first cacao beans from Mexico to Spain. Early in the 17th century chocolate factories were started in Spain and the cocoa drink spread gradually over Europe. In the middle of the 17th century, there were coffee and chocolate houses in Holland where this drink could be bought. In the Netherlands cacao has been traded since the end of the 17th century (Wennekes 1996).

Cacao grows in tropical areas along the equator, especially along the African west coast. In the 1680s the Chartered Society of Surinam (Geoctroyeerde Societeit van Suriname) (founded in 1683 by the Dutch West India Company (WIC) together with the town of Amsterdam and the private investor Cornelis van Aerssen) had established, apart from sugar cane plantations, also cacao plantations in Surinam. In itself not a strange choice as the tropical jungles of the Guyanas were the cradle of *Theobroma cacao*. Incidentally, the cacao seeds planted in Surinam originated in the West Indian islands where cacao production had started earlier. In addition to chocolate drink (first medicinally against diarrhoea), chemists made cocoa butter from the cacao which helped against chilblain and chapped lips. Soap-boilers in their turn processed the cocoa butter into fine toilet soaps (Wennekes 1996). The Society controlled the trade in cacao well into the 18th century[4]. The plant was cultivated in Africa from the end of the 19th century.

Other archaeological finds

We do not know of any other finds of cacao in Europe.

4.3 *Sugar cane* (Saccharum officinarum *L.*) – figs. 6 and 7

The plant is a type of grass which grows to a height of several metres. The sugar is extracted from the juice in the culms. Cultivation is done on well-irrigated fields in tropical areas.

The finds

Sugar cane was present as culm fragments. These fragments measured 7, 12, 12, 16, 16, 25, and 28 cm. The diameter was c. 2.5 cm. There were joints (nodes) every 5-6 cm in the culm fragments.

A few times there were in the samples inconspicuous small flat plant fragments from a few millimetres to c. 2 cm in length. With a coarse-veined pattern, shiny surface and small white hairs at the 'base' of these fragments, they fully correspond with the side buds of modern culms of sugar cane.

During the investigation, sugar cane culms were discovered in a number of barrels; the ends of these culms protruded through a small hole in one of the heads (fig. 6), thus preventing gasification by heating in the cargo of coffee. The problem with transporting unroasted coffee beans is that they produce gases. When the beans are stored in barrels, these beans are protected against water (if they are good-quality barrels of course), but there is a risk that the barrels will explode when the pressure of the released gases becomes too great. An ingenious solution had been found for this problem. The barrels of the BZN 4-wreck apparently had specially prepared sugar cane culms, which protruded through the lid of the barrel and served as pressure-release valves. This way, no water could enter the barrel but the gasses could escape if the pressure became too high.

The historical background

Originally sugar cane came from New Guinea (Indonesia). The plant was possibly first used by man in Polynesia, from where it ended up in India.

Emperor Darius (of Persia) encountered sugar cane in 510 BC during his invasion of India. Already in 327 BC, Alexander the Great mentioned the cultivation of sugar cane in India. Via Persia and Egypt, the plant arrived in Sicily and

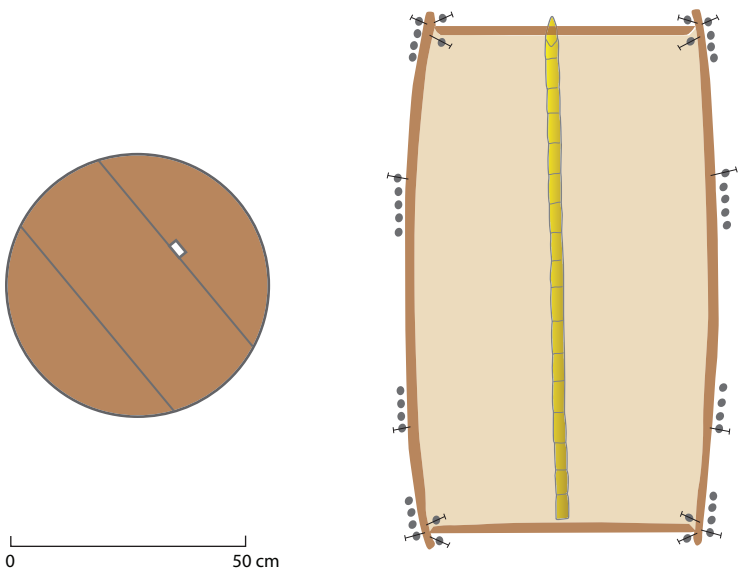


Figure 6 BZN4, reconstruction of a barrel with a culm of sugar cane

Figure 7 BZN4, sugar cane, fragment of stalk 24.5 cm (find no. 1028)

Spain. The substance at stake in the sugar cane – sugar – was first recorded in England in 1099. In 1492 Columbus brought sugar cane from the Canary Islands to Santo Domingo. In 1520 it was first cultivated in Mexico. It was gradually introduced into many areas and presently it grows in all tropical areas.

