Title
Roman Foodprints at Berenike: Archaeobotanical Evidence of Subsistence and Trade in the Eastern Desert of Egypt

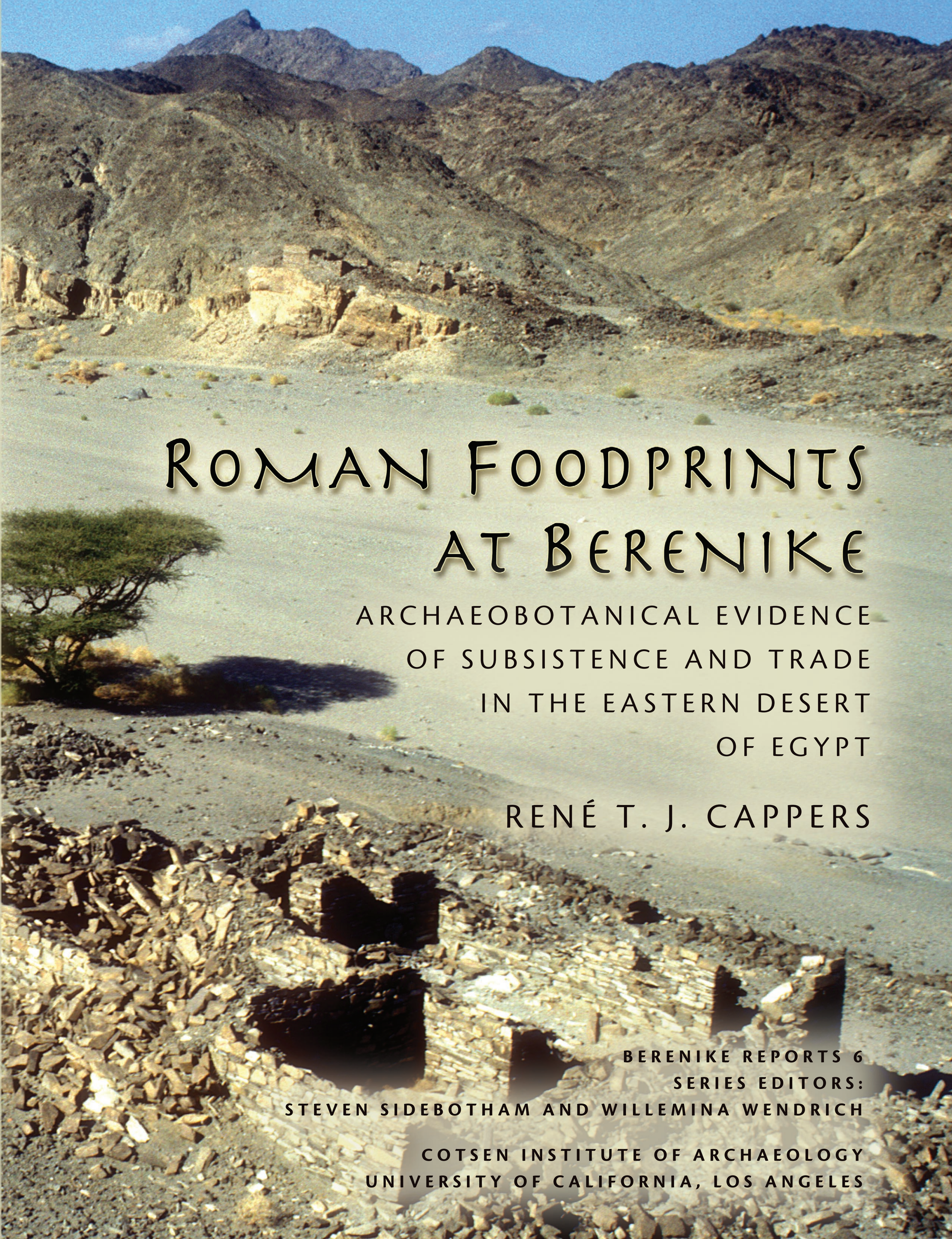
ISBN
978-1-931745-26-0

Author
Cappers, René T.J.

Publication Date
2006-08-01

Data Availability
The data associated with this publication are within the manuscript.

Peer reviewed



Roman Foodprints at Berenike

Archaeobotanical Evidence of Subsistence and Trade in the Eastern Desert of Egypt

René T. J. Cappers

Berenike Reports 6
Series Editors:
Steven Sidebotham and Willemina Wendrich

Cotsen Institute of Archaeology
University of California, Los Angeles

ROMAN FOODPRINTS AT BERENIKE

COTSEN INSTITUTE OF ARCHAEOLOGY AT UCLA

Monographs
Contributions in Field Research and Current Issues in Archaeological Method and Theory

MO54	*Advances in Titicaca Basin Archaeology - 1*	Charles Stanish, Amanda B. Cohen, and Mark S. Aldenderfer
MO53	*Us and Them: Archaeology and Ethnicity in the Andes*	Richard Martin Reycraft
MO52	*Archaeological Research on the Islands of the Sun and Moon, Lake Titicaca, Bolivia: Final Results from the Proyecto Tiksi Kjarka*	Charles Stanish and Brian S. Bauer (editors)
MO51	*Maya Zooarchaeology: New Directions in Theory and Method*	Kitty F. Emery (editor)
MO50	*Settlement Archaeology and Political Economy at Tres Zapotes, Veracruz, Mexico*	Christopher A. Pool (editor)
MO49	*Perspectives on Ancient Maya Rural Complexity*	Gyles Iannone and Samuel V. Connell (editors)
MO48	*Yeki bud, yeki nabud : Essays on the archaeology of Iran in honor of William M. Sumner*	Naomi F. Miller and Kamyar Abdi (editors)
MO47	*Archaeology in the Borderlands : Investigation in Caucasia and Beyond*	Adam T. Smith and Karen S. Rubinson (editors)
MO46	*Domestic Ritual in Ancient Mesoamerica*	Patricia Plunket (editor)
MO45	*Pathways to Prismatic Blades*	Kenneth Hirth and Bradford Andrews (editors)
MO44	*Ceramic Production and Circulation in the Greater Southwest*	Donna M. Glowacki and Hector Neff (editors)
MO43	*Pottery of Postclassic Cholula, Mexico*	Geoffrey McCafferty
MO42	*Pompeian Households: An Analysis of the Material Culture*	Penelope M. Allison
MO41	*Rethinking Mycenaean Palaces: New Interpretations of an Old Idea*	Michael L. Galaty and William A. Parkinson (editors)
MO40	*Prehistory of Agriculture: New Experimental and Ethnographic Approaches*	Patricia C. Anderson (editor)
MO39	*Recent Advances in the Archaeology of the Northern Andes. In Memory of Gerardo Reichel-Dolmatoff*	Augusto Oyuela-Caycedo and J. Scott Raymond (editors)
MO38	*Approaches to the Historical Archaeology of Mexico, Central and South America*	Gasco, Greg Charles Smith, and Patricia Fournier-Garcia
MO37	*Hawaiian Adze Production and Distribution: Implications for the Development of Chiefdoms*	Barbara Lass
MO36	*New Light on Old Art: Recent Advances in Hunter-Gatherer Rock Art Research*	D. W. Whitley and L. L. Loendorf (editors)
MO35	*Pottery of Prehistoric Honduras: Regional Classification and Analysis*	J. S. Henderson and M. Beaudry-Corbett
MO34	*Settlement Archaeology of Cerro de las Mesas, Veracruz, Mexico*	Barbara Stark (editor)
MO33	*Girikihaciyan: A Halafian Site in Southeastern Turkey*	P. J. Watson and S. LeBlanc
MO32	*Western Pomo Prehistory: Excavations at Albion Head, Nightbirds' Retreat and Three Chop Village, Mendocino County, California*	Thomas N. Layton
MO31	*Investigaciones Arqueológicos de la Costa Sur de Guatemala*	David S. Whitley and Marilyn P. Beaudry (editors)
MO30	*Archaeology of the Three Springs Valley, California. A Study in Functional Cultural History*	Brian D. Dillon and Matthew A. Boxt
MO29	*Obsidian Dates IV: A Compendium of Obsidian Hydration Readings from the UCLA Obsidian Hydrastion Laboratory*	Clement W. Meighan and Janet L. Scalise (editors)
MO28	*Archaeological Field Research in the Upper Mantaro, Peru, 1982-1983: Investigations of Inka Expansion and Exchange*	Timothy Earle et al. (editors)
MO27	*Andean Archaeology, Papers in Memory of Clifford Evans*	Ramiro Matos M., Solveig Turpin, Herbert Eling, Jr. (editors)

MO26	*Excavations at Mission San Antonio 1976-1978*	Robert L. Hoover and Julio J. Costello (editors)
MO25	*Prehistoric Production and Exchange in the Aegean and Eastern Mediterranean*	A. Bernard Knapp and Tamara Stech (editors)
MO24	*Pots and Potters: Current Approaches in Ceramic Archaeology*	Prudence Rice
MO23	*Pictographs and Pegroglyphs of the Oregon Country, Part 2*	J. Malcolm Loring and Louise Loring
MO22	*The Archaeology of Two Northern California Sites*	Delmer E. Sanburg, F. K. Mulligan, Joseph Chartkoff, and Kerry Chartkoff
MO21	*Pictographs and Petroglyphs of the Oregon Country, Part 1*	Malcolm Loring and Louise Loring
MO20	*Messages from the Past: Studies in California Rock Art*	Clement W. Meighan (editor)
MO19	*Prehistoric Indian Rock Art: Issues and Concerns*	JoAnne Van Tilburg and Clement W. Meighan (editors)
MO18	*Studies in Cypriote Archaeology*	Jane C. Biers and David Soren
MO17	*Excavations in Northern Belize, Central America*	Raymond Sidrys
MO16	*Obsidian Dates III: A Compendium of Obsidian Hydration Determinations Made at the UCLA Obsidian Hydration Laboratory*	Clement Meighan and Glenn Russell
MO15	*Inland Chumash Archaeological Investigations*	David S. Whitley, E. L. McCann, and C. W. Clewlow, Jr. (editors)
MO14	*Papers in Cycladic Prehistory*	Jack L. Davis and John F. Cherry (editors)
MO13	*Archaeological Investigations at the Ring Brothers Site Complex, Thousand Oaks, California*	C. W. Clewlow, Jr., David S. Whitley and Ellen L. McCann (editors)
MO12	*The Running Springs Ranch Site: Archaeological Investigations at VEN-65 and VEN-261*	Jack Prichett and Allen McIntyre
MO11	*The Archaeology of Oak Park, Ventura County, California*	C. William Clewlow, Jr. and David S. Whitley (editors)
MO10	*Rock Art of East Mexico and Central America: An Annotated Bibliography*	Matthias Strecker
MO09	*The Late Minoan I Destruction of Crete: Metal Groups and Stratigraphic Considerations*	Hara Georgiou
MO08	*Papers on the Economy and Architecture of the Ancient Maya*	Raymond Sidrys (editor)
MO07	*History and Prehistory at Grass Valley, Nevada*	C. W. Clewlow, Jr., Helen F. Wells, and Richard Ambro (editors)
MO06	*Obsidian Dates II: A Compendium of Obsidian Hydration Determinations Made at the UCLA Obsidian Hydration Laboratory*	C. W. Meighan and P. I. Vanderhoeven (editors)
MO05	*The Archaeology of Oak Park, Ventura County, California*	C. W. Clewlow, Jr., Allen Pastron, and Helen F. Wells (editors)
MO04	*Ethnoarchaeology*	Christopher B. Donnan, C. William Clewlow, Jr.
MO03	*Obsidian Dates I: A Compendium of the Obsidian Determinations Made at the UCLA Obsidian Hydration Laboratory*	Clement W. Meighan, Frank J. Findlow, Suzanne P. De Atley
MO02	*Chevelon Archaeological Research Project*	Fred T. Plog, James N. Hill, Dwight W. Read
MO01	*Investigation of a Late Prehistoric Complex in Cuyamaca Rancho State Park, San Diego County, California*	D.L. True

Roman Foodprints at Berenike

Archaeobotanical Evidence of Subsistence and Trade in the Eastern Desert of Egypt

René T. J. Cappers

Monograph 55
Cotsen Institute of Archaeology
University of California, Los Angeles

The Cotsen Institute of Archaeology at UCLA is a research unit at the University of California, Los Angeles that promotes the comprehensive and interdisciplinary study of the human past. Established in 1973, the Cotsen Institute is a unique resource that provides an opportunity for faculty, staff, graduate students, research associates, volunteers and the general public to gather together in their explorations of ancient human societies.

Former President and CEO of Neutrogena Corporation Lloyd E. Cotsen has been associated with UCLA for more than 30 years as a volunteer and donor and maintains a special interest in archaeology. Lloyd E. Cotsen has been an advisor and supporter of the Institute since 1980. In 1999, The UCLA Institute of Archaeology changed its name to the Cotsen Institute of Archaeology at UCLA to honor the longtime support of Lloyd E. Cotsen.

Cotsen Institute Publications specializes in producing high-quality data monographs in several different series, including Monumenta Archaeologica, Monographs, and Perspectives in California Archaeology, as well as innovative ideas in the Cotsen Advanced Seminar Series and the Ideas, Debates and Perspectives Series. Through the generosity of Lloyd E. Cotsen, our publications are subsidized, producing superb volumes at an affordable price.

This book is set in 10-point Janson Text, with titles in 27-point ITC Cerigo.
Edited by Rena J. Copperman
Designed by William Morosi

Library of Congress Cataloging-in-Publication Data

Cappers, René T. J.
Roman foodprints at Berenike : archaeobotanical evidence of subsistence and trade in the Eastern Desert of Egypt / René T.J. Cappers.
p. cm. -- (Monograph series ; 55)
Includes bibliographical references and index.
1-931745-26-9 (paper)
1-931745-27-7 (cloth)
1. Barānīs (Egypt)--Antiquities, Roman. 2. Plant remains (Archaeology)--Egypt--Barānīs.
3. Commerce--Egypt--Eastern Desert--History--To 1500. 4. Romans--Egypt--Barānīs.
I. Title. II. Series: Monograph (Cotsen Institute of Archaeology at UCLA) ; 55.
DT73.B375C37 2006
932--dc22
ebook ISBN: 978-1-938770-28-9 2006010596

This book is dedicated to the Ababda nomads of the Eastern Desert of Egypt.

هذا الكتاب مهدى إلى عرب العبابدة فى صحراء مصر الشرقية

CONTENTS

Preface

STEVEN E. SIDEBOTHAM, WILLEKE WENDRICH

Between 1994 and 2001 a joint expedition of the University of Delaware (USA) and Leiden University (The Netherlands) conducted eight seasons of excavations at the Ptolemaic-Roman emporium of Berenike on the Red Sea coast of Egypt. It was a great opportunity to work in an area that is usually closed for research, because it is part of Egypt's border area with Sudan and is protected by the military. The Berenike Project was created as an interdisciplinary research effort involving a large number of archaeological specialists, who discussed their findings and interacted both on and off the site. Since many of the specialists were present on-site at the same time, preliminary results and conclusions could be shared and discussed often while excavations were in progress. This valuable collaborative effort could then be shared with those conducting the actual excavations. The annual reports on the excavations and specialists' results have been published in six volumes, while the seventh, and last, is in preparation (Sidebotham and Wendrich 1995, 1996, 1998, 1999, 2000, 2006). These reports provide comprehensive interpretations and conclusions that have emerged over the years. At the end of this phase of fieldwork, however, it is time to publish an overview, and in the coming years several specialists will produce final reports. Although such final publications concentrate on specific artifact or material groups, they have the benefit of ongoing discussions among various Berenike team members. The result, in each case, will be a specialist's report rooted in a broad basis of multidisciplinary insights (cf. Wendrich et al. 2006).

As the present volume amply demonstrates, the archaeobotanical research at Berenike provides essential information for our understanding of the subsistence patterns of the inhabitants, as well as the long-distance trade. The occurrence of exotic plant remains at Berenike changed through its history, with clear peaks in the first/second and fourth centuries CE. The results of the archaeobotanical research, therefore, provide extremely important information that supplements, complements, and, in some cases, changes the image that emerges from the ancient written sources. The variety of plants traded was larger than expected. Analysis of the well-preserved archaeobotanical remains found in our excavations at Berenike also indicates the regions with which the traders were in contact and when.

This book will not only be interesting for archaeologists and archaeobotanists, but the comparison with written "classical" (viz. Greek and Roman) sources provides a fascinating read for historical and classical scholars as well. In some cases the Berenike finds provide evidence to propose new translations for Greek or Latin botanical terms, and correct current interpretations.

Perhaps the most important result of the archaeobotanical research conducted at Berenike is the attested correlation between the harbor function, where goods were transferred from ship to caravan, and the amount and variety of goods that can be recorded. The items lost, purchased, or pilfered over the centuries at Berenike represent a micro version of the goods that were in demand throughout the Roman Empire as a whole. To research the imports used in Rome effectively, it is effective to start the investigation at the periphery of her empire: at Berenike, the harbor town through which many of these products once passed.

The series editors would like to thank the following organizations and individuals for enabling the eight

years of archaeological work at Berenike on which the annual reports and final compilations such as the present volume are based: National Geographic Society, Netherlands Foundation of Scientific Research (NWO-GW), Gratama Foundation, donors of the Berenike Foundation, Mallinson Architects of London, the University of Delaware, the American Philosophical Society, the Dorot Foundation, the Samuel H. Kress Foundation, Lotus Hotel in Cairo, Utopa Foundation, Organon Egypt, Eastmar Travel in Cairo, Philips Egypt, 3-Com Computer, Dionysus Systems, and in alphabetical order the following private donors: Carmine Balascio, Millie Cassidy, Bruce Gould, James Harrell, Charles Herndon, Susan Hodge, Dorothy Johnson II, Norma Kershaw, Carol Maltenfort, W. Weissman and W. Whelan.

References

Sidebotham, S.E., and W.Z. Wendrich (editors)
1995 *Berenike 1994 : Preliminary Report of the 1994 Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert.* Leiden University Research School of Asian, African and Amerindian Studies CNWS, Leiden, Netherlands.

Sidebotham, S.E., and W.Z. Wendrich (editors)
1996 *Berenike 1995 : Preliminary Report of the 1995 Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert.* Leiden University Research School of Asian, African and Amerindian Studies CNWS, Leiden, Netherlands.

Sidebotham, S.E., and W.Z. Wendrich (editors)
1998 *Berenike 1996 : Report of the 1996 Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert.* Leiden University Research School of Asian, African and Amerindian Studies CNWS, Leiden, Netherlands.

Sidebotham, S.E., and W.Z. Wendrich
1998 Berenike: Archaeological Fieldwork at a Ptolemaic-Roman Port on the Red Sea Coast of Egypt: 1994–1998. In *Sahara* 10, pp. 85–96.

Sidebotham, S.E., and W.Z. Wendrich (editors)
1999 *Berenike 1997 : Report of the 1997 Excavations at Berenike and the Survey of the Egyptian Eastern Desert, Including Excavations at Shenshef.* Leiden University Research School of Asian, African and Amerindian Studies CNWS, Leiden, Netherlands.

Sidebotham, S.E., and W.Z. Wendrich (editors)
2000 *Berenike 1998 : Report of the 1998 Excavations at Berenike and the Survey of the Egyptian Eastern Desert, Including Excavations at Wadi Kalalat.* Leiden University Research School of Asian, African and Amerindian Studies CNWS, Leiden. Netherlands.

Sidebotham, S.E., and W.Z. Wendrich
2001–2002 Berenike Archaeological Fieldwork at a Ptolemaic-Roman port on the Red Sea coast of Egypt. In *Sahara* 13, pp. 23–50.

Sidebotham, S.E., and W.Z. Wendrich (editors)
2006 *Berenike 1999–2000. Report on the Excavations at Berenike and the Survey of the Eastern Desert, Including the Survey of Sikait.* Cotsen Institute of Archaeology at UCLA Publications, Los Angeles.

Wendrich, Willeke, Roger S. Bagnall, René T.J. Cappers, James A. Harrell, Steven E. Sidebotham, and Roberta S. Tomber
2006 Berenike Crossroads; The Integration of Information. In *Excavating Asian History: Interdisciplinary Studies in Archaeology and History*, edited by Norman Yoffee and Bradley L. Crowell. University of Arizona Press, Tucson.

Acknowledgments

Numerous people have been consulted on many aspects that have been incorporated in this book. I wish to acknowledge C. C. Bakels, H. N. Barakat, H. Barnard, S. Bottema, A. Bottini, L. Boulos, A. Butler, A. C. D'Andrea, J. E. M. F. Bos, M. T. Bruning, A. Clapham, B. E. E. De Wilde-Duyfjes, P. R. Del Francia, D. Q. Fuller, D. A. Gould, A. E. Haeckl, J. Harrell, R. de Jong, M. D. Kajale, M. Kislev, A. Kreuz, J. P. W. Letschert, G.P. Luttikhuizen, U. Maier, J. P. Meffort, W. van Neer, O. M. van Nijf, H. Nouwens, M. Nouwens, E. Panagiotakopulu, R. Pieters, H. P. Ray, D. Samuel, S. E. Sidebotham, R. S. Tomber, M. van der Veen, C. E. Vermeeren, W. Wetterstrom, W. Z. Wendrich, J. P. Wild, A. Witte, K. A. Worp, and B. Zach. Figures have been prepared by E. Bolhuis, A. M. Hense, J. Pauptit, and S. Tiebackx. I would also like to thank our colleagues from the Supreme Council of Antiquities in Qena and the present Secretary General Dr. Zahi Hawass. The correction of the English text was carried out by P. Bleeker. The research was supported by the Foundation for History, Archaeology and Art History subsidized by the Netherlands Organization for Scientific Research (NWO).

List of Figures

TABLES

Introduction

Archaeobotanical Research

For a long time Berenike has been on the list of desiderata of many archaeologists. It was not until 1818, however, that G. B. Belzoni, a weightlifter engaged in hunting antiquities in Egypt, identified Berenike south of the large Ras Banas peninsula. Several visitors became interested in the site, and the expeditions that followed were mainly focused on excavating the temple dedicated to the Greek-Egyptian god Serapis, situated on the highest ground at Berenike (Sidebotham 1995a: 14). These visits, however, were short-lived due to the extreme desert conditions and related logistic problems. Food and water were not locally available and could be only delivered over large distances.

In addition to the logistic problems, security reasons were also a serious hindrance to the realization of a large-scale excavation. The strategic location of the Greek-Roman harbor of Berenike has its modern counterpart in the presence of a large military base on Ras Banas and scattered bunkers on the limestone outcrop on which Berenike was founded. Furthermore, both Egypt and Sudan have a claim to the Hailab area, a triangular piece of land bordered along the Red Sea by Shelateen and Hailab. For these reasons, the Eastern Desert south of Marsa Alam was until recently only accessible with special permission.

A couple of years after the Gulf War (1990–1991), it became possible to start the Berenike project, which included excavations at Berenike and Shenshef and the survey of the southern part of the Egyptian Eastern Desert. The excavations and surveys were directed by Prof. Dr. S. E. Sidebotham from Delaware University and Dr. W. Z. Wendrich from Leiden University. After a pilot excavation season in 1994, large-scale excavations began and continued until December 2003, when the threat of an invasion of Iraq was at hand. Including the pilot study, a total of eight excavations seasons were conducted.

The aim of the research project was to study the organization of trade and the subsistence economy at Berenike. Berenike was, together with Myos Hormos, an important harbor along the Red Sea coast. It was founded approximately 275 BC for the import of all kinds of luxury commodities from Africa south of the Sahara, Arabia, and India. Only at the beginning of the seventh century AD before the Arabs arrived in Egypt, was Berenike abandoned by the Romans. Several written historical sources deal with this trade, and these documents have been used for a long time to reconstruct this foreign trade. It remained uncertain, however, how reliable this picture was. Written sources are certainly not complete in their enumerations, and the interpretation of certain exotic commodities is still under discussion, as can be judged by the different translations of the Greek and Latin texts. The available information on the ancient trade contrasts sharply with that dealing with the subsistence economy of Berenike. Although located along the Red Sea, Berenike faced a desert climate that must have drawn heavily on its food supply.

Much progress was therefore to be expected from the Berenike project, which had the cooperation of all kinds of specialists. This book synthesizes the results of the archaeobotanical research carried out over the years at Berenike and Shenshef and includes information that has been published in previous interim reports. The archaeobotanical research is based on the study of plant remains that have been preserved in both sites. In Egypt, plant remains are predominately preserved by desiccation owing to the arid climate. Additionally, plant remains may become charred as a result of deliberate burning, such as in the offering of food items, or by accidental fire. The desiccated plant remains, in particular, are still in an excellent condition and facilitate, in most cases, identification to the level of species. In this way, a detailed list of plant species could be produced from Berenike and Shenshef, providing a solid basis for a reconstruction of the international trade of plant products and the food economy.

The subfossil plant remains from Berenike originate from 794 samples and those from Shenshef from 86 samples. The samples from Berenike represent 34 different trenches, which are partly related with buildings and partly with trash deposits. Those from Shenshef originate from 10 different middens. Basically, each soil unit (locus) from a particular trench has been dry-sieved over a sieve with a mesh size of 4.0 mm. All sieve residues have been sorted out and have yielded many so-called "hand-picked" plant remains. A disadvantage of this procedure is that it is highly biased in favor of plants that produce large fragments. Cereals, for example, will only be secured in this way by the long rachis fragments in such sieve residues, whereas most of the grain kernels, threshing remains, and accompanying seeds of weed plants will get lost. To obtain a representative record of plant remains from Berenike and Shenshef, botanical samples were collected that have been processed by using sieves with a standardized mesh size of 5.0 mm, 2.0 mm, 1.0 mm, and 0.5 mm. The botanical samples from trash deposits, in particular, proved to be rich in well-preserved plant remains. Samples that were secured from the inside of buildings, on the other hand, were in most cases soil samples with only a low concentration of plant remains. Because these sediments were, for the greater part, considered as wind-blown secondary fillings of buildings, the plant records from these samples could not be used for an interpretation of the use of these buildings.

For the reconstruction of agricultural practices, it is desirable to have at one's disposal a considerable number of samples that presents one particular crop and associated weed plants. Unfortunately, almost all samples did contain at least two crops, such as wheat, barley, or lentil. This makes it frustrating to reconstruct the specific agricultural practices and also hampers the tracing of the origin of the crops. Most crops have acquired a broad tolerance to environmental factors as a result of selection processes, which is, for example, expressed by the many land races that have evolved. In most cases it is not possible to identify the area of origin of a cultivated plant found outside its production area, such as in Berenike, by studying the morphological features of its remains. Weed plants, on the other hand, are partly indicative of specific environmental conditions. Such plants can be used to trace the source of a particular crop plant indeed, though its association with a particular crop should be evidenced by the archaeobotanical record. Samples with only a few plant species, rather than those with a high diversity, are suitable in this respect because one can usually unequivocally match these crops with their associated weed plants. Because the samples from Berenike and Shenshef did not meet this condition and also because of the large number of samples, it has been decided to categorize all plant records in several tables.

Although Berenike was inhabited throughout the Ptolemaic and Roman periods, the archaeobotanical results are confined to the Roman period. It appeared that most of the Ptolemaic remains are located eastward of the Roman settlement. The few Ptolemaic contexts that have been unearthed had suffered seriously from salt seepage and did not yield identifiable plant remains.

It was realized at an early stage in the project that the interpretation of the archaeobotanical records would benefit from the study of the current natural vegetation around the Roman installations and from observations of the local Ababda nomads who live in the southern part of the Eastern Desert. For that reason, inventories have been made of the desert vegetation around the Roman installations during the various excavation seasons. Additionally, a separate visit was organized to the Gebel Elba area, located some 260 km south of

Berenike, which was one of the source areas of some of the trade products. The ethnoarchaeobotanical research of the Ababda nomads was focused on the basic necessities of desert life with special emphasis on their material culture, their exploitation of the natural environment, and the possibilities of local food production.

The reconstruction of the former natural vegetation is based on the archaeobotanical records, evidence from written sources, and the current vegetation. Special emphasis is laid on the possible shifts of the local arboreal vegetation. The interpretation of the cultivated plants found at Berenike and Shenshef summarizes their possible use, including the possibility of local food production, the differences in habitation periods, and the identification of their possible source of supply. The identification of the possible area of supply proved to be rather problematic because of the botanical richness of most of the samples. Determining the supply area is based on the natural distribution of the plant species, its archaeobotanical record from Egypt and the surrounding areas, and on the evidence from written historical sources, if available. A special topic related to the long-distance transport and the hot climate in Egypt is the preservation of food and the luxury status of food items. Based on the different methods of food preservation known from historical sources and those practiced today, the possible ways in which the various plant products might have been treated are discussed. Finally, the archaeobotanical record of exotic plant species from ancient Egypt is discussed, with special emphasis on those evidenced from Myos Hormos, the other important harbor along the Red Sea.

Written Sources

Knowledge of Indian trade comes from various historical sources. Two of these sources, the Alexandrian Tariff and the *Periplus Maris Erythraei*, are of particular interest since they include a considerable list of botanical commodities that might have been traded through Berenike (Miller 1998:279–280; Casson 1989). Both sources provide firsthand information. It is assumed that the author of the *Periplus* was an Egyptian Greek who had traveled at least along the African coast south to Rhapta (present Dar es Salaam) and to the west coast of India. Contrary to other *periploi* that have survived, this *Periplus* is exceptional in its emphasis on trade items, in addition to information on the trade route proper.

The Alexandrian Tariff was issued between AD 176 and 180 by Marcus Aurelius and enumerates 54 items subject to import duty at Alexandria on their way to Rome. It includes 20 different plant products, only half of which are also mentioned in the *Periplus*: costus, cassia, aloe, lykion, myrrh, malabathron, black and long pepper, nard, and aromatics.

The *Periplus*, dated between AD 40 and 70, describes in great detail the trade routes from Myos Hormos, now identified as Quseir al-Qadim, and Berenike to India, including many harbors along the African, Arabian, and Indian coasts. The Erythraean Sea formerly included the Red Sea, the Gulf of Aden, and the Indian Ocean. The *Periplus* enumerates a vast number of import and export commodities, including 34 products of botanical origin, of which 18 are reported as import items from Berenike.

The trade items mentioned in both documents represent a wide variety of plant parts: root; wood; bark; plant secretions such as resins, gums, and oils; leaves; flowers; seeds; and fruits, as well as whole plants (Table 1.1). Plant secretions and seeds or fruits are the best-represented categories. A few trade items are either unspecified (aromatics and spices) or not documented in such a way that a reliable identification can be made (costamomum).

The arrangement according to plant part is in some cases arbitrary. Aloe, for example, may be either a resin or fragrant wood, and both rhizomes and leaves were traded as (spike)nard. In some cases, trade items are reduced to a common trade name, such as "cassia" for "cassia turiana" and "xylocassia." The scientific plant names are mainly based on Warmington (1995), Miller (1998), and Casson (1989) and have been updated where necessary.

The linkage of ancient trade names with the plant species that they probably represent is based on a variety of evidence. Useful information may be provided by morphological and anatomical features, by specific uses of the plant products, and by accompanying descriptions of the area of origin, for example, in references to the import or export status of the trade item in a specific harbor. A second source of information is linguistic evidence, in which both ancient literature and modern Latin nomenclature of plant names are considered. However, the latter should be used with some reservation. In principle, every taxon may be subjected to remodeling, and consequently new names may have been introduced, in which the assignment of plant names is determined by the international code of botanical nomenclature (ICBN). The scientific plant name is followed by the author citation,

Table 1.1. Trade items of botanical origin mentioned in the *Alexandrian Tariff* (AT) and the *Periplus Maris Erythraei* (PME).

Trade item	Source AT	PME	Scientific plant name
Root			
costus(m)	X	X	*Saussurea costus* (Falc.) Lipsch.
cyperus		X	Two species are suggested:
			Cyperus longus L.
			Cyperus rotundus L.
ginger	X		*Zingiber officinale* Roscoe
Wood			
ebony		X	*Diospyros ebenum* Koenig
sissoo		X	*Dalbergia sissoo* Roxburgh ex DC.
teak		X	*Tectona grandis* L.f.
Bark			
cassia	X	X	*Cinnamomum aromaticum* Nees
			Cinnamomum burmannii (Nees & T. Nees) Blume
			Cinnamomum loureirii Nees
			Cinnamomum tamala (Buch.-Ham) Nees & Eberm.
cinnamon	X		*Cinnamomum verum* Presl
makeir		X	*Holarrhena pubescens* (Buch.-Ham.) Wallich ex G. Don
Secretion from stem, leaf or root (e.g. resin, gum or oil)			
aloe(-wood)	X	X	Resin:
			Aloe perryi Baker
			Aloe vera (L.) Burm. f.
			Wood:
			Aquilaria malaccensis Lam.
assafoetida/laser	X		Three species are suggested:
			Ferula assa-foetida L.
			Ferula foetida (Bunge) Regel
			Ferula narthex Boiss.
bdellium		X	*Commiphora wightii* (Arn.) Bhandari
cinnabar		X	*Dracaena cinnabari* Balf. f.
duaka		X	Species from two genera are suggested:
			Cinnamomum species
			Commiphora playfairii (Hook. f.) Engl.
frankincense		X	*Boswellia sacra* Flueck.
galbanum	X		*Ferula gummosa* Boiss.
indigo		X	*Indigofera* species
kankamon		X	Possibly *Commiphora erythraea* (Ehrenb.) Engl.
lykion/lycium	X	X	Several suggestions, including:
			Acacia catechu (L.f.) Willd.
			Berberis aristata DC.
			Berberis asiatica Roxburgh
			Berberis lycium Royle
mokrotu		X	-
myrrh	X	X	*Commiphora myrrha* (Nees) Engl. (?)
sarcocolla	X		Several suggestions, including:
			Astragalus fasciculifolius Boiss.
			Saltera species
storax		X	Two species are suggested:
			Styrax officinalis L.
			Liquidambar orientalis Miller
sugar cane		X	*Saccharum officinarum* L.

Trade item	Source AT	PME	Scientific plant name
Leaf			
barbaricum	X		?
malabathron	X	X	Two species are suggested:
			Cinnamomum tamala (Buch.-Ham) Nees & Eberm.
			Cinnamomum bejolghota (Ham.) Sweet
pentasphaerum	X		? (according to Warmington possibly malabathron)
Flower			
saffron		X	*Crocus sativus* L.
Seed or fruit (including liquids prepared from them)			
amomum	X		Two species are suggested:
			Amomum compactum Soland. ex Maton
			Amomum subulatum Roxburgh
cardamom	X		*Elettaria cardamomum* (L.) Maton
dates		X	*Phoenix dactylifera* L.
grape/olive		X	*Vitis vinifera* L./*Olea europaea* L.
olive oil		X	*Olea europaea* L.
pepper (black)		X	*Piper nigrum* L.
pepper (white)	X		*Piper nigrum* L.
pepper (long)	X	X	*Piper longum* L.
rice		X	*Oryza sativa* L.
sesame oil		X	*Sesamum indicum* L.
wheat/grain		X	*Triticum* sp./Gramineae tribe Triticeae
wine		X	*Vitis vinifera* L.
Whole plant			
clover (yellow)		X	*Melilotus officinalis* (L.) Pallas
nard (spike-)	X	X	Nard:
			Cymbopogon schoenanthus (L.) Spreng.
			Spikenard:
			Nardostachys grandiflora DC.
Unspecified or unknown			
aroma indica/ aromatics	X	X	-
costamomum	X		?
spices		X	-

referring to the Latin description or diagnosis of the taxon in question. This enables one to judge the status of a specific scientific plant name and also provides a foundation for comparing synonyms. 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. Cassia, for example, of which the uncurled bark was traded, should not be confused with cultivars from the genus *Cassia*, including senna (*Cassia senna* L.) and purging cassia (*C. fistula* L.), both cultivated for their pods. Sarcocolla may serve as a second example. Though this brittle resin is still traded in the spice markets of the Near East, its real source is not yet clear. Species belonging to three different genera have been put forward. Some of them are known as "sarcocolla," yet it has to be realized that *Sarcocolla* Kunth is a synonym of the currently accepted name *Saltera* Bullock. Both *Penaea sarcocolla* and *P. mucronata* are unlikely suggestions, for their natural distribution area is South Africa.

In some instances, two trade items mentioned in literary sources are linked to the same plant species because different names were used for different plant parts (e.g., cinnamon and malabathron) or different methods of preparation, resulting in different products (e.g., black and white pepper).

A comparison between the Alexandrian Tariff and the *Periplus* shows that they have a small quantity of commodities of botanical origin in common. Together, they mention 45 different trade items. Only nine of them are mutual trade items: costus, cassia, aloe, lykion, myrrh, malabathron, long pepper, nard, and aromatics. Plant products mentioned only in the Alexandrian Tariff may include some African plant products that were obtained from alternative trade routes.

It is also possible that differences between both written sources are linked to developments in trade, since the Alexandrian Tariff is dated more than 100 years earlier than the *Periplus*. Two arguments are presented to support this idea. Warmington (1995:184–5) supposes that amomum or cardamomum, both considered by him as seeds from *Elettaria cardamomum*, were initially traded exclusively over land routes and only in the second century AD were they imported by maritime trade. This would explain the absence of *Elettaria cardamomum* in the *Periplus* and its inclusion in the Alexandrian Tariff. The predominance of incense products in the *Periplus*, on the other hand, can be explained by the shift of the Nabataean trade towards full-time specialization in the incense trade at the end of the first century AD According to Johnson (1987:29–34), this specialization was a response to the increasing demand for incense in the Roman Empire and the competition for commercial activities in the Red Sea, initiated by the development of an infrastructure of ports, watering stations (*hydreumata*), and military posts in the Eastern Desert. This would have resulted in a decline in the import of incense via maritime trade.

The origin and destination of the 34 plant products mentioned in the *Periplus* have been summarized in Table 1.2, in which the plant products are clustered into five categories. In the first three categories they are clustered in accordance with their use, whereas the last two categories concern a botanical classification. Some plant products, such as rice and malabathron, were used for a multitude of purposes and have been arbitrarily categorized. For the sake of convenience, information about different harbors is merged per continent, with the exception of Berenike itself. Consequently the letter *B* indicates that some harbors along the Arabian and Indian coasts exported trade items, whereas others on the same continent imported these items. According to the *Periplus*, eight different trade items of botanical origin were exported from Berenike to outlets, particularly along the African and Arabian coasts: saffron, olive oil, grapes or olives, wine, grain, cyperus, yellow clover, and storax. In return, harbors along the African coast provided Berenike with makeir and a variety of resins, gums, and bark extracts, whereas exports from the Arabian harbors to Berenike concerned aloe, frankincense, and myrrh. Items traded from India to Berenike were indigo, long and black pepper, lykion, costus, nard, bdellium, and malabathron.

The number of plant products exported via Berenike (8) is far less than the number of imported plant products (18). This could be explained by the difference in luxury status. Food staples such as oil, grain, and wine were relatively cheap export items in comparison with exotic luxury products such as incense, aromatics, and spices. Furthermore, part of the luxury products was paid with cash money, as was, for example, the case with black pepper (*Piper nigrum*) (Pliny, *NH* 12.41.84).

A rich deposit of pottery sherds with written texts (ostraka) was found in the first century dump trench BE97–19 and is contemporary with the *Periplus*. The ostraka represent several archives, which document customs duties at Berenike and are possibly linked to the transportation of goods between Berenike and Koptos (Bagnall et al. 1999, 2000). Commodities that are mentioned are wine, imported from Syria, Italy, and Rhodes; olive oil; vinegar; “flatbread;” lykion; onions (*Allium*); beets (*Beta vulgaris*); and barley (*Hordeum vulgare*). The most common commodity mentioned in the ostraka is wine. Plant products that are also recorded by the archaeobotanical analysis of the trash are limited to beets, onions, and an unknown medical herb, which occur in just three ostraka.

Table 1.2. Trade items of botanical origin according to the Periplus (D = dye, F = food, M = medicine, R = resin, gum, bark, W = wood, I = import item, E = export item, B = both import and export item, BE = Berenike, OP = other ports).

		Africa		Arabia	India
		BE	OP		
F	olive oil	E	I		
F	grape/olive	E	I		
F	wine	E	I	?/I	B
F	wheat/grain	E	I	I	B
F	long pepper	I			E
F	black pepper	I			E
F	rice				E
F	sesame oil				E
F	dates			B	E
F	spices		E		
D	saffron	E		I	
D	indigo	I			B
M	cyperus	E		I	
M	clover (yellow)	E			I
M	makeir	I	E		
M	aloe	I		E	
M	costus(m)	I			E
M	malabathron	I			E
M	lykion/lycium	I			E
M	nard (spike-)	I			E
M	sugar cane		I		E
R	storax	E		I	I
R	aromatics	I	E		
R	mokrotu	I	E		
R?	duaka	I	E		
R	cassia	I	E		
R	kankamon	I	E		
R	cinnabar	I	E		
R	myrrh	I	E	E	
R	frankincense	I	E	E	
R	bdellium	I			E
W	ebony			I	B
W	sissoo			I	B
W	teak			I	B

CHAPTER 1

ROME'S EASTERN TRADE

"Obgleich eine geringe Anzahl von Schiffen im Hafen liegt, so ist der Verkehr mit Arabien doch lebhaft, da täglich 1 bis 3 Schiffe kommen und gehen. Alle Karawanen, die von Suakin ihren Ausgang nehmen, gehen entweder nach Berber oder Kässela, gegenwärtig völlig sichere Strassen, welche nur selten durch Wassermangel unbequem werden." [G. Schweinfurth 1865a: 354]

TRADE NETWORKS

At its greatest extent, the Roman Empire enclosed an uninterrupted area around the Mediterranean Sea. The northern frontier was bordered by Hadrian's Wall between England and Scotland and stretched as far as the Rhine and Danube rivers on the Continent. The eastern border ran across territories of modern Turkey, Iraq, Syria, Lebanon, Jordan, and Israel. The extent of the Roman Empire on the African continent was relatively small, with the exception of Egypt (Bunbury 1959:166–168).

