BERENIKE CROSSROADS: THE INTEGRATION OF INFORMATION

BY

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Abstract

The harbor town of Berenike functioned in the long-distance trade between the Mediterranean and the Indian Ocean Basin from the third century BC to the early sixth century AD. This contribution aims to view the Berenike material within its wider historical context through a preliminary analysis of the combined archaeological and textual evidence. By comparing the results of the work of different specialists, the potential of a multi-disciplinary approach becomes apparent. A number of caveats are given, which illustrate the interpretative problems arising from comparing the results of different disciplines. Lastly, this attempt at integration shows that the discrepancies between the different sources offer important insights.

Le port maritime de Berenike fonctionnait dans le commerce de longue distance entre la Méditerranée et le bassin de la Mer des Indes depuis le troisième siècle avant JC jusqu'au début du sixième siècle après JC. Cette contribution examine le matériel de Berenike dans un contexte plus large par une analyse préliminaire croisant des données archéologiques et textuelles. En comparant les résultats proposés par plusieurs spécialistes, le potentiel du travail multidisciplinaire devient évident. Un nombre de caveats est présenté pour illustrer des problèmes d'interprétation, provenant des comparaisons de résultats de plusieurs disciplines. Enfin, cet essai d'intégration montre que les divergences entre plusieurs sources offre des aperçus importants.

Keywords: maritime trade, Egypt, Roman, gem stones, botanical

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Introduction: History as Text and Archaeology

The dichotomy of history and pre-history suggests that historical information by definition is 'textual information.' The insight that more often than not texts give biased and incomplete information is now generally accepted, and it seems that a more balanced historiography is in place, in which textual and archaeological evidence are used to balance the representation of past periods. Textual evidence in the form of inscriptions, ostraka, papyri and graffiti is, however, also archaeological evidence and should be studied using the same methods as other archaeological finds. The depositional and post-depositional processes result in an often erratic survival. The textual materials we find in excavations thus are not only the result of original human intervention, i.e., of deliberate decisions in antiquity on what to save and what to discard, but also of natural processes of decay and of later human intervention. These processes thus provide another, uncontrolled, selection. This sometimes results in the ironic situation that what was discarded in antiquity is what survives today. Primary textual finds thus are an integral part of the archaeological record, in contrast to what perhaps could be called secondary textual finds: texts that have survived in often much later copied versions. These, mostly literary, historical or geographical texts, served a specific purpose that may have changed over time from invaluable source of practical information to canonic textual corpus and finally to important historical source. Both primary and secondary textual sources are considered in relation to our ongoing effort to understand life and work in the Greco-Roman harbor town of Berenike.

The Study of Berenike's Role in the Long Distance Trade

Berenike was one of the Egyptian Red Sea emporia in the long distance trade between the Mediterranean, Arabia, Africa south of the Sahara, and the Indian Ocean Basin. The existence of a harbor by the name of Berenike was known from classical texts such as Pliny the Elder's late first century AD *Natural History* (Ball 1950; Eichholz 1962; Rackham 1952). Additional sources include

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Agatharchides' second century BC *On the Erythraean Sea* (Burstein 1989; Huntingford 1980), Diodoros Siculus' first century BC *Library of History* (Murphy 1989; Oldfather 1961) Julius Solinus' early third century AD *Collection of Memorabilia* (Mommsen 1958), Strabo's late first century BC or early first century AD *Geography* (Jones 1959; 1961; 1966), archives found elsewhere in Egypt, such as the Nikanor archive (Fuks 1951; Meredith 1956) and an anonymous first century AD merchant's handbook, the *Periplus of the Erythraean Sea* (Casson 1989; Huntingford 1980; Schoff 1912).[1] These sources describe the character of the harbor and the goods transferred there from ship to desert caravan and *vice versa.*

Excavations from 1994 to 2001 have shown that the harbor town of Berenike existed for eight centuries, from the third century BC to the early sixth century AD (Sidebotham and Wendrich 1995; 1996; 1998; 1999; 2000; forthcoming).

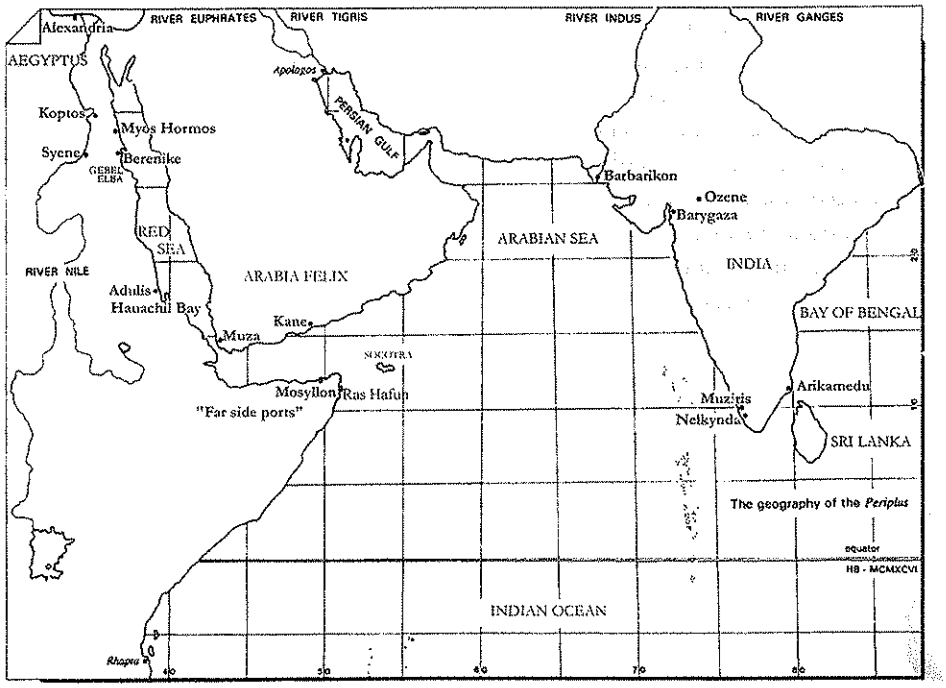

Figure 1: Map of the Indian Ocean Basin

[1] These sources are abbreviated as follows: CM (*Collection of Memorabilia*); G or Geography (Strabo, *Geography*); LH (*Library of History*); NA (*Nikanor Archive*), NH (*Natural History*); OES (*On the Erythraean Sea*); *Periplus* or PME (*Periplus Maris Erythraei*).

The Berenike excavation team has a strongly international and multi-disciplinary character.

Due to the fact that Egypt does not allow archaeological finds to leave the country, all project staff travel to the site and work in the laboratories at Berenike. This enables an interaction of specialists that, in theory, should lead to integrated results of the research. In practice, however, the pressure of work does not allow for a leisurely comparison of results, and staff are not all on site at the same time. The Berenike project publishes its yearly reports promptly, but for the final report the available information will be integrated fully. This edition of *JESHO* is, therefore, a good opportunity to explore the methodological angle, using a selection of the specialized information in a process of discussing interpretations and deciding the central issues of the past excavation and study seasons in the light of the original research questions and the subsequent excavation results. We would like to stress that this paper draws upon the results of all expedition members and that those who are not listed as co-authors have also made extremely important contributions to the database from which this article draws.[2]

For our present exposition we choose to concentrate on a specific period and subject matter: the provenance and destination of trade commodities in the early Roman period (first and second century AD). For this period we have a wealth of both archaeological and textual evidence that is in stark contrast with both earlier and later periods. Although it has been shown clearly that Berenike was active in the Ptolemaic period, the evidence of habitation and trade is scant (Sidebotham and Wendrich 2000). The Ptolemaic remains were robbed extensively in the later periods of occupation. During the third century AD there is evidence for a decrease in activity in the town, while the early fourth century AD was clearly a period of expansion, during which the entire eastern part of the town was rebuilt, and extended following the gradually receding shoreline. The general historical sources for the late Roman period, however, are not as abundant as those of the first and second centuries AD and, therefore, the late Roman evidence from Berenike, albeit ample, is less suitable for a comparison between archaeological and historical evidence. The organic remains in the late Roman trash dumps yield important information on trade contacts in the fourth and fifth centuries AD, but show a dearth of textual evidence from Berenike

[2] During the past nine years over 90 persons have contributed to the work in Berenike. Here we would like to highlight in particular the work of our excellent trench supervisors, especially Shinu Abraham, Jolanda Bos, Lauren Bruning, Anne Haeckl and Lisa Pintozzi, along with specialists Peter Francis Jr. (beads), Martin Hense (metal), Wim Van Neer (archaeozoology), André Veldmeijer (cordage) and John Peter and Felicity Wild (textiles).

itself. Why the quantity of textual records in the early Roman period differs remarkably from that in the late Roman contexts is a matter of debate. Should we presume that in the fourth century textual records were deemed less important than in the first century AD? That seems too simple a conclusion. The first century AD trash dumps which yielded most textual evidence were located in a separate sector, away from the town itself, while the late Roman trash was excavated in residential areas, on empty plots of land, along the outside wall of a shrine and even in abandoned houses. Thus the trash deposits in the two periods indicate very different patterns of discard. The late Roman period trash dumps are very near to the areas where the refuse was produced. We probably just have not found the relevant fourth century offices and their adjacent office dumps.

The early Roman textual material has been partly published (Bagnall *et al.* 2000); our tables below also use the unpublished material. Most ostraka and papyri were found in the first and second centuries AD trash dumps northwest of the main part of town. The collection comprises a customs archive (ostraka) and letters and contracts (ostraka and papyri), that give some insight into the organization of trade and the movement of people and goods, as well as the mode of living in Berenike. Apart from the Berenike textual evidence, other historical sources are the ostraka found in the way stations along the route from Berenike to the end of the desert route in Koptos in the Nile Valley, archives found in Koptos, such as the Nikanor archive (Fuks 1951; Meredith 1956) and the well known literary, historical and geographical sources mentioned at the beginning of this section.

The integration of archaeological and historical information sources proves to be extremely useful, but it has to be stressed that further work is necessary, especially the difficult task of quantifying the different commodities in relation to the archaeological context, in order to determine the size and extent of the freight traffic (Tomber 1993). This contribution should, therefore, be considered a work in progress, rather than the final word on the trade that came through the harbor of Berenike.

COMMODITIES AND CONTAINERS

Berenike was a desert town on a wind-swept sea shore, an arid coastal emporium with hardly any local food production and a lack of local raw materials. Apart from a small number of sheep, goats and camels, animals that could survive on the desert vegetation in an area with a limited carrying capacity, local

food stuffs would be mainly garlic, beans, salad greens and other plants that could be grown in small garden plots, moistened with waste water (Cappers 2002: 51-53). Most food (for instance grain), but also water and raw materials had to be brought in. Therefore, the goods transported by caravan from the Nile Valley to Berenike, a trip that took 12 days along a well-established route with way stations at regular intervals, were not entirely shipments of trade goods. A considerable part of the commodities were destined to be consumed at Berenike.

Water was brought in from a number of fortified wells at a distance of approximately 8 kilometers from the town. We must keep in mind that just as the caravans that traveled through the Eastern Desert brought not only goods for export, but also supplies for the ships as well as the local inhabitants of Berenike, the water transports, probably on donkey or camel back, provided the drinking water both for the town's consumption and for provisioning the ships in sufficient quantities to allow them to reach the next place along the Red Sea shore where water could be taken in.

Furthermore, the trade passing through Berenike moved in two directions: from the Mediterranean and Egypt goods were transferred onto Nile ships, taken by boat up the Nile to Koptos, loaded on camels and walked through the Eastern Desert to the harbor, to be transferred there from caravan to seagoing vessel. The ships awaiting the goods had just unloaded their commodities from India, Arabia and Africa; these were taken back to Koptos, Alexandria and thence on to many other places in the Roman Empire. Most of this activity took place in summer months, the ships arriving with the Monsoon wind from the East and up the Red Sea in early summer, while ships heading out across the Indian ocean had to leave in late summer (PME 39, 49, 56). At a transfer harbor there is always a certain percentage of loss of goods, partly through accidents with loading, partly because even in well-controlled circumstances, the local population seems to get access to some of the commodities, either legally or otherwise. Thus our evidence in Berenike consists partly of mentions of goods in documents, partly of containers (wine, oil or fish sauce amphorae) from different areas of the Mediterranean, partly of remains of the goods themselves that were apparently available in such abundance that they could end up in the trash dumps. The archaeological finds from the higher elevated and western parts of Berenike show a surprisingly good level of preservation of organic materials (Wendrich 1998). Thus, the area of the early Roman trash dump, which is located at a considerable height above ground water level and to the west of the town's center, has yielded an abundance of organic evidence that includes seeds, textiles, basketry, matting, cordage, leather, animal bones and papyri. Apart from these perishable articles, there are also commodities that

have a much more permanent character. Gems were an important commodity and they do survive in the archaeological record. A wide variety of precious and semi-precious stones have been found in early Roman contexts in Berenike.