Other archaeobotanical finds
No other finds are known to us from Europe.

4.4 Peanut (Arachis hypogaea *L.*) – fig. 8

The plant
The peanut is a 30 cm high plant belonging to the Fabaceae family, and is an annual. After flowering, the stalk bends towards the ground and in the soil a pod with some seeds is formed.

The finds
We hesitate slightly to report the find of two fragments of a peanut shell (pod). Recent peanut shells are present at the bottom of the North Sea, and they are regularly washed ashore. We are possibly dealing here with a later contamination of the wreck, but it is also quite possible that this type was on board.

Only in a sample from a large barrel were 2 fragments of a pod found, which possibly came from one pod.

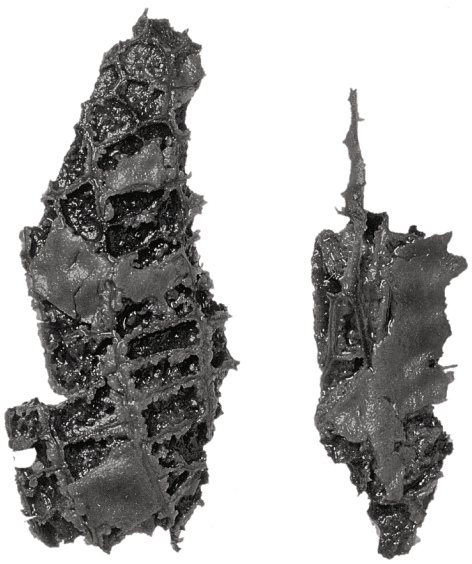


Figure 8 BZN4, peanut, two fragments of a pod (measurements left: 10×23 mm)

The historical background
Originally the peanut comes from Brazil. Around 800 BC the peanut was already known in Peru. The plant reached North America via Mexico and the West Indies. In the 16th century the Portuguese brought peanuts to West Africa. The Spanish were responsible for the distribution to the Far East. Nowadays the plant is cultivated in all tropical and subtropical countries.

Other archaeobotanical finds
We are not aware of any reports of archaeobotanical finds.

4.5 Buckwheat (Fagopyrum esculentum *Moench*), *Bean* (*Fabaceae, cf* Vicia faba), *and Oat* (Avena *sp*.)

From time to time the hard seed walls (chaff) of buckwheat were found. These pieces could originate from packing material or such like on board, as for instance in boxes with clay pipes. Or it might be waste from food preparation. We are probably not dealing with a stock of buckwheat but possibly with just 'litter' on board.

In the Middle Ages buckwheat was an important foodstuff for many people. It was cultivated in abundance in a.o. the Netherlands, and the 'chaff' had many uses (Kok and Kuijper 2001).

Some small fragments with a hilum are from a type of bean. We did not investigate whether there are (sub)tropical types of bean that correspond with our material, which looks very much like a broad bean (*Vicia faba*).

In one case (sample no. 1340), a fragment of oat chaff was found. It is not certain whether we are dealing here with cultivated oat.

4.6 Other finds of seeds

All remains in the samples have been collected. Among these are also some seeds and the like of plants that do not belong to the vessel. It concerns seeds which grow in saline conditions (6 species, such as *Zostera marina* and *Suaeda maritima*), in freshwater conditions (5 species, such as *Menyanthes trifoliata* and *Potamogeton* sp.), marsh and shore/bank species (12 species, such as *Schoenoplectus* sp. and *Sphagnum* sp.), as well as species from all kinds of damp and dry open terrains (19 species, such as *Chenopodium album* and *Rubus fruticosus*). By nature these are present in and at the bottom of the sea. These remains are washed into the wreck with the sand and silt, and thus say something about the environment in which the ship now lies. Many of the seeds we regard as recent or of insignificant age. The seeds of plants from saline coastal areas undoubtedly come from the edges of the Waddenzee. Other species will have been washed out of the peat layers that can be found in the subsoil of the Wadden area. This

applies in particular to the freshwater species and species from marshes, banks and damp terrains.

With this investigation we had hoped to find species that arrived with the coffee beans. But unfortunately no clear remains of wild plants were found from the source areas of the coffee or cacao.