Rome's southerly expansion in Egypt can be explained by a threefold interest. First of all, the annual flooding of the Nile and the artificial irrigation replenished the minerals on the fields in the Nile Valley and Delta, thus ensuring high yields without exhausting the soil. Due to these conditions, Egypt could feed Rome for four months of the year (Rickman 1996:118). In this respect it is important to realize that ancient Rome was an imperial metropolis. According to Rickman (1996:8–10) the city of Rome had a million residents in the first century AD. A second interest of the Romans concerned the mines and quarries, especially in the Eastern Desert. Important quarries were Mons Porphyrites, Mons Claudianus, and Mons Smaragdus, which produced valuable porphyry, granodiorite and beryl, respectively. Finally, ports along the Red Sea coast could be used by the Romans for long-distance trade in eastern and southern directions.

Covering such a large area, the Roman Empire comprised several distinct plant-geographical regions, determined primarily by climate and soil. Taking trees as an example, we can see that the Romans had access to a great variety of economically valued species. In central Europe, both conifers and deciduous trees, including silver fir (*Abies alba*) and elm (*Ulmus*), provided excellent wood for furniture and building purposes. Trees with edible fruits, with a predominantly Mediterranean distribution, included the olive (*Olea europaea*), the pomegranate (*Punica granatum*), the stone pine (*Pinus pinea*), and the grapevine (*Vitis vinifera*). In the more southerly Saharo-Arabian region, the date (*Phoenix dactylifera*) was the important source of highly valued foodstuff. Despite this variety within the Limes (frontier line), Rome also maintained trade relations with far-flung foreign regions, importing all kinds of exotic commodities, including a wide range of botanical products.

As the Roman Empire extended over parts of Europe, Asia, and Africa, foreign trade could penetrate in all three of these continents. Trade routes were developed over land and water, either by river or sea. The most illustrious trade routes in Arabia and Asia became known as the Silk Road, the Incense Road, and the Cinnamon Road, so-called after the most important commodities on those routes. All these trade routes were much branched and connected with each other (Figure 1.1, after Miller [1998] and Franck and Brownstone [1991]).

The Silk Road connected old trade centers in the Mediterranean area, such as Antioch (modern Antakya) and Petra, with those of the Yellow River valley in western China, such as Loyang (*Sinae Metropolis* of Ptolemy). The Silk Road branched off in a southern direction to the Ganges Delta in northeast India and to main trade centers in northwest India, such as Barygaza (modern Broach) and Barbarikon in the Indus Delta. The exact location of this Barbarikon is still unknown. The *Periplus Maris Erythraei*, a handbook for merchants describing the commerce between Roman Egypt and eastern Africa, the southern part of the Arabian Peninsula, and India mentions the regular supply of Chinese silk and furs at both these Indian harbors (Casson 1989:75). The eastern part of the Silk Road was also connected with trade routes penetrating into Indochina and Indonesia. Soon after the expansion of the Chinese Empire toward the east during the Eastern Han dynasty (AD 25–220) the Silk Road connected the Roman Empire and supplied, in addition to silk, spices such as ginger (*Zingiber officinale*) and cassia bark (*Cinnamomum aromaticum*; Miller 1998:42–47, 53–57).

The Incense Road had its origin in the southern part of the Arabian Peninsula, where both myrrh trees (*Commiphora* spp.) and frankincense trees (*Boswellia sacra*) grew in abundance, and had its main terminal in Petra. According to Pliny (*NH* 12.32.64), the author of the *Natural History* in the first century AD, the route from the southernmost located Thomna (modern Asaylan) to Petra was divided into 65 camel stages.

Miller (1998:104) refers to the Incense Road as the Frankincense Road, implying that only frankincense was exported from this area. According to the *Periplus Maris Erythraei*, however, myrrh was not only obtained from Malaô (modern Berbera) and Mundu (modern Heis) along the Somalian coast, but also from Muza (modern Mukha) along the coast of Yemen (Casson 1989:128, 154–156). With respect to Muza, myrrh and *stacte* (a myrrh oil) are explicitly mentioned as local products in the *Periplus*. Although Pliny (*NH* 12.32.60) states that myrrh from Somalia (e.g., the *Trogodytica*) was more expensive than that from Arabia, the quality of the Arabian myrrh must still have been good as the author of the *Periplus* advises to bring a considerable amount of money to Muza for this purpose (Casson 1989:30).

Miller derives an argument for his opinion from the number of *Commiphora* species present in Arabia and the Horn of Africa. This is not a convincing argument, however, as production and quality are merely correlated with the abundance of highly esteemed myrrh trees, which might in fact be confined to a single species. Moreover, recent taxonomic studies have revealed that several *Commiphora* species are native to the southern part of the Arabian Peninsula, its exact number still obscure due to the presence of aberrant forms and intermediates (Wood 1997:197). A more serious objection to the production of myrrh in the Arabian Peninsula is put forward by Wood (1997:198), who casts doubt on the status of *Commiphora myrrha* as a source of myrrh, despite its scientific name and its bitter taste, and even admits that he never witnessed the collection of resin from any of the *Commiphora* species that occur in north Yemen. The myrrh that is offered for sale in Yemen today is imported from Somalia and India. It seems, therefore, that in antiquity Somalia was the most likely source of myrrh.

The status of the Cinnamon Road is less clear. China, Indochina, Malaysia, India, and Ceylon are the main distribution areas of the genus *Cinnamomum*, which includes species that yield cinnamon (*C. verum* = *C. zeylanicum*), cassia (*C. aromaticum*, among other species), and camphor (*C. camphora*). Cinnamon is native to Ceylon and India, whereas cassia species occur in China (*C. aromaticum* = *C. cassia*), Indochina (*C. loureirii*), Malaysia (*C. burmannii*), and India and Ceylon (*C. tamala*). The cinnamon species *C. tamala* also occurs in Indochina (Wiersema and León 1999:132).

According to Miller (1998:153), the Cinnamon Road connected China and Southeast Asia via the East African coast with Egypt. Unlike the Silk Road and the Incense Road, this trade route was based on seafaring. It is assumed by Miller that Malayan seafarers reached Madagascar in the second millennium BC. From there commodities were traded to Rhapta (modern Dar es Salaam) and the entrepôts along the Somalian coast. From a botanical point of view, the Cinnamon Road as described by Miller would have been a trade route for cassia (*C. burmannii*) in particular, as far as members of the genus *Cinnamomum* are concerned. True cinnamon

(*C. verum*) is a native of Ceylon and the Malabar coast, and was traded by Arabs and Indians together with Indian cassia and malabathron, both originating from the same tree (*C. tamala*). These products reached the East African coast, where they became available to the Roman traders. It is also possible that Chinese cassia (*C. aromaticum*) was brought to Barbarikon and Barygaza in northwest India, from where it could also have been transported further to Africa. Because of this indirect trade, it was wrongly believed by classical writers that cinnamon and cassia originated from East Africa. Camphor (*C. camphora*) is not mentioned as a possible trade item by these sources.

The foreign trade of the Roman Empire from Berenike and Myos Hormos to the ports of Sudan, Eritrea, Somalia, and southern Arabia was based on coastal navigation. Direct, short-trade routes with India, on the other hand, crossed the Indian Ocean and presupposed advanced techniques for navigation and specific knowledge of wind and water.

Seafaring in the Indian Ocean is determined by seasonal wind patterns (monsoon winds) and tides, as well as the equatorial currents. Sailing from East Africa and Arabia to India is possible from October until the end of March. In the rest of the year, sailing in the reverse direction should be done, though the sailing season is interrupted at different months in India, Arabia, and East Africa due to severe storm winds (Yajima 1976:44).

Being acquainted with these conditions, having knowledge of advanced techniques for navigation, and being capable of building seaworthy ships were all vital conditions for participating in the maritime trade of this area, offering a wide spectrum of commodities including both daily necessities and highly esteemed luxury items. Seafaring in the Indian Ocean became an early tradition of people whose territory bordered the Indian Ocean, such as Arabs, Persians, Indians, and Malayan people (Yajima 1976:5).

By annexing Egypt, the Greeks obtained access to the trading network connecting Africa, Arabia, and Asia. Alexander the Great founded Alexandria as a new capital at a strategic location in the Nile Delta, which soon became a center of commerce and culture. After Alexander's death, the Ptolemaic dynasty was established in Egypt, which lasted for three centuries. Macedonian-based Greeks who respected Egyptian religion and customs ruled this dynasty. During the reign of Ptolemy II, Philadelphus, and Ptolemy III, Eurgetes, several harbors along the Red Sea coast were founded. From north to south, they were Arsinoe (modern Suez); Philotera (possibly location: 26°40' N, 34°00' E); Myos Hormos (modern Quseir al-Qadim); Berenike (23°54' N, 35°28' E); Ptolemais Thêrôn (18°40' N, 37°50' E), also called Epitheras and once the great hunting-station of the Ptolemies; Berenike-ad-Sabas; a second Arsinoe; and a third Berenike. The last three sites were located along the Straits of Bab-el-Mandeb, the entrance to the Red Sea.

Together with Myos Hormos, Berenike served as a gateway to the outside world. Commodities were imported from Africa south of the Sahara, Arabia, and India into the Roman Empire, the importance of both harbors evidenced by several contemporary sources. The part of the trade route between Berenike and Rome consisted of a caravan track through the Eastern Desert, followed by river transport over the Nile toward Alexandria, and ending with a sailing voyage over the Mediterranean Sea to Ostia, Portus Uterque (Portus Traiani and Portus Claudii), or Puteoli (Pozzuoli), the main maritime centers of Rome.

The identification of Myos Hormos as present-day Quseir al-Qadim has only recently been proposed with cogent arguments by Peacock (1993). Other sites along the Red Sea coast that have been proposed include Abu Sha'ar, Ras Abu Soma, and Safaga. Alternatively, Quseir al-Qadim had previously been identified by Whitcomb and Johnson (1982:1–3) as Leukos Limên. Peacock puts forward several arguments. First, the distance between Quseir al-Qadim and Berenike is 1,800 stades, as mentioned in the *Periplus Maris Erythraei*. In the second place, the winding entrance of the harbor, as described by Strabo (*Geography* 16.4.5), has recently been identified on satellite images some distance inland, its current location the result of progressive infilling of the lagoon. Furthermore, Strabo (*Geography* 16.4.24; 17.1.45) mentions that the route between Myos Hormos and Koptos was supported by several watering stations (*hydreumata*), which still exist.

Berenike, the other transit port along the Red Sea, is located immediately south of the large Ras Banas peninsula. The shallow lagoon south of Berenike must have functioned as a natural harbor, as described by Strabo (*Geography* 17.1.45).

Several reasons have been put forward for the southern location of Berenike. Sidebotham (1995a: 6) mentions piracy throughout Greek (332–30 BC) and Roman/Byzantine times (30 BC–AD 638), the strong prevailing winds in the northern part of the Red Sea, the protection against these winds by the Ras Banas

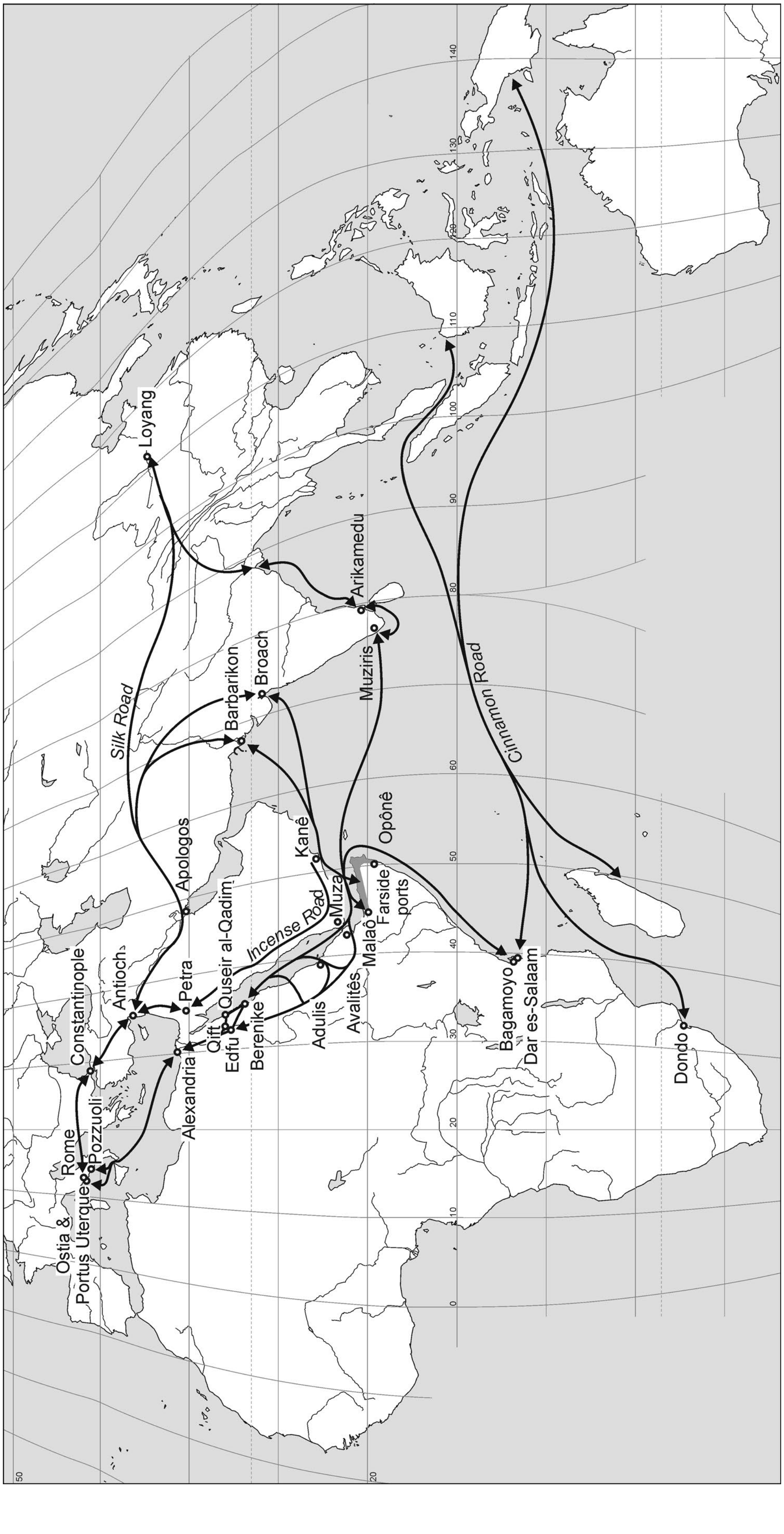


Figure 1.1. Main trade routes in the Roman period.

Figure 1.2. Aerial view of the Eastern Desert showing wadi branches dissecting the Red Sea mountains (November 1996). See Color Plates section, page 201.

peninsula, and the obstruction by shoals and coral reefs near the coast, especially northward of Jedda. It is because of the many accidents that still happen in our times with vessels in the Red Sea that insurance companies even today refuse to offer insurance cover. Another reason for the southern location of Berenike might be linked to minimizing the transport over land, which is much more time consuming and therefore more expensive. Berenike is located at the same latitude as Aswan and overland routes connecting Berenike with the Nile Valley link up with the navigable part of the Nile. The presence of rapids in the Nile between Aswan and Khartoum make the river unnavigable in this part. Also the logistics with respect to the protection of the relatively short overland routes that connect Berenike with the Nile Valley might have been taken into consideration.

The seaborne voyage from Berenike to Africa, Arabia, and India is described in detail in the *Periplus Maris Erythraei*. The first part of this voyage led through the Red Sea. Leaving the Straits of Bab-el-Mandeb, the vessels could sail along the African coast as far as Rhapta and along the Arabian Peninsula with Barbarikon and Barygaza as their final destinations. Alternatively, they could cross the Arabian Sea toward the coast of southeast India and along the east coast of India up to the Ganges Delta (Figure 1.1). Strabo, referring to the Greek vessels sailing to India, also mentions that some of these vessels sailed as far as the Ganges (*Geography* 15.1.4).

Transport of commodities between Berenike and the Nile was done by caravan transport. The caravan track had a northwest direction and forked halfway, one branch leading to Edfu (Apollinopolis Magna) and the other to Koptos (Qift). The tracks followed branches of the dry riverbeds (wadis) that dissect the Red Sea mountains (Figures 1.2 and 1.3). The shortest road to the Nile Valley was the one that led to Edfu and measured some 310 km. The alternative route with the more-northern Koptos is 50 km longer. According to Pliny (*NH* 6.29.103), it took twelve days to travel by camel from Koptos to Berenike, a journey made at night because of the heat. Along these caravan tracks, fortified watering stations were present at fixed distances and were used as resting places during the day. Since the sparse vegetation in these wadis would not have been

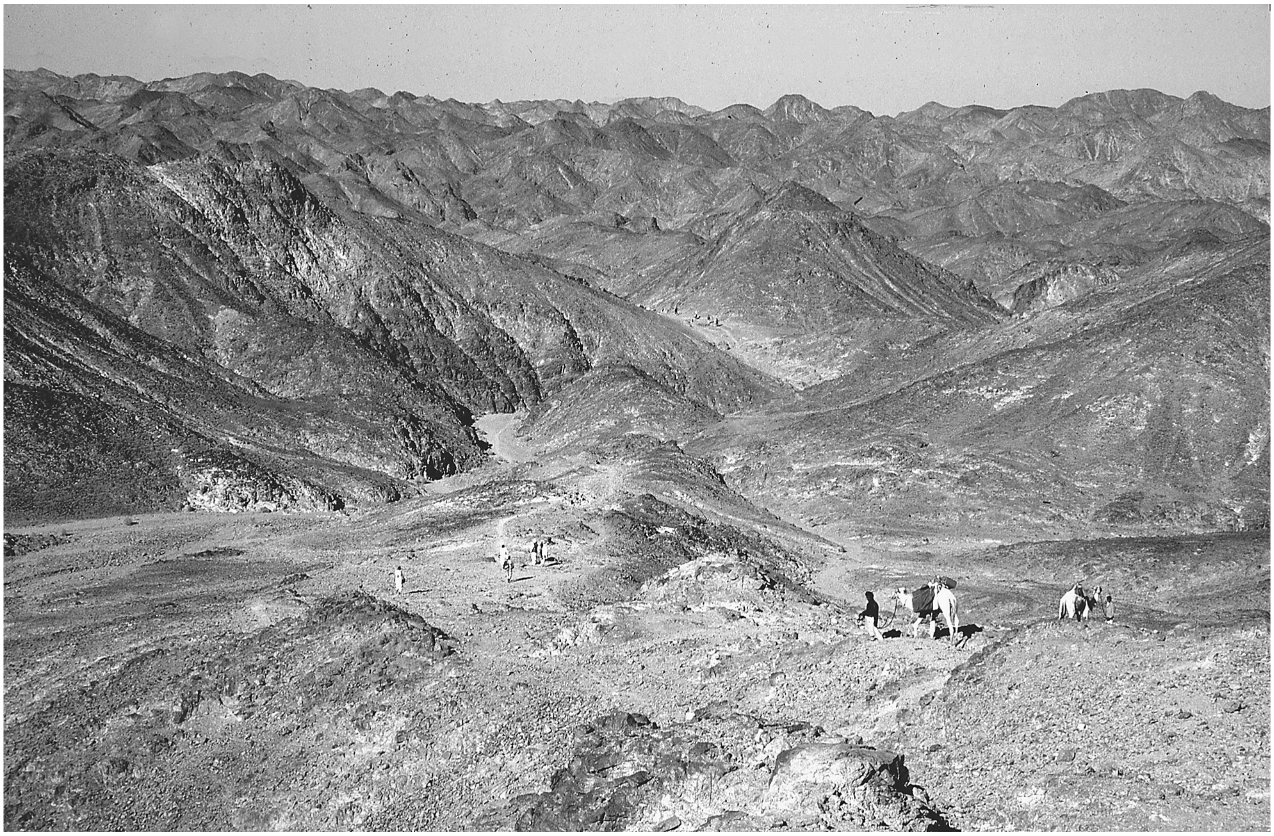


Figure 1.3. Part of wadi system with sparse vegetation and bare mountains (January 1995). See Color Plates section, page 202.

sufficient for grazing by camels and animals that were transported to Berenike on the hoof, these stations must also have been provided with fodder. The presence of archers at these watering stations offered protection to the traders and their valuable commodities.

From Edfu or Koptos the remaining trade route continued again by water transport, first along the Nile River to Alexandria and next across the Mediterranean Sea toward Rome. A main advantage of the Nile is that the direction of its current is northerly. The Nile flows into the Mediterranean Sea, whereas other large rivers used by long-distance traders, such as the Euphrates, Tigris, Indus, and Ganges, all flow from north to south, facilitating the transport of commodities from the hinterland to the littoral of the Indian Ocean.

Because water transport was cheaper than transport over land, direct trade connections between Rome and India could compete even with indirect trade via land routes, although this seems to have been true only for the more-luxurious products such as black pepper (*Piper nigrum*). Depending on the Berenike–Nile route, which had either Edfu or Koptos as its destination, and the sea route across the Indian Ocean, only 3.5 percent to 4.5 percent of the distance between Rome and India was covered by caravan transport.

Obviously, the interest of the Greek and Roman traders in Berenike differed. The prime focus of the Greek activity along the Red Sea coast was dictated by military interest. Berenike and the more-southerly harbors were used to acquire war elephants and gold to facilitate payment of military expenses (Sidebotham 1991:12). Elephants were captured in the semi-evergreen and deciduous forests of present-day Ethiopia and transported by special ships (*elephantagoi*) to Berenike. From there, the animals had to walk along the caravan track to Edfu, where further transport north could be continued via water. It is assumed that the elephants used during the Punic Wars were of African origin, despite their reputation to be untamable. An inscription on the monument of Adulis (modern Massawa), dated to the second half of the third century BC, mentions the capturing and training of elephants (Bunbury 1959:608). More indirect evidence is provided by ancient graffiti on a wadi wall near the Abraq fort, approximately 100 km southwest of Berenike, representing a somewhat caricatural specimen with relatively small ears characteristic of the African species (Sidebotham and Zitterkopf 1996:376).

In Roman times, the elephant trade was abolished and replaced by the import of ivory. The author of the *Periplus Maris Erythraei* mentions that large quantities of elephants and rhinoceroses were killed for this purpose. The excavations at Berenike have also produced archaeozoological evidence of the import of elephant and hippopotamus tusks throughout the Roman period (Van Neer and Ervynck 1999a: 332). In addition to these enterprises dictated by military importance, commercial activities had been developed. In the first instance, their explorations were probably confined to littoral trade routes. Trading contacts with India were made only after 120 BC (Hourani 1995 [1951]:18).

The trade route with India became more important from the first century AD onward. Although the Greeks were already acquainted with the monsoon winds, as can be deduced from the reference by Posidonius to Eudoxus of Cyzicus (and not to Hippalos) as a sailor who traced and pointed out the monsoonal route to India at the end of the second century BC, it was the Romans who intensified the trade contacts with the already flourishing trade network in the Indian Ocean. This was facilitated by the improved economic prospects after the battle of Actium in 31 BC (Mazzarino 1997:77; de Romanis 1997:82). It has been suggested that the gradual shift of a littoral trade route with northwest India as a destination to a transoceanic voyage to southwest India was determined by a change in interest in new commodities rather than by a discovery of the monsoon in stages (de Romanis 1997:85–86).

It is evident from Figure 1.1 that the sea voyages by Roman traders as described by the *Periplus* were connected with the Incense Road, the Silk Road, and the Cinnamon Road. This implies that the commodities available at the harbors that were visited were by definition not restricted to the hinterland, but could also have been imported from more-remote areas. Calling at ports along the Red Sea coast would have gained traders access to items from western Africa brought there by the Sudan Road, though part of the trade items would have been distributed along the Nile Road in a north–south direction. The voyage down to Rhapta is of particular interest because it gave traders access to products from the Malayan archipelago, which most probably not only included cinnamon and cassia but also other exotic communities. It is striking that the author of the *Periplus* only mentions some animal export products for Rhapta: ivory, rhinoceros horn, tortoise shell, and nautilus shell. Finally, calling at Barbarikon and Barygaza in northwest India and sailing to the mouth of the Ganges also offered a market for commodities that originated from China and were supplied via a southern branch of the Silk Road (Cappers 2003:198).

This pattern of interconnecting trade routes is further complicated by indirect trade in which Arab and Indian seafarers were engaged. This implies that certain commodities, such as those from India, were also available at ports along the Persian coast, southern Arabia, and East Africa. Thus, the import of Indian commodities at Berenike does not necessarily imply that Roman vessels returning from India transported them. This is documented in the *Periplus* by several examples and concerns food items (grain; rice; sesame oil; cane sugar; and ghee, an easily preserved butter obtained by heating), textiles and clothing, lac dye (a resinous incrustation that can be used as a pigment), and slaves (Casson 1989:39–43).

After the downfall of the Roman Empire and the arrival of the Arabs in Egypt in AD 640, Berenike lost its transfer function and was at the mercy of the destructive forces of the desert. Both sandstorms and supply of sand by the wadi branches north and south of Berenike buried the city in the course of time, leaving only a vague contour of the walls of the latest buildings and a variety of densely scattered trash. The lagoon south of Berenike has been filled by wadi flood sediments and windborne sediments (Harrell 1996:124).

Roman Installations in the Eastern Desert

Roman activity in the Eastern Desert lasted from 30 BC to AD 638 and is still reflected by many archaeological installations, including settlements, watering stations (*hydreumata*), forts, quarries, roads, graves, and cemeteries. This is also true for the environment of Berenike. To optimize a comparison of the subfossil plant remains of this harbor site with the present-day situation, it was decided to make an inventory of the present vegetation of the immediate surroundings of Berenike, the nearby watering station Kalalat, and the mountain settlements of Khesm Umm Kabu, Hitan Rayan, Shenshef, and Qariya Mustafa 'Amr Gama (Figure 1.4). These sites will be briefly described, starting with the northernmost site and ending with the most southerly one.

Khesm Umm Kabu is located in the upstream part of Wadi Gimal (24°35' N; 34°53' E). In this part of the wadi, the Romans exploited several beryl mines in

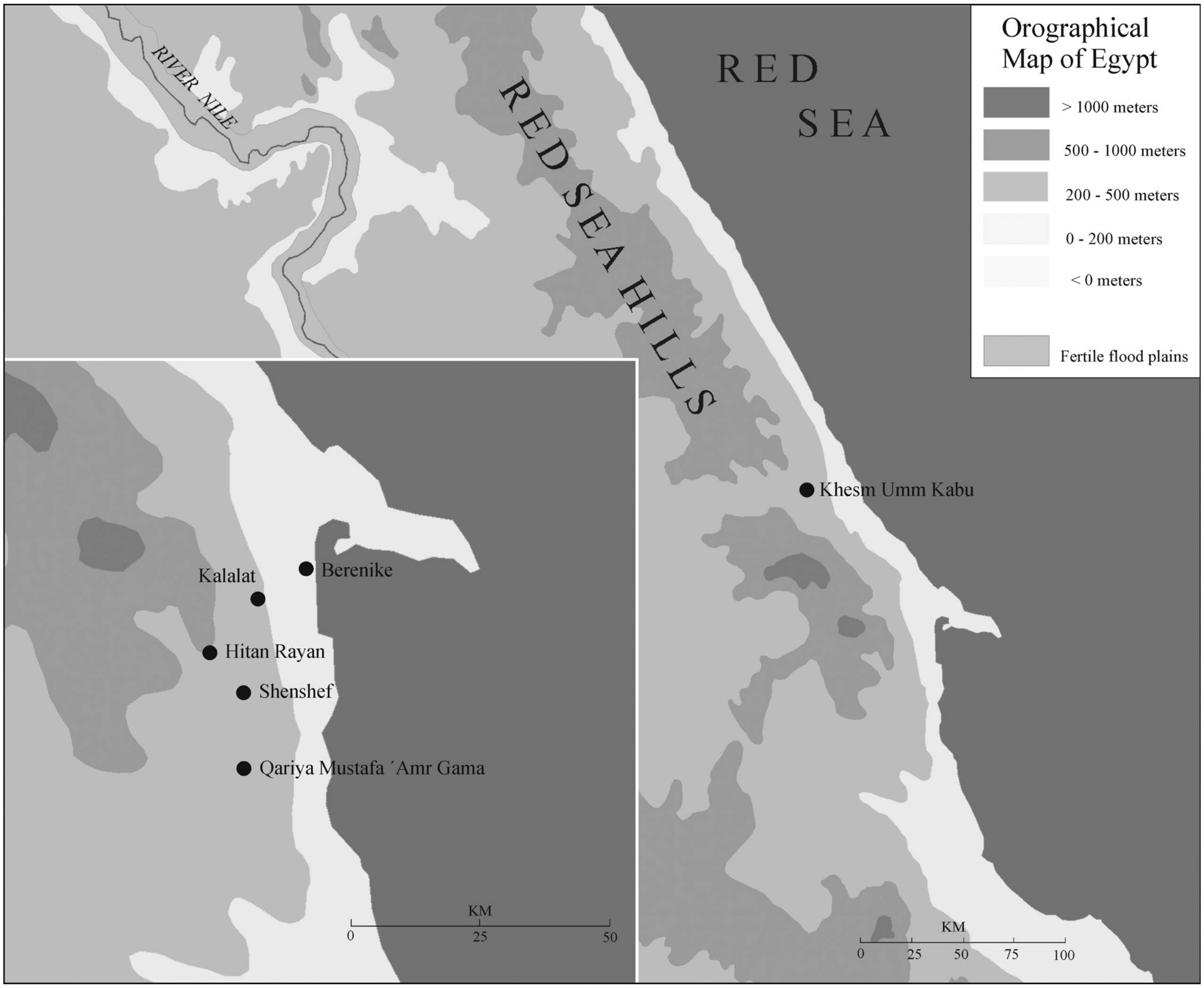


Figure 1.4. Roman installations in the southeastern part of the Eastern Desert from which the vegetation of the near surroundings has been described. See Color Plates section, page 202.

the mountains. These mines are located at different branches of this wadi and are referred to as Mons Smaragdus. Surface finds indicate that the occupation period of the mining settlements lasted from the first to the fifth centuries AD (Sidebotham 2000:356). Contrary to the nearby mining settlements Sikait and Nugrus, no obvious remnants of Roman buildings are present these days at Khesm Umm Kabu. The only two ruins and an associated well are of recent date.

Berenike (23°54' N; 35°28' E) is located on the seaward edge of the coastal plain between the branches of Wadi Mandit and Wadi Umm el-Mandit. The Ptolemaic buildings were founded on an elevated limestone outcrop that originally had a maximum elevation of well over 3 m above the current high tide (Harrell 1998:121). Ptolemaic as well as Roman buildings have been completely covered by wind-blown sand, which has accumulated during the course of time. With the exception of the remains of the temple of Serapis, located on the highest point of the town center, only the contours of the most elevated walls are visible on the surface (Figure 1.5). Photographs taken during an expedition in 1897 conducted by Raimondi (1923) clearly show that this temple has suffered much from its exposure during the twentieth century. Therefore, the Berenike project decided to rebury the temple.

Although detailed maps are now available presenting the buildings visible on the surface (made by J. G. Wilkinson in 1826 and by F. Aldsworth and H. Barnard based on site survey during 1994–96 [Aldsworth et al. 1995: Fig. 66; Aldsworth and Barnard 1998a: separately enclosed map]) and despite eight years of excavation, it is still difficult to make a reliable estimate of the total number of buildings. Demographic data, such as the

Figure 1.5. Berenike with contours of buildings and scattered specimens of *Zygophyllum coccineum* and small hillocks of *Tamarix nilotica*, looking southeast (February 1995). See Color Plates section, page 203.

size of the population in a particular period, are equally unclear. This is especially true for earlier habitation periods, as these have been built over or destroyed by subsequent activities in the town. An estimate for the last habitation phase, dated to the fifth to the early sixth centuries AD, is also difficult to make, since part of the topmost portion of the surface on the west side has been leveled by bulldozing in about 1973, when military installations were built in this area. Estimating the original size of the settlement is further complicated by the fact that it is likely that only a part of Berenike consisted of stone structures. Locally available fossilized coral was the most commonly used building material (Figure 1.6). Temporary residence, using tents in a similar way as was practiced during the excavation seasons, could have been established perhaps west of the town center on a flat area that covers about 7 ha.

At its maximal extension, Berenike may have comprised an area of about 2 km². This area not only included living quarters, but there is also evidence of some industrial activity, including the production of metal, rope, and perhaps glass and beads (Sidebotham and Wendrich 1995:105). A conservative estimate of 500 persons is given by Wendrich (1998:244), taking into consideration only the small buildings visible in the still-intact town center and supposing an occupation per house of an average of five persons.

The location of the harbor, whether it was a real harbor or some convenient landing place, as described by Strabo (*Geography* 17.1.45), is not yet known for certain. Possibly its location shifted from north to south of the town in the course of time, as did the extension of the town center.

Although some burials were found in the built-up area of Berenike, most bodies seem to have been buried outside the town. Scattered over the higher levels of the coastal plain, dozens of graves are still present. Here they are well protected against flooding, although this location could not have prevented plundering.

In Wadi Kalalat, close to the mountains, a small fort and a large watering station are present at a distance of about 1 km from each other. The function of the small fort is still unclear. The watering station (23°52' N; 35°24' E) has a rectangular outside wall and a large, walled, circular depression on the inside. Measuring approximately 80 x 90 m, it is measured up to the

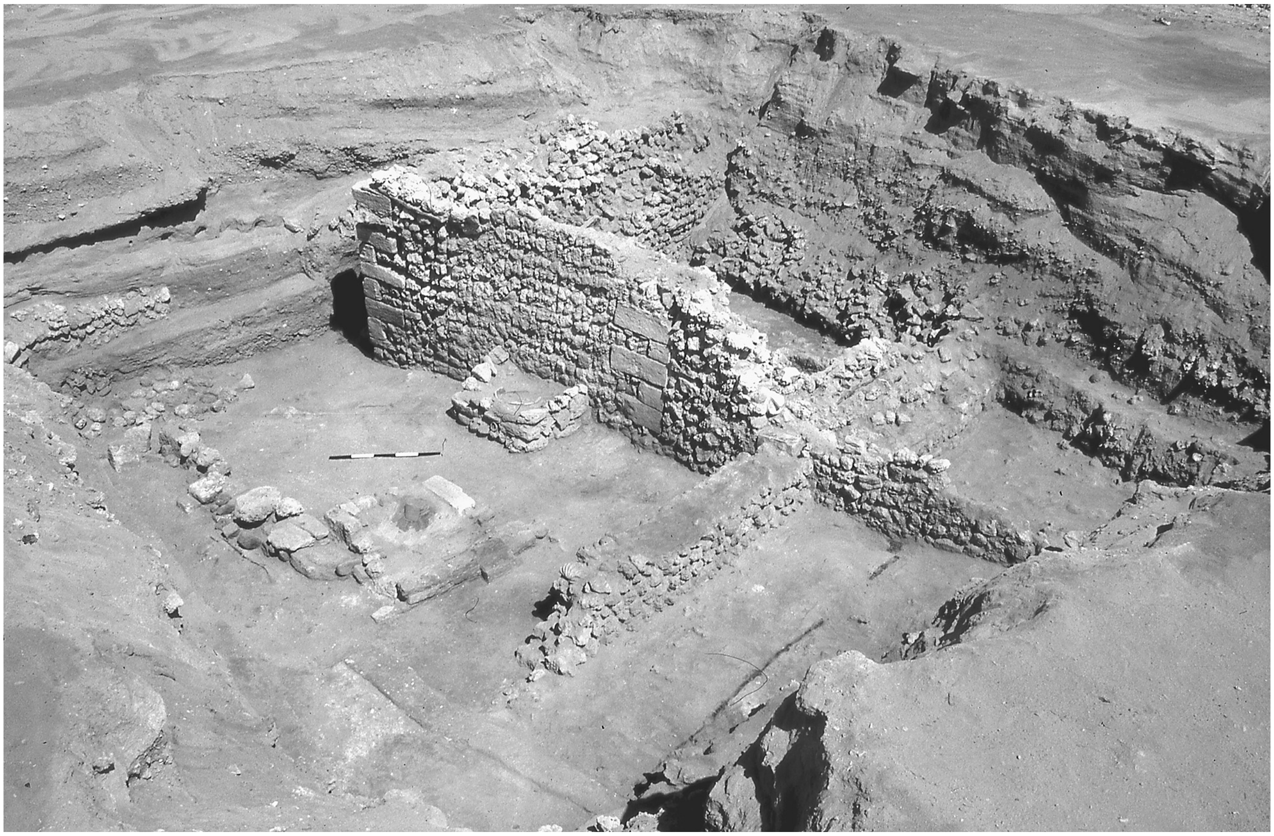


Figure 1.6. Overview of western part of trench 10, looking northeast. Scale is 1 m (February 1998). See Color Plates section, page 203.

largest forts of the Eastern Desert (Sidebotham 1995b: 91). The watering station is located on the floor of the most active part of Wadi Kalalat. At this latitude most of the water drains off underground to the Red Sea, but occasionally serious flooding may occur after heavy rainfall. Probably, the thick outside walls were built to protect the inner construction, in which the latter probably functioned as a well (Harrell 1998:125). To ensure the indispensable supply of water throughout the year, Harrell suggests that a large diameter of the well should have been necessary because of the low ground-water-flow velocity. It is very likely that this watering station played an import role in the supply of fresh water to Berenike. Although the principal drainage course of Wadi Kalalat flows into the Red Sea just south of Berenike, the watering station is located 8.5 km southwest of the site. This western location was probably chosen to avoid the effect of saltwater penetration nearer to the sea. Partly, salt water penetrates through the soil and partly salt crystals are blown inland from dried-up land during low tide (Aldsworth and Barnard 1998a: 8–10). Excavations have, so far, produced no evidence of the existence of a pipeline to transport water from Kalalat to Berenike. Because the watering station is located in the active part of the wadi, where a direct water pipeline between Kalalat and Berenike could easily be damaged by erosive floodwaters, it seems more likely that the water was carried to Berenike by animal transport (Harrell 1998:125).

Hitan Rayan (23°48' N; 35°20' E) and Shenshef (23°44' N; 35°23' E) are located in Wadi al-Rayan and Wadi Shenshef, respectively, at a distance of 8.5 km in a straight line from each other. Obviously, both settlements are located west of an outcrop of the impermeable bedrock, in very shallow sand. As a result, the underground water flow is pushed up and slowly running fresh surface water is present (Figure 1.7). Probably because the drainage basin of Wadi Shenshef is larger than that of Wadi al-Rayan, the amount of surface water in the latter is more substantial and has never been seen dried up over the last six years, as has been the case in Wadi al-Rayan. The long-term character of surface water is supported by the presence of bulrush (*Typha domingensis*) near Hitan Rayan and common reed (*Phragmites australis*) and *Cyperus laevigatus* near Shenshef.

Figure 1.7. Surface water in Wadi Shenshef near a narrow gorge westward of the settlement (January 1996). See Color Plates section, page 204.

The function of Hitan Rayan is enigmatic. Shenshef was, most likely, a satellite settlement of Berenike and was occupied during the fifth to early sixth centuries AD.

The settlement area of Hitan Rayan, which is mainly concentrated on the terraces on the north side of the wadi, comprises remnants of 141 separate structures and 31 burial cairns, partly concentrated in a cemetery on a terrace at the east side of the settlement and partly at isolated locations on the mountains. An analysis based on variables, such as the method of wall construction in relation to roofing; the number of enclosed spaces in one building, varying from one to three; and the position of components such as ovens and storage vessels to each other, suggest that the settlement was primarily used for living (Aldsworth and Barnard 1996:423–436). Despite the abundance of quartz veins in the rocks around Hitan Rayan, there is, with the exception of one locality close to the ruins, no indication of gold mining as is evidenced more to the southwest (Harrell 1998:136). The Hitan Rayan settlement might have been a gold exploration camp.

Unlike Hitan Rayan, there is an obvious plan to the settlement of Shenshef. There, also, the buildings are of a better quality, due to the drystone construction with laminar-formed stones. The ruins of houses are present over a distance of about 800 meters and occur on both elevated terraces of the wadi that become only occasionally flooded (Figure 1.8). In total, 332 structures are mapped, representing four distinct phases of construction. A comparison with Murray's plan of the site, reflecting the situation in the 1920s, shows that in the last decades several buildings have been destroyed (Aldsworth and Barnard 1998b: 430). In addition to the houses, there is an enclosure, and many partly clustered graves are scattered over the area. Finally, a large hilltop fort on the east side of the settlement stretches over two adjacent hilltops from which the Red Sea can be seen. Ceramic finds date this fort to the first century AD, possibly predating the settlement.

Shenshef is not located along a major roadway or are quarries or mines present in the surroundings of Shenshef, which might have explained its former function. The quarries north and south of Shenshef follow aplite dikes and were only used for the production of local building material. They yielded the better-quality stone used for the houses of the later habitation period (Harrell 1998:131). It is also from this construction phase that some of the houses still have walls about 2.5 to 3 m high standing, with complete doorways, windows, and internal niches.

The last Roman installation to be mentioned here is Qariya Mustafa ʻAmr Gama, located in Wadi Umm Athl (23°37' N; 35°23' E). S. Sidebotham named the site in honor of the Ababda, who showed them the site, whereas the wadi itself bears the vernacular name of the leafless tamarix (*Tamarix aphylla*), which grows in this wadi at the site proper. This tree, which is also present near the former settlement of Khesm Umm Kabu, is sensitive to water shortage and its presence may be indicative of water accumulation or crack seepage. The site dates to the late fifth century, possibly early sixth century, and is, thus, contemporary with Hitan Rayan and Shenshef. A nearby shady rock pool contained a reasonable amount of water during a visit in early February 1998.

Figure 1.8. Shenshef with remains of buildings along both sides of the wadi, looking northwest (January 1995). See Color Plates section, page 204.