In this section an inventory is made of the commodities that we would expect to encounter in Berenike, based upon textual evidence and the goods that were actually found. In the discussion we will try to explain why certain goods do not occur in the archaeological record, while others have been found in abundance, but are never mentioned as a trade commodity. This enables us to define the specific angle from which the texts were written, and so gives insight into the possible biases of our textual sources. To balance the information the authors of this contribution have looked at perishable and non-perishable materials, products for local use, and trade goods.

There are some fundamental problems with the latter division. Goods passing through the Eastern Desert to Berenike were transported to support the local population of the harbor town and to provision ships as well as Roman communities abroad. An important part of the goods transported from the Nile Valley to Berenike were not trade goods, but support products. To a lesser extent goods that came to Berenike by ship may have contained support products (e.g. rice) for a local non-Romanized population or for ships' crews while in port.

In Tables 1-3 an inventory is made of a selection of goods found in first and second century AD contexts. A summary of the archaeological context type is given, and the historical context is indicated (type of source), as well as the information we have on the provenance and destination of the goods. The latter information is mainly based on textual evidence, since we do not have comparable archaeological data for the distribution of the goods around the Red Sea and in the Indian Ocean Basin for all our categories. Table 1 deals with a non-perishable goods *par excellence*: stone. The distinction between stone for local use and as a trade good is not very complicated for this category. It follows roughly the distinction between building stones and gemstones, although there are some exceptions, as will be shown below. Table 2 lists botanical commodities. Table 3 lists wine, oil and fish products, based on ceramic evidence. This selection excludes a large number of goods, such as glass, beads, metal, textiles and animal products (e.g. ivory, leopard skins, turtle shell, coral, pearls, and of course fish, meat, lard as well as escargots that were imported for local consumption in Berenike).

The three categories presented in Tables 1-3 have been selected because they give a good overview of the different types of evidence as well as the variation in sources and destinations. Gemstones are non-perishable and their transporta-

tion is based solely on their value as trade goods. The botanical evidence is much more complicated, because shipments of, for instance, wheat may have any of four functions: provisioning of the population of Berenike, provisioning ships for crew consumption at sea, shipments of food for the outlying Roman posts in Africa and India, and trade commodity. Apart from the complex question of the destination of wheat, the fact that botanical materials are perishable means that the amounts found at Berenike do not reflect the quantities that were once deposited. Archaeological evidence for spices and incense is equally dependent on the preservational circumstances for organic materials, but the rationale behind the shipment of these goods is less equivocal than for that of food stuffs. The shipments of wine and oil, as outlined in Table 3, are based upon a third body of evidence, the remains of amphorae.

Stone (Table 1)[3]

Egyptian stone products for local use and export—The Eastern Desert was an important source for both decorative building stones and gemstones. In the early Roman period the quarries of Mons Porphyrites and Mons Claudianus produced columns, fountain basins and revetments which were exported to other parts of the Roman Empire. The only decorative building stone found in Berenike, however, was Proconnesian marble from the Sea of Marmara in northwestern Turkey (Harrell 1996: 111; Harrell 1998: Table 4-13). The marble is never mentioned in ancient sources concerning Berenike and was probably transported to Berenike in small quantities to decorate some of the temples and official buildings in the harbor town, rather than for export. Most of Berenike was built of coral heads collected from the nearby reefs. Rock gypsum and the closely related rock anhydrite were also used at Berenike for ashlar blocks and other architectural elements. These materials were locally available on Ras Benas, the peninsula just north of Berenike which shelters the harbor from the prevailing northern winds (Harrell 1996: 106-107).

Exports from Berenike concentrated on gemstones, which were mostly shipped to Arabian and African harbors. The abundance of Indian gemstones (see below) effectively closed off the Far Eastern market, with the exception of three minerals and one type of gemstone. The latter is the *chrysolithon* of the *Periplus* (PME 39, 49 and 56) and was taken to Barbarikon, Barygaza, Muziris

[3] In addition to the abbreviations listed above in note 2 this section has the reference OS to Theophrastus' *On Stones* (Caley and Richards 1956).

Table 1: evidence for stones found in early Roman (1st and 2nd century AD) contexts in Berenike or in contemporary textual sources, in the order of their occurrence in the text

Commodity: Stones	Berenike Finds	Textual Source	Provenance (harbor)	Destination
marble	yes	no	Turkey (Proconnesus)	Berenike?
rock anhydrite	yes	no	Eastern Desert	Berenike
rock gypsum	yes	no	Eastern Desert	Berenike
coral heads	yes	no	Berenike	Berenike
Peridot	yes	Agatharchides (OES), Diodorus (LH), *Periplus* (PME), Pliny (NH), Strabo (G)	Red Sea (Berenike)	India (Barbarikon, Barygaza, Muziris, Nelkynda)
realgar	yes	*Periplus* (PME), Pliny (NH)	Eastern Desert (Berenike)	India (Barygaza, Muziris, Nelkynda)
orpiment	no	*Periplus* (PME), Pliny (NH), Theophrastus (OS)	Eastern Desert	India (Muziris, Nelkynda)
stibnite	no	*Periplus* (PME), Pliny (NH)	Eastern Desert	India (Barygaza, Muziris, Nelkynda)
amethyst quartz	yes	*Periplus*' (PME) "stones"	Eastern Desert (Berenike)	Africa (Mosyllon)
green beryl (emerald)	yes	*Periplus*' (PME) ("stones") Pliny (NH), Strabo (G)	Eastern Desert (Berenike)	Africa (Mosyllon)
alabaster	no	Diodorus (LH),	South Arabia	Egypt or Mediterranean
gypsum ("true alabaster") or white marble	yes	*Periplus* (PME), Pliny (NH)		
obsidian	yes	*Periplus* (PME), Pliny (NH)	Ethiopia/Eritrea	Egypt or Mediterranean
turquoise	no	*Periplus* (PME), Pliny (NH)	Sinai/NE Iran (Barbarikon)	Egypt or Mediterranean
lapis lazuli	yes	*Periplus* (PME), Pliny (NH)	NE Afghanistan (Barbarikon)	Egypt or Mediterranean

Table 1: (*cont.*)

Commodity: Stones	Berenike Finds	Textual Source	Provenance (harbor)	Destination
chalcedonic quartz: banded agate, onyx and sardonyx (cameo blanks)	yes	*Periplus* (PME), Pliny (NH)	India (Barygaza)	Egypt or Mediterranean
fluorite and/or chalcedonic quartz: agate, carnelian or sard	yes (quartz only)	*Periplus* (PME), Pliny (NH)	Iran or India (Barygaza)	Egypt or Mediterranean
diamond, or colorless corundum	no	*Periplus* (PME), Pliny (NH), Theophrastus (OS)	India (diamond) or Sri Lanka (corundum) (Muziris, Nelkynda)	Egypt or Mediterranean
blue corundum (sapphire)	yes	*Periplus* (PME), Pliny (NH) Solinus (CM)	India or Sri Lanka (Muziris, Nelkynda)	Egypt or Mediterranean
red corundum (ruby)	no			
amethyst quartz	yes	*Periplus'* (PME)		
citrine quartz	no			
colorless quartz	yes	"transparent gemstones of all kinds"	India or Sri Lanka (Muziris, Nelkynda)	Egypt or Mediterranean
chrysoberyl	no			
aquamarine beryl	yes			
almandine garnet	yes			
zircon	no			
tourmaline	no			

and Nelkynda (Casson 1989: 74-85). Pliny says *chrysolithus* is "a bright golden transparent stone [that] comes to us from Ethiopia" (NH 37: 126), which, for the Romans, included the southern part of Egypt's Eastern Desert and its extension into present Sudan. The *Periplus' chrysolithon* can only be the warm yellowish-green peridot (the gemstone variety of olivine) from Zabargad or St. John's Island, 80 km southeast of Berenike (Ball 1950: 281-284; Casson 1989: 190, 260; Harrell 1999: 115-116). Zabargad Island was the only known source of peridot in the Classical world (Keller 1990: 119-127; Warmington 1974: 253) and, thus, would have been an important Egyptian export during Roman times. It is odd that the *Periplus* does not refer to this mineral by its common ancient name *topazos*.

Numerous ancient writers refer to the Egyptian peridot. Strabo (G 16.4.6) describes the neighborhood of Berenike and mentions the existence of *topazia* quarries on the island of Ophiodes ("snakey") that produced a "transparent stone that sparkles with golden luster (*chrysoeides*)." Strabo's account basically paraphrases that of Agatharchides (OES 5.82), which was also the source of Diodorus' nearly identical account (LH 3.39). Pliny (NH 37.107-109) certainly knew the Egyptian *topazo* and, significantly, says that *topazo* "is the only precious stone that is affected by an iron file, whereas all others have to be smoothed with Naxian stone [i.e. emery, a granular variety of corundum]." With a Mohs hardness of 6.5-7, peridot is softer than most other gemstones. It is clear from the above descriptions of topazo that it would not be out-of-line for the author of the *Periplus* to call peridot *chrysolithon* ("golden colored stone"). Several unworked pieces and one shaped cabochon of peridot have been found at Berenike.

At Berenike the team found a few small pieces of realgar, a red mineral (AsS), which was used anciently for paint pigment and medicine (Caley and Richards 1956: 171-172; Casson 1989: 208; Harrell 1999: 116-117; Schoff 1912: 191-192). Geologically, realgar commonly occurs in gold veins, and usually in close association with orpiment and stibnite. All three minerals were exported from the numerous Roman gold mines in the Eastern Desert to India. However, no evidence was found in Berenike for orpiment and stibnite.

In ancient sources realgar is referred to as *sandarache* (PME 49, 56), while orpiment (As_2S_3), which like realgar, contains arsenic, is called *arsenichon* (PME 56), *arrhenicum* (NH 34.56.178) or *arrenikon* (OS 40, 51). Stibnite (Sb_2S_3) should perhaps be identified as the *stimi* of the *Periplus* (PME 49, 56). Even though Pliny's (NH 33.33.101) description of *stimi* (also *stibi*) is not a good fit to this mineral, it is still probably the material referred to by the *Periplus*' author (Casson 1989: 208-209; Harrell 1999: 117; Schoff 1912: 192-

193). This identification is strengthened by *stimi*'s close association with *sandarache* and *arsenichon* in the Eastern trade, and with the close geologic occurrence of stibnite, realgar and orpiment. All three were used as medicine. Realgar and stibnite were exported to Barygaza, Muziris and Nelkynda (Casson 1989: 80-85), while orpiment was shipped to Muziris and Nelkynda only (Casson 1989: 84-85).

The *Periplus* mentions export from Egypt to the African harbor of Mosyllon of *lithia* which is the iotacistical writing of *litheia* (PME 10). The term literally means 'gemstones' but Schoff (1912: 26) thinks it refers to glass. This latter translation is almost certainly wrong, because the author of the *Periplus* identifies glass as *hyelos* in a list of Egyptian exports (Casson 1989: 80-81). As indicated above, it is significant that these were brought to Mosyllon, rather than to the gemstone-exporting Indian ports.

Two gemstones which Egypt surely exported and for which Roman quarries are known are amethyst (purple quartz, SiO_2) and emerald, the Roman *smaragdus* (green beryl, $Be_3Al_2[Si_6O_{18}]$). The amethyst quarries are in Wadi el-Hudi, 230 km west of Berenike (Shaw and Jameson 1993: 84, 86, 94) and Wadi Abu Diyeiba, about 300 km north of Berenike, near the Roman port of *Myos Hormos* at Quseir (Meredith 1958: 9; Murray 1914). Amethysts have been found at Berenike, but these could have come from India rather than the Eastern Desert (see below).