5 Animal remains

This category can be subdivided into two parts. Firstly, the remains of animals that lived in the cargo or on board. In particular the group of 'insects' falls into this part. Except one, these remains (cocoons, beetles, wing cases, wings, etc.) have not been determined. Hence of most species we cannot say whether they indeed have anything to do with the ship. As with the plant remains, many insect remains can be found on the seabed and can have been washed into the wreck. An exception are the cockroaches which must have lived in the ship. Various parts of these animals were found in most samples. The egg cases (oothecae) were present in half of all samples. Usually there were a few specimens, but once there were 10 and once 20 specimens (per 0.5 litre).

The egg cases are about 8 mm long, 5.5 mm high and 5 mm thick, and have a characteristic shape (fig. 9). They consist of brown chitin, are hollow and have a sturdy thin wall. There is room for two rows of 8 eggs each. Some identified egg cases and fragments of adult animals appeared to come from the American cockroach (*Periplaneta americana*). Originally this animal probably came from Southwest Asia. Cold is lethal: after a few days with temperatures of 5˚C, they will die. And the temperature should not drop below c. 15°C for a continuous period of 6 weeks. In the old days, cockroaches could be found on ships in large numbers (Oudemans 1900).

In one of the pieces of stowing wood/firewood, a not further identified long-horned beetle was found (Luckers 2002).

Another indication of the presence of animals on board are the finds of hairs in the material. These hairs have not been identified, so both people, rats, cats and various pet animals qualify.

The second group concerns finds of animals that are known to live in the Waddenzee. The shells, bryozoans, hydroid polyps, fish and barnacles found had been living locally or in the direct vicinity. The shells derive from species such as mudsnail, common mussel, cockle, Baltic tellin, and periwinkle. They can date from various ages. It is a normal phenomenon that all these remains of the environment end up in wrecks or lived on them.

6 Discussion and conclusion

The Burgzand Noord 4 (BZN 4) wreck was once a large heavily-built seagoing vessel, which was wrecked on the

Figure 9 BZN4, egg cases of cockroaches (measurements lower left: 5.2 × 8.0 mm)

roadstead of Texel. Botanical analysis of wreck BZN 4 samples taken during an intrusive evaluating investigation in 2000 yielded interesting data on the cargo of a ship dating to the second half of the 18th century AD.

Analysis of the contents of various barrels showed that a large part of the cargo consisted of unroasted coffee beans. That the coffee was unroasted is standard practice. The coffee was often – and still is – roasted in the country of destination according to the traditions of taste prevailing there.

The second remarkable species on board was cacao. Several dozens of beans were found. It is not clear how these were transported, nor how much was on board. Sugar cane that was also found was used as pressure release valve in the barrels of coffee beans. Whether the find of a piece of pod from a peanut belongs to the wreck is not certain. Other plants (buckwheat, bean) probably are food remains of the crew.

The find of a cargo with coffee and cacao in an archaeological context is unique in the Netherlands and elsewhere. At the time, the value would have been high and the wrecking of the ship would have constituted a considerable financial loss to the shipowner. In 1730, a 'pikoel' of coffee cost 7 rijksdaalders ("coffee from own company land"). The coffee from Cheribon was 5 rijksdaalders, in 1735 increased to 6 rijksdaalders (Godee Molsbergen 1939). One pikoel (pikul = shoulder load, weight – 'what one man can carry') is about 62.5 kg (Teeuw 1990). The possible cargo of of 22,000 kg would then represent a value of 352×7 = 2464 rijksdaalders. When we compare this amount (6160 guilders) with for instance the earnings of the middle classes in the most important towns in Holland (about 250 – 300 guilders annually) (Van der Heijden and Schmidt 2007), then we are certainly dealing here with a valuable cargo.

On the basis of the coffee beans themselves, the origin cannot be determined. The wood of the barrels and stowing wood have a Central and South American origin. The marking 'SD' on one of the barrels could relate to Santo Domingo. It would appear that the area of origin is the Caribbean (including the northeastern part of South America). In the stern of the ship evidence was found for repairing the barrels on board with a.o. willow hoops which can but come from Northern Europe. The cargo was possibly destined for the market in Amsterdam, but the ship could have been in transit to another destination (in Europe).

The presence of cockroach remains indicates that these animals were on board in abundance. From historical sources we know that cockroaches could indeed be an infestation on ships. The many remains of cockroaches and cocoons of flies etc. would indicate that it was not very clean on board. The hygienic conditions were probably very bad.

Information on the name, the owner, the destination etc. of the ship have not yet been investigated in the archives and it is therefore not yet certain whether the wreck belonged to the West India Company. After the evaluation, the ship was covered *in situ* thus enabling further research in the future.