CHAPTER 2

NATURAL VEGETATION

> "Ich habe meine Reise von Kosser [Quseir] nach Suakin angenehm und glücklich zuruckgelegt, unterwegs einige Excursionen in's Innere unternommen und eine massenhafte Ausbeute an Pflanzenarten gewonnen. Ich glaube gegenwärtig das Gebiet der Küstenflora ziemlich erschöpft zu haben, da ich eine verhältnissmässig geringe Anzahl von solchen Gewächsen einsammelte, die mir auf der frühren Reise entgangen waren. Nur hinsichtlich des Vorkommens machte ich zahlreiche neue Beobachtungen. Meine Sammlungen sind sämmtlich wohl präparirt und nicht den geringsten Schaden habe ich zu beklagen. 15-20 Exemplare besitze ich gegenwärtig fast von allen Arten, die ich auf circa 600 schätze, welche der bewussten Küste entnommen wurden." [G. Schweinfurth 1865c: 537]

WATER STRESS AND PLANT SURVIVAL

The Eastern Desert of Egypt is characterized as hyperarid with a mild winter and a hot summer, with average temperatures in the hottest month ranging from 33–40°C (Ayyad and Ghabbour 1986:151). The mean annual rainfall in the Red Sea coastal land, including the coastal plain and the Red Sea mountains, ranges from 25 mm in Suez (29°59' N), 4 mm in Hurghada (27°14' N), to 3.4 mm in Quseir (26°07' N) (Zahran and Willis 1992:119). Nevertheless, the Eastern Desert has a considerable rich flora, which can be explained by the availability of sufficient water sources on the one hand and the adaptations of desert plants to water stress in particular on the other.

Rainfall

Rainfall in the Eastern Desert is scanty, unpredictable, and concentrated in the winter period. Short, heavy showers may produce huge quantities of water, but these cloudbursts are quite rare and localized. After such heavy rains, silty, flat depressions are filled for weeks or even months with water and can be used for cultivating plants that are adapted to this kind of water supply, such as sorghum (*Sorghum bicolor*). Especially in the Red Sea coastal strip, where a well-developed seed bank is present owing to the atmospheric humidity, which is responsible for a more regular water supply, such erratic cloudbursts will result in a considerable increase in the vegetation cover (Figures 2.1 and 2.2).

In his description of the Eastern Desert, Theophrastus (*EIP* 4.7.1), states that it never rains except at intervals of four or five years, and then the rain comes down heavily and is soon over. According to Hobbs (1990:139), rainfall is sometimes especially abundant in a particular year or even for several consecutive years. In the Ma'aza territory, north of the road between Quseir and Qift, such wet years are reported, among others, 1928–1932, 1949–1951, 1956–1958, and 1977–1985. Seven cloudbursts are recorded by Springuel (1997:180) over the past 15 years in the southern part of the Eastern Desert. The most recent one was in November 1996 and fell over much of the Western and Eastern deserts.

However, winter rains mostly result in limited amounts of rainfall. Because the main rain-producing winds come from a northeasterly direction, rainfall is concentrated on the northeastern sides of the mountains. This orographic influence of the Red Sea coastal

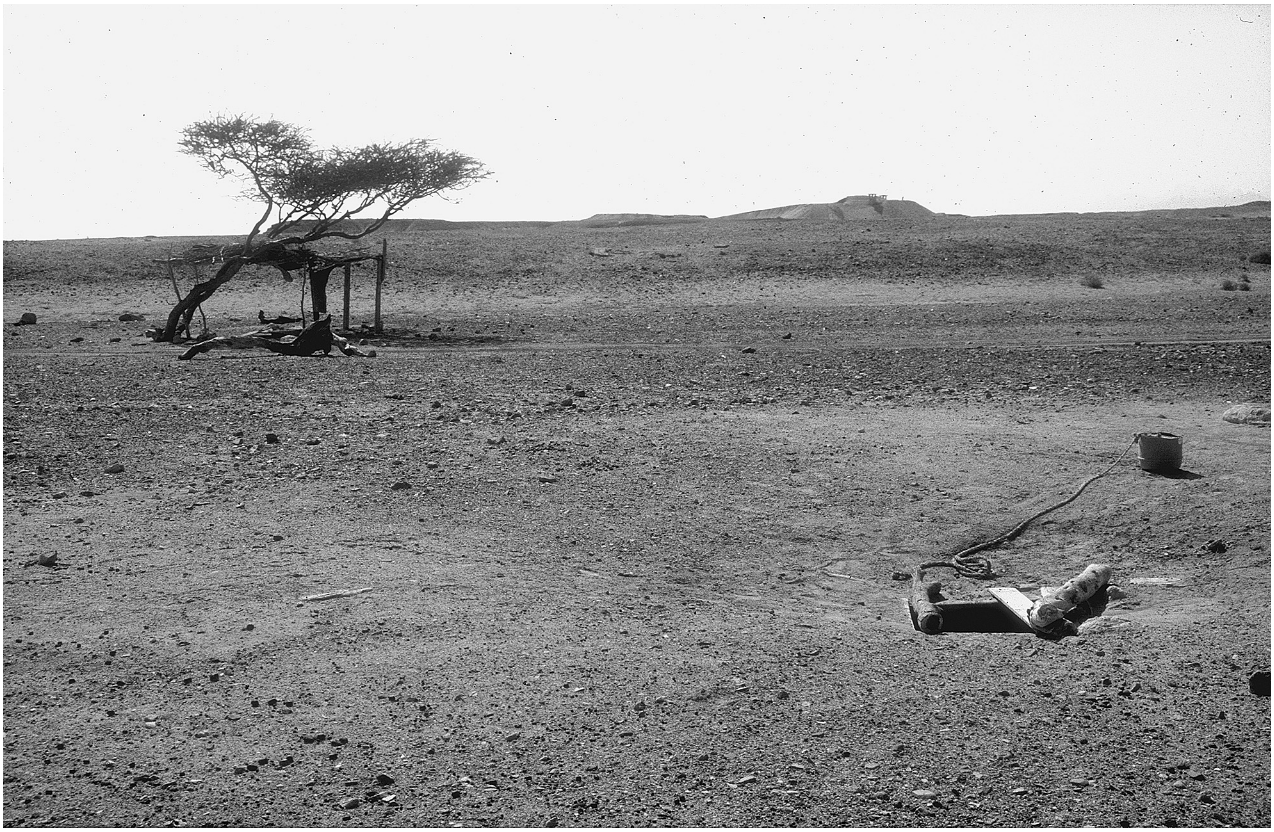


Figure 2.1. Wadi Mandit west of Berenike with *Acacia tortilis* near a well, looking south (January 1995). See Color Plates section, page 205.

Figure 2.2. Same location as Figure 2.1, looking east. Wadi branch and the elevated terraces of the coastal plain are clothed with ephemeral vegetation after heavy autumn rains (December 1996). See Color Plates section, page 205.

mountains results in a comparatively well-developed flora on the slopes. The Elba area in particular, located some 260 km south of Berenike, catches much water in this way, and a unique Sudanese flora characterizes its slopes. Most mountain slopes north of the Gebel Elba are, however, almost barren. The absence of soil and plants results in a quick surface runoff toward the wadis. Especially during nighttime, the evaporation is minimal, and much water sinks into the coarse wadi sand. Some water is caught in rock depressions and is used by animals and humans as a source of drinking water. Even if such rocky clefts are difficult to inspect by eye, the presence of water can easily be checked by throwing a piece of stone.

For the Eastern Desert it should thus be realized that the almost-barren orographic relief affects principally the redistribution of rainfall. As a result, the water supply of wadi branches is actually much more than what is calculated on the basis of the mean annual precipitation. This concentration of water is also supported by the presence of impervious surface crusts, which are found in hyperarid regions in particular and are virtually water resistant (Walter 1983:122).

Water that penetrates deep into the wadi escapes evaporation and will be available for plants with deep taproots. The amount of water that can sink into the ground will largely depend on the texture of the soil, in which penetration and the coarseness of the soil texture are positively correlated. For this reason, sandy soils offer better water supplies in dry regions than clay soils (Walter 1983:116). Silty depressions are an exceptional case as the concentration of the water may compensate the high field capacity, which hinders water penetration.

Groundwater will be drained by an underflow toward the Red Sea or the Nile. Such an underflow was probably used by the Romans in the watering station Kalalat as a source of water for the inhabitants of Berenike. The persistence of this water flow is demonstrated by the permanent presence of slow running water in a narrow gorge of Wadi Shenshef, even when preceding winter rains have not been recorded. From the Greek period onward, the groundwater in Arabia, stretching from Kuwait through eastern Arabia to Bahrain, has been exploited via a network of aquifers, which could be tapped for drinking water and irrigation (Ray 1994:54).

Atmospheric Humidity

Atmospheric humidity is an important source of water for plants growing in the Red Sea coastal zone. Evaporation of seawater during daytime replenishes the water content of the air. This water partly condenses again as the temperature of the air sufficiently drops during winter and early spring. Considering the fact that air temperature is lowest just before sunrise, morning dew (nada) may therefore be responsible for damp soils. Unlike precipitation, morning dew is a much more steady water source for plants. Referring to agricultural practices in Bactria, Africa, and Cyrene, Pliny (*NH* 18.50.186) even states that crops depend on the dewfall at night for their nourishment. Also Theophrastus (*EIP* 4.3.7 and 8.6.6) emphasizes the contribution of dew to plant growth in regions with no rainfall, including Egypt. According to Jabbur (1995:47), who studied the bedouin life in the Syrian Desert, there is so much dew on plants in spring, that some women collect the water in their waterskins.

This atmospheric humidity is of value for both the flat coastal plain adjacent to the Red Sea proper and the mountains, which intercept the clouds blown inland. Especially high mountain massifs may receive considerable amounts of rain in this way. This also explains the presence of several mosses and ferns on the higher levels of the Gebel Elba (Figure 2.3). Fertilization of these plants is only possibly under moist-to-wet conditions.

Figure 2.3. A thalloid, fruiting liverwort on the upper part of the northeastern slope of the Gebel Elba (February 1999). See Color Plates section, page 206.

Plant Adaptations to Water Stress

The adaptation of desert plants to water stress is diverse. Several principles can be distinguished and specific combinations of such principles may find their expression in desert plants. One possible adaptation that has arisen by natural selection is the storage of water in leaves, stems, or roots. Such plants are called *succulents* and are adapted to arid habitats as well as to saline environments. Succulent plants that grow in the Eastern Desert, including the environment of Berenike, are *Suaeda monoica* Forssk. ex J. F. Gmel, *Halopeplis perfoliata*

(Forssk.) Bunge ex Asch., and *Aizoon canariense* L. A good example of a halophytic succulent is *Zygophyllum coccineum*, which has swollen stems and leaves and is able to abort part of its leaves and even young shoots to prevent excessive water loss.

Other plants have leaves with xeromorphic features. They are called *xerophytes* and are, by definition, adapted to arid regions. A common feature is the reduction in size and/or number of the leaves, as can be observed by *Crotalaria aegyptiaca* Benth. and *Moringa peregrina* (Forssk.) Fiori. An extreme example of leaf reduction is demonstrated by *Tamarix aphylla* (L.) H. Karst, a shrub that has only sheath-like leaves.

Another way of drought survival is shortening the life cycle. Annual plants that take advantage of the availability of water independent of the season, being either a rain shower or a damp period caused by dewfall, are called *ephemerals.* They include succulents, such as *Zygophyllum simplex* L.; nonsucculents, including grasses such as *Aristida funiculata* Trin. & Rupr.; and nongrasses such as *Lotononis platycarpa* (Viv.) Pic. Serm. Such plants can survive by a quick absorption of the rainwater and dew. Some of them have reasonably long roots, such as species of *Aristida*, whereas other plant species have only very small and shallow root systems, such as stunted but flowering specimens of *Triraphis pumilio* R. Br., *Eragrostis ciliaris* (L.) R. Br., and *Coelachyrum brevifolium* Hochst. & Nees. These plants were frequently found in the environment of Berenike and Shenshef. Some plants may develop temporarily so-called rain or extension roots, which grow in the upper part of the soil and absorb the water from a rain shower or dew (Girgis 1971:523).

Perennials may also behave as ephemerals. Conversely, some species, such as *Zygophyllum simplex*, that normally behave as ephemerals, can prolong their life span under favorable conditions (Zahran and Willis 1992:151). They are as resistant to drought as a seed.

Plants that obtain their water directly or through the capillary fringe from the groundwater are called *freatophytes.* Because in most cases groundwater is only available at considerable depths, freatophytes are predominantly perennial species that are able to develop deeply penetrating taproots. Regeneration of freatophytes will be especially successful during years with heavy showers, resulting in a moist soil from the surface down to the water table over a considerable time span. During this period, long taproots must grow to the water table. As soon as this is reached, the plants will have become independent of the unpredictable rainfall and can survive in an apparent unfavorable environment.

A good example of a desert freatophyte is the twisted acacia (*Acacia tortilis* [Forssk] Hayne), which may have a taproot of more than 40 m. Owing to its deep, penetrating root, this tree is capable of growing in the fringe of wadi branches. Their presence is even indicative of the many wadi branches that dissect the flat coastal plains along the Red Sea. The growth of the root starts soon after germination. A seedling under a full-grown tree in Wadi Shenshef of only 2 cm high could be dug out to a length of 25 cm before its fragile root broke off. Examples of herbaceous species with long roots are *Aerva javanica* (Burm. f.) Juss. ex Schult., and *Aizoon canariense* L.

Some plants, such as the Nile tamarisk (*Tamarix nilotica* [Ehrenb.] Bunge), are capable of initiating condensation of atmospheric moisture by means of special hygroscopic salt crystals under conditions of high humidity (Figure 2.4). For this reason, drops of water on the surface of the Nile tamarisk taste rather salty. The water condensation is triggered when the humidity

Figure 2.4. Nile tamarisk (*Tamarix nilotica*) in the salt marsh area north of Berenike covered by morning dew (February 1996). See Color Plates section, page 206.

of the air exceeds 76 percent (Walter 1986). Like dew deposition on the plant surface, which depends on a lower plant surface temperature in relation to the dew point temperature of the adjacent air, this salty water drips from the plant and can be absorbed by the shallow roots. The effectiveness of this self-induced sprinkling is evidenced by the many imprints of raindrops in the damp soil beneath such excretive plants.

The availability of water is, however, no guarantee for the presence of desert plants. This is especially true of regions that do not profit from the dewfall. Here, the irregularity of rainfall is at odds with the presence and longevity of seeds in the soil. Seed banks in desert soils are characterized by a concentration of seeds in the upper 2 cm of soil, with a high degree of spatial heterogeneity and a great seasonal and annual variability. Seeds tend to be concentrated in depressions where water collects and in wind shadows, such as below established plant species (Kemp 1989). As dispersal distances are generally short, a specific type of ephemeral vegetation may exist for several years (Zahran and Willis 1992:151). Isolated spots that are completely dependent on unpredictable showers may lack a viable seed bank, and consequently no vegetation will develop after rainfall (compare Figures 2. 5 and 2.6).

Figure 2.5. Wadi Shenshef in flower after serious cloudbursts in November. The transition zone between the wadi and the terrace is dominated by *Rumex vesicarius* (December 1996). See Color Plates section, page 207.

Figure 2.6. Small lake in the Western Desert along the road between Luxor and the Kharga Oasis. Vegetation is not developed due to the lack of a seed bank (November 1996). See Color Plates section, page 207.

Present Desert Vegetation

Phytogeographical Districts

The major phytogeographical districts that are distinguished in Egypt are: (1) the Mediterranean coastal strip, (2) the Nile region, (3) the deserts, (4) the mountainous region of the Sinai proper, (5) the oases, and (6) the Sahelian scrub region in and around Gebel Elba (Figure 2.7). A further division is possible with respect to the Mediterranean area, the Nile Valley, and the deserts (El-Hadidi 1980). Because the desert vegetation is of prime interest, only the division of the desert vegetation will be discussed in more detail.

The Egyptian desert is divided by the Nile Valley into the Western or Libyan Desert and the Eastern or Arabian Desert. Additionally,

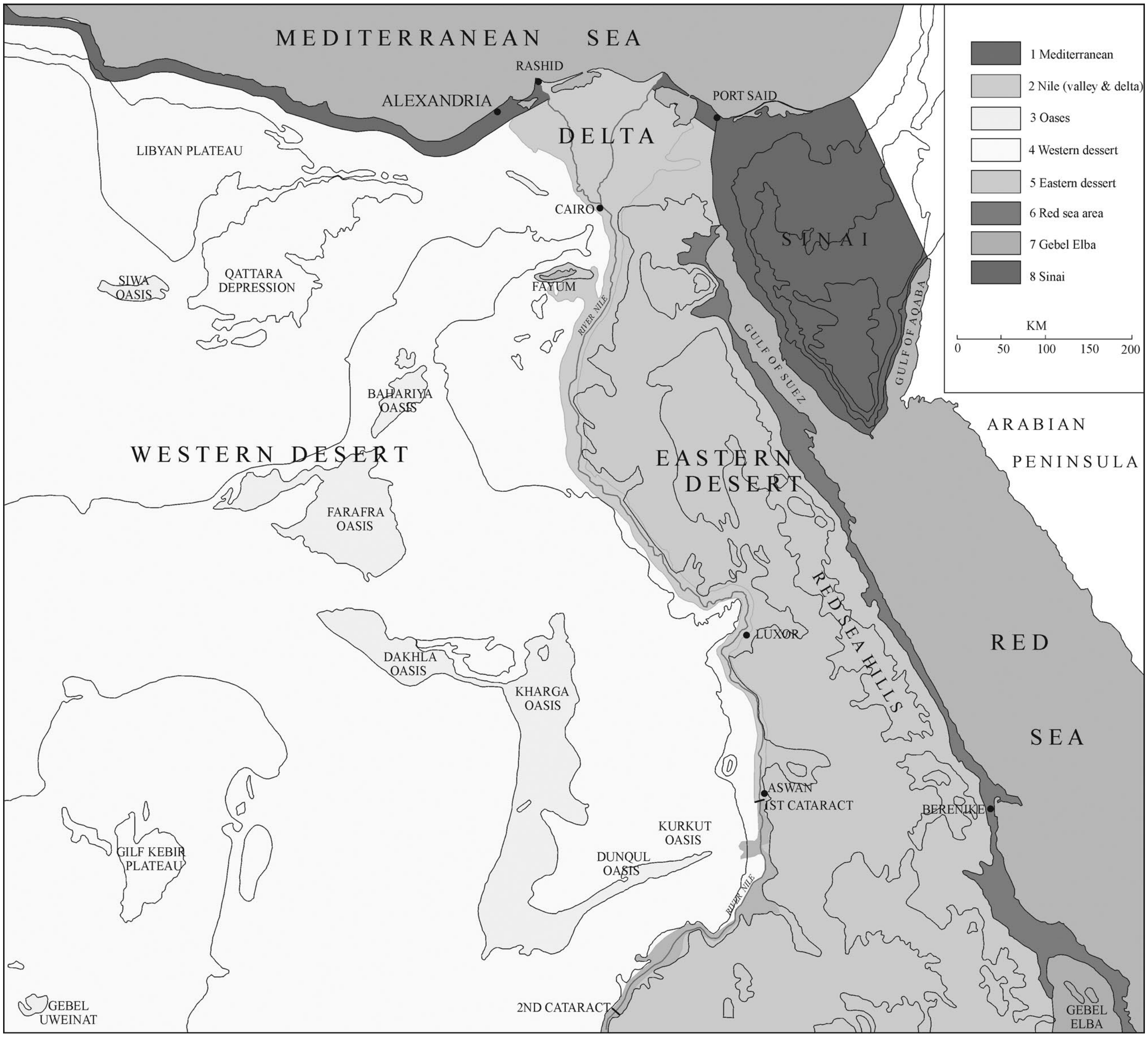


Figure 2.7. Phytogeographical regions of Egypt after Boulos (1995). See Color Plates section, page 208.

the Nubian Desert is distinguished, being present on both sides of the Nile south of Aswan. Both the Libyan and Nubian deserts are flat and have several large depressions (oases). On the eastern side of the Nile, three different deserts are distinguished. The Isthmic Desert is located south of the Mediterranean coastal strip on both sides of the Suez Canal. South of this desert, fringed by the Nile and the Gulf of Suez, lies a small desert area consisting of limestone mountains called the Galaga Desert. The Eastern Desert is the third one in the row and extends southward from about lat 26° N to the Gebel Elba region (Zahran and Willis 1992:117). This large desert is characterized by rugged, igneous mountains that run parallel to the Red Sea on the east side and a rocky plateau on the west side. The Red Sea mountains are dissected by a web of branched wadis that drain off into either the Nile or the Red Sea. Although a detailed labeling of the distribution of the complete Egyptian flora is presented by Täckholm (1974:19–20), including a dichotomy between the northern and southern part of the Eastern Desert, which coincides with the territories of the Ma'aza and Ababda nomads, respectively, it has not been used in this study because it is too out-of-date due to many taxonomical revisions and corrections of geographical distribution records during the last decades. Between the mountains and the Red Sea there is a gently sloping coastal plain. Near Berenike this plain is only 8 km wide, but elsewhere it can extend as far as 35 km. This flat plain is dissected by many wadis draining off into the Red Sea, and its flora differs so much from the flora of the mountainous areas that it represents a separate phytogeographical district.

The Egyptian flora comprises almost 2,100 plant species. The distribution of these species over the major phytogeographical regions is presented in Figure 2.8. The analysis is based on the checklist of the *Flora of Egypt* (Boulos 1995), the *Flora of Egypt* (Boulos 1999, 2000, 2003) and the *Key to the Egyptian Grasses* (Cope and Hosni 1991). The first two sources refer to the major phytogeographical districts only, whereas the grass monograph uses a detailed subdivision. Because of this, the assignment of some grasses that are recorded for the Isthmic Desert remains problematic and should be added either to the Sinai district or to the Eastern Desert. The number of these grass species is low, however, and therefore has no significant influence on the calculations (Figure 2.8).

In each phytogeographical district, plants have been divided into three classes. The first class represents the number of species recorded from the particular region only. The second class shows the number of species also recorded from the Eastern Desert and Red Sea coastal strip. For the Eastern Desert this second class refers only to the number of plants also found in the Red Sea coastal plain, and for the Red Sea coastal plain the case is vice versa. The third class represents plant species found in the concerning region and other regions but excluding the Eastern Desert and the Red Sea coastal strip.

Four phytogeographical districts are characterized by a reasonable number of indigenous plants, which give them their individual status: the Mediterranean coastal strip (16 percent), the Nile region (18 percent), the Gebel Elba (35 percent), and the Sinai (22 percent). In the other four districts, these percentages vary between 2 to 5 percent, indicating that on a presence/absence analysis the flora in these districts does not differ much.

The flora of the Sinai comprises no less than 61 percent of the Egyptian flora. This high percentage, together with the rather high number of indigenous plant species, reflects the variety of habitats in this district and may also justify a further subdivision of the Sinai phytogeographical district as has been published elsewhere (e.g., El-Hadidi 1980). The Mediterranean area, where plant growth is favored by the relatively large annual precipitation (90–190 mm) and mild

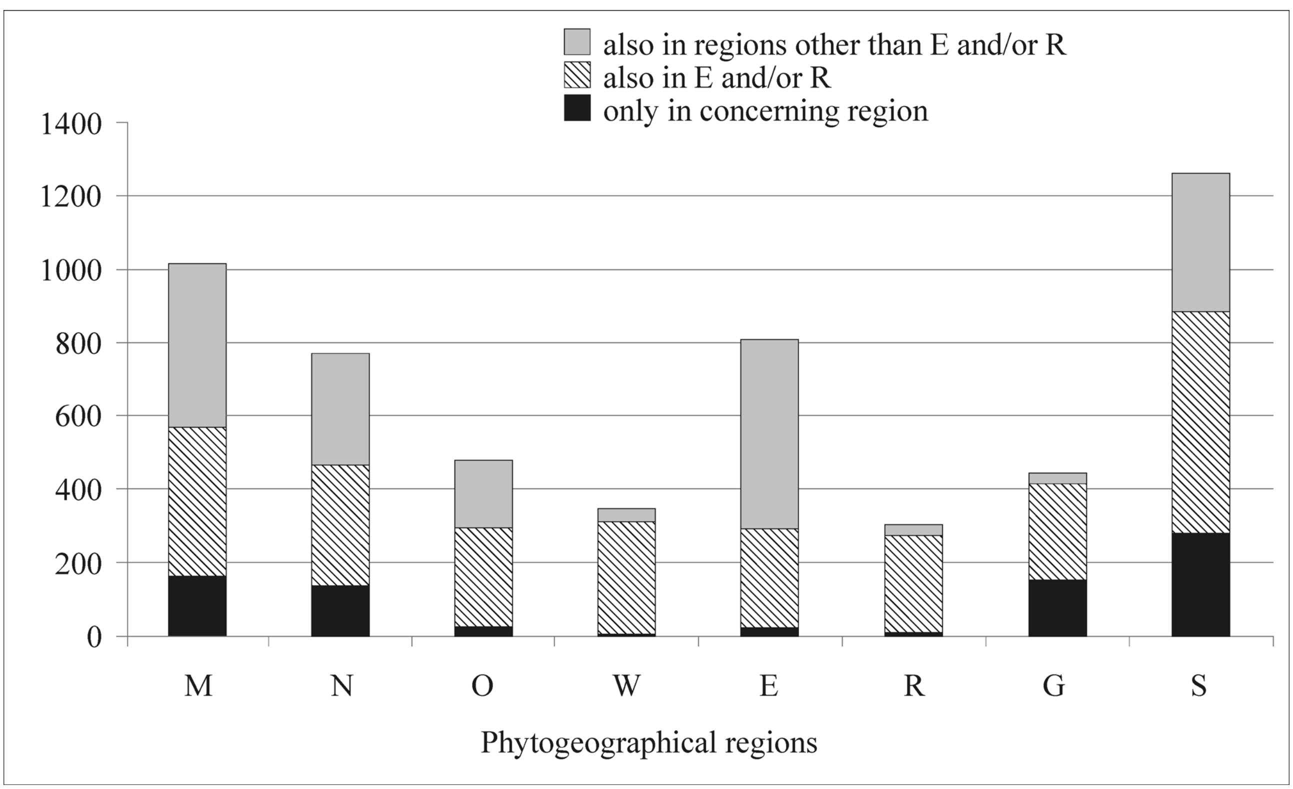


Figure 2.8. Species richness of the phytogeographical regions. The sequence of the regions is similar to that of Figure 2.7.

temperatures in winter and summer, represents 49 percent of the Egyptian flora.

Although the Egyptian deserts are characterized as hot and hyperarid, the desert flora is quite rich and diverse in plant numbers. Remarkably, the number of species in the Western Desert is considerably smaller than that of the Eastern Desert. With 39 percent, the number of species in the mountainous area of the Eastern Desert is more than twice as much as that of the Western Desert and almost equals the species richness of the Nile Valley and Delta. Even the number of species recorded for the small coastal plain bordering the Red Sea is considerable: 15 percent. The proximity to the sea, the variation in environmental conditions, and the effective concentration of rainwater in the wadi system seem to be favorable factors in this respect.

The flora of the coastal plain is, for the most part, also present in the Red Sea mountains. At least 800 plant species occur in both these landscapes. Of these species, 32 percent is present in both areas and only 3 percent is unique for the coastal plain (*Salsola spinescens*, *Cornulaca ehrenbergii*, *Lotus schimperi*, *Indigofera colutia*, *Polygala irregularis*, *Halophila ovalis*, *Thalassia hemprichii*, *Rhizophora mucronata*, *Cymodocea serrulata*, and *Halodule uninervis*). The small percentage that is specific for the coastal plain can be attributed to the presence of salt marshes, an ecosystem that is characterized by its limited number of species. Certain species of the flora of the Red Sea mountains and the coastal plain are also present in the other phytogeographical districts. This is also true for the Gebel Elba area, where the Sudanian flora penetrates into the north. A group of large mountains, including the Gebel Elba, is located near the sea and causes much orographic rain. This is especially true for the north and northeast flanks, where even several moss species and ferns are quite abundant on the higher latitudes. A total of 443 different vascular plant species have been recorded for the Elba mountains, and its botanical richness is in marked contrast with that of the mountains north of this area.

The barren Red Sea mountains north of lat 23° N have only a limited plant cover. On rock surfaces where some soil has accumulated and in the many small affluents through which the runoff water drains into the main wadi beds, short-lived plants (ephemerals) are present in particular. Most of the vegetation is, however, concentrated in the wadi branches and consists of both ephemeral and perennial vegetation. The number of flowering plants in a particular wadi is estimated by Schweinfurth (1865a: 333) at 60 to 100 species. The vegetation in these wadis also penetrates the coastal plain close to the Red Sea, where it is finally replaced by a salt-marsh vegetation. These salt marshes can be quite small, as is the case in the delta of Wadi Gimal, or may penetrate inland for several kilometers. Plant growth in wadis is determined by the catchment area as well as the thickness and composition of the wadi filling. Small, shallow wadis are dominated by drought-tolerant plant species. Broad and deep wadi beds on the other hand, which are filled with sand deposits and are fed by a large mountainous area, act as natural reservoirs for large quantities of water. In such deep wadis, only the upper layers dry up completely. Remarkably, perennials with long roots can reach the deep water table and are able to survive in these restricted environments year-round. Trees, such as *Acacia tortilis*, are mainly found in the transitional zone between the elevated terraces and the central part of the wadis and along the convex sides as this fringe optimizes the availability of groundwater and protection against erosive floodwaters. Smaller perennial species, such as *Chrozophora plicata* and *Cornulaca monacantha*, that have successfully established themselves in the central part of the wadi are often badly damaged by previous floodings. The thick, woody stems indicate that such specimens have a considerable age. The terraces of the coastal plain support almost no vegetation: only ephemeral vegetation is present, this being dependent on rainfall.

Plants in the Vicinity of Some Roman Installations

Representativeness of the Data: To facilitate a better interpretation of the subfossil record of wild plant species from Berenike and Shenshef, a small-scale inventory of the recent natural vegetation has been made. This inventory of the vegetation is based on plants collected around Berenike, Kalalat, Khesm Umm Kabu, Hitan Rayan, Shenshef, and Qariya Mustafa 'Amr Gama and on the description of 16 relevés (2m x 2m) located at Berenike, Kalalat, and Shenshef (Figure 2.9). A relevé is a vegetation sample which is deliberately chosen as being a uniform and representative sample of the plant community being described (Kent and Coker 1992: 40). It is stressed that, apart from the descriptions of the relevés, these inventories are biased by differences in the duration of the visits paid to these sites. A short visit will certainly result in an incomplete inventory, as many plants are relatively small in size due to an adaptation to moisture shortage in particular and may easily be overlooked if they are present in

Figure 2.9. Relevé nr. 11 (size: 4 m²) near the large watering station Kalalat (January 1997). See Color Plates section, page 209.

low frequencies. *Gisekia pharnaceoides* may serve as an example. This plant species is the only member of the *Gisekiaceae* (formerly also classified under the *Aizoaceae* and the *Molluginaceae*) in Egypt and is recorded for the Eastern Desert and the Gebel Elba area (Boulos 1995:9). Several specimens of this prostrate annual were found around Fort Kalalat and measured sometimes hardly more than 1 cm (Figure 2.10), whereas in the wadis of Gebel Elba this plant species is considerably larger. Under more favorable conditions, the stems may reach a length of 10 to 40 cm (Boulos 1999:40). The possibility that this particular plant species has been overlooked at other sites cannot be ruled out.

The Roman settlements that have been less-intensively investigated are Khesm Umm Kabu, Hitan Rayan, and Qariya Mustafa ‘Amr Gama. The first two settlements were visited twice and the last one only once. In all of these locations, most of the plants that have been recorded originate from the wadi branches. Berenike, Shenshef, and Kalalat have been visited during all excavation seasons. Berenike was visited during the excavation seasons from 1994 to 1998, making it possible to look at the vegetation from late December until early March. The inventory covers the salt-marsh vegetation and the vegetation

Figure 2.10. *Gisekia pharnaceoides* along the eastside of the watering station Kalalat. A fruit of *Zilla spinosa* is in the background January 1997). See Color Plates section, page 209.

in the branches of Wadi Mandit west of Berenike and Wadi Umm el-Mandit south of the site. The inventory of the vegetation in the surroundings of the watering station (*hydreuma*) Kalalat is based on the plant species that grows inside the fort and on the sand that has accumulated along the outside of the external walls. Additionally, plants from the wadi branches around the watering station and on the flat coastal plain were listed. A thorough study of the plants around Shenshef could be made because one of the visits lasted for two weeks and took place after heavy rainfalls. Plants were collected from the main wadi branch and its affluents, from the slopes of the mountains, and from the terraces occupied by the former settlement (Figure 2.5).

The completeness of the inventory is also affected by the time of the year. Although all sites were visited during the excavation seasons, which lasted from late December to early March, and the life cycle of most annuals coincide with this relatively mild part of the year—due to lower temperatures and availability of water— plant species may still have been missed because they had not yet germinated or were already withered. Identification of very young plants, lacking characteristic features of flowers and fruits was, however, still possible in most cases by using leaf characteristics and by looking at the germinated seed or fruit still attached to the root, which was easily gathered from the loose sand. This last method proved to be successful especially with respect to grasses with a resistant fruit coat, such as *Centropodia forsskalii*, *Aristida* spp., and *Stipagrostis* spp. All Egyptian members of both last genera can easily be identified to the level of species on the basis of their fruit characteristics (Cope and Hosni 1991:34–36). Some other young plants lacked such characteristic features, such as *Fagonia* spp., and could therefore not be identified beyond the genus level.

Finally, the sampling is further distorted by differences in the vegetation between years, which in turn are related to variations in precipitation. This seasonal phenology is witnessed in nonsaline ecosystems of the deserts (Zahran and Willis 1992:142). Some plant species, such as *Arnebia hispidissima* and *Zilla spinosa*, were observed every season, though in varying density, whereas others, such as *Senna italica* and *Cleome amblyocarpa*, were infrequently present in the same wadi branches.

Differences Between Sites: The plant composition in the relevés is summarized in Table 2.1. Although the size of the relevés is relatively small for a desert environment, the number of species is surprisingly high. It varies from 5 to 19 with a mean value of 13. Also the plant cover can be reasonable high as it varies from 10 percent to 85 percent. It has to be realized, however, that these inventories were made after heavy rainfall, resulting in exceptionally rich vegetation, which found its expression in both plant cover and in the proportion of ephemeral species.

Ephemeral species have a short life cycle and need water only during a part of the year. The distinction between ephemerals and perennials is not exclusive, as some perennials such as *Zilla spinosa*, *Pulicaria undulata*, *Farsetia ramosissima*, *Citrullus colocynthis*, and *Trichodesma africanum* can also behave as ephemerals if there is a shortage of water.

Common ephemeral species are *Zygophyllum simplex*, *Lotononis platycarpa*, *Triraphis pumilio*, *Eragrostis ciliaris*, *Arnebia hispidissima*, and *Astragalus vogelii*. *Zilla spinosa* is a perennial species that is present in most relevés, though mostly at a young stage of development as perennial species tend to develop more slowly. *Z. spinosa* is absent in the vicinity of the sea.

The diversity of grasses is striking. A total of 16 species has been recorded, of which 15 grasses are also present in the relevés. With the exception of *Rostraria pumila*, which grows as a small grass in a wadi branch near the watering station Kalalat, all these grasses are C4-species. Such species are adapted to arid conditions by a different photosynthetic pathway and a regulation mechanism that minimizes evaporation. The distribution of the C4-grass species seems to be influenced primarily by temperature (Batanouny et al. 1988:546). In the southern part of the Eastern Desert (26°-20° N) C4-grasses make up 81 percent of the species, in the Red Sea coastal zone 93 percent, and in the southerly located Gebel Elba area even 95 percent. The high proportion of C4-grass species in the vicinity of the Roman installations corresponds quite well with these percentages.

Most grass species become reasonably tall and produce a substantial amount of biomass for grazing, such as *Aristida* spp, *Stipagrostis* spp., *Dichanthium foveolatum*, *Cenchrus ciliarus*, and *Panicum turgidum*. In years with limited or no autumn rain, those species are heavily grazed (Figure 2.11). Only isolated specimens in inaccessible spots of rocky affluents succeed in flowering and fruit setting in such years. Other grasses remain small in size, even in favorable years, and it seems as if these grasses are present at the fringe of their distribution area. A good example is the presence of dwarf specimens

Table 2.1. Floristic composition of 16 relevés (2 x 2m)².

1	3-1-1997	terrace, in ruins
2	1-1-1997	foothill of north-facing slope (stones)
3	1-1-1997	foothill of north-facing slope (sand/stones)
4	1-1-1997	foothill of north-facing slope (sand)
5	4-1-1997	affluent of main wadi (sand)
6	3-1-1997	peripheral part of main wadi (sand)
7	1-1-1997	central part of main wadi (sand)
8	22-1-1997	depression on coastal plain (sand)
9	12-1-1997	peripheral part of wadi (gravel)
10	4-1-1997	intermediate between 9 and 11
11	12-1-1997	central part of wadi (sand)
12	10-1-1997	peripheral part of affluent (stones)
13	10-1-1997	peripheral part of wadi branch (sand/stones)
14	10-1-1997	central part of wadi branch (sand)
15	10-1-1997	central part of wadi branch (sand/stones)
16	10-1-1997	silty depression within the site

	Shenshef					Kalalat				Berenike						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A Ephemerals																
Caylusea hexagyna													r		1	
Crotalaria microphylla													r		1	
Stipagrostis hirtigluma												+				
Rostraria pumila										+						
Polygala irregularis								1								
Aizoon canariensis											+	+	1		1	r
Astragalus eremophilus								+			r	r	1	1	2	+
Aristida adscensionis								1	+		+	+	r		+	
Zygophyllum simplex	3	2	+	3	1		+	+	1	+	+	1	+	+	3	+
Lotononis platycarpa	r	1	+	+	+	1	2	1	r	1	+	+	1		r	
Triraphis pumilio	+	+	+	+	+		+		+	1	1	r			r	
Eragrostis ciliaris	1		+		+		+	1	+	1	1		1	1	1	
Arnebia hispidissima	+	r			r	r			+	r		+	1	1	1	
Astragalus vogelii	+		r	+	+	+	+	1	r	+						r
Aristida funiculata				r	1			1					1	r	1	
Euphorbia granulata		+	+	+				+					+			
Aristida mutabilis	+				1	+		1	+				1			
Launaea capitata					+					r					r	
Coelachyrum brevifolium					+				+	r	+				r	
Tribulus terrestris		r			r						r					
Eragrostis cilianensis					+					r	r					
Monsonia cf. senegalensis					r											
Reichardia tingitana			+													
Rumex vesicarius			r													
Aristida mut./fun.			+													
Trichodesma ehrenbergii		r		r												
Stipagrostis uniplumis		2														
Subtotal	**8**	**8**	**9**	**7**	**13**	**4**	**5**	**10**	**9**	**10**	**10**	**8**	**12**	**5**	**13**	**4**
B Perennials																
Zygophyllum coccineum																2
Crotalaria aegyptiaca														1		
Indigofera articulata														1		
Senna italica														r		
Crotalaria aegyptiaca													r	1		
Cyperus conglomeratus														+		
Dichanthium foveolatum													1	+		
Citrullus colocynthis													+			
Fagonia			r										r	r	+	
Panicum turgidum					r								r	r		
Aerva javanica												+				
Cenchrus ciliarus												1				
Monsonia cf. nivea								+	+	+	+		r		r	
Centropodia forskalii									+	r	+					
Stipagrostis plumosa							+		+	r	+					
Zilla spinosa	2	+	2	+	2	+	+	r	r	r	+		r			
Pulicaria undulata		r	+	r	+		+				+					
Polycarpaea robbairea	1		r		+		3		+		+				+	
Acacia tortilis		r					r							r		
Polycarpaea repens			r						r		+			r		
Amaranthus graecizans	2				r											
Forsskålea tanacissima		+	r	+	+		+									
Lotus hebranicus			2				2									
Subtotal	**2**	**3**	**6**	**3**	**6**	**1**	**7**	**2**	**6**	**4**	**7**	**2**	**7**	**10**	**3**	**1**
Unidentified			**r**													
Species number	**10**	**11**	**16**	**10**	**19**	**5**	**12**	**12**	**15**	**14**	**17**	**10**	**19**	**15**	**16**	**5**
Plant cover (%)	**85**	**35**	**40**	**60**	**30**	**10**	**70**	**20**	**20**	**35**	**10**	**50**	**35**	**25**	**30**	**40**

Figure 2.11. A stump of heavily grazed *Panicum turgidum* in Wadi Mandit, west of Berenike (January 1996). See Color Plates section, page 210.

of *Triraphis pumilio* and *Eragrostis ciliaris* in this part of the Eastern Desert. Although the abundance may be large, as is the case in, for example, relevé nr. 11 where 78 specimens of *T. pumilio* and 155 specimens of *E. ciliaris* were counted in 4 m^2 of the central part of a sandy wadi branch near watering station Kalalat, the seize is extremely small. Full-grown, flowering specimens rarely exceed 2 cm in height (Figure 2.12). Only in more-suitable habitats, such as the Roman ruins in Shenshef, were larger specimens of *E. ciliaris* found. But these specimens are still rather small in comparison with normal-sized specimens, which have an average culm length of 20 to 30 cm. The fact that this grass still manages to produce seeds in such unfavorable environmental conditions guarantees the presence of a substantial seed bank and explains its abundance in this area.

The conditions for plant growth on the elevated coastal plain between the wadis, which are covered by gravel and cemented sand, are most unfavorable. This part of the desert only receives water from the air, either by rain or by dew. Because this supply is limited in time as well in space, due to the locality of rain showers, the vegetation is very sparse and predominantly ephemeral. Nevertheless, some vegetation may be present in sheltered habitats such as sandy depressions. Surprisingly, such microhabitats can contain a diversity of plants, as is shown by relevé nr. 8. Although the plant cover is low, the frequency of ephemeral species (N = 10) is quite high. The only perennial species are *Monsonia* cf. *nivea* and *Zilla spinosa*. *Polygala irregularis* was called "gazelle-tree" by the Ababda guide, despite its very small size. Maybe it was confused with *P. erioptera*, whose size varies from a few centimeters to over half a meter.