Emerald is by far the most abundant gemstone found at Berenike, with several scores of crystal fragments recovered to date. Does this indicate that it was an important trade item, or was it the only gemstone readily available to the Berenike inhabitants? The quarries of *Mons Smaragdus* (the mountains around wadis Sikait, Zabara, Nugrus and Umm Kabu), about 90 km northwest of Berenike (Hume 1934: 109-125; Sinkankas 1989: 542-548) were well known in antiquity. Several ancient authors refer to these quarries, among whom are Strabo (G 17.1.45) and Pliny (NH 37.17.65, 37.16.64 and 37.18.69). Emerald is, however, not specifically mentioned in the *Periplus*. Perhaps Pliny gives a clue to why the emeralds were apparently not exported to India, but instead to Mosyllon and perhaps minor ports along the various routes. He describes the Egyptian variety of *smaragdus* as "bright green, although they are rarely flawless or uniform in tint." More recent authors share this low opinion of Egyptian emeralds. For example, Smith and Phillips (1972: 308) write they are mostly "cloudy and rather light in color." They were, thus, probably not a trade item to India, which had its own pale greenish-blue aquamarine beryls (De Romanis 1997: 95-98; Sinkankas 1989: 445-555, 507-508; Wadia 1975: 458). Other possible gemstones for export from Egypt are green malachite ($Cu_2CO_3[OH]_2$) and

greenish-blue turquoise associated with copper deposits in the Sinai (Lucas and Harris 1962: 202-205, 400-401, 404-405). Malachite is also commonly associated with copper deposits throughout the Eastern Desert. The Sinai mines were heavily worked during the Egyptian dynastic period, but they may not have been active in Roman times. Egypt's importation of Indian turquoise (see below), indeed, seems to indicate that they were not. No turquoise has been found at Berenike and only one piece of malachite has been recovered.

African and Arabian stones encountered in Berenike—Some stones that are presented as 'Arabian' by classical authors did not necessarily originate in the Arabian peninsula, but were traded through the Arabian harbors. An example is Pliny's listing of 'Arabian' varieties of *adamas*, a costly clear stone, either a clear colorless variety of corundum or diamond (see below). The first probably came from Sri Lanka, the latter from India, but both were probably traded through Arabian ports.

A stone that probably did derive from the Arabian peninsula was *lygdinos*, a celebrated sculptural stone, which Pliny compares to the brilliantly white marble from the Greek island of Paros and of which he says: "in earlier times it [*lygdinos*] was normally imported from Arabia" (NH 36.13.62, a similar account is found in Diodorus' LH 2.52). Pliny's Arabia is almost certainly *Arabia Felix*, which corresponds geographically to modern-day Yemen (Harrell 1999: 109-110). The *Periplus* mentions "*lygdos*" (PME 24) and states that its provenance is Muza in South Arabia (Casson 1989: 64-65, 156). Contrary to the translation of Huntingford (1980: 34, 141) and Casson (1989: 31, 114), the *lygdos* mentioned in the *Periplus* may not be geologic marble (i.e. a metamorphic rock consisting largely of the mineral calcite $CaCO_3$), but rather, as Schoff (1912: 31, 114) suggests, "alabaster gypsum." This is the 'true alabaster,' not to be confused with the 'Egyptian alabaster,' which is a calcitic rock more correctly referred to as 'travertine.' True alabaster is a fine grained, massive variety of 'rock gypsum,' which is a sedimentary rock consisting mainly of the mineral gypsum ($CaSO_4 \cdot 2H_2O$). Although an ancient quarry for white marble does exist near Marib in Yemen (Geukens 1966: B12), this country is better known for its alabaster gypsum. From at least medieval times until the present, it has been the principal decorative stone used in Yemen with quarries near Sana'a and elsewhere (Fricke 1953: 1062; Scott 1947: 125). The *lygdos* of the *Periplus* may, thus, be either alabaster gypsum or, less likely, marble. The former has not been encountered in Berenike and the presence of the latter is uncertain, unless a fragment of a well-carved platter in white marble is of Yemeni origin. The building stones in Berenike were either local rock gypsum, rock anhydrite or Proconnesian marble imported from Turkey (see above).

A harbor in Eritrea, Hauachil Bay, is mentioned in the *Periplus* as the source of *opsianos lithos* (PME 5, Casson 1989: 52-53). This stone is the only one mentioned in the *Periplus* that was not specifically identified as a trade item. The fact that it is mentioned at all, however, suggests that it may have been of interest to traders and, thus, a commercial commodity. It is the same material as Pliny's *opsiano* (NH 37.65.177) and *obsianae* (NH 37.76.200), about which he says (NH 36.67.196): "the stone [was] found by Obsius in Ethiopia" (De Romanis 1996: 225-239).

Opsianos lithos is clearly the black volcanic glass known as obsidian (Ball 1950: 327; Casson 1989: 109; Harrell 1999: 115; Schoff 1912: 66). The locality mentioned in the *Periplus*, Hauachil Bay, is a well-known source of this rock (Zarins 1989: 348). Although not normally considered a gemstone, obsidian was occasionally used anciently for jewelry and other small, carved objects. Its naturally ultra-sharp edges would have also made it especially useful for cutting blades. Numerous unworked fragments of obsidian have been found at Berenike. An alternative source of these may be areas in South Arabia.

Gemstones from India and Sri Lanka—In the early Roman period India was the preeminent source of gemstones. The *Periplus* lists *challeanos lithos, sappheiros, onychine lithia, moyrrine, adamas, hyachinthos* and *lithia diaphanes pantoia*. The first came from Barbarikon (Casson 1989, 74-75). The *challeanos lithos* corresponds with Pliny's *callaina* and *callais*, which he says (NH 37.33.110-112) originates in the "hinterland beyond India" (see also NH 37.56.151). There is widespread agreement that the name *challeanos lithos* and its variants refer to the gemstone turquoise ($CuAl_6$ $[PO_4]_4[OH]_8 \cdot 4H_2O$) (Ball 1950: 285-289; Casson 1989: 194; Harrell 1999: 110; Schoff 1912: 170; Smith and Phillips 1972: 447). Wadia (1975: 460) and Warmington (1974: 255) report that turquoise was not a product of India, but was probably brought to Barbarikon, where it was traded, from the well-known deposits at Ma'dan near ancient Nishapur in northeast Iran, i.e. in Pliny's "hinterland beyond India." If turquoise was truly imported into Egypt this is somewhat surprising, because this mineral was quarried anciently (from the Old Kingdom onwards) at Magharah and Serabit el-Khadim in the southwest Sinai peninsula (Lucas and Harris 1962: 202-203, 404-405). Pliny (NH 37.33.112) seems to know this when he says "some authorities say that *callainae* are found in Arabia." Perhaps the Eastern turquoise was of a superior quality, as Smith and Phillips (1972: 448) maintain, and so fetched a better price in the Mediterranean trade than that from the Sinai. Alternatively, perhaps the Sinai quarries were not in operation at the time the *Periplus* was written. No turquoise has so far been found at Berenike.

The *sappheiros* (PME 39) came from Barbarikon along with the *challeanos*

lithos (Casson 1989: 74-75). Pliny, in referring to *sappiri*, says (NH 37.39.120) "the best is found in Persia" (see also NH 33.21.68, 37.39.119 and 37.54.139; Theophrastus' OS 23 and 37). *Sappheiros* is, unquestionably, the gemstone now known as lapis lazuli, although the name was apparently also occasionally applied to other opaque blue stones (Ball 1950: 291-292; Caley and Richards 1956: 136-137; Casson 1989: 194; Harrell 1999; Schoff 1912: 170-171). Lapis lazuli is a medieval rendering of the Persian *lazhward*, meaning blue (Mitchell 1985: 110). It is a rock consisting mainly of dark blue lazurite ($[Na, Ca]_8[AlSiO_4]_6[SO_4, S,Cl]_2$) or the closely related mineral haüynite ($[Na, Ca]_{4-8}[AlSiO_4]_6[SO_4]_{1-2}$) with scattered specks of golden pyrite (FeS_2) and occasional veins and patches of white calcite ($CaCO_3$). The only known ancient source for this rock is the Kokscha Valley in northeast Afghanistan (in the eastern part of Pliny's Persia), and so the port of Barbarikon would have been a place where lapis lazuli was traded (Rosen 1988: 11-13; Smith and Phillips 1972: 446-447; Warmington 1974: 251-252). Only one small, unworked piece of lapis lazuli has so far been found at Berenike.

The *onychine lithia* (PME 48-49) came from Barygaza (Casson 1989: 80-81). Pliny (NH 37.24.90-91), in describing *onychis*, says "while the Indian *onychem* has several different colors, fiery red, black and that of horn, surrounded by a white layer as in an eye, and in some cases traversed by a slanting layer . . . [there is] also an Arabian *onychem* which differs from the Indian in that the latter displays a small fiery red layer surrounded by one or more white bands . . . [whereas the former] is found to be black with white bands . . . [but there is also another] Indian [onyx] that is flesh-colored, with part of it resembling the *carbunculi* [possibly red] and a part, the *chrysolithis* [i.e., yellow or perhaps yellowish green as in peridot, see above] and the *amethystiu* [i.e. purple amethyst quartz]." A complementary description of *onychion* is provided by Theophrastus (OS 31).

From these descriptions there can be no doubt that the *onychine lithia* of the *Periplus* is the gemstone variety of chalcedonic quartz (SiO_2) known as agate (Ball 1950; Caley and Richards 1956: 127-128; Harrell 1999: 111-112; Schoff 1912: 193-194), including its subvarieties 'banded agate' with concentric layers of various colors, 'onyx' with plane-banded alternating white and dark grayish to brownish layers, and 'sardonyx' with plane-banded white and reddish layers. There are many sources of fine agate in India and these have been a trade commodity from ancient times onward (Smith and Phillips 1972: 434; Wadia 1975: 460; Warmington 1974: 237-242). Warmington (1974: 259) is of the opinion that the agate referred to by Pliny as "Arabian" actually came from India, but was traded from some of the Arabian ports. Many pieces of onyx and sardonyx

have been found at Berenike, and most of these are cut into flat, oval disks for cameos. It may be then that the trade in *onychine lithia* mentioned by the *Periplus* largely involved cameo blanks.

The *mourrhine* (PME 48) came from Barygaza along with *onychine lithia* (Casson 1989: 80-81). This material is probably the same as Pliny's *myrrhina* (also *murrina* and *murrhina*) that he says (NH 37.8.21-22) "come to us from the East . . . particularly within the kingdom of Parthia (see also NH 33.2.5; 36.67.198 and 37.7.18-20). There has been disagreement among scholars over the identity of this material, but the strong consensus is that the name *mourrhine* and its variants refer either to fluorite, also known as fluorspar, or agate (Ball 1950: 215-221; Casson 1989: 206; Harrell 1999: 112-113; Loewental *et al.* 1949; Schoff 1912: 193-194). Roman cups and bowls in both materials are known. However, the properties of the material as described by Pliny and other ancient writers fit only fluorite (CaF_2) as is convincingly argued by Loewental *et al.* (1949). Also, it seems unlikely that Pliny would have confused his *achates* (NH 37.54.139-142) and *onychis* with a *myrrhina* of agate composition. Although there are reports of fluorite deposits in Iran (Loewental *et al.* 1949), no ancient and modern workings are known. There are also no anciently worked deposits in India and this led Ball (1950: 220-221) and Warmington (1974: 238-239, 259) to conclude that *myrrhina* from India was either agate or another form of chalcedonic quartz, such as carnelian or sard. In one passage (PME 6), the *Periplus* mentions *morrines* in the context of glassware (apparently glass imitations of stone), and says it was a product of Diospolis (Thebes) in Egypt and exported to Barbarikon (Casson 1989: 52-53, 111-112). Thus, the *mourrhine* imported from Barygaza is not likely to also be glass. No fluorite has been found at Berenike, but carnelian, sard and agate are abundantly present. Occurrences of these gemstones are rare in Egypt and no ancient workings are known. The carnelian at Berenike commonly occurs as well-worn pebbles and this is consistent with a provenance in Sri Lanka's famous gemstone-rich placer gravels.