Acknowledgements

Assistance in the determination was given by J.F. Veldkamp (Leiden), the Nationaal Herbarium Nederland (sugar cane), and K. Huitema (Krimpen aan de IJssel)/Catz International b.v. Rotterdam (cacao). S. Langeveld (Lisse) and W.R.B. Heitmans (Amsterdam) helped us with the identification of the egg cases (cockroaches) which were regularly found in the material. K. Fennema translated the manuscript into English. We are very grateful to them all.

Notes

1. In this publication the Water barrel wreck still has the toponym Burgzand Noord V, which was later changed to BZN 4.

2. This is a very rough estimate.

3. In addition to *Plathymenia reticulata* which occurs further south, two European species were found. These were the hoops of willow (*Salix* sp.) and a loose piece of wood of birch (*Betula* sp., probably *pendula*) from the hold.

4. The Society of Surinam was dissolved in 1795, four years after the dissolution of the West India Company.

References

Godee Molsbergen, E.C. 1939. *Geschiedenis van Nederlandsch Indië, deel IV*. Amsterdam: Joost van de Vondel

Greig, J.R.A. 1991. The British Isles. In W. van Zeist, K. Wasylikowa & K.-E. Behre (eds.). *Progress in Old World Palaeoethnobotany*, 299-334. Rotterdam: Balkema

Habermehl, N. 2000. *Scheepswrakken in de Waddenzee (1500-1900)***.** Lelystad: ROB

Hanraets, A.E.M. 1999. *Rapportages daterend onderzoek WVW-wrak*. Onderzoeksrapport RING

Heijden, M. van der en Schmidt, A. 2007. In dienst van de stad: vrouwen in stedelijke ambten, Holland 1500 – 1800. *Tijdschrift voor Sociale en Economische Geschiedenis* 4(4), 3-34

Hurst, W.J., Tarka, S.M., Powis, T.G., Valdez, F. & Hester, T.R. 2002. Archaeology: Cacao usage by the earliest Maya civilization. *Nature* 418, 289-290

Kleij, P. 1991. *Onderwaterarcheologie rond Texel, een schatkamer onder de zeespiegel*. Texel: stichting Texels Museum

Kok, R. en Kuijper, W.J. 2001. Het gebruik van boekweitkaf in Nederland: (bouw)historische en archeologische gegevens. *Westerheem* 50, 109-116

Luckers, J. 2002. *Houtdeterminatie als middel tot reconstructie van de reis van een 18de eeuws schip, het BZN-4 wrak*. Wageningen: Universiteit Wageningen

Manders, M. 1996. *De tonnen uit het Scheurrak SO1*. Doctorale eindscriptie Faculteit der Prehistorie, Universiteit Leiden. Leiden

Manders, M. 2007a. Koffie uit Zuid-Amerika. In J. van den Akker, M. Manders, W. van der Wens & A. Zandstra (eds.), *Bundel Maritieme Vindplaatsen* 1, 14-16. RACM & LWAOW

Manders, M. 2007b. Coffee from South America, *Maritime Lanka* 2, 25-28

McCants, A.E.C. 2008. Poor consumers as global consumers: the diffusion of tea and coffee drinking in the eighteenth century. *Economic History Review* 61/S1, 172-200

W.J. Kuijper
Archeologisch Centrum (Botanisch Laboratorium), Faculteit der Archeologie, Universiteit Leiden, Postbus 9515, 2300 RA Leiden, the Netherlands.
w.j.kuijper@arch.leidenuniv.nl

M. Manders
Rijksdienst voor het Cultureel Erfgoed, Smalle Pad 5, 3811 MG Amersfoort, the Netherlands.
m.manders@cultureelerfgoed.nl

Montanari, M. 1994. *Honger en overvloed*. Amsterdam

Oudemans, J.T. 1900. *De Nederlandsche insecten*. Zutphen: Thieme & Cie.

Rech, M. 2000. Bohnen – Kaffee. *Archäologie in Deutschland* 16(4): 42

Robbrecht, E. (ed.) 1995. *Kawa, koffie ontsluierd: van koffiestruik tot kopje koffie*. Nationale Plantentuin van België

Teeuw, A. 1990. *Indonesisch-Nederlands woordenboek*. Dordrecht – Holland / Providence –U.S.A.: Foris Publications Holland

Thorn, J. 1999. *Koffie. Alle informatie voor de liefhebber*. Hedel

Ward, C. 2001. The Sadana Island shipwreck: an eighteenth-century AD merchantman off the Red Sea coast of Egypt. *World Archaeology* 32: 368-382

Wennekes, W. 1996. *Gouden Handel. De eerste Nederlanders overzee, en wat zij daar haalden*. Amsterdam/Antwerpen: Atlas