A total of 114 different taxa has been recorded for the surroundings of the Roman installations, of

Figure 2.12. Small-sized specimen of *Eragrostis ciliaris* in relevé nr. 11 near the watering station Kalalat (January 1997). See Color Plates section, page 210.

which 102 could be identified to the level of species (Table 2.2). Species recorded for the first time for the Eastern Desert (De) are *Amaranthus graecizans* and *Monsonia senegalensis*. Those recorded for the first time for the Red Sea coastal strip (R) are: *Cistanche tubulosa*, *Forsskålea tanacissima*, *Polycarpaea repens*, *Balanites aegyptiaca*, *Fagonia arabica*, *Polycarpaea robbairea*, and *Aizoon canariense*.

Clear anthropogenic indicators are not found near the present Roman installations, though *Chenopodium murale* and *Amaranthus graecizans* are well-known species of fallows and waste grounds around settlements. Both species were found inside the Roman ruins of Shenshef, the latter one also near the Roman ruins of Qariya Mustafa ʻAmr Gama. Zohary (1973:650) categorizes *Gisekia pharnaceoides* among a group of anthropophilous plants. Its presence near Fort Kalalat, however, does not seem to suggest human interference. The only disturbance is caused by occasionally passing herds of sheep and goats.

A special case in this respect is *Aristida adscensionis* var. *ehrenbergii*. Of the 19 specimens that have been collected of this species spread over five Roman

Table 2.2. Plants growing in the vicinity of some Roman installations (KK = Khesm Umm Kabu; BE = Berenike; KA = Kalalat; HR = Hitan Rayan; SS = Shenshef; QM = Qariya Mustafa ‘Amr Gama).

	KK	BE	KA	HR	SS	QM
Boraginaceae						•
Caryophyllaceae						•
Lavandula pubescens						•
Lycium shawii						•
Monsonia						•
Senna holosericea						•
Reichardia tingitana					•	•
Stipagrostis uniplumis					•	•
Amaranthus graecizans					•	
Anticharis glandulosa					•	
Cyperus laevigatus					•	
Monsonia senegalensis					•	
Scirpus (?)					•	
Typha domingensis					•	
Chenopodium murale				•		•
Lotus hebranicus				•	•	•
Cometes abyssinica				•	•	
Lindenbergia sinaica				•	•	
Lotus cf. glinoides				•		
Fagonia arabica			•		•	•
Rumex vesicarius			•		•	•
Astragalus sp.			•		•	
Eragrostis cilianensis			•		•	
Stipagrostis plumosa			•		•	
Boerhavia repens			•			
Cotula cinerea			•			
Cruciferae			•			
Gisekia pharnaceoides			•			
Indigofera sp.			•			
Indigofera argentea			•			
Kohautia caespitosa			•			
Rostraria pumila			•			
Stipagrostis ciliata			•			
Crotalaria aegyptiaca		•				•
Morettia philaena		•				•
Senna italica		•				•
Citrullus colocynthis		•			•	•
Acacia tortilis		•		•	•	•
Zilla spinosa		•	•	•	•	•
Zygophyllum coccineum		•	•	•	•	•
Euphorbia granulate		•	•		•	•
Launaea capitata		•	•		•	•
Lotononis platycarpa		•	•		•	•
Panicum turgidum		•	•		•	•
Polycarpaea robbairea		•	•		•	•
Aizoon canariensis		•	•		•	
Astragalus eremophilus		•	•		•	
Astragalus vogelii		•	•		•	
Cenchrus ciliarus		•	•		•	
Coelachyrum brevifolium		•	•		•	
Cyperus conglomeratus		•	•		•	
Eragrostis ciliaris		•	•		•	
Gramineae		•	•		•	
Heliotropium bacc./ra.		•	•		•	
Indeterminate		•	•		•	
Tribulus terrestris s.l.		•	•		•	
Triraphis pumilio		•	•		•	
Glossonema boveanum		•			•	
Leguminosae		•			•	
Tamarix nilotica		•			•	
Dichanthium foveolatum		•	•	•		
Pergularia tomentosa		•	•	•		
Cornulaca monacantha		•	•			
Crotalaria microphylla		•	•			
Dipterygium glaucum		•	•			
Hippocrepis cf. constricta		•	•			
Monsonia nivea		•	•			
Polygala erioptera		•	•			

Table 2.2. (continued)

	KK	BE	KA	HR	SS	QM
Polygala irregularis		•	•			
Anastatica hierochuntica		•				
Cistanche tubulosa		•				
Cleome amblyocarpa		•				
Convolvulus hystrix		•				
Fagonia cf. glutinosa		•				
Fagonia cf. indica		•				
Halopeplis perfoliata		•				
Indigofera articulata		•				
Launaea cassiniana		•				
Suaeda monoica		•				
Suaeda sp.		•				
Zygophyllum album		•				
Aerva javanica	•	•	•	•	•	•
Aristida mutabilis	•	•	•	•	•	•
Forsskålea tanacissima	•	•	•	•	•	•
Pulicaria undulata	•	•	•	•	•	•
Trichodesma ehrenbergii	•	•	•	•	•	•
Cleome droserifolia	•	•		•	•	•
Stipagrostis hirtigluma	•	•		•	•	•
Cleome chrysantha	•			•	•	•
Zygophyllum simplex	•	•	•		•	•
Aristida adscensionis	•	•	•		•	•
Aristida funiculata	•	•	•		•	•
Arnebia hispidissima	•	•	•		•	•
Caylusea hexagyna	•	•			•	•
Chrozophora tinctoria	•				•	•
Kickxia acerbiana	•				•	•
Senecio flavus	•				•	•
Reseda	•	•				•
Salvadora persica	•					•
Tamarix aphylla	•					•
Trichodesma africanum	•					•
Fagonia sp.	•	•	•	•	•	
Polycarpaea repens	•	•	•		•	
Asphodelus tenuiflorus	•				•	
Centropodia forskalii	•	•	•			
Farsetia ramosissima	•	•	•			
Neurada procumbens	•	•	•			
Ochradenus baccatus	•	•	•			
Balanites aegyptiaca	•					
Calotropis procera	•					
Cucumis prophetarum	•					
Farsetia longisiliqua	•					
Ifloga spicata	•					
Leptadenia pyrotechnica	•					
Rumex simpliciflorus		•				

installations, only one could be assigned to this variety. Several specimens were found between stones in a small affluent, which are relatively large in comparison with the variety *typicum*. The variety *ehrenbergii* Henr. is characterized by its scabrous lemmas, which are covered by thick hyaline-curved hairs. This variety is not mentioned for Egypt. According to Henrard (1932:323), its distribution area stretches from Ethiopia and Eritrea to Arabia and Iran. In the more southerly Gebel Elba area, which is characterized by the presence of the Sudanese flora, in addition to the variety *typicum*, only two other varieties have been recorded, viz. *pumila* and *aethiopica* (Drar 1936:64). Thus the presence of the variety *ehrenbergii* in Shenshef clearly points to a connection with more-southerly-located areas. One may wonder if the presence of this plant in the vicinity of Berenike can be related to the former trade contacts with Arabia, Ethiopia, and Eritrea.

The investigated localities in the Eastern Desert have many species in common, especially when they are connected by the same wadi system. In Khesm Umm Kabu and Qariya Mustafa ʻAmr Gama, which are located about 115 km apart, mutual species are rare, namely, *Tamarix aphylla*, *Salvadora persica*, and *Trichodesma africanum*. The number of unique species for a particular site is relatively small. Examples are *Ifloga spicata* and *Rumex simpliciflorus* near Khesm Umm Kabu in the upstream part of Wadi Gimal. Obviously, both species were also found in the delta of this wadi and this shows that the dispersal within a specific wadi is not problematic.

Seed Dispersal: The high percentage of species that is present in more than one locality seems to indicate that seed dispersal, which is mainly dependent on wind and animals, is quite effective. Additionally, strong water currents after heavy rainfall transport a lot of sediment including the existing seed bank. Dispersal by the agency of water is, however, always restricted to the specific catchment area of a wadi system. Moreover, seeds are transported in either the direction of the Nile Valley or the Red Sea coast. The effectiveness of this kind of dispersal can be observed, for example, in drift litter along the Red Sea coast. Fruits of *Zilla spinosa*, *Balanites aegyptiaca*, and *Neurada procumbens*, for example, were frequently found in such concentrated organic debris.

Due to wind and animals, seeds succeed in reaching new wadi systems. Probably, the flat coastal plain plays an important role in this respect as seeds that arrive on this coastal strip can easily be transported in a northerly or southerly direction, depending on the prevailing wind direction. Wadi branches in the coastal plain proper constitute no serious obstacles in this respect. I once witnessed a huge *Zilla spinosa* of almost 1.5 m in diameter rolling over the coastal plain. The wind was strong enough to lift this plant over a steep slope of a wadi branch of about 3 m high. The mountain slopes, however, constitute insurmountable barriers, resulting in large concentrations of tumbleweeds on specific spots (Figure 2.13).

Dispersal of seeds by means of tumbleweeds, which lose their seeds during rolling, is an effective method in arid and semi-arid environments. Due to the scarcity of water, no closed vegetation is developed, and most plants can reach their optimal shape. This enables plants such as *Zilla spinosa* to develop into a spherical shape. The root of this species is twisted alternately to the left and right and weakens at the ground level after seeds are ripe. As a result, the plant is easily uprooted and becomes a tumbleweed.

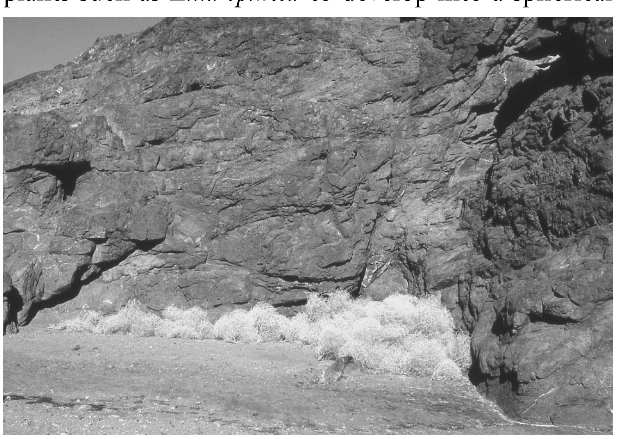


Figure 2.13. Stuck tumbleweeds of *Zilla spinosa* (January 1995). See Color Plates section, page 211.

Not only spherical-shaped plants behave as tumbleweeds. For example, the procumbent *Aizoon canariense* also is uprooted and becomes a tumbleweed, even with part of the root still attached. The small seeds can easily escape from the cracks in the capsules. Finally, the whole plant becomes disintegrated. A special case in this respect seems to be *Aristida funiculata*, which might be described as "tumbleseeds." Unlike the other two Egyptian species of this genus, namely, *A. adscensionis* and *A. mutabilis*, both column and awns of *A. funiculata* are long and stiff. The total length of a spikelet is almost 8 cm. It has been observed several times that seeds form a cluster in such a way that the awns are interwoven and the seeds are projected on the outside of the clump. Another advantage of this species in this respect is that the articulation point is just below the base of the column. Due to this position, the shape of the clump of seeds is not affected when seeds break off during tumbling. Two such seed tumbles were found entangled in *Convolvulus hystrix*, showing that only part of the seeds were lost during their probably short trip.

Dispersal by animals is possible by external carriage and by secretion via the guts. Spiny fruits, such as those of *Arnebia hispidissima*, or sticky ones, such as those of *Boerhavia repens*, are primarily transported via the outside of animals. The seeds of *Acacia tortilis* may serve as an example of the second mode of dispersal. Both unripe and ripe fruits of *A. tortilis* are partly found beneath the foliage, partly covered by sand. Such seeds need a secondary dispersal agent to find a safe site to germinate. More effective is the dispersal by camels internally. Camels have no problems with the long, stiff spines and are able to browse from the branches (Figure 2.14). Whereas twigs, leaves, and fruits are

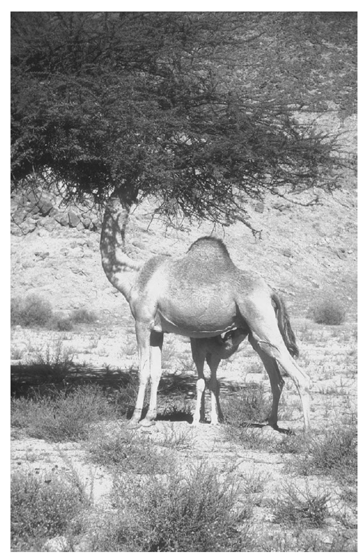


Figure 2.14. Nursing camel browsing from *Acacia tortilis* in Wadi Umm Athl (February 1998). See Color Plates section, page 211.

Figure 2.15. Seedlings of *Acacia tortilis* germinated in camel dung covered with sand, Wadi Shenshef (January 1997). See Color Plates section, page 212.

Figure 2.16. Similar seedlings as in Figure 2.15, but camel dung now exposed, Wadi Shenshef (January 1997). See Color Plates section, page 212.

digested, the extremely hard seeds are excreted with the dung. Frequently, seedlings can be observed that germinate from inside camel dung (Figures 2.15 and 2.16). Owing to the wind, dung particles are quickly covered with sand, which in turn improves the growing conditions for the young tree. The number of seedlings that develop in a dung particle may vary considerably and will depend on the number of fruits excreted in a dung particle, as well as the number of mature, unaffected seeds in those fruits. Failed fertilization, abortion of seeds, and the attack of insects all contribute in reducing the number of viable seeds in a fruit (Figure 2.17). A concentration of 17 seedlings of *A. tortilis* proved to have originated from camel dung containing 18 seeds and covered by 10 cm of sand. Only when such camel dung is dropped at the edge of a wadi can one of the seedlings become a full-grown tree because strong water currents periodically destroy the vegetation in the central part of a wadi. For the same reason, these trees have a better chance of surviving along convex banks. One of the few shrubs that has frequently been observed in the central part of the wadi and is capable of surviving flooding is *Chrozophora tinctoria*, though its appearance is little more than that of a heavily damaged dwarf specimen.

Plants Adapted to Saline Conditions: A variety of trees and shrubs were found in the vicinity of the Roman installations: *Lycium shawii*, *Tamarix nilotica*, *T. aphylla*, *Suaeda monoica*, *Acacia tortilis*, *Salvadora persica*, *Balanites aegyptiaca*, *Calotropis procera*, and *Leptadenia pyrotechnica*. The most common tree proved to be *A. tortilis*, found along the edges of many wadis, both in the mountains and in the coastal plain. Also around Berenike, this tree

Figure 2.17. Twisted fruit of *Acacia tortilis* with some exit holes of insects. See Color Plates section, page 213.

is frequently present in the small wadi branches. More substantial populations of acacias have been observed in the coastal plain south of Berenike.

Despite its predominance, *Acacia tortilis* may be absent locally, such as in Wadi Gimal near Khesm Umm Kabu. Here, *Balanites aegyptiaca* and *Calotropis procera* are the predominating trees. Ababda nomads confirmed that Wadi Gimal, in particular, was characterized by *B. aegyptiaca*. In wadi branches dissecting the coastal plain, this tree is a rather strange phenomenon. This is not the case with *C. procera*, which can frequently be observed in the coastal plain, especially south of Berenike.

Tamarix nilotica and *Suaeda monoica* are halophytes and occur in the near vicinity of Berenike. On the higher levels of the salt marsh north of Berenike, several large hillocks of *T. nilotica* are currently present. When several rows of such hillocks are present, the population functions as a natural barrier against penetrating windblown sand. In the salt marsh south of Berenike, *T. nilotica* is intermixed with *S. monoica*. Here, *T. nilotica* does not form hillocks and is present on the more-elevated levels, whereas *S. monoica* is concentrated in the lower levels of the salt marsh, together with the halophytic *Halopeplis perfoliata*. On both sides of the Red Sea coast, *S. monoica* gradually replaces the halophyte *Nitraria retusa* in a southerly direction. Halfway between Wadi Gimal and Ras Banas there is a transitional zone, whereas south of Ras Banas only populations of *S. monoica* are present (Zahran and Willis 1992:136). The *Suaeda* population south of Berenike dropped most of its leaves after the heavy showers in November 1996. It probably suffered from the temporary desalinization of the groundwater. The distribution of the salt-requiring *S. monoica* is confined to locations with a specific chloride content (0.1–3.5 percent) and the water table (1.3–3.9 m below soil level). Laboratory experiments with artificial solutions containing only traces of sodium resulted in the yellowing of leaves of *S. monoica*, as well as curling and wilting, whereas field observations revealed that seasonal fluctuations have apparent effects on the distribution of this species (Waisel and Ovadia 1972).

Other salt-tolerant species present in the salt marsh around Berenike are *Cyperus conglomeratus*, *Zygophyllum album*, and *Z. simplex* and an herbaceous *Suaeda* sp. *Zygophyllum album* has a wide ecological range with respect to the salt content of the soil, and *Z. simplex* is even less demanding as it also grows in the mountains, far away from the influence of the sea. The ecological preference of *Z. coccineum*, which is also rather common in the surroundings of Berenike, is less clear. The species has a large tolerance with respect to salinity and it is said to be indicative of limestone (Zahran and Willis 1992:192). In fact, both environmental conditions are present around Berenike, and each condition could explain its presence in itself. With respect to the salt content, possibly two ecotypes exist: a salt-tolerant and a nonsalt-tolerant one. It could be that the specimens growing in the vicinity of Berenike concern the salt-tolerant ecotype. Obviously, these specimens are full sized, whereas those found in the vicinity of the Roman settlements in the Red Sea mountains were less frequent and also of a reduced size. The population of *Z. coccineum* near Hitan Rayan might be of the nonsalt-tolerant type as this inland area does not witness the maritime influence of the Red Sea. Furthermore, the area is of Precambrian crystalline (igneous and metamorphic) rocks and no limestone is present in Hitan Rayan or any of the surrounding hills (personal communication from J. Harrell).

Salt-tolerant plant species are present near the shoreline on the supratidal flat (*sabkha*), which consists of sandy, silty, and clay-like sediments (Harrell 1996:114–124) and on a broad strip of the coastal plain adjacent to the *sabkha*. The latter is characterized by a salty horizon near the surface, which is quite difficult to penetrate.

Mangrove vegetation is absent in the near vicinity of Berenike; its nearest population is located several kilometers north of Ras Banas. In Egypt this kind of vegetation mainly consists of *Avicennia marina*. South of lat 23° N it is also mixed with *Rhizophora mucronata* (Zahran 1965:8). Mangrove is present in calm, shallow water and on a flat, muddy soil, permanently flooded or during high tides. Both protected lagoons and bays are suitable habitats. The northeast boundary of the present distribution is marked by some scattered specimens about 20 km north of Hurghada and becomes quite dense south of lat 25° N. At some localities this species also grows on sandy hills along the coast.

CHAPTER 3

LIVING IN THE DESERT

"Ausser den gefangenen Fischen, welche sie, um Trinkwasser und Salz zu sparen mit abscheulichem Meerwasser kochten oder die sie auf Kohlen brieten, lebten meine Leute fast ausschliesslich von einer Art Brot, welches Abends und Morgens auf dem heissen Boden unter der Feuerstelle gebacken wurde. Von diesem groben, aus einer verbrannten Kruste und kleisterartigem Inhalte bestehenden Gebäck konnte ihr kräftiger Verdauungsapparat unglaubliche Quantitäten verarbeiten." [G. Schweinfurth (1865a: 147]

NOMADIC LIFE

Different Tribes in the Eastern Desert

Living in a desert environment essentially leads to its exploitation. Due to the limited carrying capacity of the environment, which is basically determined by the availability of water, people mostly live in relatively small groups that have adopted a nomadic life style. As a consequence, the material culture is strongly related to the bare essentials of life. The current arid climate of Egypt was established during the early second part of the Holocene and has had an intrinsic influence on the desert culture. Dwellers who lived in the Eastern Desert at the time of the Roman Conquest must have faced conditions comparable to those of the present time. Therefore, a study of the current mode of nomadic living is of great value, all the more because the traditional way of nomadic living is likely to alter greatly and will disappear for the most part within the coming decennia.

This change is being accelerated by the increasing contact with the outside world, mainly due to the international transport between Egypt and Sudan, rising tourism, and the employment of nomads in the Nile Valley. But also our presence during the excavation seasons has had its own influence on the traditional material culture. Leather objects, for example, are being replaced more and more by imported items made from synthetic materials. Fashion also is playing a role. Leather sandals, for example, are now being offered for sale as a curiosity, and plastic or rubber sandals (made from old car tires) are worn instead. The author experienced that even nomads in such remote areas are fashion conscious when he asked one of them (Mohammed Auwdid) what he would like to have as a present from Holland the following year. The matter was not given much thought and he answered promptly: Nike shoes and an Arabic-English grammar book for his oldest son. I copied the contour of his foot in my notebook and was able to give him the desired shoes the next excavation season.

The Eastern Desert is for the main part occupied by two different nomad tribes. The Ma'aza bedouins have their territory north of the road between Quseir with Qift and the Ababda nomads south of this road. The Ababda nomads share the southern border of their territory with the Bisharin nomads, who live in present-day Sudan (Figure 3.1). The Ma'aza bedouins have their origins in the Arabian Peninsula. They probably arrived in Egypt in the 1700s and had succeeded in establishing

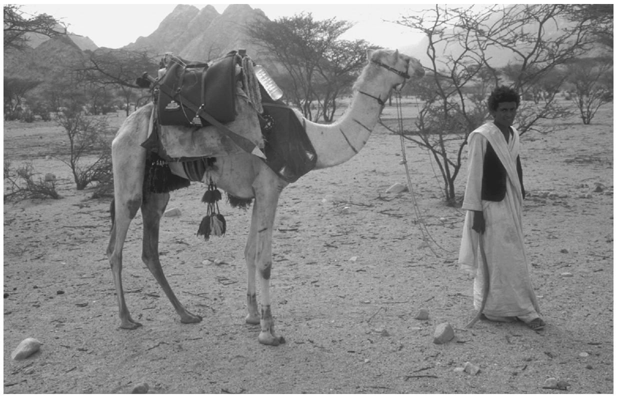


Figure 3.1. Bisharin nomad with camel in Gebel Elba (February 1999). See Color Plates section, page 213.

Figure 3.2. Imitation of a Roman coin used as a pendant by Bisharin women (diameter: 43 mm). See Color Plates section, page 214.

their current territory by about 1805 at the expense of the Ababda territory (Hobbs 1990:12-14). The Arabic origin of the Ma'aza bedouins is still expressed, for example, in the elaborated masked veils worn by the women.

The Ababda and Bisharin nomads belong, among other tribes, to the Beja nomads. The name *Beja* is probably a corruption of the Arabic word *badiya*, which means "plain" or "desert." Both nomadic tribes are closely related through marriage. The Blemmyes are considered the ancestors of the present-day Beja nomads (Braukämper 1992:44). They were a powerful group in the southern part of the Eastern Desert from the third century to the first part of the sixth century AD, and were probably also part of the native groups that once lived in Berenike (Sidebotham 1998:184).

A conspicuous link between modern Bisharin nomads and their presumed ancestors who were engaged in late Roman trade is visible in ornaments still in use among the Bisharin. Such ornaments have been collected by the author and depict three different impressions of Roman coins. The presence of a laurel wreath as well as the stylized shoulder pad suggest that these imitations are based on Roman coins dating back to 270–350 AD (Figure 3.2). Some coins of Constantine bear resemblance to the copper ornaments, but none of them is a perfect match. Similar inaccurate ornaments from Sudan, described by Schienerl (1992:148–157), are identified as stylized or even rather abstract reproductions of French coins and depict Hercules and two women representing liberty, equality, and fraternity. Sudanese silversmiths most probably copied this so-called "Hercules-group" from coins dating back to the Third Republic. These coins were introduced into Sudan in large numbers during the last decade of the nineteenth century.

Forced by governmental policy, most Ababda nomads have given up their nomadic way of life and have become settled. The houses vary from wooden shacks to concrete buildings, with the choice of building material largely opportunistic. Traditionally, their houses consisted of wooden frames with mats, carpets, and skins as coverage (Figure 3.3). Today, modern materials such as corrugated iron and softboard have become increasingly popular, too. Near the sea, where sufficient driftwood is available, wooden houses are also built. In the wooded Gebel Elba area, houses are predominantly made from branches interwoven to form solid walls. Recently, concrete buildings are being offered by the government as accommodation, as is the case in Arab Saleh nearby Berenike. Separate enclosures are made to protect domestic animals from wild dogs during the night.

The nomadic way of life of the Ababda nomads has, however, not completely been abandoned because the unpredictable and sporadic rain still has a large impact on the fluctuating carrying capacity of the desert

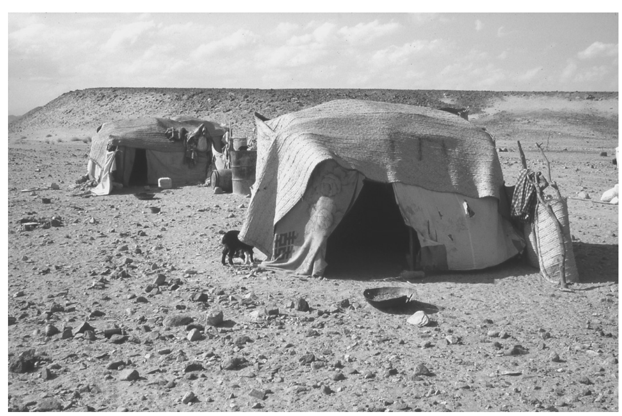


Figure 3.3. Houses predominantly made from mats in a wadi south of Berenike (March 1998). See Color Plates section, page 214.

environment. In dry years, sheep and goats that need frequent watering and grazing may be transported as far as the Gebel Elba area, where regular rainfall ensures rich vegetation every year.

Food and Water

The basic necessities of desert life concern food, water, and fuel. Foodstuffs that make up the staple diet of the present-day Ababda nomads, such as flour, lentils, dried leaves of mulukhiyah or Malta (also spelled Nalta) jute (*Corchorus olitorius*), sugar, tea, and coffee are all available in shops and markets. Mulukhiyah is a member of the lime family (Tiliaceae) and native of tropical Africa and Asia. Together with jute (*C. capsularis*), Mulukhiyah was cultivated for its fiber in India, although its quality is inferior to that of jute (Townsend and Guest 1980:219). In Egypt, mulukhiyah has a long tradition as a spinach-like vegetable and is still cultivated there on a large scale. From about 8 to 10 weeks after sowing, the first upper leaves of this vegetable can be harvested. After drying, leaves are chopped and added to a broth of meat. The mucilaginous soup is cooled down and spiced with fried garlic (*Allium sativum*) and coriander (*Coriandrum sativum*). Soups made of mulukhiyah and lentils are served with bread and are among the cheapest of staple foods, which is eaten a few times a week. Recently, mulukhiyah has also become popular in Yemen (Wood 1997:102). The poisonous seeds of mulukhiyah are erroneously recorded from the Roman site Karanis (Kôm Aushim; Fayum) by Darby et al. (1977:671–672). It is also said that classical authors such as Theophrastus (*EIP* 4.8.14) and Pliny (*NH* 21.106.183) make reference to this plant, but only Theophrastus' description is convincing.

Two kinds of unleavened bread are made from a mixture of flour, salt, and water. Traditionally, wheat kernels were grinded into flour with the aid of small stone rotary querns. Although such querns are still in use, nomads increasingly buy large quantities of ready-milled flour.

One type of bread is *fatiira*, a round thin sheet of bread baked on a round, iron baking sheet, such as the bottom of an oil drum. *Gurs*, on the other hand, is thicker and baked in hot sand under a charcoal fire. Making this bread requires great skill. The crust should be free of sand to prevent damage to the teeth, which already suffer from the excessive use of sugar. To minimize the inclusion of sand particles, as well as to optimize brushing off the remaining sand, much tension is exerted on the dough, resulting in a smooth flat surface. To make sure that the bread is baked thoroughly, the sand should be properly heated. The baking process in the sand takes about half an hour, and starts with heating the sand with a charcoal fire. The temperature of the sand depends on the kind of charcoal that is used. As soon as the sand reaches the right temperature, the trick is to brush the charcoal carefully aside with a stick so that it does not become covered with sand. Next, the sand itself is pushed aside so that the bread can be put into the hot sand. The bread is covered up again, first with sand and next with the charcoal. After about fifteen minutes, the procedure is repeated in order to turn the bread. If the charcoal consists of solid pieces and is handled with care, it is possible to finish the bread with the same charcoal coals. Charcoal made from twisted acacia (*Acacia tortilis*) fulfills this condition, and is therefore highly suitable, whereas that from sugar date (*Balanites aegyptiaca*), for example, appears to be too soft.

Coffee is made in a traditional way. The equipment usually consists of a coffeepot, a set of three small cups, a tin for roasting coffee, and a mortar and pestle (Figure 3.4). Currently used earthenware coffeepots are imported from Sudan, and the glazed cups without handle are made in China. To facilitate the transportation of this fragile crockery, the coffeepot and cups are stored in special baskets (*kabutah*). Traditionally, these containers are covered by leather. New models are embroidered with plastic, which is mostly woven in traditional triangular patterns. Mortars are preferably made from thick roots of twisted acacia (*A. tortilis*), and old specimens are often repaired with pieces of metal. One mortar shown to us by an Ababda nomad was made from teakwood and illustrates the opportunistic use of high-quality drift material. Other domestic goods may

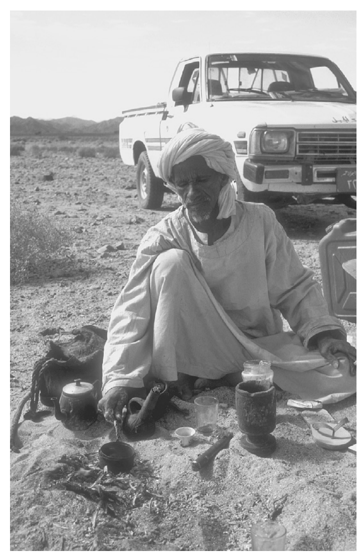


Figure 3.4. Ababda nomad roasting coffee beans. Also visible are, from left to right, skin container, teapot, roasting pan made from a pineapple tin, coffeepot, coffee cup, tea glass, pestle, mortar, sugar and water container (January 1996). See Color Plates section, page 215.

consist of coiled fans (*hababah*) and mats for the coffeepots. Together with coffee beans, sugar, and ginger, this equipment is stored in a skin bag. Coffeepots are comparatively expensive, and a group of Ababda nomads that were employed for the excavation season used a remodeled hair-spray siphon instead. For the same reason, pestles are mostly recycled solid bars, whereas roasting equipment is mostly made from tins with a handle of twisted metal. Such cans used for roasting are either self-made or bought in markets.

The coffee ceremony starts with making a charcoal fire and roasting a handful of coffee beans. Once roasted, the coffee beans are pounded in a mortar. Ginger is used as a coffee flavor enhancer. Some small, dried pieces are pounded and poured into the coffeepot together with the pounded coffee beans and water. The coffeepot is then heated on the charcoal fire. A ball of palm fibers, currently replaced by plastic fibers or something of that sort, is used as a sieve in the gap of the spout to prevent coffee grounds from coming out. Coffee is served with much sugar and it is the custom to drink an uneven number of cups of coffee. Weir (1990:25) mentions the use of cardamom seeds (*Elettaria cardamomum* [L.] Maton) as an additive in Palaestina. Coffee can be made inside a tent or house by putting charcoal on a metal plate or dish. In this way the source of heat can easily be removed.

The Ababda nomads who live in small settlements around Berenike, such as Arab Saleh and Manazig, can buy regular food products in a local shop, but rely on the market at Shelateen for a broader selection. This market offers common food and spices, such as cardamon (*Elettaria cardamomum*), rosary pea (*Abrus precatorius*), white lupin (*Lupinus albus*), *Haplophyllum tuberculatum*, clove (*Syzygium aromaticum*), fenugreek (*Trigonella foenum-graecum*), coriander (*Coriandrum sativum*), mahaleb cherry (*Prunus mahaleb*), cumin (*Cuminum cyminum*), lentil (*Lens culinaris*), sorghum (*Sorghum bicolor*), anise (*Pimpinella anisum*), cress (*Lepidium sativum*), black pepper (*Piper nigrum*), and black cumin (*Nigella sativa*). The more-luxurious spices are only available in specialized shops in big cities. Shops with a good assortment of spices are still present in the bazaar of Khan al-Khalili in Cairo and can be rated among the best ones of the Near East (Figure 3.5).

Due to the vicinity of the Red Sea, seafood is also available to the Ababda nomads. Today, fishing is even practiced on a commercial basis in Manazig. Shellfish are also consumed, as is evidenced by concentrations of shells in the desert. Gazelles are frequently seen in the

Figure 3.5. Drug store in Khan al-Khalili (Cairo), carrying a broad assortment. Recently, this shop has been modernized, resulting in a reduction of stock (December 1996). See Color Plates section, page 215.

Eastern Desert, but it is unknown to what extent they are still hunted. Traditional traps for catching gazelles consist of a ring in which spines of date palm leaves (*Phoenix dactylifera*) are tightened so that their pointed ends are in the center. The trap is put over a hole in the vicinity of water or food and covered with sand. The ring is connected to a pole about 75 cm long by a rope. When an animal treads on it, it is unable to free itself and in trying to do so its legs become damaged by the fastened pole, making it an easy catch. The Ababda could not show me such traps, but they are still available and in use by the Bisharin nomads.

Permanent water is found only in scattered wells. Additionally, water may be obtained from shadowed rock shelters in periods following heavy rainfall. Some of these shelters may provide water for considerable periods. The Derfaui well, located twelve hours walk southeast of Quseir, for example, will not run dry even after five years without rainfall (Schweinfurth, 1865b: 271–272). Nowadays, two wells in the vicinity of Berenike are in use. One is located in the salt marsh south of Berenike and consists of a large trench. Its water is clear but tastes salty. The other well is located 1 km west of Berenike. The water table is almost 4 m below the surface and is potable despite its turbidity. The nomads give this water to their livestock. The water they use themselves is sourced from a more remote well in the mountains.

Food and water are also used as grave offerings, examples of which are sugar, salt, and tomato purée (Figure 3. 6). But also packets of cigarettes, wrapped in pieces of cloth, are regularly seen. Isolated graves still have stone pans that can be filled with water to put corvines in the right mood. Recently, such pans have become rare, as they are collected for putting them on the market.

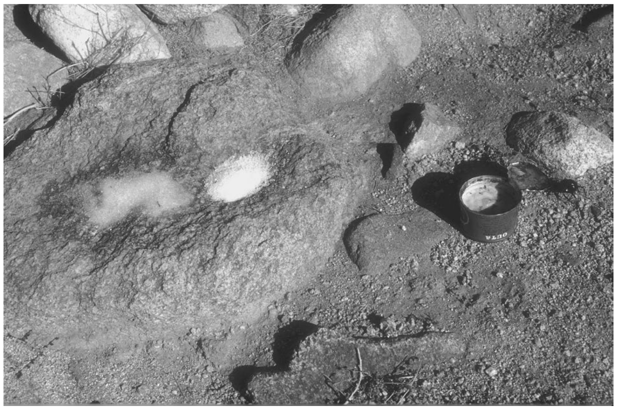


Figure 3.6. Offering of salt, sugar, and tomato purée at an Ababda grave in Wadi Umm Athl (February 1998). See Color Plates section, page 216.

Fuel

The availability of fuel is indispensable for preparing food and making coffee or tea, and for warmth during cold winter nights. Basically, both wood and dung come into consideration as sources of fuel. The production of dung cakes, a mixture of dung and threshing remains, is still practiced in rural areas of the Near East. According to the Ma'aza bedouins, who live in the northern part of the Eastern Desert, dung of ruminants such as camels is clean and can be used as fuel, if no wood is available (Hobbs 1990:90). The use of dung by the Ababda nomads has not been observed.

The nomadic way of life is basically determined by the sparseness of the desert vegetation. But as nomads become increasingly settled, the availability of fuel becomes a critical factor. In order to preserve the present populations of trees, Ababda nomads only use dead wood for making charcoal. The author once experienced that a large living branch from an acacia tree, painfully cut off by a helpful inspector of the Supreme Council of Antiquities, was refused by our Ababda guide for preparing the meal. As long as the tradition of using dead wood is maintained, the linking of the amount of dead wood to the population size is of crucial importance and indeed comparable to the degree to which the carrying capacity of the sparse vegetation set bounds to the size of the animal flocks. An alternative solution is the import of fuel or the use of living wood. The latter choice will, inevitably, threaten the current vegetation. Hobbs (1990:27) also states some occasions in which Ababda nomads charcoaled trees outside their own territory, a practice for which they are still blamed by their neighbors.

Gathering wood occupies an important place in daily life. During surveys, nomads take their time about collecting suitable pieces of plants. At the very start of a two-week camp at Wadi Shenshef, the nomads almost immediately started with collecting considerable amounts of firewood. This investment proved to be quite deliberate as they could start cooking soon after they had stopped working.

To make a fire, a quick-burning annual and some branches of a woody plant species are needed. The annual plant is used as a starter. Good starters are dead specimens of *Zilla spinosa* and *Zygophyllum coccineum*. The former one is predominantly used in the mountainous area, where it is widely distributed in the wadis, whereas the latter is a good alternative in the flat coastal area. The bushy annual is trampled down, covered by wood, and set on fire. Before matches became available, the fire was started with the help of a piece of flint and a steel fire lighter. These typically shaped fire lighters are widespread, both geographically and historically. Highly inflammable material was used for catching the sparks, such as the dried hair tufts from *Leptadenia pyrotechnica*, which probably owes its specific epithet to this use (Mandaville 1990:238). The blazing, short fire is sufficient for the branches to catch alight. Only when the wood has completely turned into charcoal is the heat used for cooking and making coffee or tea. At first sight this seems a waste of energy, all the more because of the calorific inefficiency of conversion from wood (Horne 1994:49), but a charcoal fire is easy to handle and keeps producing heat for many hours.

Trees may become endangered if their exploitation is not balanced with their natural regeneration. This is not only true for a popular species such as twisted acacia (*Acacia tortilis*), but also for soft-wooded species such as *Avicennia marina*, *Tamarix aphylla*, and *T. nilotica* (Figure 3. 7). Zahran and Willis (1992:167) emphasize that the softness of both *Tamarix* trees eventually acts to their disadvantage. The trees had been easily gathered in former times,

Figure 3.7. Ababda collecting firewood in the vicinity of Berenike for making *gurs*. In his right hand he is carrying an ax and an aluminum abriq (January 1997). See Color Plates section, page 216.

resulting in an under representation in the present vegetation. The sparseness of *T. nilotica* in the southern part of the Red Sea coast is considered to be the result of overexploitation, its wood being used as a source of fuel for centuries. Nomads are aware of their potential overexploitation and special rules have been issued to establish at least a status quo (Hobbs 1990:106–107).

Animals

Most of the Ababda nomads still have a pastoral lifestyle by keeping domestic livestock, and most of their traditional material culture was, until recently, based on these animals. They have sheep, goats, camels (dromedaries), donkeys, and chickens. It is the job of women and girls to look after the animals. Domestic dogs are used for protecting sheep and goats, both during the daytime while herded by woman and children, and at night, even when the animals are stored in enclosures. That this is not effective when dogs are in heat may not be surprising.

Donkeys and camels are used as pack animals, but are replaced more and more by motor vehicles, of which mechanical Toyota pickup trucks manufactured in 1974 are very popular. Nevertheless, transport by camels remains necessary when the inner part of the Eastern Desert has to be reached, although camels are better adapted to sandy than stony environments.

Sheep are kept for their wool, and goats are suppliers of milk and hair. Women spin and weave wool and hair, that of camels the strongest and goat hair the weakest. Women carry out the weaving inside or immediately outside the house, and carpets are made on a ground loom.

Sheep and goats are slaughtered on special occasions and provide Ababdas with meat and skins. Skins, which are also available from camels and wild animals such as gazelles, are used for a variety of products, including building material for tents; leather articles for storage of food; clothes and luxury items; garments such as sandals, amulets, necklaces (*muqlar*); belts and sheaths for knives and swords; household goods such as pillows (*wasadah*); pan holders (*sha'alug*), and headrests (*muqrais*); and camel saddles and trappings such as decorated belts.

The shape of the leather bags is characteristic of their use. Skin sacks used for storing the food and the equipment for cooking and making coffee and those used for churning (*sa'an*) are normally made from complete skins of sheep or goat. Those for storing clothes and the like (*garab*) are made from camel skin and can be sealed with a lock and key. The fringes of these bags are decorated with printed designs and colored triangles, nowadays mostly made from plastic. Small leather bags (*gabiah*), used for keeping valuables, are mostly well decorated with beads and cowrie shells. Water scoops (*dalu*) are made from circular pieces of leather.

Wild Plants

The Ababda nomads depend to a great extent on the desert vegetation. This vegetation in turn is directly influenced by the availability of water and the grazing intensity. Because of the short growing season, the vegetation is especially vulnerable to overgrazing by herds of sheep and goats. These herds are allowed to graze in the wadis, but not on the mountain hills, as goats at high altitudes develop a deadly disease that is possibly caused by either a tickborne protozoan or trypanosome (Hobbs 1990:33).