The *adamas* (PME 56) came from Muziris and Nelkynda (Casson 1989: 84-85). Pliny (NH 37.15.55-58) recognized varieties of *adamas* from widely scattered localities throughout the ancient world, including Arabia and India (see also NH 37.15.60-61 and 37.76.200 and Theophrastus' OS 19). It is widely agreed that *adamas* is either colorless corundum (Al_2O_3) or, more likely, diamond (C), both among the most precious of gemstones (Ball 1950: 242-246; Caley and Richards 1956: 91-92; Casson 1989: 223; Harrell 1999: 113-114; Schoff 1912: 224-226). The name 'corundum' is apparently derived from the Indian *kauruntaka*, and 'diamond' is a corruption of the Greek *adamas* (Mitchell 1979: 107, 111). Pliny's detailed description of *adamas* fits best with

diamond. In antiquity, diamonds came only from India (Ball 1950: 249-250; Smith and Phillips 1972: 26; Wadia 1975: 455-456; Warmington 1974: 236), and so the other varieties of *adamas* mentioned by Pliny may be corundum which is a more widely distributed mineral. Colorless corundum could also have come from Sri Lanka (Smith and Phillips 1972: 300) where deposits of colored varieties of this mineral (red ruby and blue sapphire) are well known (Wadia 1975: 456-457; Warmington 1974: 247-249). No diamond or colorless corundum has been found at Berenike.

The *hyanchinthos* (PME 56) came from Muziris and Nelkyunda along with *adamas* (Casson 1989, 84-85). Pliny (NH 37.41.125) and Solinus (CM 30.32-33) provide useful descriptions of *hyacinthos* (Ball 1950: 294) but say nothing of its source. It is generally accepted that the word *hyanchinthos* and its variants refer to the blue variety of corundum known as sapphire (Ball 1950: 294-295; Casson 1989: 223; Harrell 1999: 114; Schoff 1912: 226-227). This modern name is derived, of course, from the ancient *sappheiros/sappiri*, which referred to lapis lazuli and occasionally other blue stones. Blue sapphire was produced anciently on Sri Lanka and would have been traded in the nearby ports on the Indian mainland (Smith and Phillips 1972: 299-300; Wadia 1975: 456-457; Warmington 1974: 247-249). One unworked fragment of sapphire has been found at Berenike, and a nicely shaped double cabochon was recovered from Shenshef, a satellite settlement 35 km southwest of Berenike.

The *lithia diaphanes pantoia* (PME 56) translates as "transparent gemstones of all kinds," and these came from Muziris and Nelkynda along with the *adamas* and *hyachinthos* (Casson 1989: 84-85). It is impossible to say what stones these are, but they undoubtedly include at least some of the following gemstones that are known to have come from southern India and especially Sri Lanka: amethyst quartz, citrine quartz, colorless quartz (rock crystal), chrysoberyl, ruby corundum, aquamarine beryl, almandine garnet, zircon, and tourmaline (Ball 1950: 66-67; De Romanis 1997: 95-98; Sinkankas 1989: 445-455; Warmington 1974: 245-254). Of these minerals the ones found at Berenike were: amethyst quartz, colorless quartz, aquamarine beryl, and almandine garnet.

Botanical commodities (Table 2)

In Egypt plant remains are preserved in both a charred and a desiccated condition. Especially the latter preservation mode, owing to the arid climate, facilitates identification mostly to the level of species. A successful identification, however, depends on the degree of fragmentation and the availability of matching reference material. In an archaeobotanical context, solid plant parts such as

seeds, fruits and stem fragments of woody plants, account for the largest part of the archaeobotanical records. This will introduce bias for plant species that are traded for their fragile plant parts such as flowers (e.g. saffron [*Crocus sativus* L.]) or leaves (e.g. malabathron [*Cinnamomum* spp.]). The identification of the well preserved and diagnostic plant remains at Berenike is partly hampered by their broad scope of origin. The number of cultivated species that come into consideration is huge, as trade contacts were maintained with Africa south of the Sahara, the Arabian peninsula and the Indian Ocean Basin. Furthermore, indirect trade contacts with the Far East via India were possible from the first century AD onwards, enlarging the potential commodities with a distinct set of vegetal products (Cappers forthcoming a).

The archaeobotanical research at Berenike has yielded a substantial list of cultivated plants, representing cereals, pulses, vegetables and tubers, fruit plants, condiments and spices, oil, incense and fibre crops, and dye and tannin producing plants (Table 2). The identification of their possible area of origin and final destination is often ambiguous. To determine the area of origin is especially problematic when the distribution range of a plant species is relatively large. A complicating factor is the enlargement of the distribution area by a spread of cultivated species such as rice and cotton outside their area of origin, a process that was accelerated during classical times. The destination of the plant products could have been Rome, Berenike or foreign harbors that were visited for their exotic commodities (for a detailed discussion see Cappers forthcoming b).

The number of plant species that is evidenced by both texts and botanical remains at Berenike is limited. Of the 54 botanical commodities mentioned in Table 2, only nine items meet this criterion. They concern staple foods representing cereals, vegetables and fruits. Three plant species are, so far, only known from written sources: cabbage, dill and parsley. The absence of seeds/fruits might partly be explained by assuming that vegetative plant parts were consumed. The 'pickles' mentioned in the Berenike ostraka refer perhaps to pickled peach and apricot. These were perishable fruits that could not be grown in Berenike, nor, when ripe, could have survived the 12-day crossing of the Eastern Desert, but remains of which were, nevertheless, found in the trash dumps of Berenike.

In more detail, this lack of balance is also recognized in the *Periplus* with respect to import and export localities of botanical commodities. A total of 34 items of botanical origin are mentioned. The enumeration of plant names in Table 2 clearly demonstrates that this document is far from complete.

Table 2: evidence for botanical commodities found in early Roman (1st and 2nd century AD) contexts in Berenike or in contemporary textual sources

Commodity: Botanical Goods	Berenike Finds	Textual Source	Transport	Provenance	Destination
CEREALS					
Hard wheat and bread wheat (*Triticum turgidum* ssp. d*urum* / *Triticum aestivum*)	desiccated and carbonized grains from trash dump	*Periplus* (PME), Nikanor (NA), Ostraka Berenike	in bulk	Nile Valley	Berenike and India
Hulled 6-row barley (*Hordeum vulgare* ssp. *vulgare*)	desiccated and carbonized grains from trash dump	*Periplus* (PME), Nikanor (NA), Ostraka Berenike	in bulk	Nile Valley	Berenike
Rice (*Oryza sativa*)	desiccated grains from trash dump	*Periplus* (PME) (not considered as a grain)	small numbers	India	*Periplus*: east African ports; Roman Empire
Job's tears (*Coix lacryma -jobi*)	desiccated fruits from trash dump	no textual sources	small numbers	India	Roman Empire
PULSES					
White lupine (*Lupinus albus*)	desiccated seeds from trash	no textual sources	reasonable numbers	Nile Valley	Berenike
Grass pea (*Lathyrus sativus*)	desiccated seeds from trash	no textual sources	small numbers	Nile Valley	Berenike
Lentil (*Lens culinaris*)	desiccated seeds from trash	no textual sources	in bulk	Nile Valley	Berenike
Bitter vetch (*Vicia ervilia*)	desiccated seeds from trash	Nikanor (NA)	small numbers	Nile Valley	Berenike
Faba bean (*Vicia faba*)	seeds from trash desiccated	no textual sources	small numbers	Nile Valley	Berenike
Mung bean (*Vigna radiata*)	desiccated seeds from trash dump	no textual sources	small numbers	India	Berenike or Roman Empire

Table 2: (*cont.*)

Commodity: Botanical Goods	Berenike Finds	Textual Sources	Transport	Provenance	Destination
VEGETABLES AND OIL PLANTS					
Beet (*Beta vulgaris*)	desiccated receptacle clusters	Ostraka Berenike	reasonable numbers	Nile Valley and Berenike	Berenike
Garlic (*Allium sativum*)	desiccated bulbs and bulbel bases	no textual source	reasonable numbers	Nile Valley and Berenike	Berenike
Onion (*Allium cepa*)	desiccated bulbel base	Ostraka Berenike	small numbers	Nile Valley and Berenike	Berenike
Caper bush (*Capparis spinosa*)	desiccated seeds from trash	no textual sources	reasonable numbers	Local production	Local use
Colocinth (*Citrullus colocinthus*)	desiccated seeds from trash	no textual sources	reasonable numbers	Local production	Local use
Watermelon (*Citrullus lanatus*)	desiccated seeds from trash	no textual sources	reasonable numbers	Nile Valley	Berenike and export?
Bottle gourd (*Lagenaria siceraria*)	desiccated seeds	no textual sources	reasonable numbers	Nile Valley and Berenike	Berenike
Cabbage (*Brassica* sp.)	no archaeological evidence	Ostraka Berenike	pickled?	Nile Valley	Berenike?
Dill (*Anethum graveolens*)	no archaeological evidence	Nikanor (NA)	unknown	Nile Valley	Berenike?
Parsley (*Petroselinum crispum*)	no archaeological evidence	Ostraka Berenike	unknown	Nile Valley	Berenike?
Safflower (*Carthamus tinctorius*)	desiccated fruits from trash	no textual sources	reasonable numbers	Nile Valley	Berenike?
Sesame (*Sesamum indicum*)	desiccated seeds	Nikanor (NA) and *Periplus* (PME): sesame oil	in sacks, possibly limited supply	India	Egypt
Flax (*Linum usitatissimum*)	desiccated seeds	no textual sources	small numbers	Nile Valley	Berenike?

Table 2: (*cont.*)

Commodity: Botanical Goods	Berenike Finds	Textual Sources	Transport	Provenance	Destination
FRUITS AND NUTS					
Fig (*Ficus carica*)	desiccated fruits from trash	no textual sources	Fresh? Dried? reasonable numbers	Nile valley	Berenike?
Hazel (*Coryllus avellana*)	desiccated fruits from trash	no textual sources	reasonable numbers	Mediterranean area	Berenike?
Almond (*Amygdalus communis*)	desiccated fruit remains from trash	no textual sources	reasonable numbers	Mediterranean area	Berenike?
Stone pine (*Pinus pinea*)	desiccated and charred seeds and cone fragments	no textual sources	in bulk	Mediterranean area	Berenike and export item?
Peach (*Prunus persica*)	desiccated fruitstone	no textual sources	single specimen	Mediterranean area	Berenike
Pomegranate (*Punica granatum*)	desiccated seeds	no textual sources	small numbers	Nile Valley	Berenieke?
Apple (*Malus domestica*)	desiccated seeds	no textual sources	small numbers	Mediterranean area and Nile Valley	Berenike?
Nabq (*Ziziphus spina-christi*)	desiccated fruit remains from trash	no textual sources	Fresh in bulk	Eastern Desert	Berenike
Olive (*Olea europaea*)	desiccated and charred fruit stones	*Periplus* (PME): olive oil and possibly olives (translation unclear), Nikanor (NA)	in bulk	Fayum and Mediterranean area	*Periplus*: not mentioned
Grape (*Vitis vinifera*)	desiccated seeds from trash	*Periplus* (PME): possibly grapes (translation unclear), Ostraka Berenike	Fresh, bunches of grapes	Nile valley and Mediterranean area	Berenike and ?

Table 2: (*cont.*)

Commodity: Botanical Goods	Berenike Finds	Textual Sources	Transport	Provenance	Destination
Sugar date (*Balanites aegyptiaca*)	desiccated fruit remains from trash	no textual sources	in bulk	Eastern Desert	Berenike
Doam palm (*Hyphaene thebaica*)	desiccated fruit remains from trash	no textual sources	in bulk	Eastern Desert	Berenike
Egyptian plum (*Cordia myxa*)	desiccated fruits and calyxes	no textual sources	in bulk, dried? Fresh?	Nile valley and Mediterranean area	?
Cordia nevilliilsinensis	desiccated fruits	no textual sources	small numbers	Gebel Elba and southern area	Berenike?
Date (*Phoenix dactylifera*)	desiccated and charred seeds	*Periplus* (PME)	in bulk	Arabia and India	Arabia
Balsam tree (*Commiphora* cf. *gileadensis*)	desiccated fruits and seeds	no textual sources	small numbers	Gebel Elba and southern area	Berenike?
Coconut (*Cocos nucifera*)	Trash dump: fruit fragments (endo-, meso- and exocarp)	Vita Apollonii: possibly first record	complete fruits or fruits without fibers	India	Roman Empire
Carob tree (*Ceratonia siliqua*)	desiccated seeds	no textual sources	reasonable numbers	uncertain	?
Senna (*Senna alexandrinalho loseri-cea*)	desiccated fruits and seeds	no textual sources	reasonable numbers	numbers Desert	Desert
Cocculus pendulus	desiccated fruits	no textual sources	small numbers	Gebel Elba and southern areas	Berenike?
pickles	stones of peaches	Ostraka Berenike	pickled fruit?	Nile Valley?	Berenike?
SPICES AND CONDIMENTS					
spices (unspecified)	several	*Periplus* (PME)	dried	East African ports	not specified

Table 2: (*cont.*)

Commodity: Botanical Goods	Berenike Finds	Textual Sources	Transport	Provenance	Destination
Fenugreek (*Trigonella foenum-graecum*	desiccated seeds	no textual sources	reasonable numbers	Nile Valley and Berenike	Berenike?
Cumin (*Cuminum cyminum*	desiccated seeds	no textual sources	reasonable numbers	Nile Valley and Berenike	Berenike?
Black pepper (*Piper nigrum*)	abundant evidence in trash dump and as hoard	*Periplus* (PME) Alexandrian Tariff: black and white pepper	in bulk	India (Muziris, Nelkynda)	Roman empire
Long pepper (*Piper longum*)	no archaeological evidence	*Periplus* (PME)	dried	India (Barygaza)	Roman empire
Saffron (*Crocus sativus*)	no archaeological evidence	*Periplus* (PME)	dried pistils	?	*Periplus*: Arabia
Coriander (*Coriandrum sativum*)	desiccated fruits from trash dump	no textual sources	regular supply	Berenike	Berenike
Fennel (*Foeniculum vulgare*)	desiccated fruits from trash	no textual sources	reasonable numbers	Nile valley and Mediterranean area	Berenike
Abrus	desiccated seeds from trash	no textual sources	reasonable numbers	East Africa?	Roman Empire?
Incense	indirect evidence	Ostraka Berenike?	Resin	Ethiopia or South Arabia	Berenike Roman Empire

The fact that Berenike was located in a remote, desert environment that only facilitated local cultivation of some vegetables on a regular scale, implies that both staple and luxury items must have been imported from other regions (Cappers forthcoming b). Most of the staple food, cereals and legumes, were obtained from the Nile Valley. Additional supplies were imported from the Mediterranean area and from more southernly located regions, including Gebel Elba, 210 km south of Berenike, which receive considerable rainfall and are characterised by a different flora (*i.e.* Flora Sudanense).

The Mediterranean area not only delivered food which keeps well, such as walnut (*Juglans regia* L.), hazel (*Corylus avellana* L.) and almond (*Amygdalus communis* L.), but also perishable food such as peaches (*Prunus persica* [L.] Batsch.), cherry plums (*P. cerasifera* Ehr.) and domestic plums (*P. domestica* L.). The less arid regions south of Berenike provided, for example, incense (*Commiphora gileadensis* [L.] C. Christ.) and the rare Ethiopian pea (*Pisum abyssinicum* Braun), which has recently been accepted as a separate species. The only archaeological context from which this plant is presently known is Berenike.

Several textual sources mention pepper trade as one of the main objectives of the Indian connection, in which three kinds of pepper are distinguished: white and black pepper (respectively unripe and ripe fruits of black pepper [*Piper nigrum* L.]) and long pepper (*P. longum* L.). Long pepper grows in north India and could have been obtained from Barygaza, whereas black pepper is native to the Malabar coast (Kerala) and could have been traded in Muziris and Nelkynda. Long pepper is traded as complete spikes with quite small fruits and is, therefore, not to be confused with black pepper which has much larger fruits that are separated from the spike. The presence of the wrinkled outer fruit wall in most of the Berenike specimens indicate that we most probably are dealing exclusively with 'black pepper.' The huge quantities of black pepper that have been found at Berenike, including an Indian dolium (storage jar) filled with well over 7.5 kg of peppercorns, representing a value equivalent to enough wheat to supply the average Roman for two years, contrast sharply with the scanty records from other localities within the Roman Empire: Oberaden/Germany: 12 (Kucan 1984); Straubing/Germany: 52 (Küster 1995); Hanau-Salisweg/Germany: 12 (Kreuz 1995); Biesheim-Kunheim/France: 1 (Jacomet and Schibler 2001). The dearth of pepper finds in Rome itself, perhaps the most important destination for the trade, should probably be explained by a combination of factors. The published botanical research from excavations at Rome itself is scant (Follieri 1975), and the preservational circumstances for organic materials are less favorable than in the deserts of Egypt. The large quantities of peppercorns found at Berenike are only a fraction of the large supplies that must have been temporarily stored in the town on their way to the large *Horrea piperataria* near Rome (Platner and Ashby 1929: 16.63; Rickman 1971: 104-106).

The absence of long pepper, the price of which was 3.75 times that of black pepper according to Pliny (NH 12.14.26-28), from the archaeobotanical record seems to indicate that this spice was not much traded, possibly because it was not much in demand or because most ships called at Indian harbors along the Malabar coast (Kerala). It is striking that today's supply of black and long pepper in Near Eastern spice markets mirrors that of Classical times.

Whereas texts and archaeobotanical evidence supplement each other with respect to black pepper, written sources are silent on other Indian plants found at Berenike (coconut [*Cocos nucifera* L.], rice [*Oryza sativa* L.], amla [*Phyllanthus emblica* L.], mung bean [*Vigna radiata* (L.) Wilczek] and Job's tears [*Coix lacryma-jobi* L.]). The transport of these items might, of course, be related to the presence of Indian traders in Berenike, preferring their own food above local supply, but the quality of the items suggest that they were also brought to Rome. The presence of many botanical items found at Berenike without Roman counterparts illustrates that trade centers such as harbors are pre-eminently places for studying exotic commodities for the Roman markets.

The discrepancy between the archaeobotanical evidence from Berenike and evidence from written sources is not confined to commodities from India, but reflects also evidence from other botanical items. This phenomenon is explainable by taphonomic processes and excavation strategies. Unlike written sources, botanical remains are not intentionally archived and the recovery of reasonable concentrations *in situ*, such as the dolium with black pepper, is rather exceptional. Most of the unearthed botanical remains can be classified as waste matter and would have been discarded outside buildings. In the very early stage of deposition, much of this archive will vanish, as it becomes prey to wind dispersal and browsing animals. Also incinerating rubbish will partly result in loss of plant remains. Only when it is covered with a sufficiently thick layer of new rubbish or sand will it have the opportunity to become part of the archaeobotanical archive of the site. The quality of the archaeobotanical record greatly depends on the sampling procedure. Common plant species, such as wheat, barley and date are present in almost every sample. Rare species, on the other hand, such as amla and Ethiopian pea have a disjunctive dispersal pattern. It is obvious that the presence of large dump areas calls for special sampling strategies to optimize the recovery of these clustered species.

Because archaeobotanical research in Berenike has been based on morphological features, special categories of plant products will be underexposed. This is true for liquids and secretions from stems, leaves and roots (e.g. resins, gums and oils), all of which are well represented in written sources dealing with the trade in Berenike.

A special problem is the interpretation of plant names in written sources. For many botanical commodities from India it is still unclear which Latin or Greek names were used. Although scientific plant names are in Latin, it should be realised that the binomial nomenclature was only introduced by C. von Linné in the 18th century. And even though these binomials are partly based on Greek and Latin names mentioned by classical writers, their current status might deviate from their original 'classical' name. The reason is that every taxon (e.g.

plant species, subspecies or variety) may be subject to remodelling and consequently new names may be introduced, in which the assignment is determined by the international code of botanical nomenclature (ICBN). Because the ICBN rules may result in the reuse of existing names for newly defined taxa, linking old trade names with analogous modern scientific plant names may lead to wrong identifications. For the interpretation of the Latin *cuci* and the Greek *cuciofeer* in classical texts, for example, references have been made to *cucifera* and *nucifera*. Both words are used in Latin plant names, including palm trees. Pliny (NH 15.34.114) uses the word *cuci* for an Egyptian tree and it is most likely that it concerns the indigenous doam palm. The legitimate scientific name for this plant is *Hyphaene thebaica* (L.) Mart., but one of its synonyms (i.e. *Cucifera thebaica* Delile) includes the original classical term. In his translation of the *Periplus*, Schoff (1912: 99) interprets the Greek term *nauplios* (PME 17) as 'palm oil,' a translation which is adopted by Miller (1969: 27). Schoff reached this identification through first correcting the Greek word *nauplios* to *nargilios*, which in turn is related to the Sanskrit *narikela* or *narikera* and the Prakrit *nargil*. According to Schoff, this palm oil came from the coconut. He supports this interpretation by relating the Greek *cuciofeer* and the Latin *cuci* to the scientific name of the coconut (*Cocos nucifera* L.), which, however is not tenable. Especially for the coconut, which is conspicuous for its size, use and taste, it is likely that a separate trade name was in use by the Romans. Hohlwein (1939), citing a work by Theophrastus (IV.II.7), was misled by the current scientific name for the coconut (*Cocos nucifera* L.) and interpreted κουκιόφορὸν as a coconut. Also Warmington (1928: 217) was of the opinion that early classical writers mentioned the coconut. The coconut is mentioned in *Vita Apollonii* (3.5), a book on the life of Apollinius of Tyna written by Philostratus, who lived in the second century AD, but only by a brief descriptive phrase: large nuts that are dedicated to shrines (cited by Warmington 1928: 217). Warmington is correct in his interpretation that coconuts are meant, but he misjudges the context: the text is not referring to Greek temples, but to Indian (family) altars dedicated to deities such as Saraswati, Dantesvari and Khandoba. The first indisputable description of the coconut is from Cosmas Indicopleustes in his *Topographia Christianae* (11.444.D, Wolska-Conus 1973), which is dated to 530 AD. This text gives a name for the nut (Greek: *karuon indikon*, "Indian nut"; Latin: *argellia*).

Of the 34 botanical commodities listed in the *Periplus*, 23 have been 'identified' by conspicuous parallels in which generally the level of speculation is high. Only the 11 botanical commodities, of which the identification is more or less established, have been incorporated into Table 2.

The introduction of new botanical commodities into the Roman Empire also necessitated the introduction of new plant names by the classical authors. Such new names may contain clues, relating them to indigenous terminology, but for many their exact identification has to be derived from the textual context. This might be a description referring, for example, to the morphology of the plant product, its use or its origin. Also the common denominator in an enumeration may contribute to a well-considered interpretation. But prudence is called for as modern groupings may deviate from former ones. In the *Periplus*, for example, rice is not considered a grain, nor is Berenike mentioned as a transit port for rice. Nevertheless, the import of rice in Berenike has been confirmed by archaeobotanical research. Rice could have been obtained from Socotra or the so-called far-side ports on the northern coast of Somalia.

Amphora-borne Products (Table 3)

Table 3 summarizes the evidence for the different products and source areas represented by the amphorae from Berenike. This includes all types of first/second century AD date, regardless of their findspot and therefore includes those that may be present only residually in later deposits. There are, naturally, additional imported amphora types for which no source can be assigned.

Amphorae, the transport containers of antiquity, were used for the long-distance conveyance of liquid commodities, particularly for goods associated with and necessary to the Roman way of life. Although a diverse range of products was transported in amphorae, the most common include wine (and by-products such as *defrutum* and inferior wine known as vinegar), olive oil, and fish products (such as *garum*). The manufacture of amphorae is normally linked to the regions or estates producing their contents and in this way to the agricultural economy. Their widespread distribution relates primarily to their contents, rather than to the amphorae as objects in their own right. Many other ceramic classes, including fine table wares, were imported into Egypt, from where they were transported to the Red Sea and eventually further east, alongside amphorae but whereas amphorae are considered primary objects of trade because of their contents these objects are considered secondary.

Amphora studies in themselves provide a complex example of the inter-relationship between textual and archaeological studies, for when well preserved many of the vessels have inscriptions relating to source, contents, weight etc. These inscriptions—known as *tituli picti* or *dipinti*—can clarify many details about specific vessel types, including date, provenance and contents. In addition, some vessels, particularly during the period being dealt with here, are stamped with the name of their maker or estate (see Peacock and Williams 1986: 9-14

for a summary). As archaeological objects, source can also be investigated through scientific analysis of the clay body (Bourriau *et al.* 2000), the distribution patterns of the objects and, in some cases, the discovery of production sites. Contents, too, can be scientifically investigated to detect residue absorbed into the clay wall (Serpico 2000).