Apart from this indirect type of protection, plants themselves have also developed responses to predation. The most striking feature in this respect is the presence of thorns. This kind of defense may be developed as soon as plants such as *Fagonia* spp., *Zilla spinosa*, and *Acacia tortilis* germinate. Nevertheless, camels in particular are capable of browsing such spiny plants, an adaptation that also makes it possible to graze and browse in periods when vegetation cover is minimal due to prolonged drought. *Fagonia* and *Z. spinosa* are late bloomers and adapted to more drought. They do not seem to take advantage of the availability of much water in spring as was experienced during the excavation season in 1997. The adaptability of *A. tortilis* to predation is illustrated by the hard seeds that leave the gastrointestinal tract without damage (Figure 2.16, p. 36). The same is probably also true for the extreme hard fruits of *Z. spinosa*. Other species, such as *Panicum turgidum* and *Cyperus conglomeratus*, have hard culms that protect these plants to some extent from grazing. Schweinfurth (1865a: 145) states that the former species is therefore only first choice for camels. Sheep and goats prefer more palatable grasses, such as *Dichanthium foveolatum* and *Cenchrus ciliaris*. *Cyperus conglomeratus* is also capable of sprouting from rhizomes.

Another defense mechanism against herbivory is the presence of repulsive metabolites in the plants' tissue. Some plants produce aromatic metabolites. According to Schweinfurth (1865a: 139), donkeys spurn aromatic species such as *Pulicaria undulata*. Other species are unpalatable because they taste bitter, sour, or salty. A good example is *Zygophyllum coccineum*, which has a bitter and salty taste and therefore remains untouched by all animals despite its high water content.

The contribution of wild plant species to the nomads' food supply is of limited value as only a few species are edible and the vegetation is scarce most years. Young leaves from *Rumex vesicarius* do not taste sour and are eaten raw as a salad. Bebawi and Neugebohrn (1991:124) state that leaves of *Chenopodium murale* are eaten in Sudan. Also fruits of *Glossonema boveanum* are eaten in an immature stage of development. By then, the seeds are still undeveloped and the spines on the fruits are small and soft. The fruits have a nice taste that is similar to that of a nut. According to Drar (1936:9), it is just the contents of the ripe fruits that are eaten by the Ababda nomads.

Several plants are collected for making tea. Osborne (1968:165) states that Ababda nomads make tea from the dried leaves of the fragrant *Pulicaria undulata*. He also informs us that the nomads use the dried leaves of *Senna italica* to make a purgative tea. A tea made from *Anastatica hierochuntica* is recommended to ease childbirth (Mandaville 1990:144). According to Osborne (1968:175), seeds of *Aizoon canariense* are cooked into a gruel, as an Ababda nomad who collected the plants told him. Judging by the very small size of the seeds, this practice however seems dubious. From Saudi Arabia it is recorded that bedouin children sometimes eat young fruits of *Neurada procumbens* and that, in former times, seeds of *Panicum turgidum* were collected as famine food (Mandaville 1990:352).

In addition to edible plants, the vegetation of the Eastern Desert also offers some plants with a miscellaneous use. The woolly flowers of *Aerva javanica* were formerly used by nomads from the Eastern Desert and Saudi Arabia for stuffing pillows and donkey saddles (Drar 1936:5; Zahran and Willis 1992:188; Figure 3.8). The relatively large plants of *A. javanica* bear densely flowered spikes that are easily gathered in reasonable quantities. Also after seed ripening, when flowers fall to the ground and form large concentrations under the lee of the plants, they are easy to collect. Leather pillows from the Ababda nomads living around Berenike, which could be checked by the author, only contained rag and indicate that this kind of exploitation is diminishing. Also the floss from the seeds of *Calotropis procera*, which is easily gathered from the large fruits, is sometimes used as stuffing material (Bebawi and Neugebohrn 1991:86).

Figure 3.8. Woolly bracts and perianth of *Aerva javanica*.

The roots of *A. javanica* can be used as a toothbrush. This is also true for the midribs of the date palm (*Phoenix dactylifera*) leaves, which are cut into small sections for this purpose. The branches of the toothbrush bush (*Salvadora persica* L.), from which large populations are present in Wadi Gimal and Wadi Umm Athl, are commonly used for this purpose. Ababda nomads still harvest suitable branches from these plants (Figure 3.9). Branches of the toothbrush plant are cut into pieces about 15 cm long and made into a brush at one end. *Salvadora persica* often remain bushy as a result of this exploitation. Some antispasmodic properties of this plant have been proven, for which reason extracts are also recommended for certain diseases (Zahran and Willis 1992:259). In 1988, a commercial toothpaste containing *Salvadora* was even put on the market in Saudi Arabia (Mandaville 1990:198). Branches of the plant are still offered for sale in markets in the Middle East. Another plant that is still used for oral hygiene in this area, and also still available in markets, is toothpick ammi (*Ammi visage* [L.] Lam.). Complete umbels are collected from this plant. The rays thicken after flowering and can be used as toothpicks. In Egypt, this plant has been recorded from the Nile Valley and the Mediterranean region but has become an endangered species in this country by now.

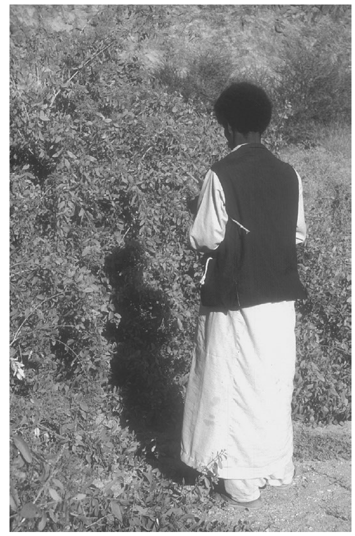


Figure 3.9. Bushy population of *Salvadora persica* in the downstream part of Wadi Umm Athl, exploited by an Ababda for its toothbrush wood (February 1998). See Color Plates section, page 217.

Potential dye plants that grow in the immediate surroundings of Berenike are *Arnebia hispidissima*, *Chrozophora tinctoria*, and *Indigofera articulata*. The thickened root of *A. hispidissima* is a source of yellow dye. Crushed leaves of *C. tinctoria* can be used to give the skin a purple tone. Fermented leaves of indigo species can be used as a source of blue dye. When synthetic indigo became available in 1897, the production of natural indigo dropped dramatically (Lemmens and Wessel-Riemens 1992:81–82). According to Drar (1936:75), by the beginning of the twentieth century, the extensive cultivation of indigo was confined to the Nile Valley and the Dakhla oasis. Local Ababda nomads do not use either of these plants today.

Polycarpaea repens and *Citrullus colocynthis* are used for treating wounds, in particular those of camels. Leaves from *P. repens* are either crushed on the skin or first made into ash (Mandaville 1990:67). A more-detailed description of the processing of tar from the seeds of *C. colocynthis* follows in the "Local Food Production" section. *Echium rauwolfii* is widely valued in Yemen for its medical properties, where it is used as a diuretic, tranquilizer, and aphrodisiac (Wood 1997:242).

Local Food Production

For the interpretation of the subfossil record of cultivated plants from Berenike and Shenshef, it is important to explore the present-day practices of local food production in the Eastern Desert. Water availability and labor can be considered as the main limiting factors. Nevertheless, it may be assumed that the inhabitants of Berenike and Shenshef may also have practiced the small-scale examples that can be encountered today.

Although the part of Egypt that is suitable for agricultural production is relatively small, being confined to the Nile Valley, the Nile Delta, and the oases in the Western Desert, it still is capable of producing very high yields. Before the construction of the Aswan High Dam, the Nile Valley and the Delta owed their fertility to the yearly flooding of the Nile. Because sufficient rainfall is only available in the Mediterranean coastal area, irrigation is necessary elsewhere.

But even in far less suitable environments, such as the Eastern Desert, agricultural practices can be observed almost everywhere where people have settled. This is not only true for cities such as Quseir, but also for small villages of settled Ababdas and restaurants along desert roads. In order of importance, we can distinguish kitchen gardens, cultivated trees, and fields.

Kitchen Gardens

Both permanent and semipermanent settlements in the Eastern Desert are characterized by the presence of small kitchen gardens. The cultivation of vegetables and herbs with a short life cycle enables their cultivation even in temporarily occupied settlements. In most instances the gardens are private domains and of limited size. Both the presence of the kitchen gardens and their size are mainly determined by the amount of water that is available. Kitchen gardens that were seen in the Eastern Desert have a size of about 4 to 20 m^2.

A necessary condition for the cultivation of crop plants in these kitchen gardens is the availability of water and minerals. Due to their fixed location, manuring might be necessary if gardens are used intensively. According to the sheikh of Arab Saleh, one of the few owners of a kitchen garden in this settlement, their gardens are not fertilized. He referred to the former situation in the Nile Valley (before the construction of the Aswan High Dam), where only additional camel dung was used as a natural fertilizer. Applying this traditional and natural manure, vegetables were produced with a good taste. Nowadays artificial manure has to be brought onto the land as the Nile flooding is blocked. Much organic waste is present in the water used for irrigation and on the fields proper, which in their turn affects people's health.

Despite their relatively small size, kitchen gardens produce quite a variety of crops. Although the productivity is limited, the yield may be self-supporting if the family is not too big. If water is available throughout the year, kitchen gardens can produce several yields a year.

Kitchen plants are mostly grown in a protected area near the house, although occasionally it was also seen that plants such as karkadeih (*Hibiscus sabdariffa*) and basil (*Ocimum basilicum*) were cultivated in a flower box. The gardens are surrounded by walls or fences to prevent the browsing of domestic animals such as sheep and goats, which are a serious threat to a good harvest. Fences are constructed from spiny branches, such as those from twisted acacia (*Acacia tortilis*), wire netting, wood, or sheet iron. It is conceivable that in Roman times spiny branches were used especially for this purpose. When fenced off, kitchen gardens may be completely hidden from view. I once stayed for a couple of days at the accommodation of the Geological Survey in Shelateen and only discovered the small kitchen garden producing faba (fava) beans (*Vicia faba*) by accident after two days.

Figure 3.10. Unfenced kitchen garden with a scarecrow near a temporary settlement, some 30 km north of Berenike (March 1995). See Color Plates section, page 217.

In a temporary settlement of workmen from an asphalt company, some 30 km north of Berenike, a larger kitchen garden was observed, which was a communal property. In this case, the kitchen garden was unfenced because no domestic animals were present. Only a scarecrow was erected for protection (Figure 3.10).

Most garden plants are characterized by their edibility. The following species have been recorded in kitchen gardens in the Eastern Desert: basil (*Ocimum basilicum*), sunflower (*Helianthus annuus*), caper bush (*Capparis spinosa*), possibly cumin (cf. *Cuminum cyminum*), lavender (*Lavandula* sp.), fennel (*Foeniculum vulgare*), Johnson grass (*Sorghum* cf. *halepense*, named by the owner: djarraaoo, used as fodder for donkey and camel), faba bean (*Vicia faba*), morning glories (*Ipomoea* sp.), karkadeih (*Hibiscus sabdariffa*), cress (*Lepidium sativum*), coriander (*Coriandrum sativum*), tomato (*Lycopersicon lycopersicum*), potato (*Solanum tuberosum*), onions (*Allium* sp.), garden rocket (*Eruca vesicaria*), watermelon (*Citrullus lanatus*), cucumber (*Cucumis sativus*), and courgette (*Cucurbita pepo*). Hobbs (1990:45–46) also mentions Malta jute (*Corchorus olitorius*), snake melon (*Cucumis melo* Flexuosus Group), okra (*Abelmoschus esculentus*), chickpea (*Cicer arietinum*), white lupin (*Lupinus albus*), lentil (*Lens culinaris*), and tobacco (*Nicotiana tabacum*). The cultivation of tobacco is forbidden in Egypt today as it is related with the period in which Nasser was in power, during which close relations with the former Soviet Union were maintained.

Vegetables and herbs are sown in early spring to profit from the winter rains and to avoid high temperatures during the growing season. But additional watering is always necessary. This might be done with a watering can or, more advanced, with the aid of small gutters that transect the garden and are regularly filled with water. Wastewater may be used for this purpose, but special water is also bought. That the presence of kitchen gardens is directly determined by the availability of water is clearly illustrated in Quseir, where kitchen gardens are in abundance and owners are assured of a steady supply of cheap water. This water originates from the Red Sea and is desalinated in a special factory. The content of a whole oil drum costs less than one Egyptian pound and is filled up every week. This amount of water is sufficient for a kitchen garden of approximately 12 to 15 m^2. In Arab Saleh, an Ababda village some 15 km northwest of Berenike, water has become a scarce item and has led to the reduction of kitchen gardens in this area. Contrary to Quseir, the water used for human consumption and for irrigation originates from the same source.

A special type of irrigation is obtained by diverting floodwaters to particular depressions, which are subsequently used for farming purposes. The practice of this kind of runoff or floodwater farming, which is restricted to years with heavy winter rains, is observed for the Arab bedouins in the northern part of the Eastern Desert and the Sinai (Hobbs 1990:45; Zahran and Willis 1992:171, 235).

Cultivated Trees

The presence of trees is conspicuous, as most of them overtop shelters and fences. They are planted solitary near a building or are part of a small kitchen garden. Trees that have been recorded in the Eastern Desert, are: twisted acacia (*Acacia tortilis*), Nile acacia (*Acacia nilotica*), nabq (*Ziziphus spina-christi*), date palm (*Phoenix dactylifera*), fig species including the edible fig (*Ficus carica*), mango (*Mangifera indica*), henna tree (*Lawsonia inermis*), guava (*Psidium guajava*), castor-oil plant (*Ricinus communis*), banana (*Musa* sp.), sesban (*Sesbania sesban*), orange (*Citrus sinensis*), tangerine (*Citrus reticulata*), tamarind (*Tamarindus indica*), Australian pine (*Casuarina cunninghamiana*), river red gum (*Eucalyptus camaldulensis*), and several unidentified trees.

Only a minority of these trees is indigenous to the Eastern Desert: twisted acacia, nabq, and date palm. Some others originate from the Nile Valley or are cultivated there from classical times onward: Nile acacia, fig, henna tree and castor-oil plant. All the others trees can be considered as exotic species. A good example is the *Eucalyptus* tree, which originates from Australia and has a widespread distribution today throughout the Mediterranean region, where it can be found near settlements and also in more natural environments. As most people like to cultivate exotic species in their gardens, the planting of foreign trees by desert dwellers may therefore not be surprising. The *Eucalyptus* tree in Arab Saleh, for example, was grown from a young sprout that originated from the Nile Valley. The large proportion of exotic trees in Cairo also illustrates people's preference for nonindigenous plants (El-Hadidi and Boulos 1989).

Such nondesert trees, however, need special attention and are restricted to settlements only. But desert trees that are cultivated near shelters may also need supplementary watering. Schweinfurth (1865a: 140) states that a small date-palm grove near Quseir was irrigated with brackish water obtained from Wadi Ambagi. The author witnessed in Marsa Alam, located between Quseir and Berenike, a full-grown *Balanites aegyptiaca* that was watered with wastewater via a gully.

Trees that are adapted to desert conditions may survive when settlements become abandoned or may even escape from cultivation through seed dispersion. According to Schweinfurth (1865a: 293–294) such a palm grove is present in the Wadi Gimal estuary, 93 km north of Berenike, and consists of date palms (*Phoenix dactylifera*) and doam palms (*Hyphaene thebaica*). Today, these palm trees are not cultivated anymore: the old leaves are still attached to the stem. Hobbs (1990:92) states that nabq trees (*Ziziphus spina-christi*) in the Ma'aza territory are regarded by the nomads as "antiquities," which were cultivated by the Romans.

Once full-grown, trees may serve as shade plants. They also may be exploited for useful products, which is true for almost every species enumerated above. Dead branches can be used as firewood, and most of the cultivated trees are valued for their edible fruits. Others, such as the henna tree (*Lawsonia inermis*) and the Nile acacia (*Acacia nilotica*), produce other useful products. The powdered leaves of the henna tree can be used as a cosmetic dye and is applied to the hands and feet of women in a characteristic pattern. Fruits of the Nile acacia are used for tanning. Both the henna tree and the Nile acacia are present in gardens of Quseir, and it is likely that leaves and ripe pods are harvested for personal use or sold in markets. Even in Cairo's spice markets, these products are offered for sale. The Ababdas from Arab Saleh do not cultivate these trees, despite their frequent use of henna and acacia fruits. Both products are obtained from the markets in Shelateen, approximately 90 km to the south.

Cereal Cultivation

At several locations the author has witnessed that cereal cultivation in the Eastern Desert is possible. A fairly large wheat (*Triticum aestivum*) field next to an orchard has been seen in Wadi el-Matuli, along the former caravan track between Berenike and Koptos (Qift), some 17 km from the Nile Valley. A barley (*Hordeum vulgare*) field of only 4 m^2 was seen near a frontier station about 10 km north of Quseir (Figure 3.11). Both these fields were irrigated. An example of rain-fed farming was found about 1.5 km south of Arab Saleh, near Berenike, where sorghum (*Sorghum bicolor*) was occasionally cultivated on a small scale. A necessary condition for sorghum cultivation in this area is sufficient rainfall during the winter period, with most rain falling in November. The field near Arab Saleh measures a couple of hectares and had been sown with sorghum in 1995 and in 1997 after heavy winter rains. Suitable locations for such rain-fed agriculture are shallow depressions in which rainwater is concentrated. Even when all the water has been absorbed by the soil, which may take a couple of weeks or even months, depending on the amount of water and the soil structure, such playas are still easily recognized because their surfaces are sealed with silt, which bursts open after drying. When all the water has been absorbed, small holes are made in the soil, which are then filled with water. The next day, several seeds of sorghum are put in each hole. Only during the first week, extra water supply is given if necessary. From then on, the farmer only does the weeding (Figure 3.12). The plants can be harvested after six months and are used as forage for camels.

Figure 3.11. Small barley field near a military post north of Quseir (January 1997). See Color Plates section, page 217.

One would assume that the cultivation of cereals such as sorghum and barley is only meaningful if fair-sized fields are sown. Evidently, present cultivation of cereals in the Eastern Desert is mostly practiced on a small scale and has an opportunistic character. Sorghum

Figure 3.12. Ababda weeding a sorghum field three kilometers south of Arab Saleh (January 1997). See Color Plates section, page 218.

is a crop domesticated in Africa and has a C_4-metabolic pathway making its photosynthesis very efficient in an environment characterized by high temperatures and light intensities. Being C_3-crops, barley and wheat lack this photosynthetic adaptation to arid conditions and, as a consequence, irrigation is necessary. Long-term irrigation is a disadvantage as the soil may become salty, a condition to which only barley has a considerable tolerance, as far as cereals are concerned. The reason that barley is the preferred crop in drier environments but still suitable for agriculture is that it has a relatively short life cycle. In this way, it succeeds in avoiding water stress. Additionally, its roots are well developed in the upper soil layer, enabling the plant to benefit from rain showers and morning dew.

Besides problems dealing with water and thermal stress, cereals also have to survive diseases and predation. Crops may be affected by flying animals and microbial diseases such as smut. The leaves of sorghum plants near Arab Saleh, for example, were partly damaged by caterpillars. A fungal disease that was found on subfossil remains of barley will be discussed in Chapter 4. Although the grains of sorghum are mostly used as animal fodder—the absence of gluten making it is unsuitable for breadmaking—it can only be fed in a fresh condition to animals after seed ripening. The presence of the poisonous dhurrin, a cyanogenic glucoside, in the leaves during the growing season and also after drying (Langer and Hill 1982:109–110), makes it necessary to fence off the fields and excludes the possibility of hay making. The dried culms can be used as fuel or as building material.

The competition for water in an arid environment results in relatively large distances between plants, so that the spatial distribution of the roots of each plant ensures the uptake of sufficient amounts of water. The relatively large distance between plants is apparent in sorghum fields and kitchen gardens. To reduce water competition, special attention has to be paid to weed control. Nevertheless, in most kitchen gardens, desert plants with a weedy character, such as *Sonchus* sp., *Zygophyllum simplex*, and *Caylusea hexagyna*, were found. In the sorghum field south of Arab Saleh, the following weed plants were recorded: *Forsskålea tanacissima*, *Farsetia ramosissima*, *Aristida funiculata*, *A. adscensionis*, *Tribulus terrestris*, *Dichanthium foveolatum*, *Astragalus eremophilus*, *A. vogelii*, *Trichodesma ehrenbergii*, *Zilla spinosa*, *Acacia tortilis*, and *Morettia* sp. All these species are desert plants and are also found outside the cultivated areas.

CHAPTER 4

ARCHAEOBOTANICAL RESEARCH

"Ships in these ports of trade [Muziris and Nelkynda] carry full loads because of the volume and quantity of pepper and malabathron. They offer a market for: mainly a great amount of money; peridot (?); clothing with no adornment, in limited quantity; multicolored textiles; sulphide of antimony; coral; raw glass; copper, tin, lead; wine, in limited quantity, as much as goes to Barygaza; realgar; orpiment; grain in sufficient amount for those involved with shipping, because the [sc. local] merchants do not use it." [Periplus Maris Erythraei 56:16–22]

CULTIVATED PLANTS

With respect to the exploitation of plants by man, two terms need to be addressed: cultivation and domestication. Cultivation concerns the exploitation of plants in its broadest sense, including the harvest of useful products of wild growing plants. Domestication, on the other hand, is restricted to a human-induced process in which plants become dependent on humans for their reproduction (Harlan 1992:63–64).

It follows logically from these definitions that domestication implies cultivation. Domesticated plants are mostly recognizable, as such, in an archaeobotanical context, since generative parts, especially, have undergone morphological changes. It may be difficult however to pronounce upon the cultivated status of wild plant species that are considered to be part of the surrounding vegetation in former times. As far as edible plants are concerned, the presence of leftovers unequivocally indicates a cultivated status. But more often, remains of wild plant species are found that do not show clear evidence of a special use. Sometimes, a specific use is known from present-day dwellers, eventually from a more remote area, but mostly no traces of such a use are detectable. In such cases the plant (parts) might have been deliberately collected by man but may also have been transported to the site by natural dispersal agents. In the Eastern Desert, both strong winds and irregular occurring torrents are responsible for the transport of plant remains over long distances. Obstacles such as buildings and depressions are excellent seed traps. This process was continuously evidenced during the excavation seasons, where a trench sweep is a daily procedure, and old trenches are filled with sand intermixed with all kinds of plant remains, including tumbleweeds and plants that germinate in such protected safe sites.

It may thus be clear that the status of some wild plant species that have been found at Berenike and Shenshef is still obscure. Some of them have been categorized as cultivated ones, such as beet (*Beta vulgaris*; Figure 4.1) and Johnson grass (*Sorghum halepense*; Figure 4.2), although conclusive evidence is lacking for such a labeling. On the other hand, the potential use of several wild plant species will be mentioned in the next section to compensate for the assumption that they were dispersed by natural dispersal agents. It is assumed that most desert plants with an economic value will have been exploited without intentional planting in gardens or plantations. For this reason, all (potential) cultivated plants that grow wild in the Eastern Desert, the Red

Figure 4.1. Two-germ receptacle cluster of beet (*Beta vulgaris*) (3.6 x 3.2 mm). Photograph by J. Pauptit.

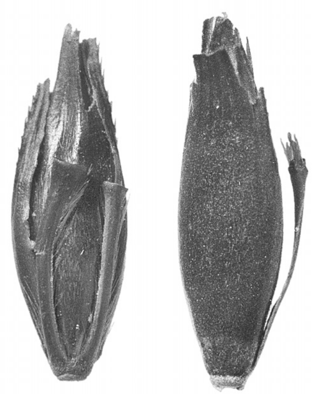


Figure 4.2. Sessile spikelet of *Sorghum halepense* in ventral view (right) and in dorsal view (left) (6.3 x 2.1 mm). Photograph by J. Pauptit.

Sea coastal area, and/or the Gebel Elba area will also be dealt with in the next section.

This section presents all cultivated plants from Berenike and Shenshef that have been evidenced by at least nonwoody remains. Plants evidenced by wood identification are described by Vermeeren (1998, 1999a, b, 2000). Some of them will be discussed briefly in the summarizing section.

The cultivated plants are described separately in alphabetical order. Each description starts with the scientific name and, as the occasion arises, relevant synonyms are also mentioned. Synonyms that are linked to wild progenitors, such as *Olea oleaster* Hoffm. & Link. and *Vitis sylvestris* C.C. Gmel, have been omitted. Next, English, Arabic, and Indian names are presented alphabetically, followed by a description of the plant parts, the trenches in which the plant has been evidenced, the period, the state of preservation, and a reference to a picture of the plant remain.

The scientific (Latin) plant names are mainly based on Wiersema and León (1999). Tentative identifications on a species level are indicated with "cf." (confer). For example, *Monsonia* cf. *nivea* means that only the identification on the genus level is certain, but that the identification to the level of species is only tentative.

The common names were obtained from a variety of sources, in which the preferred common English plant name follows Wiersema and León (1999). The Arabic and Indian names are taken mainly from Bedevian (1994 [1935]), Kamal (1975), Kay (1979), Mandaville (1990), and Dey (1980). These common names refer to whole plants as well as particular plant parts of economic value. All variant spellings have been listed that were found in literature. Doubtless this compilation is by no means complete. The common names are arranged alphabetically and are also indexed. It should be realized that the same name may be used for several plant species, including noncultivated ones.

For each plant, the official names of the recovered remains are mentioned. Sometimes such labels deviate from the names that are commonly used. Such established names may, however, be incorrect and confusing, which is caused by several factors. The main objective of using the official botanical names is that it facilitates an unequivocal description. This, in turn, enables an interpretation with respect to the processing of the plant remains, including preservation techniques that might have been used and a comparison with present-day samples of these plants. To avoid an unreadable text, the botanical names are explained when necessary and eventually also linked to more-popular terms. For the same reason, specific names of fruit types, such as pods and legumes, have been omitted in the description of the botanical remains.

First of all, the labeling of "seed" and "fruit" is not always correct. Strictly speaking, an ovule develops into a seed and an ovary develops into a fruit. This means that a seed is always enclosed by a fruit. Unfortunately, seeds and fruits are not always clearly separated, as for example, the members of the mustard family (Cruciferae or Brassicaceae) and the legume family (Leguminosae or Fabaceae). If only one seed is produced in a fruit, very often the fruit coat (pericarp) is fused with the seed coat. What appears to be a seed is in fact a fruit. Such fruits are produced, for example, by members of the buttercup family (Ranunculaceae) and the daisy family (Compositae or Asteraceae).

A second factor that obscures the issue is the great variety of fruit types. A further complication results from the incorporation of vegetative parts in the effective dispersal unit. Thus, the so-called diaspore may either be a seed, a fruit, or even a false fruit. The fig may serve here as an illustrative example. Very often, subfossil records mention that seeds or fruits of the fig have been retrieved, but the official labels should be "fruits" and "accessory fruits," respectively. If the description is unequivocal, for instance in the case of dried fruits, it is not problematic. Unfortunately, this is mostly not the case, as can be deduced, for example, from the codex of ancient Egyptian plant remains by de Vartavan and Amorós (1997), which lacks a sound botanical standardization.

Another complication arises from the taphonomic processes and preservation conditions, both resulting in the fragmentation of botanical remains. A correct identification of such fragments should ideally be based on the anatomy of the diaspore. But again, popular names, partly derived from the description of fruit types, are often used instead. Examples of such names are shell, flesh, meat, pip, and kernel. The word *stone* is used, for example, both for the seed of a date palm fruit and for the endocarp of fruits, which are classified as "drupes," such as the discarded inner part of an olive fruit. Standardization of descriptions for the archaeobotanical remains of cereals *Triticum* and *Hordeum*), including threshing remains, has recently been recommended (Hillman et al. 1996; Cappers et al. 2005: 288-289).

Trench numbers, recorded in a consecutive series throughout the whole excavation period, indicate the origin of the botanical remains from Berenike. In Shenshef, on the other hand, the numbering of trenches starts at one in both seasons. A complicating factor in the numbering is that a particular midden (nr. 2) has been excavated in three different trenches (SS96-3, SS97-8a and b). Therefore, the numbers of the middens from Shenshef have been used instead to designate the origin of their botanical remains. Only in particular cases, where a more detailed description is considered as informative, are complete locus identifications given. The locations of the trenches and middens are indicated in Figure 4.3 and Figure 4.4.

Plant remains can be preserved in different ways: waterlogging, mineralization, desiccation, and charring. Additionally, imprints in pottery, for example, may indirectly maintain the presence of a species in the course of time. The type of preservation depends on environmental conditions and human activity. The plant remains from Berenike and Shenshef are preserved by desiccation and charring.

Owing to the extreme arid conditions, plant remains can be preserved by desiccation without special treatments. Basically, this nondestructive mode of preservation is valid for all kinds of plant remains. Differences in fragility, however, allow for bias in favor of the more-solid remains such as seeds and fruits. Since these generative plant parts are, by nature, adapted to survival in the soil, they offer resistance to both mechanical hazards and decay by microorganisms. This kind of preservation is sometimes erroneously mentioned as "mummification," a qualification that is, however, only applicable to organic subjects that have been treated in a special way to improve preservation. Even plant remains that have been found in tombs and are stored as offerings for the dead do not deserve this special qualification.

Charring, on the other hand, is mostly human induced and destructive in character (Cappers 1995:251). Plant remains may become charred by accidental fire, for example, during cooking. They also may be the result of deliberate fire, for example, in the case of burning rubbish and offering food in religious ceremonies.

The preservation of organic materials is also affected by salts. The proximity to the sea results in relatively high salt concentrations, and even salic (salty) horizons are present in the soil around Berenike. Salt has certain conserving properties for organic remains, as it dehydrates microorganisms responsible for decay, but it also may cause damage as a result of mechanical stress resulting from crystallization and hydration (Meijers 1998:410). The latter effect is especially perceptible at the level where the salic horizon is present.

For the reconstruction of trade routes, it is important to know the possible areas of origin. Unfortunately, the assignment of a certain plant species to a particular area of origin is problematic. The main reason is, that during Roman times, many cultivated plants were introduced to new areas via old land and sea routes. Long before the Greek and Roman conquests of Egypt, transoceanic trade between India, the Arabian Peninsula, and East Africa had already been established. It is suggested that via such old trade routes African species were introduced into India, such as *Lablab purpureus*, *Vigna unguiculata*, *Sorghum bicolor*, and *Pennisetum glaucum* (Fuller 2002:288–296, 2003a: 241–256). Conversely, species from the Indian subcontinent found their way to Africa. Scientific names may, in this respect, be misleading. Those of sesame (*Sesamum indicum*) and

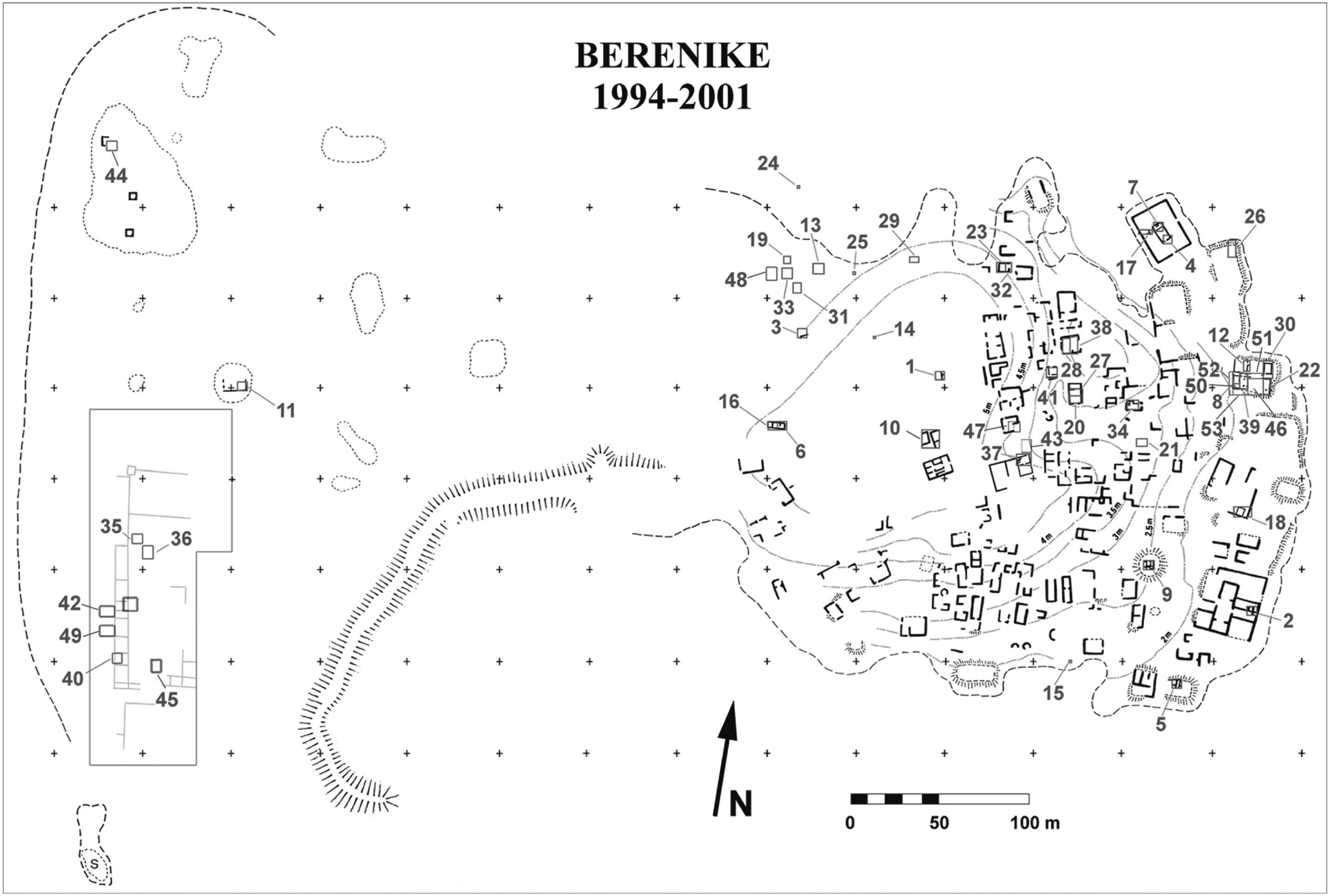


Figure 4.3. Map of Berenike showing locations of the trenches. Surveyed by F. G. Aldsworth and H. Barnard, drawn by F. G. Aldsworth. See Color Plates section, page 219.

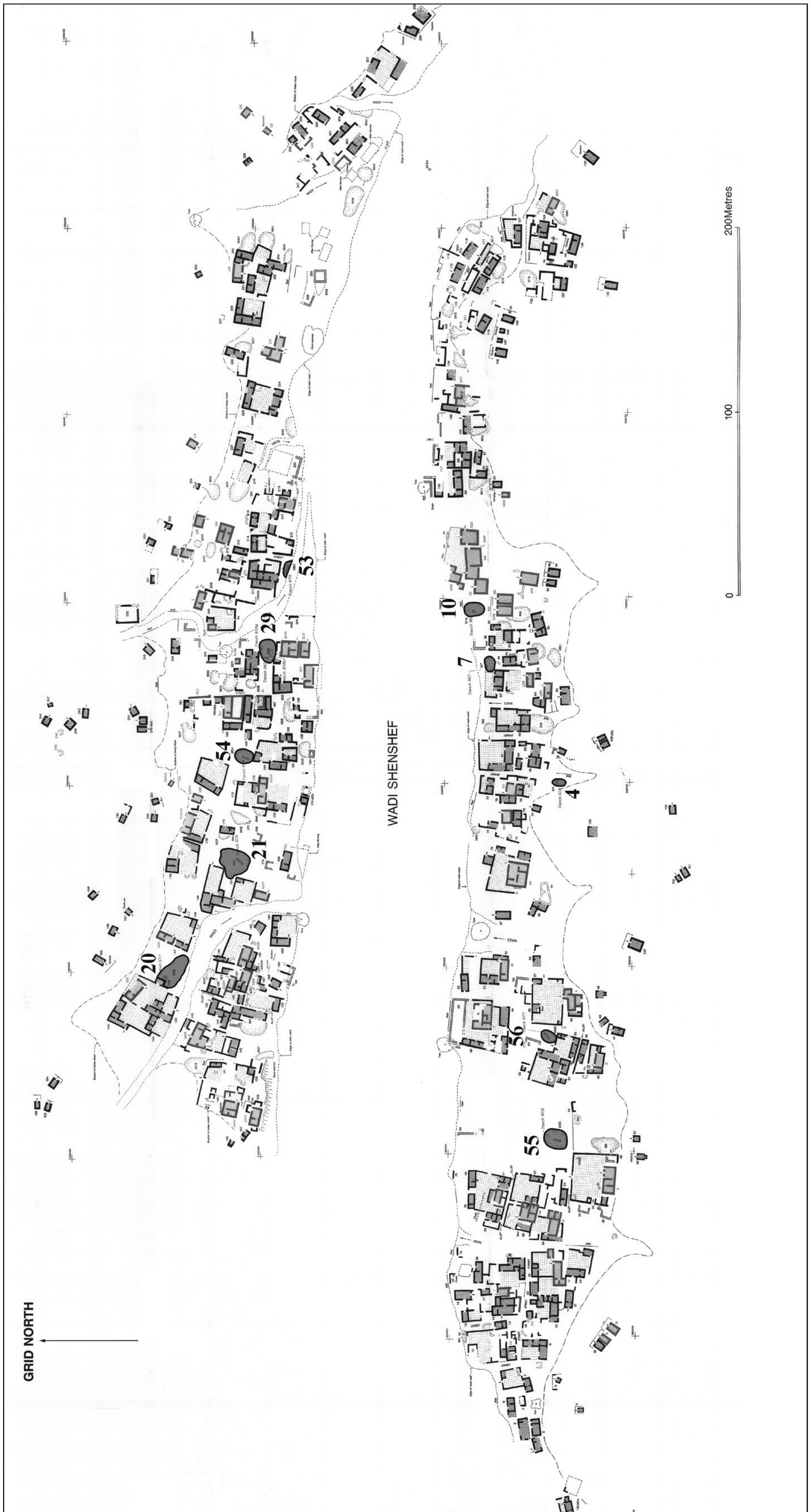


Figure 4.4. Map of Shenshef showing locations of the excavated middens. Surveyed by F. G. Aldsworth and H. Barnard, drawn by F. G. Aldsworth. See Color Plates section, page 220.

tamarind (*Tamarindus indica*), for example, suggest an Indian origin for both species, whereas this is probably only true for the former one. The unraveling of the migration and trade routes is especially complicated in the area under consideration as it is linked to the Near East where domestication started some 10,000 years ago. Information on the origin and expansion of a certain species can be derived from a variety of sources, in which evidence from archaeobotanical research, plant geography and ancient written sources all play an important role. If necessary, these sources will be discussed to determine the possible trade routes.

***Abrus* Adans.**

English:	*A. precatorius*: Coral-beadplant, Crab's-eye, Indian-licorice, Jequirity-bean, Jumbie beads, Licorice-vine, Love-bean, Lucky-bean, Minnie-minnies, Prayer-beads, Precatory-bean, Red-beadvine, Rosary pea, Weatherplant, Weathervine
Arabic:	*A. precatorius*: 'Any-al-afrit, 'Arquasus al Hind, Shagaret el masabeh, Shechm ahmar, 'Uyun al-dika
Indian:	-
Plant part:	seeds
Trench/midden:	BE: 13, 19, 21, 25, 31, 33, and 48
Period:	first, second, and fourth–fifth centuries AD
Preservation:	desiccated
Figures:	4.5 and 4.6

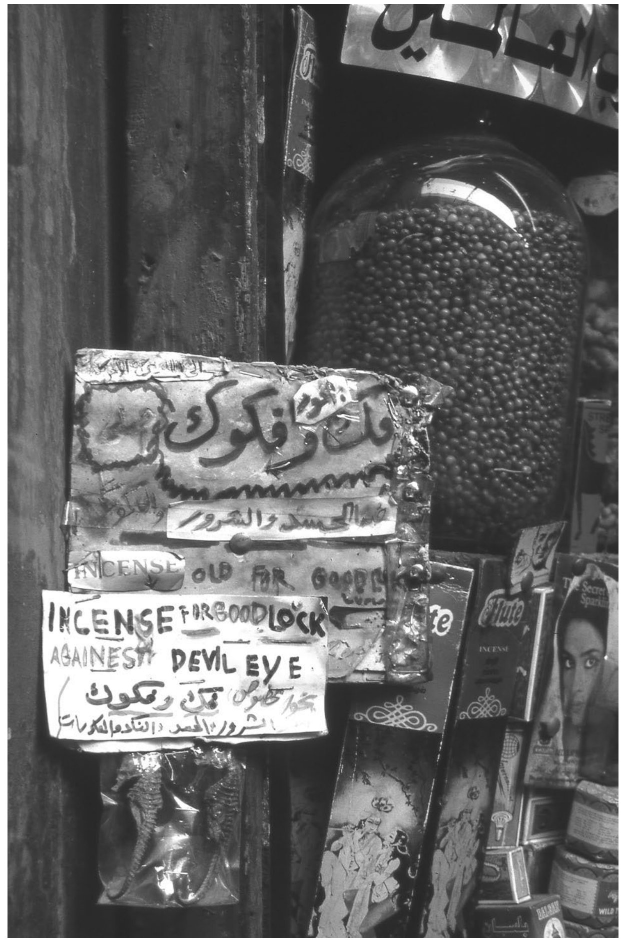


Figure 4.5. Rosary peas in a spice shop in Khan al-Khalili (Cairo) offered as a remedy against the evil eye (February 2001). See Color Plates section, page 221.

Figure 4.6. Whole Abrus seed (left: 7.4 x 5.6 mm) and Abrus seed without seed coat (right: 5.0 x 4.4 mm). Photograph by R. T. J. Cappers.

The genus *Abrus* belongs to the Leguminosae (Fabaceae) and contains twelve tropical species. The best-known member of this genus is the rosary pea (*A. precatorius* L.). The seeds of this species are normally red with a black eye around the hilum. This is interpreted as an imitation aril, but it is puzzling why birds would eat this hard seed because it does not provide any nutrition (Ridley 1990:430). Besides the scarlet seeds, entirely white seeds and black seeds have been reported from India. Although India is frequently mentioned as the geographical origin of this genus, its probable origin is Africa, where most species of *Abrus* are found (Breteler 1989:27).