The foundation for amphora typology remains that established by Heinrich Dressel in 1899, based on the amphora inscriptions from Monte Testaccio in Rome, although obviously expanded and refined over the last one hundred years. Essentially, an amphora type is defined by the association between vessel shape and clay fabric, which in turn normally equates with a production area. Furthermore, basic shapes are associated with certain food products, providing ease of product identification in much the same way as today we associate particular bottle shapes with, for example, cola or wine. Significantly, a one-to-one relationship does not exist between fabric (and in turn source) and shape: instead as already noted, certain shapes may be associated with specific products but manufactured in a number of places and therefore in a range of fabrics. The best and most extreme example of this is Dressel's Type 2-4, which is common at Berenike. This vessel, which carried wine, is characterized by a bead rim, double-rod handle, carinated shoulder and peg base.

Table 3: Ceramic vessels for the transport of wine, oil, and fish products of early Roman date (1st and 2nd century AD) found at Berenike or in contemporary textual sources

Commodity: Wine, Oil, Fish Products	Berenike Finds: Ceramic Vessels	Textual Source and Name of Vessel	Provenance	Destinations Listed in the *Periplus*
Wine	Dressel 2-4; Amphores Égyptiennes 4 (Empereur 1986, figs 2-5); Class 10 (Peacock and Williams 1986)		Mareotis	
Wine	Dressel 2-4; Class 10 (Peaock and Williams 1986)		Campania (Naples)	
Wine	Dressel 2-4 (Williams 1994); Class 10 (Peacock and Williams 1986)		Northern Campania	

Table 3: (*cont.*)

Commodity: Wine, Oil, Fish Products	Berenike Finds: Ceramic Vessels	Textual Source and Name of Vessel	Provenance	Destinations Listed in the *Periplus*
Wine	Gauloise 4 (Laubenheimer 1989); Class 27 (Peacock and Williams 1986)		Gaul (Gallia Narbonnensis)	
Wine	Dressel 2-4 (Tomber 1998); Class 10 (Peacock and Williams 1986)	*Ladikena*: Ostraka Berenike, Nikanor archive, *Periplus*	Cilicia (Laodicea ad Mare)	Adulis (PME 6) Muza (PME 24) Barygaza for Ozene (PME 49)
Wine	Dressel 2-4 (Tchernia and Zevi 1972); Class 10 (Peacock and Williams 1986)		Tarraconensis	
Wine	Early variant of Gaza vessel (Majcherek 1995, pl. 4), probably present but more typical of the late Roman period		Gaza	
Wine		*Onisian*: Nikanor archive	Near Crete	
Wine	Class 9 (Peacock and Williams 1986); (Peacock 1977)	*Rhodia*: Ostraka Berenike	Rhodes	
Wine		*Italika*: Ostraka Berenike, *Periplus*	Italy	Adulis (PME 6) Muza (PME 24) Barygaza for Ozene (PME 49)
Wine		*Periplus*	Unknown	Avalites (PME 7) Azanian ports (PME 17) Muza (PME 24) Kane (PME 28) Barbarikon for

Table 3: (*cont.*)

Commodity: Wine, Oil, Fish Products	Berenike Finds: Ceramic Vessels	Textual Source and Name of Vessel	Provenance	Destinations Listed in the *Periplus*
				Minnagar (PME 39) Barygaza for Ozene (PME 49) Nelkkynda/Muziris for Bakare (PME 56)
Wine		*Aminaia*: Ostraka Berenike, Nikanor archive	Unknown	
?Wine (Bagnall *et al.* 2000, 20)	Late Roman Amphora 3 (Riley 1981); Class 45 (Peacock and Williams) Probably represented in the 1st c, but more typical of the mid-4th and later.	*Ephesia*: Ostraka Berenike	Ephesus region/ Meander Valley	
?Wine (Bagnall *et al.* 2000, 20)		*Kolophonia*: Ostraka Berenike, Nikanor archive		
Oil	Dressel 20; Class 25 (Peacock and Williams 1986); (Ponsich 1988).		Baetica	
Oil	Tripolitania I or II (Panella 1973); Classes 36-37 (Peacock and Williams 1986). Sherds generally too fragmentary to attribute to a specific form.		Tripolitania	

Table 3: (*cont.*)

Commodity: Wine, Oil, Fish Products	Berenike Finds: Ceramic Vessels	Textual Source and Name of Vessel	Provenance	Destinations Listed in the *Periplus*
Oil		*Italika*: Ostraka Berenike		
Oil		Ostraka Berenike, Nikanor archive, *Periplus*	Unknown	Adulis (PME 6) Muza (PME 24)
Fish products, oil	Africana I 'Piccolo' (Zevi and Tchernia 1969); Class 33 (Peacock and Williams 1986).		North Africa (Tunisia, Byzacena)	
Fish products	Eg Classes 17-18 (Peacock and Williams 1986) probably represented by body sherds (see also Ponsich 1988).		Cadiz	
?Fish (Bagnall *et al.* 2000, 21)		*Epimenia:* Ostraka Berenike, Nikanor archive		
Wine (including vinegar), fish products	Egyptian early Roman, including Amphores Égyptiennes 3 (Empereur and Picon 1989, figs 11-12).	Ostraka Berenike, Nikanor archive	Egypt (Nile Valley and Mareotis)	
Unknown	(Ballet and Vichy 1992, fig. 11)		Aswan	

Despite our extensive knowledge of amphorae, both from the textual and archaeological evidence, the interpretation of amphora-borne commodities in the documents is not simple. In particular, whether the usage of place names refers to source area or is generalized to refer to vessel shapes and in turn measures has been a matter of some debate (e.g. Bagnall *et al.* 2000; Kruit and Worp

2000; Rathbone 1983): the consensus is that foreign geographical names generally refer to imported vessels/contents. Nevertheless, there is no simple resolution and individual documents need to be evaluated. For example, the Kolophonion appears to be used as a wine measure rather than as a direct indication of the presence of foreign wine (Bagnall *et al.* 2000: 18-20), and the same may be true of the Rhodion, a measure commonly used in Egypt in contexts where imported wine is unlikely. Given Berenike's role as an export entrepot, however, and the presence of Rhodian vessels on the site, it remains possible that at Berenike the term does refer to imported wine.

One example of the complexity of the documents relevant to the Berenike archive is the use of *Italika* and *Aminaia*. On the basis of the evidence available in 1983, Rathbone convincingly equated the *Aminaia* of the Nikanor with the *Italika* of the *Periplus*. Based on the large number of Berenike texts referring to Italian, rather than Aminean wine, Kruit and Worp (2000: 131-132) argued that the *Aminaia* and *Italika* could no longer be equated and that the *Aminaia* derived its name not from a place or vessel shape, but from the Aminean vine. Bagnall *et al.* (2000: 19-20) concluded from the Berenike texts, that Aminean wine was a rarer type of Italian wine, and could be Aminean wine from Campania.

Although there are numerous amphora types of this period found at Berenike for which a source cannot be identified, the majority of identifiable Italian ones are Dressel 2-4 vessels of Campanian origin. Rathbone (1983: 85) has identified Italy (especially Campania and central Italy), Sicily, Spain and Syria as areas in which the Aminean vine was cultivated. Dressel 2-4 amphoras can be identified at Berenike from three of these four areas: Italy (Campania), Spain (Tarraconensis) and Syria (Laodicea ad Mare), the last matched to the *Ladikena* of the Berenike ostraka. The only recurring and identifiable type of Dressel 2-4 not certainly mentioned in the documents is that from Mareotis, and it too may have contained Aminean wine (Empereur 1986).

Thus during the Roman period there is a correlation between the Dressel 2-4 and areas producing wine from the Aminean vine (see also Empereur 1986), suggesting that in these cases there was a link between vine and vessel shape (Dressel 2-4 amphorae produced elsewhere may have been intentionally creating an association with well-known wine producing areas). At Berenike these three source areas listed above are quantitatively represented in decreasing order by Campania, Syria and Spain. Of these, Campania is by far the most common. Therefore, quantitatively there is an argument to equate the *Aminaia* with Campania, although they could also refer solely to the vessel form we call Dressel 2-4.

While at present there is no positive evidence in support, it is not impossible that references to *Aminaia* refer to local vessels, thereby not requiring further

adjectival clarification. However, a number of texts found at Berenike in 2000 and 2001 may refer to the Mareotis region (Bagnall *et al.* forthcoming) and future interpretation of these texts will contribute to this debate.

The published documents do not provide direct evidence for the transport of Egyptian wine or other products in amphorae. Bagnall (*et al.* 2000: 19) has suggested that some of the wine from unspecified sources may have been Egyptian and this is supported by the identification of the 'Amphores Égyptiennes 3' type at Kane (Ballet 1996) and Ras Hafun (Smith and Wright 1988). The presence of the Egyptian Dressel 2-4 wine amphorae at Kane (Ballet 1996) is the most compelling evidence for the export of Egyptian wine from the Red Sea.

If we return to Table 3, we see that the majority of references to wine in the *Periplus* are to unspecified types; thus imported wine amphorae identified at Berenike but not specified in the documents may be subsumed within this category. However, refinement in our understanding of export will rely on interpretation of archaeological evidence from Berenike and more easterly sites (see Tomber forthcoming for an overview of amphora evidence available in 1998).

There are fewer mentions of oil than wine in the *Periplus*, and the text is entirely silent regarding source area, whereas Table 3 shows that in Berenike oil vessels from Spain, Tripolitania and probably North Africa can be identified in the ceramic assemblage. A single Berenike ostrakon refers to an *Italikon* of oil (Bagnall *et al.* 2000: 38 no. 4). If denoting Italian oil in an Italian vessel, the text is problematic, for during this period there are no Italian amphorae found in the Eastern Desert known to have been oil containers. A more likely explanation for this, applicable to other goods as well, is the reuse of containers. The practice is documented by Berenike ostrakon no. 88 which refers to *Ladikena* filled with local wine (Bagnall *et al.* 2000: 18). Archaeologically a similar phenomenon is indicated by a Campanian Dressel 2-4 with an intact plaster stopper stamped with the Egyptian *Uraeus*, a motif common throughout the Eastern Desert (Gates forthcoming). There is no reliable method to quantify the reuse of vessels, but here the ratio of ostraka indicating primary use (export of non-Egyptian goods) to this single example of secondary use might argue that the practice was uncommon; there is no evidence either textually or archaeologically that the bulk of containers for export were reused.

References to fish products are virtually absent from the documents, and can only be tenuously identified by equating the *Epimenia* of Berenike and the Nikanor: referring to provisions in general, this may include fish (Bagnall *et al.* 2000: 21). Nevertheless, the presence of Spanish amphorae associated with the exclusive use of fish products at Berenike, Myos Hormos and Arikamedu (Will 1996) indicate that fish products were exported from the Red Sea to India.

On the basis of the documents (mainly the Nikanor archive), Casson (1989: 113-114) interpreted the Aminaean and Italian wine sent to Berenike as local consumption rather than export, but the broader picture now available implies to Bagnall *et al.* (2000: 16) that most of the amphora-borne commodities were destined for export. Nevertheless, these goods were without doubt available to some sectors of the Berenike population, whether officially or unofficially, as seen from their presence in domestic contexts. Elsewhere in the Eastern Desert, they were available at non-port sites, including the Imperial quarries of Mons Claudianus (Tomber 1996) and Mons Porphyrites (Tomber 2001) and, significantly, on the Nile and the Red Sea road at the *praesidium* of Maximianon (Brun 1996).

Summary and Discussion

Although historians still sometimes see archaeology as ancillary to textual sources, the work at Berenike shows that combining results from various specialists on a basis of equality results in a more balanced historical reconstruction. The tables as presented in the previous sections show that there is a discrepancy between the textual evidence and the archaeology. Using these tables as a heuristic tool, by also explaining why certain commodities do *not* occur, or why some goods found in Berenike are *not* mentioned in the textual sources, our understanding of the harbor and its context is enhanced greatly.

Although the subject matter, a study of the harbor town of Berenike in relation to the long-distance trade, is the same, the four sources presented here, textual, stone, botanical, and ceramic materials, provide different kinds of information which have to be balanced carefully in order to present an overall image of the emporium and the organization of the trade. On a methodological level three caveats become apparent.

First, the interpretation of archaeological assemblages, of which locally retrieved textual evidence is a part, starts with the context. As was highlighted above, it is extremely important to understand the way objects have been deposited and preserved. While noting the occurrence or quantifying commodities one should take into account that, for instance, each date consumed in Berenike produced a hard kernel that stood a good chance to survive wind, browsing animals and fire. Plants with edible seeds will have been dispersed through human or animal feces, while a considerable portion of the original botanical presence has disappeared without trace. Peppercorns were ground before being added to food and it was such a costly commodity that spillage was rare. In Berenike the fact that peppercorns were found in the trash dumps

witnesses to the relative abundance of this spice, but they were also found charred as part of offerings. A large dolium with 7.5 kg of peppercorns reflects deliberate storage.

Incense, as was noted in Table 2, was not found. Nevertheless, indirect evidence for incense offerings was discovered in several of Berenike's shrines. Circular soil colorations, one of which was found on top of a small stone offering table, indicated the presence of wooden bowls. A cross section showed that the bowls were lined with a layer of sand and filled with charcoal, presumably in preparation of incense offerings.

Contrary to botanical remains, written sources are produced for future consulting, though their life span may be relatively short as is the case with, for example, ostraka. Written sources are sensitive to fragmentation and fire, ink may fade in the sunlight. In order to gain insight into the extent and organization of the trade, a variety and considerable number of ostraka are needed. As outlined above, to date we have not encountered a late Roman archive in Berenike. Therefore, just as with botanical remains, the sampling procedure for textual evidence is of major concern, as is the interpretation of the depositional and post-depositional processes. Thus it is important for each find to decide why and how it became part of the archaeological record and to record if it was an *in situ* discovery (archive / storage), systematically dumped waste (e.g. the Berenike ostraka 'archive'), or subject to loss.

Secondly, in a comparison of ancient Greek or Latin with modern terminology similar names may denote different materials or objects. Examples are the terms *sappheiros*/sapphire (anciently for lapis lazuli, at present for blue corundum) and coconut. For amphorae the discussion on terminology focuses on the question if geographical terms refer to the source area of the wine, to vessel shapes or perhaps even to standardized measures. Interweaving textual and archaeological evidence starts with careful identification of terms, based on specialists' knowledge and lexicographical study.

The third caveat is to be aware of the purpose and bias of the text material. The textual sources available for the first and second centuries AD show an interest in trade goods, economic value and a characterization of the different markets. The goods listed in the *Periplus* are mentioned because of their attraction as a trade item. The Berenike ostraka are overwhelmingly concerned with the transportation and customs process for export goods; only a scattering of texts so far deal with other subjects. Thus the Berenike ostraka give a good overview of the goods that were brought from the Nile Valley by caravan for loading aboard the ships. The relatively small quantities mentioned in the ostraka are probably attributable to the carrying capacity of the camels of an

individual driver rather than to the intended use of the goods. The ostraka do not specify whether these goods were trade commodities or provisions for the ship's crew and distant populations. The Nikanor ostraka, by contrast, apparently deal heavily with the supply of the population of Berenike. Differences and similarities of commodities included and excluded may be explained to a large degree by these differences of textual origins and objectives. The physical objects and materials found at Berenike, are also present for a variety of reasons: imports that represent a residue of trade, imports for local use and consumption as well as ships provisions.

In spite of these three caveats a multidisciplinary approach of archaeology is not only worth while, but necessary to maximise the level of interpretation. Especially in a site such as Berenike, where items rarely found under less favourable preservational circumstances for once become part of the archaeological record, a broad spectrum of approaches not only produces a more complete inventory but, as the occasion arises, also shed light on problems of interpretation. It is, therefore, a challenge to the multidisciplinary oriented archaeology to compare the different kinds of evidence in the hope that interpretative problems are tackled and the reconstruction of the past is as complete as possible.

Thus an integration of information on textual sources, stones, botanical commodities and ceramic evidence (to list only the Berenike specializations involved in this contribution) helps to interpret the long distance trade, but also highlights interpretative problems.

Gemstones were an important export article from India, the Indian hinterland and Sri Lanka. Some of these have been found in Berenike, others not. Turquoise, for instance, has not been encountered at Berenike. Is this a reflection of its rarity, or of the trade route? Although there are turquoise deposits in the Sinai, turquoise was imported into Egypt from northeast Iran through the harbor of Barbarikon. This was also the transit harbor for lapis lazuli, which was quarried in northeast Afghanistan. The one piece of lapis lazuli that has been found in Berenike is not a strong indication of direct contacts with Barbarikon. The rarity in Berenike of the stones said to have come through Barbarikon stands in contrast with the considerable number of cameo blanks imported through Barygaza. Fluorite, also possibly an import through this harbor, has not been encountered in the excavations.

From the evidence of the diversity in stone, it is possible to lay out a tentative trade pattern in which Barygaza seems to have been of greater importance than Barbarikon. The botanical evidence, however, suggests major contacts with the harbors of Muziris and Nelkynda, while evidence from the north is scant. The abundance of black pepper (from the south), compared with the dearth of

long pepper (from the north) could be interpreted as indicative of the trade route. Muziris and Nelkynda are located opposite the Ethiopian ports and Socotra, and can be reached through a direct crossing of the Indian Ocean, rather than a coast-hugging shipping route. The evidence from the northern gemstone trade, however, prevents a rapid and simplifying conclusion. It seems that a considerable number of ships visited or originated at the northern harbors, but did not load large quantities of long pepper for transportation to Egypt. Long pepper was more expensive and perhaps less popular than black and white pepper.

The purpose of stone shipments is clear cut: peridots and medicinal minerals were exported from Egypt, while the majority of the gemstones were imported from India and Sri Lanka. Arabia and Africa exported attractive sculptural stone and obsidian. If we concentrate for a moment on the question why some stones are found in Berenike, but are not encountered in textual sources, then the abundant presence of green beryls from the Mons Smaragdus area stand out. It stands to reason that these low quality beryls did not meet a demand in the Indian harbors that concentrated on gemstone export. Their presence in Berenike can be explained either by assuming that all beryls were for local use, which is unlikely since the stones found at Berenike were not worked, or by postulating that the beryls were traded in the less important harbors *en route*. Another possible explanation for their absence from the texts is that they did not have to travel from the Nile Valley to Berenike and thus were not part of the customs process that most of the Berenike ostraka document.

The botanical finds at Berenike do not necessarily denote trade goods, but form a combination of local produce, imported goods for consumption in the harbor town, provisioning of ships, provisioning of populations in distant harbors and, finally, trade goods. The same is true for the oil, wine and fish sauce, which are identified through their standardized containers.

Of the 53 plants listed in Table 2, 46 species have been found at Berenike, of which 36 have not been mentioned in any of the textual sources. This can partly be explained by identifying local Berenike produce, such as sugar dates, harvested in wadis in the Eastern Desert, and plants that can be grown for personal use in small garden plots. On the other hand, Berenike has yielded a considerable quantity of coconut, a species that was not mentioned in first and second century AD texts, but clearly is not a local product. The only reference is a description of the use of coconut in India. The Nikanor archive, which lists produce that is mostly for local use in Berenike, mentions wheat, barley, bitter vetch, sesame, dill and olive oil. The Berenike ostraka, referring to goods entering the harbor area, mention nine plant species: wheat, barley, beet, onion, cabbage, parsley, pickles, grapes and perhaps incense. The *Periplus*

refers to wheat, barley, rice, sesame oil, olive oil, grape, dates, spices, black pepper, long pepper and saffron as well as to 23 other plant commodities of which the identification is uncertain. Thus it is clear that, not surprisingly, wheat and barley are the most important botanical bulk goods to which all textual sources make reference.

From these examples it is clear that a systematic integration of the different sources should take into account a range of biases that are the result of deposition, post-deposition and preservation, but also of purpose and politics. Some of these biases can be countered by a well-designed sampling procedure, but for the most part they cannot be easily traced or corrected. One way of taking these biases into account in the interpretation is to specifically look for and explain evidence that does not 'fit.' The comparison of the different sources is particularly helpful in this procedure. The methodical problems that are involved in such a comparison have been highlighted in this contribution and summarized above. Apart from the 'confirmation' of textual evidence through the archaeological research, or the archaeological discovery of new textual evidence and the deeper understanding of the texts' referents, a major gain of a multi-disciplinary approach is heuristic and corrective. The discrepancies between the different sources help to identify biases and prevent a simplified interpretation. The combination of evidence gives us insights that none of the categories separately could offer and enable us to give a more balanced image of the way the harbor town functioned in the organization of the long distance trade.

BIBLIOGRAPHY

Bagnall, R.S., C. Helms, and A.M.F.W. Verhoogt. Forthcoming. Documents from Berenike, Volume 2.

——. 2000. *Documents from Berenike, Volume 1. Greek ostraka from the 1996-1998 seasons.* Bruxelles: Fondation Égyptologique Reine Élisabeth.

Ball, S.H. 1950. *A Roman Book on Precious Stones—Including an English Modernization of the 37th Booke of the Historie of the World by E. Plinius Secundus.* Los Angeles: Gemological Institute of America.

Ballet, P. 1996. De la Méditerranée à l'Océan Indien l'Égypte et le commerce de longue distance à l'époque romaine: les données céramiques. *Topoi* 5/2: 809-840.

Ballet, P., and M. Vichy. 1992. Artisanant de la ceramique dans l'Egypte hellénistique et romaine. Ateliers du Delta, d'Assouan et de Kharga. *In Ateliers de Potiers et Productions Céramiques en Egypte*, edited by P. Ballet, pp. 109-119.

Bourriau, J., P.T. Nicholson, and P.J. Rose. 2000. Pottery. *In Ancient Egyptian materials and technology*, edited by P.T. Nicholson and I. Shaw, pp. 121-147. Cambridge: Cambridge University Press.

Brun, J.-P. 1996. Le praesidium Romain de Maximianon (Al-Zarqa, Egypte). Fouilles 1994-1995. *Topoi* 6/2: 685-695.

Burstein, S.M. 1989. *Agatharchides of Cnidus on the Erythraean Sea.* London: Hakluyt Society.

Caley, E.R., and J.F.C. Richards. 1956. *Theophrastus on Stones.* Columbus: Ohio State University Press.

Cappers, R.T.J. 2002. Farming in the desert: implications of recent practices for archaeobotanical interpretations. In *Moving matters. Ethnoarchaeology in the Near East*, edited by W.Z. Wendrich and G.J. van der Kooij, pp. 45-62. Leiden: Research School CNWS, School for Asian, African and Amerindian Studies.

Cappers, R.T.J. forthcoming a. Exotic imports of the Roman Empire: an exploratory study of potential vegetal products from Asia. *Africa Oecologica*.

——. forthcoming b. *Roman food-prints at Berenike. Archaeobotanical evidence of trade and subsistence in the Eastern Desert of Egypt*. Los Angeles: Cotsen Institute of Archaeology at UCLA.

Casson, L. 1989. *The Periplus Maris Erythraei: text with introduction, translation, and commentary*. Princeton: Princeton University Press.

De Romanis, F. 1996. *Cassia, Cinnamomo, Ossidiana. Uomini e Merci tra Oceano Indiano e Mediterraneo*. Rome: L'Erma di Bretschneider.

——. 1997. Rome and the Notia of India: relations between Rome and southern India from 30 BC to the Flavian period. In *Crossings—Early Mediterranean Contacts with India*, edited by F. De Romanis and A. Tchernia, pp. 80-160. New Delhi: Manohar.

Dressel, H. 1899. *Corpus Inscriptionum Latinorum XV (1)*, Berlin.

Eichholz, D.E. 1962. *Pliny—Natural History (v. 10, books 36-37)*. Cambridge: Harvard University Press.

Empereur, J.Y. 1986. Un atelier de Dressel 2-4 en Egypte au III^{e} siècle de notre ère. *BCH* Suppl 13: 599-608.

Empereur, J.Y., and M. Picon. 1989. Les régions de production d'amphores impériales en Méditerranée orientale. In *Amphores Romaines et Histoire Economique: Dix Ans de Recherche*, pp. 223-248. Rome: Coll Ecole Française Rome.

Follieri, M. 1975. Resti vegetali macroscopici nel collettore del Colosseo. *Annali di Botanica* 34: 123-141.

Fricke, K. 1953. Bergbau auf alabaster und gips in Jemen. *Glückauf* 89: 1061-1062.

Fuks, A. 1951. Notes on the archive of Nicanor. *Journal of Juristic Papyrology* 5: 207-216.

Gates, J. forthcoming. Amphora stoppers. In *Berenike 2001: report of the 2001 excavations at Berenike and the survey of the Egyptian eastern desert*, edited by S.E. Sidebotham and W.Z. Wendrich. Los Angeles: Cotsen Institute of Archaeology at UCLA.