Seeds of the rosary pea are used in several ways. Besides its application as a stimulant and its use in medicinal preparations (e.g., for eye diseases), the rosary pea is also valued for its ornamental properties. In India its seeds have a tradition of being used as weights by goldsmiths, as beads in rosaries and necklaces, and for the decoration of objects such as baskets (Untracht 1997:284–285). Their use in weighing precious metals is attributed to the seeds' uniform size and weight. Each seed has a weight of 0.1 g. Because the seed coat is extremely hard and glossy, it is not possible to tamper with the seeds. Nevertheless, some variety in seed weight exists, and it happens that heavier seeds are used for buying and lighter ones for selling (Untracht 1997:284).

Seeds are not edible because they contain the poisonous protein abrine. The consumption of a few pounded seeds is lethal. Poisoning by rosary pea is also recorded from drinking tea in which several seeds have been immersed for a while.

In Egypt the seeds of rosary pea are also used as an additive in mixtures of incense and are offered on markets all over Egypt. An incense sample bought in November 1996 at the Khan al-Khalili bazaar in Cairo contained seeds or fruits from the following plant species: *Abrus precatorius*, *A.* cf. *fruticulosus*, *Coriandrum sativum*, *Phalaris paradoxa*, *Trigonella foenum-graecum*, *Nigella sativa*, and *Senna holosericea*. The use of rosary pea seeds in Egyptian incense is also mentioned by Kamal (1975:26). Additionally, unmixed seeds of the rosary pea are offered for sale (Figure 4.5). Such supplies together with coins are often used to scatter over bridal couples. In both instances, it is believed that the rosary pea seeds protect against the evil eye. One of the Arabic names, "Any-al afrit," refers to this belief. It holds that certain people have the power to bring misfortune that could affect other people, cattle, or even houses. The evil eye can only be effective if it strikes the victim's eye at first glance. A protection against the evil eye can either be offensive or defensive in character. An example of the first approach is the hand of Fatimah, which is used as an amulet. The use of rosary pea seeds in, for example, incense mixtures can be classified among the second approach. It was also possible, though with some difficulty, to buy an incense from Morocco at the Khan al-Khalili bazaar whose special purpose is protection against the evil eye. Contrary to normal incense samples, this gives off a ghastly smell.

That completely black seeds of *Abrus* sp. can also be used for religious purposes is evidenced by the presence of two such seeds in the well-hidden, covered hole at the back of a Yao wooden statue, which originates from either China, Thailand, or Laos. Together with a piece of animal skin, metal, a paper fragment with text, and bark, these seeds allowed the statue to become gifted with a soul.

A similar use is applied to wild rue (*Peganum harmala*), a plant species indicative of disturbance. According to Horne (1994:25), in Iran, the fruits are, among other things, worked into wall hangings and burned as a deterrent to the evil eye.

The specimens from Berenike are completely black, just as the ones that originate from grave no. 35 in the mortuary temple of Seti 1 (Nineteenth Dynasty) in the necropolis of Thebes and the four seeds stored in the Louvre, which are not further specified (Germer 1988:53). The seeds from the temple of Seti 1 are threaded on a string and have been identified by Schweinfurth. The suggestion by Germer that at the time of Schweinfurth's identification the red color was still visible, seems very unlikely as it implies that the discoloring of the seeds only started after more than 3,000 years. It is more likely that, taking its use as a bead into consideration, Schweinfurth assumed that he was dealing with the decorative rosary pea. Another possibility is that we are dealing with an African species, in which the following ones come into consideration: *A. precatorius* ssp. *africanus* Verdc. (distribution includes Sudan and Somalia), *A. somalensis* Taub. (an endemic species in Somalia, fruits are unknown), *A. schimperi* Bak. (distribution includes Sudan, Ethiopia, and Eritrea), *A. pulchellus* Thw. (distribution includes Sudan), *A. bottae* Deflers (endemic in Arabia), and *A. fruticulosus* Wall. ex Wight & Arn. (distribution includes Sudan, Ethiopia, and Eritrea). Seeds of these species are greenish or black and lack the decorative red color of the rosary pea and are only rarely seen at Egyptian markets.

With respect to the seeds from Thebes that have been used as beads, it would make sense that they belong to the rosary pea (*A. precatorius*) indeed. Although there was no direct trade during the New Kingdom with India, it is possible that we are dealing here with indirect trade via the east coast of Africa south of the Sahara.

Because the specimens of Berenike are not pierced, and thus do not indicate a decorative feature, it might well be that these seeds belong to one of the African species. That these seeds were used as gold weights in Berenike is merely speculative as it implies that precious metals were traded at Berenike, an assumption, however, of which no clear evidence is present up to now.

Acacia nilotica (L.) Willd. ex Del.

Synonym:	*A. arabica* (Lam.) Willd.
English:	Babul acacia, Egyptian acacia, Indian gum-arabic tree, Nile acacia, Thorn-mimosa, Thorny acacia
Arabic:	Ammugitan, Gorti, Sant, Sont, Qarad
Indian:	Babal, Babla, Babul, Bavul, Kikar, Kikkar (= ssp, *indica* (Benth.) Brenan)
Plant part:	fruits and possibly seeds
Trench/midden:	BE: 15, 16, 21, 25, 31, and 40; SS: 10, 21, and 29
Period:	first and fourth–fifth centuries AD
Preservation:	desiccated
Figures:	4.7 and 4.8

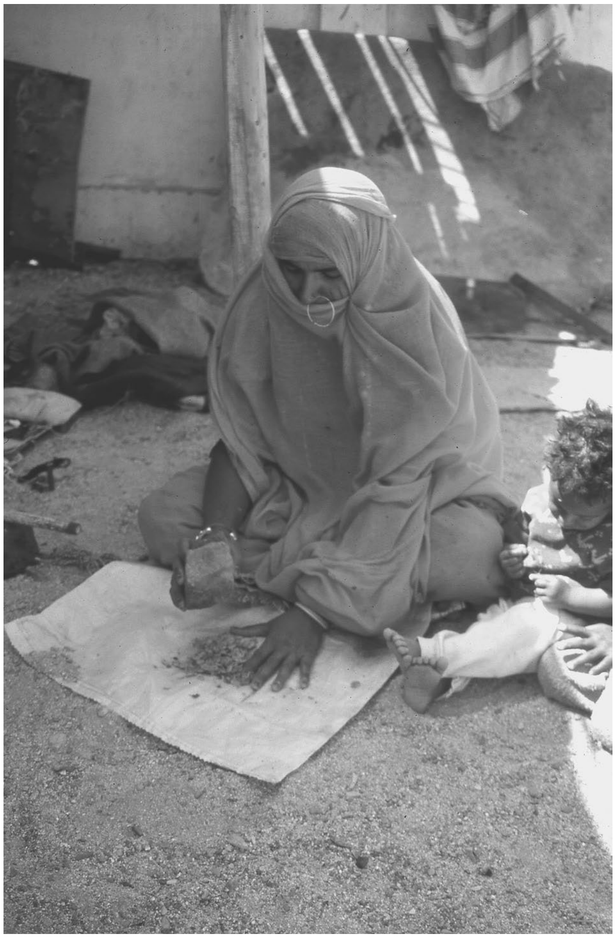


Figure 4.7. Ababda woman pounding fruits of the Nile acacia (*A. nilotica*) to make a qarad-mixture for tanning (March 1998). See Color Plates section, page 221.

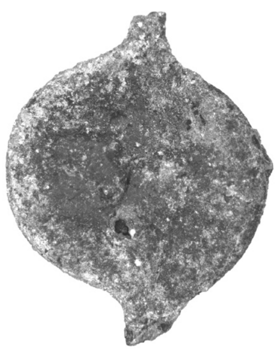


Figure 4.8. Fruit fragment of *Acacia nilotica* (width: 14.0 mm) Photograph by R.T.J. Cappers.

In addition to its valued wood, Nile acacia is exploited for its reddish gum, which exudes spontaneously from the trunk and principal branches and is stimulated by artificial incisions. Additionally, it is exploited for its bark, which contains high concentrations of tannin and can be used for both tanning and dying, and for the pods that serve several purposes. Young pods can be eaten as a vegetable, and roasted seeds serve as a spice. Although green, unripe pods contain even 50 percent more tannin than the bark of the tree, its concentration is halved when the pods are ripe (Von Maydell 1990 [1986]: 125).

At Berenike, the Nile acacia is only represented by ripe pods. Although bark and unripe fruits contain more tannin than the ripe fruits, obviously only ripe fruits were processed. The reason is a practical one. Harvesting the bark would kill the tree, whereas unripe fruits are difficult to pound. In fact, ripe pods are still offered for sale in large quantities in spice markets for tanning purposes.

Pod-tanned leather is still obtained by the Ababda nomads by using ripe pods. The following procedure was described and partly demonstrated by an Ababda woman. First, pods (Arabic: *qarad*) are pounded with a stone on a piece of cloth or plastic (Figure 4.7). The pulverized fruits are mixed with water in a proportion of 1 k fruit to 10 L of cold water. A skin is then soaked in this mixture for two days. Next, the hairs are removed by hand. Then the skin is soaked again in a *qarad* mixture for about another week. Finally, the skin is sun-dried, after which it is suitable for all kinds of processing. Other *Acacia* species that can be used for tanning are *A. oerfota* (Forssk.) Schweinf. and *A. etbaica* Schweinf., both well represented in the Gebel Elba area (Drar 1936:76–77).

Pod segments and seeds of the Nile acacia have been found in Egypt from predynastic times onward. Today, the Nile acacia grows in the Nile Valley; the desert west of the Nile, including the oases; and in the Sinai. According to Zahran and Willis (1992) the Nile acacia probably also once grew in the southern areas of the Egyptian Red Sea coast. Its exploitation, rather than ecological factors, would have been responsible for its absence in this area today. As only fruits have been attested from the late habitation period, the most likely option is that they were imported from the Nile Valley or at least from a remote distant place. In a reverse situation, namely that the fruits found were only from early deposits, overexploitation of a nearby population could be considered.

Acacia tortilis **(Forsk.) Hayne**

Synonym:	*A. raddiana* Savi
English:	Twisted acacia, Umbrella-thorn
Arabic:	‘alef (flowers), Barra, Haras, Ollaaf (pods), Samoor, Samraa, Samrahl, Samur, Sanganeib, Sayaal, Talh(a), Towaay

Indian:	Israeili babool; Israeli babul
Plant part:	fruits, seeds, spines, and wood
Trench/midden:	BE: 1, 10, 13–16, 19, 21, 25, 33, 37, and 48; SS: 4, 20, 21, 29, 53, 54, and 56
Period:	first–early sixth centuries AD
Preservation:	desiccated and charred
Figures:	1.8, 2.1, 2.2, 2.14–2.17, 4.9, 4.10–4.11

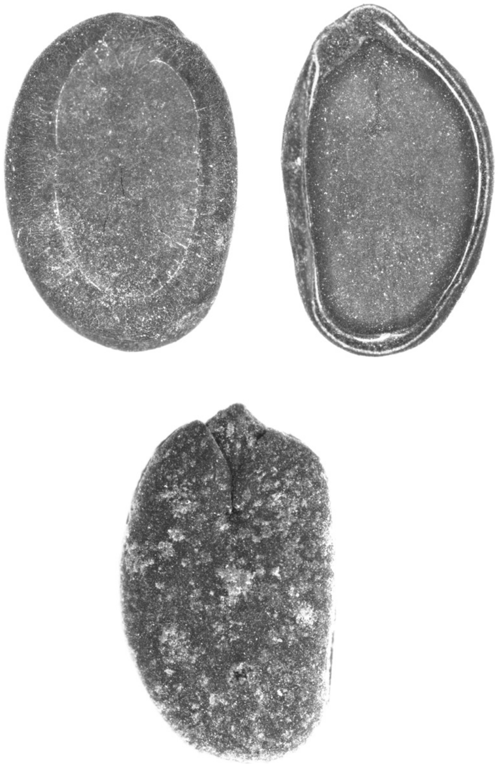


Figure 4.10. Whole *Acacia* seed with pleurocarp (top, left: 7.1 x 4.1 mm), cross section showing multilayered seed coat (top, right: 6.3 x 3.9 mm), and cotyledons with embryo and grooves (bottom: 5.1 x 3.2 mm). Photograph by R.T.J. Cappers.

Figure 4.11. Fruit fragment of *Acacia tortilis* seen from the outside (left) and the inside (right) (largest width: 5.4 mm). Photograph by J. Pauptit.

Twisted acacia can easily be distinguished from Nile acacia by its fruits, even if only small fragments are preserved. The former has small, spirally twisted fruits, which are only slightly constricted between the seeds and bear a clear veining pattern. Nile acacia, on the other hand, is characterized by more or less glabrous pods, which are deeply constricted between the seeds. Another difference concerns the spines that are present on the branches. Twisted acacia has both long straight spines and small curved spines, whereas Nile acacia has only long straight ones. Both straight and curved spines were found in the samples of Berenike and Shenshef. It has not been tried to distinguish between the two subspecies of twisted acacia, namely, ssp. *tortilis* and ssp. *raddiana* (Savi) Brenan, which were formerly treated on a species level.

The twisted acacia is a common species that grows in the midstream part of almost every wadi branch around Berenike. Leaves, young shoots, and especially fruits provide a valuable, nutritious forage for all domestic animals (Von Maydell 1990 [1986]:147). Trees are browsed by passing camels and sheep as well as goats that eat the pods that fall onto the ground. Drar (1936:77–78) states that Ababda nomads pull down ripening fruits with long, hooked sticks. Another way of harvesting could have been cutting off whole branches that were fed to animals. The disadvantage of this kind of exploitation is, however, that it reduces the tree population, which in this arid environment cannot be compensated by regeneration. Today, the Ababda nomads mainly exploit *A. tortilis* by harvesting dead branches to make charcoal. Wood of *A. tortilis* has a high calorific value and is the leading supplier of charcoal. Exceptionally, fresh branches are cut to make the skeleton of small houses that are covered by skins or, as is practiced nowadays, by mats and cloth.

The presence of seeds, fruits, and spines in many loci of Berenike cannot be explained unambiguously. Although it may not be excluded, it seems unlikely that *A. tortilis* once grew on the site proper. This tree penetrates the coastal plain via the main wadi branches but is not found today in the near vicinity of Berenike. Both its salt nontolerant status and its deep, penetrating root may prevent successful establishment on this limestone outcrop in a salt-marsh area. More to the south, however, a large population of *A. tortilis* is present in the coastal plain area. Such a population of trees would certainly have been more accessible than the more-scattered specimens in the middle and upstream part of the wadis. Another possibility that might explain its presence at Berenike is that we are dealing with plant remains that may have partly entered the trash deposits by natural agents. The use of large, spiny branches for fencing off kitchen gardens to protect them against grazing animals, as has been observed in Marsa Alam, 140 km north of Berenike, probably offers the most plausible explanation. Such branches will have disintegrated in the course of time and will have supplemented the soil with their diagnostic parts. A similar use has been described by Wood (1997) for dead branches of nabq (*Ziziphus spina-christi* [L.] Desf.), which are used to make thornbush hedges in Yemen.

***Adansonia digitata* L.**

English:	Baobab, Dead-rat tree, Cream of tartar tree, Monkey-bread tree, Sour gourd
Arabic:	Al ‘umarah, Bawbab, Hhabhhab, Shag. el bawbab, Shag. Khubz el qurud
Indian:	Chincha
Plant part:	seed
Trench/midden:	BE: 1
Period	fourth–fifth centuries AD
Preservation	desiccated
Figure	4.12

Figure 4.12. Seed of *Adansonia digitata* (10.8 x 8.3 mm). Photograph by R. T.J. Cappers.

One seed from a dump area belongs to the baobab. With its unusually thick trunk and slender branches, giving the impression that these aboveground parts are out of proportion, this tree has a characteristic appearance.

The baobab has its natural habitat in the dry woodland savanna south of the Sahara, where it is frequently associated with tamarind (*Tamarindus indica* L.), a tree that has also been attested for Berenike by its seeds. Two baobab trees are also recorded from two different localities in north Yemen (Wood 1997:104). Whether these are relics of a larger native population or have to be considered as introductions is not clear. The current distribution of the baobab in India is confined to the northern part, including the northwest coast along the Gulf of Cambay, where it grows in and around the old ports of Janjira, Chaul, and Surat (Burton-Page 1969:331). According to Burton-Page, the tree has to be considered as an early fifteenth century introduction. This rules out the possibility of an import from the Indian continent. On the other hand, the presence of a baobab seed in Berenike clearly demonstrates that it was traded in much earlier times and that an earlier introduction into India cannot be ruled out.

If the seed unearthed from Berenike originates from the East African savanna, the most probable area of origin is northeast Sudan, from where it could have been offered for trade in Ptolemais Thêrôn, a port located at lat 18°40' N and which was only accessible by small vessels (Casson 1989:101). As the baobab is almost not recorded from the Horn of Africa, a second possibility is that it originates from east tropical Africa, from where it could have been exported from Rhapta (present Dar es Salaam), according to the *Periplus Maris Erythraei* the only port of trade on the East African coast south of Opone. Because a return voyage from Berenike to Rhapta would take about a year and a half, its seems more likely that trade items from this area were subjected to distributive trade and offered for sale in the so-called “far side” ports in Somalia. This might also have been the case for the baobab. On the other hand, the uncertain status of baobab in north Yemen does not exclude the possibility that the baobab was imported from a far less distant place.

The baobab is a highly valuable tree because all parts can be used in a variety of ways. The hard, indehiscent fruits of the baobab measure 15 to 20 (-40) cm in length and contain a great number of seeds imbedded in pulp. The seeds can be eaten fresh or roasted and contain up to 15 percent oil. The fruit pulp contains tartaric acid, which is also edible and can be mixed with water or milk. Additionally, both seeds and fruits have medicinal properties (Von Maydell 1990 [1986]: 151–152). Today, whole fruits, mostly sprayed with fancy colors, are offered for sale in florist shops and are used for making bouquets of dried flowers.

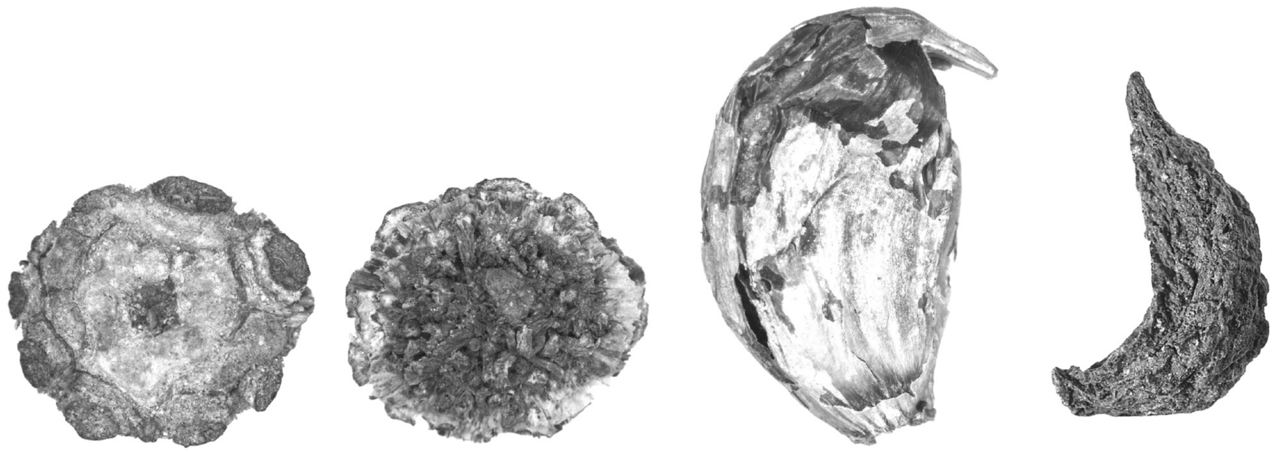


Figure 4.13. Fragments of garlic (*Allium sativum*). From left to right: top view of bulb base with characteristic scars and bottom view with remnants of roots, whole clove of garlic (length: 18.4 mm), and shriveled content of clove (length: 13.0 mm). Photographs by R.T.J. Cappers (bulb base and whole clove) and J. Pauptit (shriveled content).

Subsossil seeds of the baobab have recently been identified from several Mediterranean sites and include a large shipload of 25 boxes in one of the ships found at the ancient Etruscan port nearby Pisa San Rossore, dated to the fourth century BC (Lentini and Scala 2003). In the museums of Turin and the Louvre, some baobab fruits are stored that have originated from Egypt but without any further information concerning origin and date (Germer 1985:120).

***Allium sativum* L.**

English:	Garlic
Arabic:	Foam, Saum, Thawm, Theriac el Fuqara, Thoam, Thom, Titshert, Toam, Tuma
Indian:	Lahsun, Lasan, Rasona, Rasun, Thum, Tum, Vellaipandu, Vellati
Plant part:	bulb bases and scales
Trench/midden:	BE: 1, 13, 19, 23, 25, 31, 33, and 48
Period:	first, second, and fourth–fifth centuries AD
Preservation:	desiccated:
Figure	4.13

Bulb remains of garlic have been evidenced from the Second Intermediate period until the Islamic period. In Berenike, a reasonable number of bulb bases and bulb scales from garlic were found in different trash dumps, giving the impression that garlic was cultivated locally and consumed in reasonably large quantities.

Both garlic and onion are well represented in the archaeobotanical record of Egypt. Within the spectrum of vegetables and herbs, both species belong to a small group of species that have a good chance of ending up in an archaeobotanical record. Edible parts from vegetables and herbs such as lettuce (*Lactuca sativa* L.), thyme (*Thymus* sp.), and mint (*Mentha* sp.) have a very small chance of being discovered, even in Egypt where preservation conditions are excellent, due to the extreme arid climate. If they are found at all, it is their seeds that are unearthed. This, in turn, is exceptional because these plants are normally harvested before seed setting. In fact, the few seeds that have been found can be considered as those meant for sowing or as seeds that originate from plants that have bolted, which makes more sense. Other vegetables and herbs, such as saffron, the orange-red stigmas of the crocus (*Crocus sativus* L.), are rare because they concern plant parts that cannot be propagated. When the edible parts of plants are also used for propagation, they are adapted to living in the soil, which favors a good preservation. This is the case with bulbs of garlic and onion and with the seeds and fruits of fennel (*Foeniculum vulgare* Miller), coriander (*Coriandrum sativum* L.), and dill (*Anethum graveolens* L.).

***Amygdalus communis* L.**

Synonym:	*Prunus amygdalus* Batsch; *P. dulcis* (Mill.) D. A. Webb
English:	(Bitter/Sweet) almond
Arabic:	Lawz, Loz
Indian:	Badam
Plant part:	fruits (endocarp)
Trench/midden:	BE: 1, 10, 13–16, 19, 21, 25, 29, 31, 33, and 48; SS: 21
Period:	first, second, and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figures:	4.14 and 4.15

Figure 4.14. Three fragments of the endocarp of *Amygdalus communis*. Outside (top left) and inside (top right) view of the outer endocarp layer (12.2 x 8.3 mm) and outside (bottom left) and inside (bottom right) view of the inner endocarp layer (12.5 x 7.5). Photograph by R.T.J. Cappers.

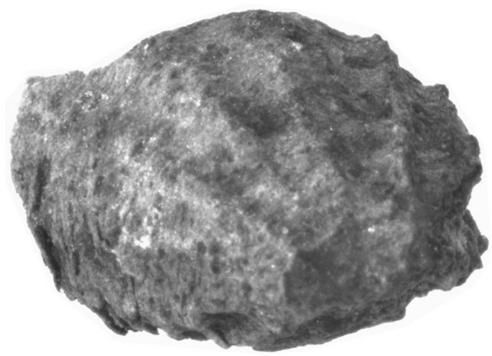


Figure 4.15. Extreme point of the endocarp of *Amygdalus communis* without the outer layer (11.7 x 8.6 mm). Photograph by R. T. J. Cappers.

Almond is one of the fruits that has been imported to Berenike from the Mediterranean area. Although no large quantities were found, fragments are present in many samples and suggest that this fruit was available on a regular scale. In addition to the records from the Greco-Roman and Byzantine periods, almond fruits as well as walking-stick handles made from the almond tree are recorded from several archaeological contexts dated to the Eighteenth Dynasty (Germer 1985:60).

It is a point of discussion whether the almond was cultivated in Egypt during this period. Germer (1989:39), for example, is of the opinion that the tree was once cultivated in Egypt because the small pot found in Tutankhamen's tomb not only contained fragments of the endocarp (the hard, inner part of the fruit enclosing the seed), but also some whole fruits. According to her, export fruits would have been traded without the outer fruit parts because of the restriction of space. Judging from the ecological requirements it seems improbable, however, that almond was once cultivated at Berenike.

***Anethum graveolens* L.**

English:	Dill
Arabic:	Hulwah, Sadhab el Barr, Shabat, Shibith
Indian:	Sowa
Plant part:	fruits
Trench/midden:	BE: 14; SS: 29
Period:	fourth–fifth centuries AD
Preservation:	desiccated
Figure:	-

The Egyptian archaeobotanical record for this plant species is limited and starts with the Eighteenth Dynasty (Murray 2000:645). Both seeds and leaves of this plant are used for their aniselike flavoring. Because this plant is rather adapted to arid conditions, it seems likely that it was once cultivated in local kitchen gardens. Moreover, it makes sense to grow a plant locally, if it is wanted for its fresh leaves. But as it can also be used in a dried state, it may have been supplemented from the Nile Valley as well.

***Armeniaca vulgaris* Lam.**

Synonym:	*Prunus armeniaca* L.
English:	Apricot

Arabic:	Barquq, Mishmish
Indian:	Khoobani
Plant part:	fruits (endocarp)
Trench/midden:	BE: 10, 31, and 48
Period:	first–second and fifth centuries AD
Preservation:	desiccated
Figure:	4.16

Figure 4.16. Endocarp of apricot (*Armeniaca vulgaris*) (17.6 x 15.0 mm). Photograph by R.T.J. Cappers.

Apricot has its origin in eastern Asia and was introduced in the Near East around the first century BC. From there it was introduced into the Mediterranean Basin where it became a well-established horticultural element (Zohary and Hopf 2000:182). Archaeobotanical records of this perishable fruit are extremely rare. In fact, the only finds from within the Roman Empire are recorded from Egypt. One of them originated from the sacred animal complexes near Saqqara. The building of these cemeteries was started in the Nineteenth Dynasty and they remained in use in the Ptolemaic period. As is suggested by Germer (1985:61), the kernel unearthed must have come from the Ptolemaic period. A second kernel is recorded by Thanheiser from Kellis in the Dakhla Oasis and is dated to the Roman period (see de Vartavan and Amorós 1997:215).

In Berenike, two fragments of apricot were found in trash layers in trench 10. The most likely origin is the Mediterranean area, although it may also have been cultivated in northerly-located Fayum. The presence of a perishable fruit in such a remote corner of the Roman Empire clearly reflects the luxury status of the food supply, though it may not have been available on a regular scale.

Avicennia marina **(Forssk.) Vierh.**

Synonym:	*A. officinalis* L.
English:	Mangrove
Arabic:	Girm, Shawra, Shura, Shurah, Qurm, Qurram
Indian:	-
Plant part:	leaves and wood
Trench/midden:	BE: 13, 19, 25, 29, 31, and 33
Period:	first–second centuries AD
Preservation:	desiccated
Figure:	-

In Egypt, mangrove vegetation consists predominantly of the *Avicennia marina* species and is restricted to the Red Sea coast, especially south of lat 25° N. This kind of vegetation is for the most part confined to the tropics and is indicative of muddy tidal waters. In the delta of Wadi Gimal, some 100 km north of Berenike, this plant is partly covered by sand hillocks, as a result of the silting of the shoreline zone. Apparently, *A. marina* can withstand the absence of nutritious mud to some extent. Along the Egyptian Red Sea this plant has mostly a shrubby habitus.

It is possible that, in antiquity, the mangrove vegetation was more widespread. According to Strabo (*Geography* 16.3.6), mangrove vegetation was present along the whole coast of the Red Sea. The comparison of the mangrove tree with the olive tree (*Olea europaea*) and the laurel (*Laurus nobilis* L.) is, however, misinterpreted by Strabo (*Geography* 16.4.5 and 16.4.14) and Pliny (*NH* 13.49.139). Both writers are talking about olives when they describe the mangrove vegetation.

The reduction to the present distribution may probably be the result of overexploitation. This exploitation of *A. marina* has had a long tradition. In the past, leaves were used as camel fodder during the summer, and shepherds ate the soft, green fruits (Drar 1936:109). This kind of exploitation would certainly not have endangered this plant species. According to Mandaville (1990:262) the leaves are merely second choice because their salty taste. Additionally, Drar mentions of the use of the mangrove as fuel, resulting in the destruction of the mangrove vegetation, especially between Quseir and Wadi Gimal. Also Schweinfurth (1865a:302) had already mentioned the use of *A. marina* as firewood, pointing to the high quality of the charcoal because it remains hot for a considerable period of time. Additionally, Schweinfurth reports the suitability of the tough and branching stems for constructing houses and fences. Today, this kind of exploitation is probably nonexistent.

Ababda nomads still use branches of the twisted acacia (*Acacia tortilis*) in combination with mats or driftwood (if available) for making their shelters, although more and more concrete houses are becoming the norm. In the Gebel Elba area among Bisharin nomads, it was observed that wooden houses are built from a variety of woody species that grow in that particular environment, including arched branches of *Cocculus pendulus*. Furthermore, *A. marina* can also be used for tanning purposes. Exploitation of the tree for this purpose has resulted in the destruction of several mangrove forests (Lemmens et al. 1992:31).

The presence of both leaves and wood of *A. marina* indicates that whole branches were harvested. Huge quantities of charcoal and some leaves of *A. marina*, intermixed with a minor fraction of *Suaeda* sp, were found in trench BE96-11, located in an industrial area southwest of the central town of Berenike (Vermeeren 1998:344–346). Most probably, this early Ptolemaic dump can be related to the cutting down of mangrove vegetation in the near vicinity of Berenike. Strabo, who visited Egypt just after the annexation of Egypt by the Romans, mentions that there were some convenient landing places for ships in Berenike (*Geography* 17.1.45). This indicates that at that time the bay was not silted up and, therefore, would have been too deep for the mangrove vegetation.

Leaves used as fodder would have been a welcome by-product in the cutting down of the mangrove vegetation. It is also possible that mangrove wood was exported to Arabia, where it is still used for various kinds of construction, including houses, and as firewood. The mangrove was once the main cargo of specially constructed dhows that exported it from the East African coast (Yajima 1976:44).

The only other archaeobotanical record of *A. marina* originates from Abu Sha'ar, a Roman settlement along the Red Sea coast 20 km north of Hurghada (El-Hadidi and El-Fayoumi 1996:12). Large quantities of leaves have been found here.

***Balanites aegyptiaca* (L.) Del.**

English:	Desert date, Egyptian balsam, Egyptian myrobalan, Hailab date, Lalob tree, Soapberry tree, Sugar date, Thorn tree, Zachum oil tree
Arabic:	Balah harara, Balah hawarah, Balah halaib, Haglig, Halag, Hala'ig, Halaj, Halig, Hegeleeg, Hegelig, Hegleeg, Heglig, Higleeg, Hel'eig, Igleeg, La(a)loab, Ligleeg, Shaashoat, Sur, Zaqqoum
Indian:	Betu, Hingan, Hingot, Hingotia, Ingudi, Lalo, Nanjunda, Ringri, Zachnun
Plant part:	fruits (endocarp and mesocarp)
Trench/midden:	BE: 1, 3, 4, 6, 10, 14–16, 19, 21, 33, 37, and 48; SS: 4, 20, 21, 29, and 53
Period:	first, second, and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figures:	4.17, 4.18, and 4. 19

Although some of its English names suggest membership of the palm family, the sugar date or desert date in fact belongs to the Balanitaceae, of which it is the only representative in Egypt. The shape of sugar dates is quite irregular and resembles that of the real date. But this resemblance does not hold for the anatomy of the fruit or the morphology of the seed. The inner layers of the fruit are woody and resistant to decay. The outer soft part of the fruit is not present anymore in subfossil specimens. The fruit pulp has a high sugar content of about 45 percent, while the relatively small seed is quite soft and yields 40 to 60 percent balanos oil.

Balanos oil was used for the production of all kinds of perfumes. Like alcohol, fats and oils are capable of absorbing and retaining odors. According to Theophrastus (*CO*: 14.14), balanos was a most valued oil because of its mildness, and these oils from Egypt and Syria were in best repute. Balanos oil was one of the ingredients of *stacte*, a myrrh oil. A highly valued *stacte* was produced in Mendes, the Greek name for two large tells located in the Nile Delta. Originally this scent was made from a simple mixture of balanos oil, myrrh, and resin. Later on, *stacte* became a very complex composition when all kinds of other substances were added (Lucas and Harris 1962:87). Schweinfurth (1865b: 273) states that the seeds can be used as a soap substitute.

The use of the fruit as a folk medicine has a long tradition in many African countries, including the use of aqueous extracts as a medicine for diabetes mellitus. It has been demonstrated that in the southern part of the Eastern Desert, the noninsulin-dependent type of diabetes mellitus is less prevalent than in, for example, the Nile Valley. This seems to be correlated with the non-Western lifestyle of the Ababda nomads, in which diet and folk remedies play an important role (Barnard et al. 1996:24). The fruits are still collected by the

Figure 4.17. Gnawed fruits of the sugar date (*Balanites aegyptiaca*) near Khesm Umm Kabu (February 1998). See Color Plates section, page 222.

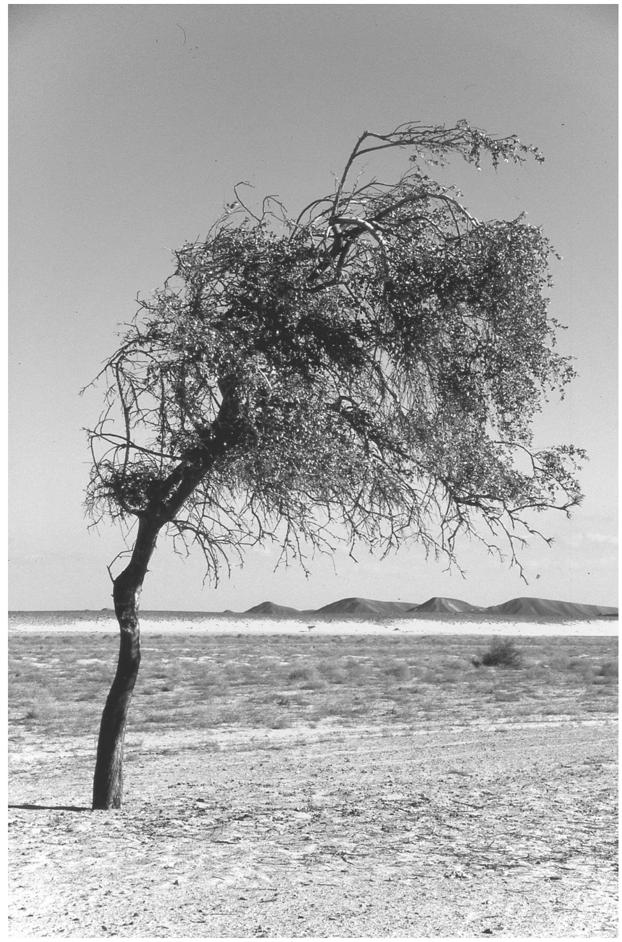


Figure 4.18. *Balanites aegyptiaca* on the coastal plain northwest of Berenike, looking west (January 1996). See Color Plates section, page 222.

Ababda nomads. They are also offered for sale at more-specialized spice markets.

Large numbers of fruits can be collected from a single tree, either from the branches or under the tree. The high sugar and oil contents also make the fruits and seeds attractive to animals. According to Osborne (1968:171), camels and donkeys eat the fruits. This could be evidenced by the author at the Roman mountain settlement Khesm Umm Kabu, where many gnawed fruits were found under a *Balanites* tree (Figure 4.17). According to the Ababda guide, gazelles or goats ate these specimens.

Very often, an insect infects fruits. In such cases, a small hole with a diameter of about 3 mm is found at a point about one-third of the total length of the fruit. In some instances, fragments of the pupa of a scolytid beetle are still present in subfossil fruits. According to E. Panagiotakopulu (personal communication), it may concern the date stone beetle (*Coccotrypes dactyliperda* F.), which is recorded from the date palm, although

Figure 4.19. Fruit (endocarp) of sugar date (Balanites aegyptiaca) with an exit hole of an insect (3.2 x 1.2 cm). Photograph by J. Pauptit.

this has to be checked with modern material. Probably, an egg is injected with the oviposter in the still soft, undeveloped fruit. The larva feeds itself with the seed. When the metamorphosis is complete inside the fruit, the imago leaves the fruit through the characteristic perforation. This kind of infection is visible in both recent and subfossil specimens. From the 255 fruits that were screened in the 0.6 m² under a *Balanites* tree in Khesm Umm Kabu, 80 percent of the specimens proved to be infected.

The perforation of the *Balanites* fruits has been recorded from many subfossil specimens and has been explained in different ways. Woenig (1971:320) states that the holes are made by a snout beetle (Curculionidae), a point of view that is also held by, for example, V. Loret and conforms to the above-mentioned observations. Keimer (1984:2), mentioning several records that concern perforated fruits found in graves, is of the opinion that humans purposely damaged such fruits in order to disturb the magic power of the fruits. This act would have been comparable to the disturbance of other offerings that were found in the graves. Another interpretation assumes that rodents such as mice and rats made the holes, as can be deduced from the traces of gnawing (Germer 1985:99; 1988:26). Such traces seem to be present in the specimens depicted by Täckholm (1961: Plate VIIc), but she is of the opinion that these holes were made by man to get the seeds for making balanos oil. Although the holes seem artificial in fruits from the Third Dynasty as presented in Darby et al. (1977:779), these fruits (or seeds?) certainly do not represent sugar dates, so extracting balanos oil is also out of the question. Keimer (1984:2) refutes the assertion of gnawing by rodents because perforated fruits were regularly found in closed graves. It may be concluded that most probably insects and rodents can be held responsible for the holes in the fruits and that these holes are not indicative of oil extraction. A practical method of oil extraction would be smashing the fruits to release the oily seeds. In Berenike, fragments of the sugar date have been frequently found, but it is seems more likely that the disintegration resulted from decay.

Today, sugar dates are mainly found in the middle and upstream parts of the wadis of the Eastern Desert. Scattered trees are present in Wadi Gimal and Wadi Gadireh south of Gebel Nugrus, 100 km and 120 km north of Berenike respectively. Rawlison (1881) states that many trees grow along the road between Koptos and Berenike. Their presence on the coastal plain seems to be quite rare. Although Schweinfurth (1865c: 539) states that the sugar date is absent from the whole Egyptian coast, the tree has been evidenced by some records. One isolated specimen was found on the coastal plain near the mountains northwest of Berenike (Figure 4.18). Fairly large quantities of the sugar date are present in the Gebel Elba area and the wadis between these mountains and the desert east of the Aswân province (governate) (Drar 1954:73), which finds its expression in the name "Hailab" date. The suggestion by Täckholm (1961:23) that the sugar date had once a more widespread distribution is unconvincing as it is only based on the analyses of ancient honey containing abundant quantities of *Balanites* pollen.

The number of subfossil sugar dates found at Berenike indicates that this fruit was available on a reasonable scale in the second habitation period (fourth to the early sixth centuries AD). The fruits probably originated from the area south of Gebel Nugrus and the Gebel Elba.

***Beta vulgaris* L. s.l.**

English:	Beet
Arabic:	Dirs el-kalb, Figl bou-leil, Sabanakh, Salq, Selg, Silq
Indian:	Chukandar, Chuquander
Plant part:	fruits and receptacle clusters
Trench/midden:	BE: 10, 13–16, 19, 21, 25, and 37; SS: 7, 20, 21, 29, and 53–56
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figure	4.1

Beet is a vegetable that can be cultivated for its leaves and its roots. It was a well-established vegetable in classical times, as is evidenced from Greek and Roman texts and subfossil records. Early cultivation produced leafy forms as well as tuberous cultivars (Zohary and Hopf 2000:200).

Besides the cultivated beet (*Beta vulgaris* ssp. *vulgaris*), two wild taxa of beet are distinguished: *B. vulgaris* ssp. *maritima* (L.) Arcangeli, which occurs in Europe, the Middle East, and the Indian subcontinent, and *B. vulgaris* ssp. *adanensis* (Pamuk.) Ford-Lloyd and Williams, which is recorded from Greece, the south and west coasts of Turkey and Syria (Letschert 1993:35).

The flowers of beet are clustered in spikelike inflorescences. Each cluster consists of (1-) 3–5 (-7) flowers, and each flower produces one seed, which becomes fused by the fruit coat. The flowers of a cluster are connected to each other by the apical part of the flower stalks (receptacles). At fruiting, these receptacles become swollen and when ripe, they fall to the ground as a unit. Consequently, the multigerm clusters may produce several seedlings close to each other.

It is striking that most of the germ clusters from Berenike and Shenshef concern two-germ clusters. Exceptionally, some three-germ and one four-germ cluster were found. On the basis of this low number of germs per cluster, two species come into consideration: *B. macrocarpa* and *B. vulgaris*. A third species, *B. patula* Aiton, has clusters with on average seven germs and is only recorded from a small island near Madeira (Letschert 1993:44). *B. macrocarpa* and *B. patula* are also classified on a infraspecific rank of *B. vulgaris* (e.g., Wiersema and León 1999:76).

It could be demonstrated that *B. vulgaris* ssp. *adanensis*, which is recorded from Greece, Cyprus, and Turkey, is highly constant in its low number of germs per cluster. *B. vulgaris* ssp. *maritima* and *B. macrocarpa*, whose distribution stretches from Western Europe to the eastern Mediterranean and, in the case of *B. maritima*, extends to the Indian subcontinent, have a low number of germs in eastern Mediterranean countries (Letschert 1993:58–59). Although *B. macrocarpa* and *B. vulgaris* are distinguished in particular by the morphology of the margins and tepals of the germ clusters, the subfossil fruit clusters from Berenike and Shenshef, from which almost all tepals had disappeared, did not allow an identification to the level of species.