Geukens, F. 1966. *Geology of the Arabian Peninsula—Yemen*. United States Geological Survey Professional Paper 560 B.

Harrell, J.A. 1996. Geology. In *Berenike 1995, Preliminary Report of the 1995 Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert*, edited by S.E. Sidebotham and W.Z. Wendrich, pp. 99-126. Leiden: CNWS, research school for African, Asian and Amerindian Studies.

——. 1998. Geology. In *Berenike 1996, Preliminary Report of the 1996 Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert*, edited by S.E. Sidebotham and W.Z. Wendrich, pp. 121-148. Leiden: CNWS, research school for African, Asian and Amerindian Studies.

——. 1999. Geology. In *Berenike 1997, Report of the Excavations at Berenike and the Survey of the Egyptian Eastern Desert, Including Excavations at Shenshef*, edited by S.E. Sidebotham and W.Z. Wendrich, pp. 107-121. Leiden: CNWS, research school for African, Asian and Amerindian Studies.

Hohlwein, N. 1939. Palmiers et palmeraies dans l'Egypte Romaine. *Etudes de papyrologie* 5: 1-74.

Hume, W.F. 1934. *Geology of Egypt (v. 3 pt. 1)*. Cairo: Survey of Egypt, Ministry of Finance (later the Egyptian Geological and Mining Authority).

Huntingford, G.W.B. 1980. *The Periplus of the Erythraean Sea by an Unknown Author with some Extracts from Agatharkhides 'On the Erythraean Sea.'* London: The Hakluyt Society.

Jacomet, S. and J. Schibler. 2001. Les contributions de l'archéobotanique et de l'archéozoologie à la connaissance de l'agriculture et de l'alimentation du site romain de

Biesheim-Kunheim. In *La frontière romaine sur le Rhin supérieur. À propos des fouilles récentes de Biesheim-Kunheim*, edited by S. Plouin et al., pp. 60-68. Biesheim: Ville de Biesheim.

Jones, H.L. 1959. *The Geography of Strabo (v. 8, book 17)*. Cambridge: Harvard University Press.

——. 1961. *The Geography of Strabo (v. 5, books 10-12)*. Cambridge: Harvard University Press.

——. 1966. *The Geography of Strabo (v. 7, books 15-16)*. Cambridge: Harvard University Press.

Keller, P.C. 1990. *Gemstones and their Origins*. New York: Van Nostrand Reinhold.

Kreuz, A. 1995. Landwirtschaft und ihre ökologischen Grundlagen in den Jahrhunderten um Christi Geburt: zum Stand der naturwissenschaftlichen Untersuchungen in Hessen. *Berichte der Kommision für Archäologische Landesforschung in Hessen* 3: 59-91.

Kruit, N., and K. Worp. 2000. Geographical jar names: towards a multi-disciplinary approach. *Archiv für papyrusforschung* Band 46.

Kucan, D. 1984. Der erste römerzeitliche Pfefferfund nachgewiesen im Legionslager Oberaden (Stadt Bergkamen). *Ausgrabungen und Funde in Westfalen Lippe* 2: 51-56.

Küster, H. 1995. *Postglaziale Vegetationsgeschichte Südbayerns*. Berlin: Akademie Verlag.

Laubenheimer, F. 1989. Les amphores gauloises sous l'Empire. Recherches nouvelles sur leur production et leur chronologie. In *Amphores Romaines et Histoire Economique: Dix Ans de Recherche*, pp. 105-138. Rome: Coll Ecole Française Rome.

Loewental, A.I., D.B. Harden, and C.E.N. Bromehead. 1949. Vasa murrina. *Journal of Roman Studies* 39: 31-37.

Lucas, A., and J.R. Harris. 1962. *Ancient Egyptian Materials and Industries*. London: Edward Arnold Publishers.

Majcherek, G. 1995. Gazan amphorae: Typology reconsidered, Hellenistic and Roman Pottery in the Eastern Mediterranean. In *Advances in Scientific Studies. Acts of the II Nieborów Pottery Workshop*, edited by H. Meyza and J. Mlynarczyk, pp. 163-178, Warsaw.

Meredith, D. 1956. Chronique d'Egypte: 356-.

——. 1958. *TABVLA IMPERII ROMANI: text for 'Map of the Roman Empire, Sheet no. NG36 (1:1,000,000).'* Oxford: Oxford University Press.

Miller, J.J. 1969. *The spice trade of the Roman Empire*. Oxford: Clarendon Press.

Mitchell, R.S. 1979. *Mineral Names—What Do They Mean?* New York: Van Nostrand Reinhold.

——. 1985. *Dictionary of Rocks*. New York: Van Nostrand Reinhold.

Mommsen, T. 1958. *C. Iulii Solini—Collectanea Rerum Memorabilium*. Berlin: Weidmannsche Verlagsbuchhandlung.

Murphy, E. 1989. *The Antiquities of Asia—A Translation with Notes of Book II of the 'Library of History' of Diodorus Siculus*. New Brunswick: Transaction Publishers.

Murray, G.W. 1914. Notes. *Cairo Scientific Journal* 8:179.

Oldfather, C.H. 1961. *Diodorus of Sicily (v. 2, books 2-4)*. Cambridge: Harvard University Press.

Panella, C. 1973. Appunti su un gruppo di anfore della prima, media e tarda eta imperiale. In *Ostia III: Le Terme del Nuotatore: Scavo dell'Ambiente V et di un Saggio nell'Area*, pp. 460-633.

Peacock, D.P.S. 1977. Roman amphorae: typology, fabric and origins. In *Méthodes Classiques et Méthodes Formelles dans l'Etude des Amphores.*, edited by G. Vallet, pp. 261-278. Rome: Coll Ecole Française Rome.

Peacock, D.P.S., and D.F. Williams. 1986. *Amphorae and the Roman economy. An introductory guide*. New York: Longman.

Platner, S.B., and T. Ashby. 1929. *A topographical dictionary of ancient Rome*. Oxford: Oxford University Press.

Ponsich, M. 1988. *Aceite de oliva y salazones de pescado*, Madrid.

Rackham, H. 1952. *Pliny—Natural History (v. 9, books 33-35)*. Cambridge: Harvard University Press.

Rathbone, D.W. 1983. *Italian wines in Roman Egypt*. Opus 3: 81-98.

Rickman, G. 1971. *Roman granaries and storage buildings*. Cambridge: Cambridge University Press.

Riley, J.A. 1981. The pottery from Cisterns 1977.1, 1977.2 and 1977.3. In *Excavations at Carthage Conducted by the University of Michigan 1977*, edited by J.H. Humphrey, pp. 85-124. Ann Arbor: Michigan University.

Rosen, L. von. 1988. *Lapis Lazuli in Geological Contexts and in Ancient Written Sources*. Paul Astroms Forlag.

Schoff, W.H. 1912. *The Periplus of the Erythraean Sea; travel and trade in the Indian Ocean*. New York: Longmans Green and Co.

Scott, H. 1947. *In the High Yemen*. London: John Murray.

Serpico, M. 2000. Resins, amber and bitumen. In *Ancient Egyptian materials and technology*, edited by P.T. Nicholson and I. Shaw, pp. 430-474. Cambridge: Cambridge University Press.

Shaw, I., and R. Jameson. 1993. Amethyst mining in the Eastern Desert—A preliminary survey at Wadi el-Hudi. *Journal of Egyptian Archaeology* 79: 81-97.

Sidebotham, S.E., and W.Z. Wendrich. 1995. *Berenike 1994: preliminary report of the 1994 excavations at Berenike (Egyptian Red Sea Coast) and the survey of the Eastern Desert*. Leiden: Research School CNWS, school for Asian, African and Amerindian Studies.

———. 1996. *Berenike 1995: preliminary report of the 1995 excavations at Berenike (Egyptian Red Sea Coast) and the survey of the Eastern Desert*. Leiden: Research School CNWS School of Asian African and Amerindian Studies.

———. 1998. *Berenike 1996: report of the 1996 excavations at Berenike (Egyptian Red Sea Coast) and the survey of the Eastern Desert*. Leiden: Research School CNWS, school for Asian, African and Amerindian Studies.

———. 1999. *Berenike 1997: report of the 1997 excavations at Berenike and the survey of the Egyptian eastern desert, including excavations at Shenshef*. Leiden: Research School CNWS, school for Asian, African and Amerindian Studies.

———. 2000. *Berenike 1998: report of the 1998 excavations at Berenike and the survey of the Egyptian eastern desert, including excavations at Wadi Kalalat*. Leiden: Research School CNWS, school for Asian, African and Amerindian Studies.

———. forthcoming. *Berenike 1999-2000, Report of the excavations at Berenike and the Survey of the Eastern Desert, including excavations in Wadi Kalalat, Siket and Wadi Abu Greiya*. Los Angeles: Cotsen Institute of Archaeology.

Sinkankas, J. 1989. *Emerald and Other Beryls*. Prescott: Geoscience Press.

Smith, G.F., and F.C. Phillips. 1972. *Gemstones*. New York: Pitman Publishing.

Smith, M.C., and H.T. Wright. 1988. The ceramics from Ras Hafun in Somalia: notes on a classical maritime site. *Azania* 23: 115-141.

Tchernia, A., and F. Zevi. 1972. Amphores vinaires de Campanie et de Tarraconaise à Ostia. In *Méthodes Classiques et Méthodes Formelles dans l'Etude des Amphores*, edited by G. Vallet, pp. 35-67. Rome: Coll Ecole Française de Rome.

Tomber, R.S. 1993. Long-distance exchange: quantitative approaches. *Journal of Roman Archaeology* 6: 144-166.

———. 1996. Provisioning the desert: pottery supply to Mons Claudinus. In *Archaeological Research in Roman Egypt*, edited by D.M. Bailey, pp. 39-49.

———. 1998. 'Laodicean' wine containers in Roman Egypt. In *Life on the Fringe. Living in the southern Egyptian deserts during the Roman and early-Byzantine periods*, edited by O.E. Kaper, pp. 213-119. Leiden: Research School CNWS, School for Asian, African and Amerindian Studies/Netherlands Flemish Institute in Cairo.

———. 2001. Pottery. In *The Roman Imperial quarries. Survey and excavation at Mons Porphyrites*

1994-1998, edited by V. Maxfield and D.P.S. Peacock, pp. 242-303. London: Egypt Exploration Society.

———. forthcoming. Trade relations in the eastern Mediterranean and beyond: the Egyptian-Indian connection. *Halicarnassus Papers*.

Wadia, D.N. 1975. *Geology of Egypt*. New Delhi: Tata McGraw-Hill Publishing.

Warmington, E.H. 1928. *The Commerce Between the Roman Empire and India*. New Delhi: Munshiran Manoharlal Publishers.

———. 1974. *The Commerce Between the Roman Empire and India*. London: Curzon Press.

Wendrich, W.Z. 1998. The Finds, Introduction. In *Berenike 1996: report of the 1996 excavations at Berenike (Egyptian Red Sea Coast) and the survey of the Eastern Desert*, edited by Steven Edward Sidebotham and Willemina Zwanida Wendrich, pp. 148-160. Leiden: Research School CNWS, School for African, Asian and Amerindian Studies.

Will, E. 1996. Mediterranean shipping amphoras at Arikamedu, 1941-50 excavations. In *The ancient port of Arikamedu. New excavations and researches 1989-92 1*, edited by V. Begley et al., pp. 317-350, Pondicherry.

Williams, D.F. 1994. Campanian amphorae. In *Excavations at South Sheilds Roman Fort*, edited by P. Bidwell and S. Speak, pp. 217-219. Newcastle upon Tyne: Society of Antiquaries of Newcastle upon Tyne.

Wolska-Conus, W. 1973. *Cosmas Indicopleustès. Topographiae Chrétienne. Tome III*. Paris: Les éditions du Cerf.

Zarins, J. 1989. Ancient Egypt and the Red Sea trade—the case for obsidian in the predynastic and archaic periods. In Essays *in Ancient Civilization Presented to Helene J. Kantor*, edited by B. Williams and A. Leonard, pp. 339-368. Chicago: Oriental Institute of the University of Chicago.

Zevi, F., and A. Tchernia. 1969. Amphores de Byzacène au Bas-Empire. *Antiquites Africaines* 3: 173-214.