From an agricultural perspective, the clustering of germs is undesirable because several plants will develop, resulting in close competition for both water and light. As a consequence, seedlings have to be planted out, which is very time consuming. On the other hand, the germination of beet is prohibited by a number of chemical compounds in the seed, which may be responsible for a delay in germination of some seeds for several years. This phenomenon was already known in antiquity, and Theophrastus (*EIP* 7.1.6) mentions that as a result of this only a few plants come up from a seed.

Recently, alternative approaches have been developed to overcome the disadvantage of using multigerm clusters for sowing. One method is to break up the clusters into fragments that contain one fruit each. Another possibility is to manipulate the number of fruits in a cluster by genetic engineering, which has resulted in races that produce monogerm clusters.

Besides this economic qualification, the reduced number of germs per clusters also has an ecological implication. Whereas multigerm clusters tend to produce perennial plants, plants that develop from low-numbered germ clusters are short living and may fulfill their life cycle within about 40 days (personal communication from J. P. W. Letschert). In this way, the plant is well adapted to arid conditions. Additionally, the bi-germ clusters have the advantage of a low level of competition for water as only a few seedlings are produced on the same spot. This germination pattern and life cycle fits in quite well with the extreme desert conditions. Also the brackish environment around Berenike and the high nutrient availability in trash areas will have been favorable for the growth of beet, which is a bad competitor but can profit from such extreme conditions in a ruderal environment. This is especially true for *B. macrocarpa*.

Beet belongs to the very few commodities that are also mentioned on an ostrakon found in Berenike (Bagnall et al. 2000:23). This implies that edible parts of beet have been imported and consumed. The scattered presence of the beet clusters at Berenike and Shenshef suggests that they originate from a weedy species because seeds for sowing would not have been dispersed in such a way. It is possible that beet clusters entered Berenike and Shenshef with cereal harvests from the Nile Valley, after which they could have successively established themselves in both sites near dump areas where the sand is mixed up with organic compounds. Alternatively, the beet may have been intentionally cultivated in local kitchen gardens. In both cases the plant might have been exploited for its leaves only and would have produced germ clusters by itself.

Only a few records of beet are available from ancient Egypt. The oldest one concerns a small apex of a flowering branch found in the Step Pyramid of Saqqara and is dated to the Third Dynasty (2650–2575 BC). The second record concerns inflorescences with predominantly two-germ clusters from the Coptic monastery of Phoebammon. Both plant remains are identified as *B. maritima* ssp. *maritima* (Täckholm 1961:11–12), and in both cases the flowering branches indicate a weedy character.

Capparis spinosa* L. *s.l.

Synonym:	*C. galeata* Fresen.; *C. sinaica* Veill. in Duh.; *C. aegyptia* Lam.
English:	Caper bush
Arabic:	Abaar, Agra, Akbaar, ’Assaaf, Girro, Kabaar, Kabbar, Lassaaf, Laysoof, Laysuuf, Shawk el hhimar,

	Shafallah, Shafella, Shoak el-homaar, Ward el-gabal
Indian:	-
Plant part:	seeds and fruit fragments
Trench/midden:	BE: 3, 10, 13–16, 19, 21, 25, and 37; SS: 4, 7, 20, 21, 29, 53, 54
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figures:	4.20 and 4.21

Figure 4.20. Inner part of fruit of caper bush (*Capparis spinosa*) with pulp and seeds (5.5 x 1.7 cm). Photograph by J. Pauptit.

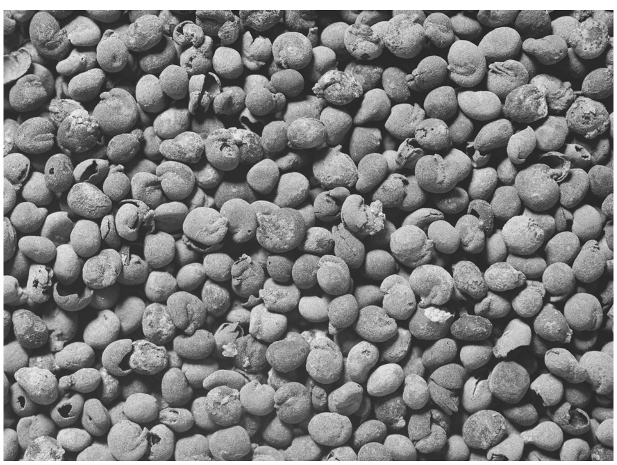


Figure 4.21. Seeds of caper bush (*Capparis spinosa*) (single seed ca. 3.0 x 2.5 mm). Photograph by J. Pauptit.

The genus *Capparis* is represented in Egypt by three species: caper bush (*C. spinosa*), *C. sinaica* Veill. in Duh., and *C. decidua* (Forssk.) Edgew. (Boulos 1999:171). The presence of the leaves and the shape of the flower and fruit can easily distinguish the caper bush from C. decidua. Also the seeds are easily recognized by the absence of warty papillae. The caper bush is subdivided into four subspecies, which were formerly even treated on a species level. The difference between caper bush and *C. sinaica* is mainly based on the length of the sepals. Because the fruits and seeds of the caper bush and *C. sinaica* are quite similar, the plant remains from Berenike and Shenshef concern both species and are identified as *C. spinosa* L. sensu lato.

More than 2,200 seeds of the caper bush have been unearthed at Berenike, all but one preserved by desiccation. Some fragments of the fruit were also found, some of which contained many seeds. The presence of both seeds and fruits does not exclude the possibility that the plants included a variety (namely, var. *spinosa*) selected for its large, edible flower buds.

Today, the caper bush is quite rare in the Eastern Desert, where it grows on rocky grounds and steep cliffs, for example the rocky sidewalls of wadis. Schweinfurth (1865a: 146; 1865b: 274; 1865c: 549) mentions a large population at the old Quseir (Philotera) and at several locations near Quseir and at several locations between Quseir and Berenike: Wadi Mre(h)k (ca. 25 km south of Quseir), near Gebel Abu Tiyur (25°43' N; 34°16' E) and Wadi Gadireh (= Wadi Ghadir, ca. 20 km N of Wadi Gimal).

The caper bush is a successful invader of fields and is capable of producing flowering specimens even after a couple of weeks. Dealing with vegetable gardening, Pliny (*NH* 19.48.163) describes the cultivation of caper in sandy plots that have been hollowed out and surrounded by stone walls to prevent the invasion into other fields. In Berenike and Shenshef, the remains of caper bush were found in some dump areas that were located on the outside of buildings. This implies that this decorative plant with its 1 to 5 cm broad, white flowers had grown on the walls of some buildings. Each flower is open for only one day and produces, after fertilization, a 3- to 8-cm-long fruit that grows on an elongated stalk (the *gynophore*) on which the stamens are implanted. The ripe fruit opens into five segments presenting the purple-red pulp to which birds are attracted, and they in turn act as dispersal agents for the seeds.

According to Pliny (e.g. *NH* 13.44.127 and 20.59.165–167) the root, wood, and fruit of the caper bush were used. Besides medical applications that concern the roots especially, it is also mentioned that the fruits are edible, though Pliny warns against varieties with nonedible fruits from Marmarica (northwest Egypt) and outside Egypt. Galen (*On the Powers of Foods*: Book 2), on the other hand, only mentions the fruit and recommends it as a medicine rather than as a source of food (Grant 2000:134). The edibility of the fruits is also mentioned by Schweinfurth (1865a: 146), who remarks that the fruits were frequently sold in the market in Quseir, and by Drar (1936:18), stating that nomads ate their contents as a remedy against fever.

The archaeobotanical record of *Capparis* in Egypt is scanty. Only *C. decidua* has been identified to the level of species on the basis of wood and seeds and is recorded from the late Paleolithic and predynastic periods. Three other records, concerning seeds and pollen, could not be identified beyond the genus level and are dated to the late Paleolithic, predynastic period and Second Intermediate periods (de Vartavan and Amorós 1997:61–62). Other references include depictions. Those from the "botanical garden" of the temple complex of Tuthmosis III in Thebes are identified by Beaux (1990:170–171) as possibly representing *Capparis*. The double fruits should resemble those of the caper bush, but similar images are also attributed to *Cucumis melo*, as Beaux admits in fairness. Moreover, the caper fruit consists of 5 to 10 carpels forming a spindle-shaped fruit. Therefore, this doubtful identification is not tenable. The picture on a tile from Amarna, on the other hand, presented in the *Flora des pharaonischen Ägypten* (Germer 1985:46), is more convincing. It shows a branch with leaves and a part of an elongated fruit, which indeed may be a representation of the caper bush.

***Carthamus tinctorius* L.**

English:	Bastard saffron, False saffron, Safflower
Arabic:	Bahram, Bahraman, Bahrameg, 'Esfur, Gole rang, Ihrid, Kosheik, Kurtum, 'Osfor, 'Osfoor, Qortom, Qartam, Qurtum, Qurtuma, 'Usfur
Indian:	Koosumbha
Plant part:	fruits
Trench/midden:	BE: 1, 13–16, 19, 25, 31, and 33; SS: 21 and 29
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4.22

Safflower is a member of the daisy family (Compositae or Asteraceae), which means that the small flowers are arranged on a common receptacle and appear as one large flower. In the case of safflower, the number of flowers in such a dense terminal head, which measures 2 to 4 cm in diameter, varies from 20 to 100. Each flower produces one seed, which is tightly connected by the fruit coat. What is called a "seed" in common parlance is basically a fruit, its official name being "achene."

Figure 4.22. Convex view (left) and concave view (right) of fruit of safflower (*Carthamus tinctorius*) with exocarp only partly preserved (5.2 x 7.4 mm). Photograph by J. Pauptit.

The plant is cultivated for its oil and its red and yellow dyes. The dye is produced from dried flowers and can be used for coloring food and textiles, whereas the oil is extracted from the fruits. This enables a combined harvest. Soon after flowering, by which process the seeds are either self-pollinated or cross-pollinated, the red flowers are carefully taken from the flower heads without disturbing the fruits. When the fruits are ripe, the second harvest may take place. Because the plants are spiny, which is particularly true for the bracts that surround the fruits, the whole plant is cut down. The top of the flower head contracts after flowering in such a way that seeds are enclosed by the bracts, preventing them from falling out. On a more commercial basis, crops are either grown for their seeds or flowers, comparable with the cultivation of flax, which is grown for its fibers and oily seeds.

The advantage of safflower as a dye plant over others such as woad (*Isatis tinctoria* L.) is that its valued pigment is directly available from the plant. The discovery of the pigment carthamin, which can be dissolved in alkaline solutions and is therefore permanent, was probably initiated by the custom of sowing flowers onto strips of papyrus and then draping them around the bodies of mummies (Langer and Hill 1982:158). The red dye has been used for textiles and as a substitute for saffron in coloring food as is expressed in some of its vernacular names, namely bastard saffron and false saffron. True saffron is obtained from the flowers of saffron crocus (*Crocus sativus* L.) and is extracted from the stigmas. Each plant produces only one stigma so that it is quite expensive and never offered for sale in huge bags such as found in many spice markets, where isolated flowers of safflower are offered for sale "as saffron" with a large profit margin.

The oil content of the fruit is relatively low (26 to 30 percent) due to the thick fruit coat, which represents

35 to 40 percent of the complete diaspore (Schuster 1992:63). The oil can be used for culinary purposes and for burning. Using the fruits as a source of oil has been practiced in Egypt and India from antiquity onward, although today Egypt is no longer a main producing country. Safflower oil was in common use in Egypt during the Ptolemaic period. The status during the Roman period is, however, ambivalent, as half of the papyri that mention this oil are statements that forbid planting safflower (Sandy 1989:87).

Safflower has been attested in ancient Egypt from the Twelfth Dynasty (1991–1783 BC) onward. The plant is represented by leaves, flowers that are partly used in mummy garlands, pollen, fruits, and chemical compounds that are indicative of its use as a dye. Most records from the Roman period concern its fruits. There is papyrological evidence of the cultivation of safflower for oil during the Ptolemaic period in the Fayum (Hagedorn 1975:89). Pliny (*NH* 21.53.90), using the word *cnecon*, most probably describes safflower by stating that this prickly plant is cultivated for its white, large, and bitter seeds that contain oil. According to Pliny, this plant is native to Egypt and does not grow in Italy, a statement that is in accordance with its ancient distribution as a cultivated crop. The most likely area of origin of the safflower brought to Berenike is therefore the Nile Valley or the Fayum.

The presence of the fruits at Berenike remains puzzling however. It might be that the fruits were imported from the Nile Valley as a source of oil. The supply of fruits instead of ready-made oil might be explained by the production of fresh safflower oil and the pressed fruitcake. This by-product would have been suitable for cattle fodder as it still contains about 43 percent protein (Langer and Hill 1982:159). A similar kind of fodder, consisting of a large pile of cake disks made from pressed olives, has been recovered from the Roman settlement Karanis (Kôm Aushim). Especially in hot climates, safflower oil is sensitive to oxidation (Seegeler 1983:106). Considering the fruit an export item is a less-plausible explanation, as safflower was introduced from the Indian subcontinent into East Africa, probably by Arab and Indian traders (Seegeler 1983:88).

***Ceratonia siliqua* L.**

English:	Carob tree, Locust tree, St. John's bread
Arabic:	Bharout, Harrub, Kharnub, Kharoub, Kharoubah, Kharrub, Khurub, Kiranit
Indian:	-
Plant part:	seeds
Trench/midden:	BE: 1, 10, 13-16, 19, 21, 31 and 33; SS: 20, 21 and 29
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4.23

Figure 4.23. Whole seed (left: 10.5 x 7.3 mm) and cotyledons with embryo of carob (Ceratonia siliqua), with only fragment of the seed coat left (right: 9.2 x 6.7 mm). Photograph by R.T.J. Cappers.

The carob is a tree that is adapted to dry and warm climates and is predominantly found in the eastern Mediterranean region where it has its southernmost limit in the Philistean Plain of Israel (Zohary 1973:370). It has also been recorded from southwestern Arabia and Somalia, but this probably concerns escapes from cultivation as is, for example, suggested for Yemen by Wood (1997). Its present distribution in Egypt is limited to some wadi beds in the Sinai (Boulos 1999:361) and some isolated localities in the Mediterranean strip west of the Nile Delta, the latter being the result of some former attempts to reintroduce the carob together with other orchard crops in this area (Zahran and Willis 1992:21).

The carob is described fairly convincingly by Theophrastus (*EIP* 4.2.4) as he mentions that it is an evergreen tree of reduced size with whitish flowers and pods that grow on the stem and branches on which both new pods and some from the previous year are present. Theophrastus is firmly of the opinion that the carob did not grow in Egypt. Strabo (*Geography* 17.2.2) states that the carob grows in abundance in Ethiopia. Strabo (*Geography* 1.2.27 and 17.3.23), who has traveled in Egypt himself, uses the name *Ethiopia* for the land that borders the south of Egypt and admits that he is not aware of Ethiopia's geographical contours, which means that this may include Somalia. This implies that the carob seeds that were found at Berenike and Shenshef might have been imported either from the Mediterranean region via the trade route along the Nile Valley, or from the so-called far-side ports along the Somalian coast. The same is probably true for subfossil remains from the pharaonic period, the oldest record dating back to the Twelfth Dynasty (1991–1783 BC). Expeditions as early as ca. 2400 BC to the land of Punt on the Red Sea, which is located south of Egypt and is assumed to be Somalia, might have resulted in the availability of this tree from this area.

Carob pods are still offered for sale in spice markets, for which Cyprus is the leading supplier. The sweet-tasting fruit is edible for humans but not of a high quality. As it only has a high content of sugar and calcium, it was probably consumed more in times of scarcity. A refreshing drink (kaftan or keratomeli) is made from the pods, and the sugar content is also sufficient for producing alcoholic beverages. Whole pods are sold as animal fodder. Pods are also used in medical treatment, which is true for both ancient and modern Egypt. Many old prescriptions are known for eye diseases and coughs (Manniche 1989). In modern folk medicine, the pods and seeds are used for the treatment of diabetes and diarrhea (Ahmed et al. 1979:90). Furthermore, the fruit is roasted and ground to be used as coffee (Kamal 1975:131).

Like the seeds of the rosary pea, the hard, glossy carob seeds were used as jewelers' weights. One seed represents the specific weight of one *carat*. In this context it has been suggested that the Arabic word *qirat*, which means "pod, husk, weight of four seeds," is derived from the Greek word *keration* (meaning "little horn," referring to the shape of the pod), which in its Latin transcription is still used in the genus name of this plant species. Originally, the weight of one carat varied from 197 mg to 216 mg and was only fixed at 200 mg in 1913. This difference might be traced back to the variability in seed weight. Basically, the variability in seed weight can be attributed to both differences between and within plants. In the latter case, differences can be related to variations in environmental conditions and the time of production, which in turn is related to the position of the fruit on the plant and, on a microlevel, also on the position of the seed within the fruit. The variability in seed weight of carob seeds is considerable as can be deduced from its difference in size: 5–10 x 3.5–7 x 1.2–4.5 mm (Gunn 1991:144).

Although it does not exclude the possibility that the carob seeds were used at Berenike and Shenshef as a unit of weight, the presence of a reasonable number of carob seeds in several trenches plead for the use of the carob fruits as animal fodder. Ripe fruits can be dried within a month and are then suitable for long-distance transport. The seeds are so hard that they will escape mastication and end up in the desert soil.

***Cicer arietinum* L.**

English:	Bengal gram, Chickpea, Egyptian pea, Garbanzo, Gram
Arabic:	Alhamos, Beiqa, Blabi, Chemps, Hammes, Ham(m)o(u)s, Himmas, Himmos, Hommes, Hom(m)os malana, Hummas, Hummus, Malanah
Indian:	Adas, Buthalai, Chahna, Chala, Chania, Chan(n)a, Chela, Chola, Chono, Chota but, Chunna, Harimandha-kam, Kadale, Kadli, Karikadale, Korkadala, Sangalu, Sundal kadalai
Plant part:	seed
Trench/midden:	Be: 2–3; 15–16; 19; 23; 25–26; 29; 34 and 37
Period:	first–second and fourth–fifth centuries AD
Preservation:	desiccated
Figure:	-

The chickpea is one of the founder crops that was taken into cultivation in the Near East. From there it spread westward over the Mediterranean area. Additionally, it was taken into cultivation in India and Ethiopia in ancient times, where now secondary gene centers exist (Van der Maesen 1972:6–8,1979:141). In the Near East, India, and Ethiopia, chickpea is still the most important pulse crop (Westphal 1974:85). In Egypt, on the other hand, the chickpea is only a minor food legume and is mainly grown in the southern Nile Valley and the Nile Delta (Nassib et al. 1990:58). It can be used in cooking or made into a roasted or candied snack.

Theophrastus (*EIP* 8.5.1; 8.6.5) states that chickpeas differ in size, shape, color, and taste. He distinguishes a red, a black, and a white type, the last one being the most appetizing. This distinction corresponds quite well with the cultivars grown today. On the other hand, Theophrastus (*EIP* 4.4.9) erroneously states that the chickpea does not occur in India, while the Indian archaeobotanical record of this food legume dates back to the third millennium BC (Kajale 1991:160–167). A substantial record of archaeobotanical finds is also available for the Middle East and the Mediterranean, but not for Ethiopia and Eritrea, where archaeobotanical research in Axum has only recently been started. Literary sources make mention of the cultivation in Ethiopia as early as AD 1520. Therefore, the origin of the chickpea in Ethiopia is still rather obscure. According to Van der

Maesen (1972:7–8), the chickpeas of Egypt and Ethiopia differ from each other, making it unlikely that this crop was traded between both countries. This would imply that the Egyptian chickpea was introduced directly from the Near East, whereas the transoceanic trade between India and East Africa might have been responsible for its introduction into Ethiopia and Eritrea.

The chickpea is represented in Berenike by only 26 seeds. This number is in marked contrast with that of two other pulses, namely lentils and white lupin, which have been found plentifully in many samples. Wastage of the relatively small lentils is obvious because seed samples are contaminated with weed seeds and small stones, and cleaning such contaminated lentils automatically means some smaller specimens will end up in the soil. The presence of the large seeds of the white lupin can be explained by the manner of consumption. Eaten as a snack, the content of the seeds is sucked out, whereas the empty seed coat is discarded. In contrast, the large chickpea seeds can be sieved effectively, resulting in almost no wastage. The chickpea was probably imported from the Nile Valley.

Citrullus colocynthis **(L.) Schrad.**

Synonym:	*Colocynthis vulgaris* Schrad.; *Cucumis colocynthis* L.
English:	Bitter apple, Colocynth, Vine-of-Sodom, Wild gourd
Arabic:	‘Alqam, Hand(h)al, Hadag, Hanzal, Hanzil, Mararet es sahhari, Oorky, Shary, Tattoor
Indian:	Chittipapra, Indra varuni, Indrayan, Kaurtumba, Makal, Rakhalsasa, Tumathi, Tumba
Plant part:	seeds
Trench/midden:	BE: 1, 6, 10, 13–16, 19, 21, 25, 31, 33, 37, and 48; SS: 4, 7, 10, 20, 21, 29, and 53–56
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figure:	4.24

The colocynth is a common desert plant that belongs to the white bryony family (Cucurbitaceae), which includes watermelons, gourds, and squashes. The colocynth has slender, procumbent stems with small yellow flowers that produce fruits with a diameter of 5.5 to 10.4 cm (Cappers 1996:325). Although tendrils are present, plants have mostly a prostrate habitus because of the lack of suitable host plants. Only occasionally plants may be seen trailing over other plants. Schweinfurth (1865b: 270) even describes many specimens hanging down from the slope of Wadi Mursseefa, south of Quseir.

Figure 4.24. Outside (left) and inside (right) of seed coat of the colocynth (*Citrullus colocynthis*) (4.2 x 8.3 mm). Photograph by J. Pauptit.

Unripe fruits are green and juicy and quite heavy. During the ripening process, the fruits become yellow and dry out completely, by which process the seeds get released from the inner fruit layers. The fruits are now very light and can easily be dispersed by the wind. As soon as the fragile fruit coat becomes damaged, the seeds are scattered into the sand.

Despite its close taxonomic relationship to the watermelon, both fruits and seeds of the colocynth are not fit to eat due to their extreme bitter taste caused by the glucoside colocinthine. According to the Ababda nomads, only donkey and gazelle eat the fruits when they are still juicy and when more preferable herbs are no longer present in sufficient amounts. Osborne (1968:167) states that they are also eaten by Barbary sheep, rodents, and, after being boiled or roasted, by Tibbu people. Personal observations confirm that juicy fruits are eaten by donkeys, but not by sheep and goats. It was also observed that holes were pecked in both unripe and ripe fruits, probably by carrion crows.

The presence of colocynth depends on the rainfall during the winter period. When there has been sufficient rainfall, some hundreds of full-grown fruits can be collected in the nearby wadi branches. After a dry winter, however, the number of plants is clearly reduced, and also the fruit diameter is relatively small. The colocynth still occurs in Wadi Shenshef and may have entered the trash deposits from this settlement by natural dispersal agents. Nevertheless, the occurrence of colocynth seeds in reasonable concentrations in most samples from Shenshef seems to exceed its presence as part of the seed bank and consequently indicates deliberate collecting. The rare occurrence of the colocynth in the immediate surroundings of this settlement can be explained by the presence of wild donkeys and gazelles, the former frequently seen passing the settlement area on special paths and the latter detected by the many hoofprints in the sand. The colocynth is also present in the many branches of Wadi Mandit in the coastal plain around Berenike, so the collecting of these fruits did not require a great deal of effort.

It is possible that the residents of Berenike collected unripe, juicy fruits of the colocynth as donkey food. In addition to camels, these animals were used for transport in Berenike (Van Neer and Lentacker 1996:346). Such unripe fruits can be stored for at least a couple of months without drying out.

Ababda nomads also use the fruits for medical purposes, and in wadis where this species is abundant, carloads are collected and brought to Aswân to sell at the markets. Fruits that are still juicy are fastened to one's heel to relieve the pain caused by rheumatism. The production of an ointment for treating camel scabies is mentioned in particular in relation to the Ababda nomads. This ointment is made by filling a pot with colocynth seeds and covering the pot's mouth with some palm leaves. Then the pot is put upside down on a dish and covered with charcoal. During this process, black oil, resembling motor oil, drips out of the seeds onto the dish. After shaving the camel's skin and removing the scab, the black ointment is then rubbed onto the wound of the camel. During his visits to the Gebel Elba area, Drar (1936:44) saw piles of colocynth fruits and a number of small ovens between Wadi Ibib and Karam Elba especially erected for extracting this tar, which they call "*diwân*." Also Osborne (1968:167) often saw piles of charred seeds and remnants of fruits in wadis of the Eastern Desert together with an oven of stones and clay. According to Girgis, cited in Zahran and Willis (1992), this tar was also used for tanning skins meant for making water bags. Bottles with such tar are still sold at local markets, such as those of Shelateen. In the Sinai, the bedouins still use colocynth seeds to cure human constipation (Hobbs 1990). Reasonable quantities of colocynth fruits are still collected in the Egyptian deserts and put up for sale in markets where they are sold for 1 Egyptian pound apiece. Although the colocynth is a common desert plant and the fruit is widely used, the subfossil remains from Egypt are relatively scanty and limited to about 10 different sites that date back as early as the Neolithic.

Citrullus lanatus **(Thunb.) Matsum & Nakai**

Synonym:	*C. vulgaris* Schrad.
English:	Watermelon
Arabic:	Battikh, Gurma, Habhab, Libb
Indian:	Indrayan, Kharbuza, Tarbooz
Plant part:	seeds
Trench/midden:	BE: 1, 6, 10, 13–16, 19, 21, 23, 25, 31, 33, and 48; SS: 4, 20, 21, 29, 53, 54, and 56
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4. 25

Figure 4.25. Outside (left) and inside of seed coat of the watermelon (*Citrullus lanatus*) (whole specimen: 11.7 x 6.7 mm). Photograph by J. Pauptit.

Contrary to the colocynth, the watermelon produces edible fruits, which are much appreciated in a desert environment owing to its high water content of about 95 percent. Both the reddish, sweet-tasting fruit pulp and the large seeds are edible. The fruit pulp has a low content of vitamins and minerals; the seeds are nutritious and contain a relatively high percentage of protein, fat, and carbohydrate.

Today, in Arabic countries, several seeds are used as a snack, including seeds of watermelon, summer squash (*Cucurbita pepo:* L.), and large seeded varieties of the sunflower (*Helianthus annuus* L.), the two last ones being New World species. A special inedible variety of watermelon with small fruits is even exclusively cultivated for its seeds, especially in Nubia, from where it is imported to Egypt (Täckholm 1961:31). The seeds are crushed between the teeth, the seed content (endosperm) is eaten, and the hard seed coats are discarded. In Egypt this is practiced by both Egyptians and nomads. About half of the subfossil seeds from Berenike and Shenshef are still whole and suggest that seeds were not eaten. The seed fragments found can be explained because old seeds easily disintegrate, especially along the lengthwise groove.

As watermelons are well adapted to hot and dry climates, they might have been locally cultivated in kitchen gardens near Berenike and Shenshef. Because the fruits have a hard rind, they can easily be transported and might also have been imported (partly) from the Nile Valley. Today, they are, for example, available from the market in Shelateen. The storage life is maximized by leaving the long peduncle on the fruit (Langer and Hill 1982:186). Unfortunately, no remains of peduncles or rinds have been found so far.

Modern watermelons produce fruits up to 10 kg in weight. Such large-sized fruits can only be successfully grown if the stems creep along the ground. The tendrils produced in leaf axils indicate that we are dealing with a trailing plant so that in the past the fruits must have been much smaller. Watermelon is a native of tropical and subtropical Africa and has been cultivated in Egypt since predynastic times.

***Cocculus pendulus* (J.R. & G. Forst.) Diels**

Synonym:	*C. laeba* DC.
English:	-
Arabic:	'Elloaq, Fashkha, Labbakh (Libbakh, Lebbakh) el-gebl, Laseit (gabal), Libaakh el-gabal, 'Ollayq, 'Olleiq, 'Olloaq, Silaangoab
Indian;	-
Plant part:	fruits (endocarps)
Trench/midden:	BE: 10, 13 and 16; SS: 20, 54, and 56
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4.26

Figure 4.26. Fruit (endocarp) of *Cocculus pendulus* (4.3 x 3.4 mm). Photograph by R. T.J. Cappers.

Cocculus pendulus is a plant that grows in cliff-side habitats or in areas where other trees are present. In the latter case it becomes a liana. As the seed germinates in the soil, it produces a creeping stem that ascends when under a tree, possibly induced by the reduction of light intensity. The lower part of the stem, which is mostly flat to some extent, may reach a diameter up to 25 cm, whereas the interweaving branches are much smaller.

The plant is recorded from the Aswân Nile islands, all deserts, including the east section of Wadi Allaqi in the Nubian Desert, the Sinai, and the Gebel Elba area (Boulos 1999:152; Zahran and Willis 1992:165, 249, 285). The present vegetation around Berenike and Shenshef does not suggest that *C. pendulus* once grew in the vicinity of either of these places. The presence of small amounts of seeds in several trenches of both sites indicates that the edible fruits must have been imported regularly. Judging by the frequency of *C. pendulus* in the Gebel Elba, this area seems to be the most plausible place of origin.

The fruits have a diameter of 5 mm. The stony endocarps are relatively large, so that only a small part of the bitter tasting fruit is edible. Arabs use the fruits for making an alcoholic beverage called *Chamr el Madjnûne* (Engler 1912:191). Fruits are also used for medicinal purposes. Another member of this plant family, namely, *Anamirta cocculus* (L.) Wright & Arn., is one of the species that according to Warmington (1995:221) might have been traded by the Romans. The dried, highly poisonous fruits of this plant cannot be confused with those of *C. pendulus*, but are still sold under the old name of *C. indicus* Wright & Arn. at Middle East markets, including the Harraz Drug Store in Cairo (Ahmed et al. 1979:41).

During a visit to the Gebel Elba area in February/March 1999, it was seen that most fruits fall when they are still green. Once the fruits are on the soil, they lose moisture and are difficult to collect because they are scattered in low densities and tend to sink in the loose sand when they are touched. Collecting fruits still attached to branches is also difficult, especially when the liana grows in large, spiny acacias. An effective way of harvesting would be pulling down the fruits with long sticks and collecting the fruits on mats or cloths.

The archaeobotanical record of this species is scanty. The oldest record is from the Eastpans site A95/1-1 in the southwestern part of the Western Desert (24°44' N, 29°13' E) where some 10 charred seeds were found in a Middle Neolithic layer (personal communication from B. Zach). Another record concerns fruits found in Ani's tomb in Gebelein dating from the Eleventh Dynasty. Schiemann reported the presence of a single fruit of *C. hirsutus* (L.) Diel among samples of *Grewia*, taken from several baskets of Tutankhamen's tomb. According to Germer (1989:54), more fruits are present in the samples stored in the Dokki Agricultural Museum in Cairo. Recently, the author had the opportunity to check this sample and it turned out that the fruits of *Grewia* were contaminated with a fruit of juniper (*Juniperus communis*), a fruit of *nabq* (*Ziziphus spina-christi*), and two spikelets of grasses. Also, the other part of the *Grewia* sample from Tutankhamen's tomb kept in Kew does not contain any seed of *Cocculus*, so the identification by Schiemann could not be confirmed (Hepper 1990:56). Another reason for doubting its identification is that *C. hirsutus* is not native to Egypt but must have been imported from either Saudi Arabia, Yemen, or tropical Africa. Moreover, there is no reference to specific uses of the small fruits.

***Cocos nucifera* L.**

English:	Coconut palm, Copra, Nariyal
Arabic:	Al-jawz al-Hindi, Gawz el hind, Narjil, Nargil
Indian:	Jaralnare, Jauzialindi, Khopar, Nariel, Narikel, Tenga, Tengamaram, Tenkai, Tennankai, Tenna-maram
Plant part:	fruits (endocap, mesocarp and exocarp)
Trench/midden:	BE: 1, 10, 13, 19, 21, 29, 31, 33, and 48
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figures:	4.27, 4.28, 4.29, 4.30, and 4.31

Botany and Exploitation

The coconut is valued for both the fruit and the seed. The fruit consists of three layers: the exocarp, the mesocarp, and the endocarp. The lignified, relatively thin endocarp (shell) is tightly connected with the thin seed coat. Initially, inside the seed coat there is a liquid endosperm, which, as the fruit ripens, gets reduced and forms a white edible layer against the seed coat. The correct name for the liquid endosperm is "coconut water." It is also called "coconut milk," but this name concerns a derived product made from a mixture of grated endosperm and milk. The solid edible layer is often referred to as "meat" or "flesh," words that wrongly suggest animal origin.

The fibrous, buoyant mesocarp takes up the largest part of the coconut fruit and is adapted to dispersal by water. It yields coir, a fiber that is used for making ropes, carpets, and mattresses. Among others, the coir is made into rigging and cordage for ships and it is also used for caulking. Coconut oil was regularly used for oiling the ropes used for sewing together the planks of ships (Ray 1994:178). Coconut has the advantage of not rotting in saltwater.

Coconuts can be harvested either by cutting them from the tree or by collecting fallen fruits. Both methods can be applied for the production of copra, although the former has the advantage of removing dead leaves and detecting damage by pests. Because ripe nuts will hang on the tree for another two or three months before falling, the amount of coconut water will be too low for long-distance trade. Therefore, harvesting the nuts by cutting is necessary if they are meant for export.

Mostly, coconuts are husked so that the fibrous mesocarp and exocarp is separated from the inner part of the fruit, consisting of the endocarp and the seed (Figure 4.27). Further processing concerns the drying of the seed into copra. The hard "shells" are split and the "meat" is dried until the moisture content is reduced to about 6 percent. During this process, the "meat" becomes loose and can be separated from the "shell," which is more effective for drying. If the copra is properly dried, it can be stored almost indefinitely. Coconut oil can be obtained from the copra.

Today, the Ababda nomads occasionally use coconuts as containers (Figure 4.28). Such containers are called *garras* or *lozes* and are mostly made from gourds (*Lagenaria siceraria* [Mol.] Standl.). They are used for storing meat, animal fat, milk, and rancid butter used as a kind of hair gel. The rancid butter is mixed with

Figure 4.27. Whole coconuts (without husk) and small pieces of the seed are being sold in a market. Discarded shell (endocarp) fragments are thrown on the ground. Roasted rhizomes of earth-almond (*Cyperus esculentus*) in the foreground (Cairo, February 2001). See Color Plates section, page 222.

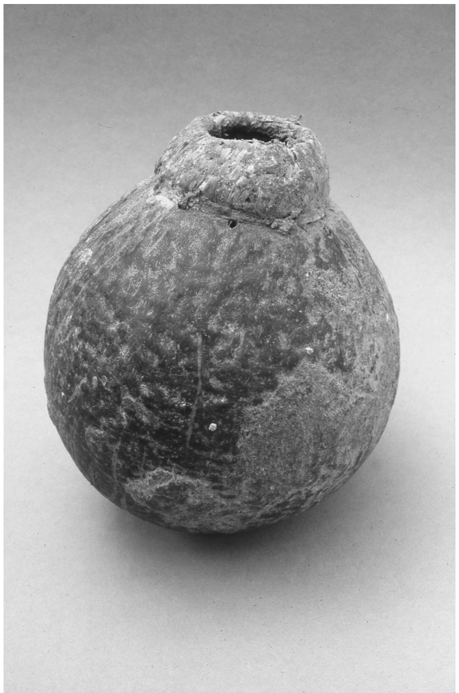


Figure 4.28. Loze with a coiled fiber neck made by an Ababda from a coconut (*Cocos nucifera*), Arab Saleh (March 1998). See Color Plates section, page 223.

Figure 4.29. Cultivated date palm (*Phoenix dactylifera*, left) and doam palm (*Hyphaene thebaica*, right) in the garden of the Dokki Agricultural Museum in Cairo (January 1998). See Color Plates section, page 223.

additives that enhance the smell. Such containers may be decorated with leather, textile, basketry shells, and beads. The whole-coconut *lozes* are obtained by removing the "meat," when it has rotted, through a hole bored through one of the eyes. The small hole is often closed with a stopper made by rolling up a piece of leather adjusted to the size of the hole.

Geographical Origin

The origin of the coconut is still unknown. The possible area of origin is Southeast Asia and Melanesia, whereas India is considered as a possible secondary center of origin (Ohler 1989:90; Zeven and de Wet 1982:78). The present distribution comprises the wet tropical lowlands, and the present-day coconut cultivation lies between lat 20° N and 20° S, although the noncommercial growth may extend as far as 27° N and 27° S (Menon and Pandalai 1958:2–6). There is still scholarly disagreement concerning the introduction of the coconut to East Africa, both with respect to period and dispersal agent. Its spread from India to East Africa by oceanic currents, preceding the distribution by humans, is only based on assumptions, although crossing the Indian Ocean by floating seems to be possible. An early introduction by humans, on the other hand, is plausible, based on the existence of ancient trade contacts between both continents. A reference made by Schuiling and Harries (1992:23) to the *Periplus Maris Erythraei* is not tenable because it is based on a mistranslation by Schoff (1995:99) of the Greek word *nauplios* [ναύπλιος].

Egypt fringes the northern distribution line of the coconut. According to Täckholm and Drar (1950:319), all attempts of cultivating the coconut in Egypt were futile because of unsuitable climatic conditions. The cultivation of coconut palms with the aid of irrigation on the island of Elephantine, near Aswân, is mentioned by Walter (1983:123). A striking record concerns the presence of a coconut palm growing near Berenike published by D'Abaza (see Täckholm and Drar 1950:317). An English naval officer, who had spent many years in the tropics and must have known the tree very well, made the observation, according to D'Abaza. The observation was confirmed in 1907 by the captain of one of the Khedivial mail boats. Distinguishing the coconut palm from the date palm is, however, quite difficult if no ripe fruits are present. Both trees have a similar shape with scattered, pinnate leaves. Another problem may be the identification of the location, as Berenike is completely covered by sand, with the Serapis temple only partly visible. Therefore, it could only have been seen with difficulty. Furthermore, south of Berenike two other Ptolemaic settlements with the same name as Berenike had been founded along the African Red Sea coast of the strait of Bab-el-Mandeb near Deirê (12°29' N, 43°19' E) and Ocelis (12°43' N, 43°28' E) (Bunbury 1959:579; Casson 1989:116, 119). It is possible that one of these sites was meant with respect to the observations. Strabo (*Geography* 16.4.14) states that palm trees are abundant in the whole region of Cape Deirê. The cultivation of coconut has been recorded on the coast of Yemen in Mukha (13°19' N, 43°15' E) by Forsskal in 1762/63. Today the coconut is not present anymore in this city and Wood (1997) assumes that it was destroyed by storms, together with most of the date palms earlier this century.

Inquiries among Ababda nomads about the former presence of coconut palm trees near Berenike produced no result. A possible coconut palm shown to me proved to be a sugar date (*Balanites aegyptiaca*) and, moreover, is not visible at all from the sea, which refutes the observation of D'Abaza (Figure 4.18).

Täckholm, who has visited the Red Sea coast several times, and particularly the district of Berenike, has not found any evidence for the existence of a coconut palm and assumes the date palm had been mistaken for the coconut palm (Täckholm and Drar 1950:318–319). According to Täckholm, isolated groves of the date palm were present along the Red Sea coast between Suez and Berenike prior to 1950. Her observations contrast with the present situation in which the nearest stand of date palms visible to passing ships is in the delta of Wadi Gimal, 93 km north of Berenike. About one hundred years before Täckholm's surveys, the German botanist Schweinfurth surveyed the Red Sea coast from Quseir southward to Suakin (19°08' N, 37°17' E, Sudan). Apart from some date palm trees in Quseir and in the harbor of Abu Nechle (*nechle/nakhl* means "date palm tree" in Arabic) (south of 22° N) and a doam palm (*Hyphaene thebaica*) near the harbor of Abu Reika (somewhere between 25°31' N and 25°12' N), the only palm grove he observed was in Wadi Gimal (Schweinfurth, 1865a: 289):

> "Hier überraschte mich der erste Anblick eines Schora-Gebüsches (*Avicennia officinalis* L.), dieses Waldes im Meere, während ich dicht daneben zu meinem Erstauen eine Dattelpflanzung und zahlreiches Tamarisken-Gebüsch wahrnahm."

According to Schweinfurth, this grove of date palms, accompanied by some dwarf specimens of the doam palm that are fully grown trees today, must have already existed there for several hundred years, and is probably a relic of an old settlement. If Berenike south of Ras Banas was meant indeed, and a date palm was mistaken for a coconut palm, it would imply that the tree must have been present only after Schweinfurth's visit to Berenike (24 February 1865) and must have been disappeared before the botanical surveys of Täckholm. As date palms can reach a height of 15 to 20 m over a period of 12 to 13 years, it is possible that a date palm grew in the vicinity of Berenike for a short period of time at the beginning of the twentieth century.

The most western occurrence of the coconut palm, according to Schweinfurth (1894–99:52), was el-Hami (14°51' N, 49°56' E) along the Gulf of Aden, located near Shihr in present south Yemen, where he saw a large plantation of coconuts palms during his visit in February 1881. The cultivation of coconut has, however, also been mentioned from Lahej (13°01' N, 44°54' E), near Aden (Schwartz 1939:344). Forsskal, who was a pupil of Linnaeus and explored the Yemen flora in 1762–1763, observed coconuts even at Mukha, although no traces of its cultivation have been found in recent times (Wood 1997:314).

The temporary presence of palm trees along the Red Sea coast is in itself not an uncommon phenomenon. This will be especially true for exotic specimens, such as the coconut palms that were planted near Suez and are recorded only at the beginning of the twentieth century (D'Abaza in 1907, see Täckholm and Drar 1950:318–319; Roelfsema 1916:3). But the native date palm and doam palm trees also can just disappear, as was experienced in Wadi Gimal, where isolated trees probably died from lack of fresh water, and others were destroyed to make room for road widening.

Historical Sources

There is much confusion with respect to the possible description of the coconut in Greek and Roman texts. Theophrastus (*EIP* 4.2.7) describes a tree that is named *cuciofeer* (Greek: κουκιόφορον) and has formerly been misinterpreted as a coconut (Hohlwein 1939:24–25). Theophrastus, who lived in the fourth century BC, visited both Egypt and India and had also access to the scientific results that were gathered during the expeditions of Alexander. His description clearly points to the doam palm (*Hyphaene thebaica* [L.) Mart.] and it is most likely that it is based on personal observations:

> Τὸ δὲ καλούμενον κουκιόφορόν ἐστιν ὅμοιον τῷ φοίνικι· τὴν δὲ ὁμοιότητα κατὰ τὸ στέλεχος ἔχει καὶ τὰ φύλλα· διαφέρει δὲ ὅτι ὁ μὲν φοῖνιξ μονοφυὲς καὶ ἁπλοῦν ἐστι, τοῦτο δὲ προσαυξηθὲν σχίζεται καὶ γίνεται δίκρουν, εἶτα πάλιν ἑκάτερο τούτων ὁμοίως· ἔτι δὲ τὰς ῥάβδους βραχείας ἔχει σφόδρα καὶ οὐ πολλάς. ... καρπὸν δὲ ἴδιον ἔχει πολὺ διαφέροντα καὶ μεγέθει καὶ σχήματι καὶ χυλῷ· μέγεθος μὲν γὰρ ἔχει σχεδὸν χειροπληθές· στρογγύλον δὲ καὶ οὐ προμήκη· χρῶμα ἐπίξανθον· χυλὸν δὲ γλυκὺν καὶ εὔστομον· οὐκ ἀθρόον δέ, ὥσπερ ὁ φοῖνιξ, ἀλλὰ κεχωρισμένον καθ’ ἕνα· πυρῆνα δὲ μέγαν καὶ σφόδρα σκληρόν

> “The tree called the doum—palm is like the date-palm; the resemblance is in the stem and the leaves, but it differs in that the date—palm is a tree with a single undivided stem, while the other, as it increases, splits and becomes forked, and then each of the two branches forks again: moreover the twigs are very short and numerous. (...) It has a peculiar fruit, very different from that of the date palm in size form and taste; for in size it is nearly big enough to fill the hand, but it is round rather than long; the color is yellowish, the flavor sweet and palatable. It does not grow bunched together, like the fruit of the date-palm, but each fruit grows separately; it has a very hard stone.” [Translation: Sir A. Hort (The Loeb Classical Library)]

A forked trunk is a very rare feature among palms and is with respect to the Egyptian trees diagnostic for the doam palm (Figure 4.31). Theophrastus’ assertion that the fruits of this palm grow separately, in contrast with those of the date palm, is not correct. It is beyond doubt that the depicted tree in Woenig (1971:289) is a doam palm and not a coconut palm, as he suggests. Remarkably, Woenig portrays an almost similar tree correctly as a doam palm when he is dealing with this tree in particular.

Warmington (1995:217) believed that Pliny referred to coconuts when he used the word *cuci*.(*NH* 13.18.62):

> “At e diverso cuci in magno honore, palmae similis, quando et eius foliis utuntur ad textilia; differt quod in bracchia ramorum spargitur. Pomo magnitudo quae manum impleat, colos fulvas, commendabili suco ex austero dulci. Lignum intus grande firmaeque duritiae, ex quo velares detornant anulos; in eo nucleus dulcis dum recens est: siccatus durescit ad infinitum ut mandi non possit nisi sit pluribus diebus maceratus.”

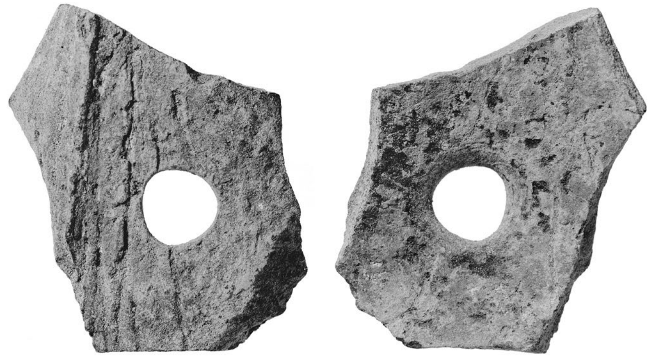


Figure 4.30. Outer and inner view of a perforated fruit fragment of coconut (*Cocos nucifera*) (endocarp: 9.2 x 6.6 cm). Photographs by J. Pauptit.

Figure 4.31. Segment of outer part of fruit (exocarp and mesocarp) of coconut (*Cocos nucifera*). Photographs by R. T.J Cappers.

> “But on the contrary the wood of the cucus is in great esteem; this tree resembles a palm in that its leaves are also used for textiles, but it differs because it spreads out into branches like arms. The fruit is of a size that fills the hand; its color is yellow and its juice has an attractive sweet taste, with a touch of astringency. It has a large and very hard shell inside, which is used by turners for making curtain-rings, and inside the shell is a kernel which has a sweet taste while fresh, but which when dried goes on getting continually harder and harder, so that it can only be eaten after being soaked in water for several days.” [Translation: H. Rackham (The Loeb Classical Library)]

Pliny’s *Natural History (Naturalis Historia)* is mainly a compilation of other sources and the description of the doam palm is obviously based on that of Theophrastus. The Latin word *cuci* can thus be related to the Greek word κοῦκι (Hohlwein 1939:27). The doam palm is native to Egypt, and also Pliny himself (*NH* 15.34.114) mentions this, using the word *cuci* again:

> *"ut cuci quam in Aegypto diximus."*
> "for instance the cuci which we spoke of as growing in Egypt." [Translation: H. Rackham (The Loeb Classical Library)}

As has been mentioned previously, it is quite tricky to link old Greek and Latin plant names with modern ones. For example, the word *cuci* can be related to one of the synonyms of the doam palm, namely, *Cucifera thebaica* Delile. The identification of *cuci* with the doam palm is also confirmed by its connection with the old Egyptian word for its fruit, namely, *kwkw* (Keimer 1984:65).

In the *Periplus Maris Erythraei* (chapter 17), which is dated to about AD 40–70, the word *nauplios* [ναύπλιος] is used, which has been translated by Schoff as "palm oil" (1995:99). Schoff corrects the word 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 coconut, which is not tenable, however. This translation is adopted by Miller (1998:36). Casson (1989:61), on the other hand, translates the word *nauplios* as "nautilus shell":

> Ἐκφέρεται δὲ ἀπὸ τῶν τόπων ἐλέφας πλεῖστος, ἥσσων δὲ τοῦ Ἀδουλιτικοῦ καὶ ῥινόκερως καὶ χελώνη διάφορος μετὰ τὴν Ἰνδικὴν καὶ ναύπλιος ὀλίγος.

> "The area exports: a great amount of ivory but inferior to that from Adulis, rhinoceros horn; best-quality tortoise shell after the Indian; a little nautilus shell." [*Periplus*: 17; Translation: L. Casson]

The area meant here is Azania, which covers the east coast of present-day Somalia, Kenya, and Tanzania south to Rhapta, the modern Dar es Salaam. Although both coconut and nautilus shells are familiar to this area today, it is more likely that the translation of nautilus shell is correct. First, the early presence of the coconut palm along the East African coast cannot be ascertained, as is discussed before. Furthermore, the nautilus shell fits in very well with the other export items that are mentioned. The nautilus shell is the external skeleton of a female octopus. It is a quite thin shell covered with mother-of-pearl and could have been used for the production of beads and jewelry.

Philostratus, who lived in the second half of the second century AD, wrote a book on the life of Apollonius of Tyana who visited, among other places, India. In this context, he mentions briefly the use of some nuts (Vita Apollonii: 3.5):

> ἐνταῦθα καὶ τὰ κάρυα φύεσθαί φασιν, ὧν πολλὰ πρὸς ἱεροῖς ἀνακεῖσθαι τοῖς δεῦρο θαύματος ἕνεκα.

> "There [or here] they say also grow the nuts, many of which are dedicated to the shrines here, to be a source of wonder." [Translation: J. P. Wild]

In this text, Philostratus also describes corn, beans, sesame, and millet that were all extra large, which might imply that the nuts were also of a considerable size. Warmington (1995:217) believes that these nuts were coconuts and that they were exposed in Greek temples. It is more likely, however, that the text is still referring to the situation in India, namely, the irrigated plain of the Ganges. In India, the coconut is an essential part of all Hindu religious ceremonies, where it is offered to several deities such as Saraswati, Dantesvari, Khandoba, Mhalsa, and Durga (Gupta 1991 [1971]: 27–28; Mallebrein 1993:270, 456). Pictures of altars show that husked but whole coconuts are offered or presented as a symbol of the god. The relatively large coconuts make up a dominant part of the objects exposed in such temples. This is especially true for the private altars present in houses. The observation of Philostratus contradicts with the situation in Roman Berenike, where the presence of coconut fragments in the trash (and not in the religious areas) does not support its use in the worship of Serapis, a hybrid deity that was introduced by Ptolemy I and who combined the Egyptian god Osiris with several Greek deities and became quite popular in Greco-Roman Egypt.

In his *De Gentibus Indiae et Bragmanibus* (*About the Nations of India and the Brachmans*), which is dated to about AD 420 (McCrindle 1979:178), Palladius (1.6) describes the island of Taprobane, the present-day Sri Lanka from which he mentions an enormous Indian nut:

> ἔχει δὲ καὶ φοίνικας καὶ τὸ κάρυον τὸ μέγιστον τὸ Ἰνδικὸν καὶ τὸ λεπτὸν τὸ ἀρωματίζον.

> "(the island of Sri Lanka) has both dates and the Indian nut, the very large one and the small one which has a spicy flavor." [Translation: J. P. Wild]

It is almost beyond doubt that in this fragment the coconut is meant indeed. Confusion with date palm is out of the question and the large size is very indicative. The third nut that is mentioned could be nutmeg

(*Myristica fragrans* Houtt.), a spice that is also suspected to be found at Berenike, but has not yet been attested. It can be assumed that the coconut was introduced to Sri Lanka at about the same time as to India, and today both countries produce a substantial amount of coconuts.

The first indisputable description of the coconut is, however, from Cosmas Indicopleustes. A similar conclusion is presented by Karttunen (1997:138), in discussing the Greek and early Roman accounts of Indian plants. The coconut is well described in the *Topographiae Christianae* (11.444.D), which is dated to AD 530:

> "Τὸ δὲ ἄλλο τῶν ἀργελλίων ἐστὶ τῶν λεγομένων, τουτέστι τῶν μεγάλων καρύων τῶν ἰνδικῶν· παραλλάττει δὲ τοῦ φοίνικος οὐδέν, πλὴν ὅτι τελειότερόν ἐστι καὶ ἐν ὕψει καὶ ἐν πάχει καὶ ἐν τοῖς βαΐοις. Οὐ βάλλει δὲ καρπόν, εἰ μὴ δύο ἢ τρία σπάθια ἀπὸ τριῶν ἀργελλίων· ἔστι δὲ ἡ γεῦσις λυκεῖα πάνυ καὶ ἡδεῖα, ὡς τὰ κάρυα τὰ χλωρά· ἐξ ἀρχῆς μὲν τοῦ ὕδατος γέμει γλυκέος πάνυ, ὅθεν καὶ ἐξ αὐτῶν πίνουσιν οἱ Ἰνδοὶ ἀντὶ οἴνου· λέγεται δὲ τὸ πινόμενον ῥογχοσοῦρα ἡδὺ πάνυ· τρυγώμενον δὲ καὶ παραμένον αὐτὸ τὸ ἄργελλιν, πήγνυται τὸ ὕδωρ αὐτοῦ κατὰ πρόσβασιν τὸ ἐπὶ τὸ ὄστρακον αὐτοῦ, καὶ μένει τὸ ὕδωρ εἰς τὸ μέσον ἄπηκτον, μέχρις ὅτου καὶ αὐτὸ ἐκλίπῃ· ἐὰν δὲ καὶ πλέον παραμείνῃ, ταγγίζει ὁ καρπὸς αὐτοῦ ὁ πεπηγὼς καὶ οὐ δύναται ἔτι βρωθῆναι"

> "There is another of the so-called *argellia*, that is, of the large Indian nuts [or nut trees]. It differs in no way from the date [or date palm], except that it is more complete both in height and in thickness and in the palm leaves. It does not shed fruit, apart from two or three stems of palm frond from three *argellia*. Its taste is very sweet and pleasant, when the nuts are green. From the beginning it is very full of the sweet liquid, wherefore the Indians also drink out of them instead of wine. What is drunk is called *Rhonchosoura* ['rhonchos-tail'], very pleasant. When the *argellion* itself is harvested and kept in store, its liquid solidifies, progressively against its outer shell, and the liquid in the middle remains unsolidified, until the point when that, too disappears. If its fruit which has solidified is kept still longer, it becomes rancid and can no longer be eaten." [Translation: J. P. Wild]

Because the Greek word for the fruit is often the same as that for the specific tree, as is the case for example with φοινιξ for both date and date palm, then it follows that *argellion* may either mean coconut or coconut palm.

Cosmas was an Alexandrian monk who was a merchant in the earlier part of his life. As a merchant he sailed on the Red Sea and the Persian Gulf and probably also visited Sri Lanka and south India. This implies that his description of the coconut palm must have been his own observation. The original manuscript is accompanied by a drawing of a coconut palm from which coconuts are harvested with a special tool. This way of harvesting is still practiced, especially in Sri Lanka and Southeast Asia (Engelhard and Fenner 1997:36).

The Subfossil Remains

The archaeobotanical record from the Roman Empire is extremely scanty. Excavations at Arikamedu on the southeast coast of India, which cover the period of about 300 BC–AD 200 and later, have yielded remains of the coconut (Kajale 1991:177). The presence of all kinds of Roman period remains that have been unearthed attest contact with the West. According to Casson (1989:25), it could well be that a colony of Westerners resided here who were chiefly engaged in forwarding goods not all the way to Egypt but only to intermediate stations at Muziris and Nelkynda on the southwestern coast of India. Both these sites have not been excavated yet, so nothing can be said about the possible presence of the coconut palm or other plant species there. Anyway, the record of coconut from Arikamedu makes it very likely that the Westerners, putatively present in Arikamedu from the early years of the first century AD until ca. AD 200, would have known it. Unfortunately, no botanical research was carried out in Arikamedu so that only species are recorded that could not have been overlooked: the coconut palm and the palmyra palm (*Borassus flabellifer* L.). Further botanical evidence of the connection between Berenike and this site, therefore, remains unknown.

With the exception of a few husk segments from trench BE99-33, all fragments of coconut unearthed in Berenike concern endocarp fragments. The unbalanced representation of different kinds of fruit fragments in the subfossil record suggests that most coconut fruits were traded as dehusked, whole fruits. It is also possible that part of the coconut had been traded as copra, but the chance of recovering such pieces is small, as no detectable waste is produced and recovery relies on discarded pieces. Unopened coconuts can be kept for consumption until all the liquid endosperm has disappeared. As soon as the coconut is opened, the production of free fatty acids starts and consumption cannot be delayed too long.

To exclude the possibility of contamination, a radiocarbon date has been obtained from one fragment, originating from BE96-13.002 and giving 1935 ± 35 BP (GrN-23465). The calibrated date coincides with the first two centuries AD.

No attempt has been made to convert coconut fragments to whole specimens. Taking into account the scattered distribution of these fragments in trash deposits and the estimated expected finds in the unexcavated area, we can deduce that the coconut was not a rare commodity in either early or late habitation periods. This interpretation is supported by the fact that most coconut fragments were not worked after consumption of its "meat." So far, only five worked fragments have been unearthed. Two of them, which have holes measuring 7.5 and 13 mm, were found in the same trench (Figure 4.30). It is possible that they were used for making beads or buttons. In trench BE99-21, a fragment was found with a carved decoration showing a pattern of lines at a right angle. Trench BE99-33 yielded two worked fragments that looked like cups with a diameter of approximately 6.5 cm. One of these fragments still had some resin present along part of its rim. Actually, this low frequency of worked fragments of such an exotic fruit, having an attractive size and a hard endocarp, making it suitable for fashioning into all kinds of decorative and useful articles, is striking. Even so, it is to be expected that future excavations at Berenike or any other Roman settlement will unearth worked fragments of this nut.

As far as the Indian subcontinent is concerned, it is very likely that the coconuts from Berenike would have been imported from ports along the Malabar coast. The most productive area of coconuts in India is confined to its interior and the present name of this state is Kerala, which literally means "the land of the coconut." The abundance of coconut palms is, for example, expressed in the description of the landscape of Tyndis (modern Ponnani) in a Tamil poem cited by de Romanis (1997), saying that "In its immense fields grow coconut palms laden with fruit, . . ." Due to the activity of pirates, Tyndis was abandoned, as the people moved to the more southerly Muziris and Nelkynda.

The cultivation of the coconut palm at isolated spots along the strait of Bab el-Mandeb and the Gulf of Aden, as recorded from the last centuries, leaves open the possibility of a shorter trade route for the coconut. If so, coconuts might have been obtained from Muza or Kanê. Today, this area falls outside the main coconut-producing areas and it is, therefore, merely speculative to assume this was an alternative trade route.

Coconut fragments belonging to several specimens were also found in Quseir al-Qadim, though dated to the Mamluk period (AD 1200–1400; Wetterstrom 1982:370). The only other reference of coconut concerns an Egyptian specimen of unknown age and origin, kept at the Florence museum. Initially, E. Bonnet did not preclude the possibility of a Greco-Roman date, suggesting that the coconut was merely a curiosity from India (see Germer 1985:236). Later, however, he expresses doubt about its ancient date. The coconut is mentioned for the first time on a list that presents all the objects that were collected by Dr. Alessandro Ricci during his travels in Egypt in 1818 and 1822. This list was compiled by M. Arcangelo Migliarini in 1932 on the occasion of the acquisition of the collection by the archduke of Toscane. The coconut is described in the last part of this catalogue as "Un frutto di Cocco. Una mezza scorza di un piccolo cocco" (A coconut. Half a shell of a small coconut). Because this last part of the list deals with Ricci's anthropological collection, it is assumed that it is of recent date, despite the fact that a contemporary is of the opinion that it is an old coconut indeed (communication by A. Bottini and P. R. Del Francia of the Florence Museum). The reliability of Italian inventories from the nineteenth century and the fact that Ricci pays no special attention to the coconut argues for a recent date. But the curious thing is that an ordinary fragment of a coconut is considered as an anthropological object. A definite answer concerning its age, therefore, can only be obtained by radiocarbon dating.

It has frequently been suggested that coconut oil was present in Egyptian graves. According to Lucas and Harris (1962:88, 328–329), however, this assumption is wrong, because the strong smell is due to a very small proportion of nonoic acid, which had been formed as a result of decomposition of fatty materials.

***Coix lacryma-jobi* L.**

English:	Adlay, Adlay millet, Job's tears
Arabic:	Amadrayan, Badrang, Dam' Ayub, Dumu' Ayyub, Qatret Ayyub
Indian:	Kasai, Kasari, Kotti beeja, Sankru
Plant part:	involucre
Trench/midden:	BE: 1 and 33
Period:	first–second and fourth–fifth centuries AD

Preservation: desiccated
Figure: 4.32

Figure 4.32. Utricle (8.3 x 4.8 mm) of Job's tears (*Coix lacryma-jobi*). Photograph by J. Pauptit.

Among the many beads that were found at Berenike, four specimens could be identified as Job's tears. This bead is made of the false fruit of Job's tears, a grass species that is closely related to maize (*Zea mays* L.). In maize, male and female flowers are arranged in separate inflorescences, in which each female inflorescence consists of a number of fertile flowers and is enclosed by a series of almost bladeless leaves. In Job's tears, however, each inflorescence bears both female and male flowers, and only the lower fertile flower of each inflorescence is enclosed by a tough and modified sheathing bract or involucre. The slender axis of the inflorescence that bears the male flowers protrudes through the somewhat oblique opening of the callous bract. Once the fruit is detached from the stem, Job's tears is already effectively a bead, as the basal area has an opening as well as the top. Moreover, the grain is folded lengthwise around the axis, creating a natural groove that facilitates its piercing. The specimen from Berenike has a hard shell, which is indicative of the wild species that is used for beadmaking.

The decorative fruits are mostly tear-shaped to globular in shape, have a white to brown, shiny coating and are 6 to 12 mm long, making them applicable to all kinds of beadwork. Although the glossy surface of the Roman specimen from Berenike had disappeared, the shape, the basal perforation, and the characteristic orifice at the top of the fruit justify the identification.

Job's tears is native to tropical Asia where it grows in forest margins and swamps and has been introduced throughout the tropics (Clayton and Renvoize 1986:373). Cultivated soft-shelled forms are grown as a cereal in northeastern India and southeastern Asia, though it has been replaced now by rice and maize on a large scale (Arora 1977:365). Forest dwellers in northeastern India gather the hard fruits of wild forms and bring them to tribal and village markets where they are sold for ornamental purposes, contributing to the local economy of the forest villages (Jain and Banerjee 1974:40). The hard-shelled form also grows along the eastern coast of India, where it is found as a weed in rice fields.

It seems possible that Job's tears is also mentioned in historical sources, but the translations of the concerning text fragments refer to wheat instead. In his enumeration of the wheat varieties, Theophrastus (*EIP* 8.4.5) mentions a variety that grows not far from Bactria and produces kernels that grow as large as olive stones. Pliny (*NH* 18.12.70) includes this Greek reference in his description of wheat varieties, but this time the size is even equated to that of the ear of a cereal. Together with barley (*Hordeum*), rice (*Oryza*), and millet (*Eleusine* and *Setaria*), Job's tears is native to this area, and it is the only one that comes into consideration when a large kernel is concerned. The glossy bract varies both in size and shape, and it may reach the length of a small olive, although most specimens are smaller.

So far, subfossil remains of Job's tears have only been found at Berenike and in India. Although fruits are actually found on many sites in India, they have only been published from eight sites, including early historical Ahichchtra and Balathal.

Other plant remains that have been used as beads in ancient Egypt include seeds of grape (*Vitis vinifera*), accessory fruits of the sycamore fig (*Ficus sycomorus*), seeds of rosary pea (*Abrus* cf. *precatorius*), unripe fruits and female flowers of the date palm (*Phoenix dactylifera*), endocarps of the Egyptian plum (*Cordia myxa*), leaves of grasses (Gramineae), fruits from *Polygonum senegalense* Meis., and possibly pierced tubers from earth almond (*Cyperus esculentus*) (Täckholm and Drar 1950:62). The stone fruit from olive (*Olea europaea*) that has been previously described as a bead (Cappers 1996:317) is now considered as a gnawed specimen.

***Commiphora gileadensis* (L.) C. Christ.**

Synonym: *C. opobalsamum* (L.) Engl.
English: Balm-of-Gilead, Balsam tree, Mecca myrrh, Opobalsamum
Arabic: Balasan, Balsam makkah, Bisham, Gafal, Mayoak, Qafal, Risha'
Indian: -
Plant part: fruits and seeds

Trench/midden:	BE: 1, 10, 14–16, 21, and 25; SS: 4, 7, 10, 20, 21, 29, 53, 54, and 56
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figures:	4.33, 4.34, and 4.35

The balsam tree is a member of the incense-tree family (Burseraceae). Two genera within this family are important for the production of aromatics. Some species of *Boswellia* produce frankincense, which is also traded as incense, and include the olibanum tree (*B. sacra* Birdw.), whereas some members of the genus *Commiphora* produce myrrh. Usually, *C. myrrha* (Nees) Engl. is considered as the tree from which common or hirabol myrrh is obtained, although this is doubted by Wood (1997). Scented myrrh is produced by *C. guidottii* Chiov. and is also known under a variety of names, including bissabol, habak hadi, perfumed bdellium, scented bdellium, coarse myrrh, East Indian myrrh, false myrrh, perfumed myrrh, sweet myrrh, and opopanax (Tucker 1986:429; Thulin and Claeson 1991:489).

Whereas frankincense and myrrh are produced as solid resins, some of the *Commiphora* species produce balsams, which are aromatics that remain liquid. One of these species is *C. gileadensis*, whose distribution in Egypt is restricted to the Gebel Elba area (Figure 4.33). The balsam can be obtained from three different parts of the tree: the dried fruits (*carpobalsamum*), the dried wood (*xylobalsamum*), and the bark from which an unguent is collected (*opobalsamum*, Figure 4.34). Judging by the many subfossil fruit fragments, it is assumed that balsam was probably available as *carpobalsamum* in Berenike. According to Pliny (*NH* 12.54.118-123), the quality of *opobalsamum* was better than that of *carpobalsamum* and *xylobalsamum*, its price comparable to that of the best-quality frankincense. Theophrastus (*EIP* 9.6.1), on the other hand, states that the fruit is more fragrant than the gum, the latter probably extracted from the stem and thus similar to *Opobalsamum*. *Carpobalsamum* was used in the production of the Egyptian perfume *metopium*, which constitutes an oil extracted from the seeds of bitter almonds (*Amygdalus communis* L.), mixed with some other plant materials (Pliny's *NH* 13.2.8). The balsam extract was also used for making ointments, such as the balm of Gilead, which is also called *Mecca balsam* and *opobals(am)um* (Hepper 1990:24).

In more than 60 different samples from Berenike, fruits and seeds have been found from *Commiphora gileadensis*. The only other member of this genus that is

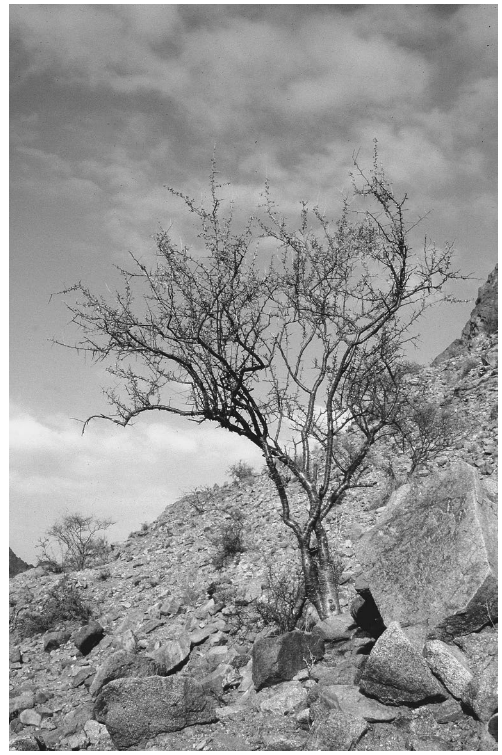


Figure 4.33. Balsam tree (*Commiphora gileadensis*) growing on the south slope of Gebel Elba (February 1999). See Color Plates section, page 223.

Figure 4.34. Balsam produced by an incision in the stem of a balsam tree (*Commiphora gileadensis*), Gebel Elba (February 1999). See Color Plates section, page 223.

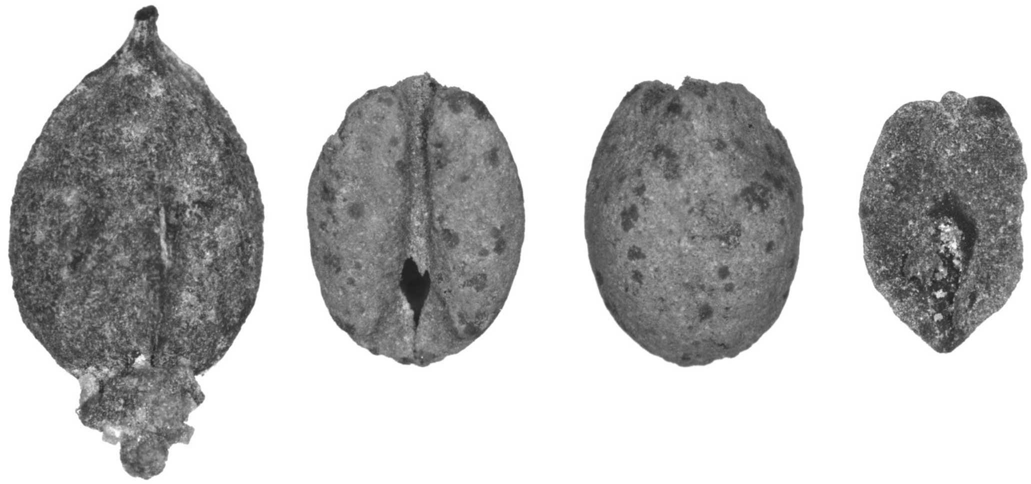


Figure 4.35. Fruit and fruit fragments of *Commiphora gileadensis.* From left to right: whole fruit (7.9 x 4.2 mm); ventral and dorsal view of fertile part of the endocarp (5.0 x 3.8 mm); ventral view of sterile part of the endocarp (4.3 x 2.8 mm). Photograph by R. T.J. Cappers.

native to Egypt is *C. quadricincta* Schweinf. ex Engl. This species is characterized by four longitudinal wings along the fruit stone, as is indicated by its Latin name. *C. quadricincta* has only been recorded in 1929 from the Hailab area and also from the Red Sea coastal area more to the south. Because of this, identifying the subfossil specimens as *C. quadricincta* is not plausible. The aromatic fruits *C. gileadensis* were probably frequently imported from the Gebel Elba area, where this tree is still quite abundant together with acacia trees. Because *C. gileadensis* is native to both sides of the Red Sea, it is also possible that the fruits were sometimes imported from more remote trade centers on the East African coast and the Arabian Peninsula. Both the presence of the fruits and seeds and their morphology exclude the possibility that we are dealing with the Indian bdellium tree (*C. wightii* [Arn.] Bhandari). The *Periplus Maris Erythraei* mentions the export of bdellium (a resin) from northwest India, so the presence of fruits and seeds is not in keeping with this kind of commodity. Moreover, the fruits of the Indian bdellium tree are two-celled, whereas the specimens from Berenike are without exception one-celled, being quite similar to those from the balsam tree.

Today, the Bisharin nomads who live in the Gebel Elba area do not exploit the balsam tree for its balsam or fragrant fruits . The same is also true for Yemen: the branches are used here instead as firewood (Wood 1997:197).

Two other records of the balsam tree from Egypt have been published, although both undated and only one with a reference to a site, namely, Thebes. Additionally, several resins are recorded that belong to *Commiphora* (de Vartavan and Amorós 1997:82).

***Cordia myxa* L.**

English:	Assyrian plum, Egyptian plum, Indian cherry, Sapistan, Sebesten plum, Sudan-teak
Arabic:	Dabq, Makhatah, Mukhayt, Mokheit, Mokk-khetah, Mokhatah, Muhet, Sabastan
Indian:	Bhokar, Gondni
Plant part:	fruits (whole fruits and endocarps) and calyxes
Trenches:	BE: 1, 3, 6, 10, 13–16, 19, 21, 22, 23, 25, 29, 31, 33, 37, and 48; SS: 4, 20, 21, and 53
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figure:	4.36

The Egyptian plum has fruits of about 2 cm in diameter. Only the outer, soft layer of the fruit is edible, comparable with, for example, plums and cherries. The edible pulp is so mucilaginous that it is also used as birdlime. According to Pliny (*NH* 13.10.51), the fruits were also used in Egypt for making wine, and Theophrastus (*EIP* 4.2.10) states that cakes are made from the stoned fruits. Also the seeds can be eaten, but this has not been practiced by the inhabitants of Berenike and Shenshef. The calyx is persistent, and this explains why it is sometimes found in addition to the fruit stones.

The genus was formerly mentioned as *Sebestena*, and the old name is still in use in the name of the New World species *Cordia sebestena* L., the geiger tree. Dried fruits of *C. myxa* and *C. latifolia* Royle are still offered in spice

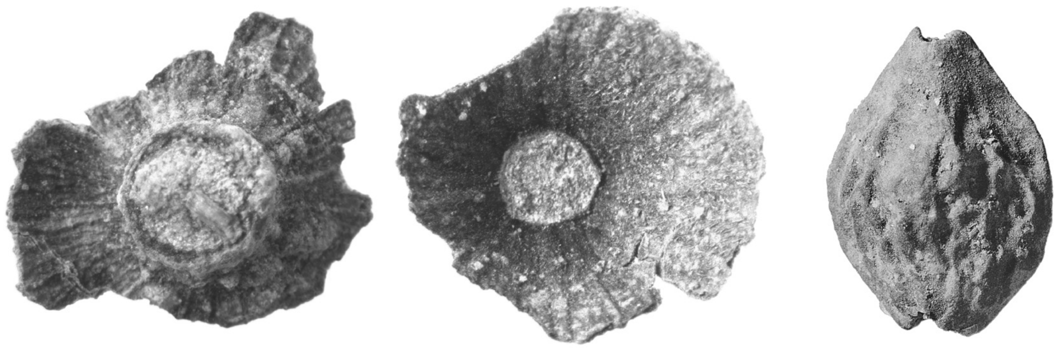


Figure 4.36. Calyx and fruit fragment of *Cordia myxa*. Outside view (left: width: 8.3 mm) and inside view (middle: width: 8.3 mm) of calyx and endocarp (right: 12.7 x 9.2 mm). Photograph by J. Pauptit.

markets as *sapistan* (*se pestan*). They are used as a medicine for chest complaints and inflammations of the urinary tract (Kamal 1975:193; Usmanghani et al. 1986:87).

Despite the well-documented archaeobotanical record of *C. myxa* from Egypt, it is thought to be a native of the Indian subcontinent. Its exotic status in Egypt is supported by the cultivated specimens grown in gardens and the absence of naturalized specimens. Most probably, *C. myxa* had been introduced at an early stage into western Asia and northeast Africa, which is expressed in several of its common names. Theophrastus (*EIP* 4.2.10), for example, states that the tree grows in abundance in Thebes. Classical writers refer to it as ἡ κοκκυμηλέα [plum] (Theophrastus *EIP* 4.2.10) or "myxis" (Pliny's *NH* 13.10.51), although there is some confusion by Pliny with respect to the plum (*Prunus domestica* L.), which is common to Europe. The English translation of Theophrastus adds "sebesten" and "Egyptian," whereas "Indian cherry" is used in India (Kajale 1991:177).

Stone fruits of this species are well represented in early and late deposits from Berenike and also in late deposits from Shenshef. Occasionally, whole fruits have been found. The fruit also occurs at other Egyptian sites, dated to the pharaonic period, such as Saqqara, Deir el-Medineh, and Thebes. The stone fruit from Saqqara, dated to the Third Dynasty, shows that the tree was introduced and cultivated in Egypt from at least as far back as the Old Empire (Täckholm 1961:29).

Thus, berries of *C. myxa* may have been imported to Berenike from the Nile Valley or the Mediterranean area, but also long-distance supply from India may not be ruled out. Because the berries are susceptible to fermentation, only fresh ones may have been available from Egypt proper. Indian berries may have been dried or pickled, methods that are still in use.

A tentative identification of *Cordia* wood has been made by Vermeeren (1999a: 315). Among the wooden pins used as building material, one smaller specimen was present that might belong to either *C. myxa* or *C. nevillii/sinensis*. This pin was unearthed from trench BE97-16.041 and dates to the fifth century AD or later.

***Cordia nevillii* Alston/*sinensis* Lam.**

Synonym:	*C. nevillii*: *C. rothii* sunsu Balf.; *C. gharaf* sensu Chiov. *C. sinensis*: *C. gharaf* Ehrenb. ex Asch.; *C. reticulata* Roth ex Roem. & Schult.; *C. subopposita* DC; *C. rothii* Roem. & Schult.
English:	-
Arabic:	Doqraar, Gharaaf, ʻInab, Miskhil, Mokheit, Sakhil
Indian:	-
Plant part:	fruits (endocarp)
Trench/midden:	BE: 1, 10, 13–16, 21, and 33; SS: 4, 10, 20, 21, 29, and 53
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4.37

In addition to *Cordia myxa*, *C. sinensis* has also been found at Berenike and Shenshef. Recently, the latter species has been split into two distinct species: *C. sinensis* Lam. and *C. nevillii* Alston (Warfa 1990:649–656). *C. Sinensis*, which grows in moist habitats, is widespread in Africa, though its distribution in Egypt is limited to the southern part (Gebel Elba and the Kharga Oasis) and one location in Sinai. In Egypt, only its presence in the Gebel Elba area may be considered as indigenous, whereas in other parts of the country it only grows in gardens. *C. nevillii*, on the other

Figure 4.37. Fruit fragments of *Cordia nevillii/sinensis*. Whole endocarp (left: 9.8 x 5.0 mm), longitudinal section of incomplete specimen, and cross section of endocarp. Photograph by J. Pauptit.

hand, is adapted to more-arid conditions and has a Somalia-Masai distribution in Africa, the Gebel Elba area in which it is found being an isolated northern outpost. Drar collected plants of both species from Gebel Elba (Warfa 1990:652, 654). According to Drar (1936:16–17), who uses the old name *C. gharaf* Ehrenb. ex Ascherson for both species, *Cordia* grows, but is not common, in the higher reaches of the rocky gorges of the Gebel Elba.

Both species have edible fruits that are about half the size of those of *C. myxa*. According to Schweinfurth (1865c: 552), the berries of *C. sinensis* are of a better taste than those of *C. myxa*. It is most likely that the fruits from Berenike and Shenshef were imported, at least partly, from the nearby Gebel Elba area. Additionally, the fruits might have been traded from Ethiopia and Eritrea, where substantial populations of both species occur. Both species are also found in the coastal areas of the Arabian Peninsula and the Indian subcontinent, including Sri Lanka.

The trees are also valued for their wood. In the Gebel Elba area, the Bisharin nomads make walking sticks from the branches, which are also products of trade. For that reason, each tree is assigned to a specific family or clan (Drar 1936:17).

As far as generative features are concerned, both species can be distinguished by their accrescent calyx but not from their fruits. As only fruits were found in Berenike and Shenshef, the identification is made to the level of a combined taxon. Consequently, previous records of *C. sinensis* from Abusir (Fourth Dynasty) and Thebes (Eighteenth Dynasty) may refer to *C. nevillii* as well.

***Coriandrum sativum* L.**

English:	Chinese parsley, Cilantro, Coriander
Arabic:	Al-naqrah, Al-naqud, Debsha, Kabsarah, Kesbour, Kosbarah, Kujjar, Kusbara, Kuzbara(h), Kuzbaruh, Qalantarah, Tabel
Indian:	Daniyalu, Dhane, Dhana, Dhania, Dhaniya, Dhanyaka, Katamalli
Plant part:	fruits and seeds
Trench/midden:	BE: 1, 6, 10, 13–16, 19, 21, 25, 31, and 33; SS: 29 and 53
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figure:	-

Coriander is a garden herb with a quite unpleasant smell. Ripe and dry fruits, however, acquire a pleasant smell and are therefore more in demand than the young plants or the leaves in the use of seasonings. Because the ripe fruits easily scatter from the plant at this late stage of development, harvesting the fruits is therefore very precise work (Jansen 1981:63).

Coriander probably originates from the eastern Mediterranean, where the oldest finds are recorded from Greece, Jordan, and India. The oldest Egyptian find originates from predynastic Adaïma (de Vartavan and Amorós 1997:85). Coriander fruits are still much appreciated in Egypt, where the plant is cultivated in the Mediterranean coastal area, the Nile Valley, the oases of the Libyan Desert, and the Sinai (Boulos 1995:101). Also, this condiment was in great demand by the Romans, and it was imported in large quantities from Egypt. Pliny (*NH* 20.82.216) states that in his time the best coriander came from Egypt. Coriander is mentioned, for example, in many recipes of Apicius, who lived in the time of Augustus-Tiberius, who collectively reigned from 27 BC–AD 37.

The predominant use of coriander's fruits in preference to its leaves explains why this plant is often found in archaeobotanical research. Fruits and seeds of coriander were scattered in small numbers over several samples, which is especially true for those of Berenike. Coriander is one of the plants that could have been locally cultivated in well-protected and irrigated kitchen gardens.

Besides its use as a condiment for flavoring foods and beverages, coriander is also used in medical treatments. It is recommended, for example, by Pliny (*NH* 20.81.216–218) for all kinds of complaints, such as the treatment of various skin disorders, the retardation of the menstrual period, and as an antidote to snake poison. To determine whether archaeobotanical remains of coriander were used for such treatments is in most cases impossible, as the archaeological context does not support such interpretations. An exceptional case is, however, a find of coriander fruits in a stockroom of a Roman military hospital (*valetudinarium*) in Neuss (Knörzer 1970:95). According to Dioscorides, the consumption of the fruits positively affects one's intellectual capabilities. Rutten (1997:62) suggests that fruits infected with the fungus Puccinia petroselini might cause this. In Egypt, the fruits are still sold for medical purposes. Pounded fruits are used for vertigo and as a carminative and tranquilizer (Ahmed et al. 1979:77).

An aberrant use of coriander concerns adding fruits to incense mixtures, as was observed in many incense samples sold today at Egyptian spice markets. It is not known if this was also practiced in antiquity. In any cases, the specimens from Berenike do not support this kind of use. The only charred fruit was found together with 64 desiccated specimens in a trash-dump sample that originated from trench 13.

***Corylus avellana* L.**

Synonym:	*C. maxima* Mill.
English:	Cobnut, Filbert, Hazel
Arabic:	Bunduq, Gillawz
Indian:	samanya pingalaphala
Plant part:	fruits
Trench/midden:	BE: 1, 10, 13–16, 19, 21, 23, 25, 29, 31, 33, and 48; SS: 21 and 55
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure	-

Hazel is an Euro-Siberian species that is native to the Caucasus, west Asia, and Europe. In the Mediterranean area, this tree only grows on the mountains, such as on Mount Tmolos and the Mysian Mount Olympus, as mentioned by Theophrastus (*EIP* 4.5.4). It does not grow in Egypt.

The nuts of this tree thus belong to the food items that have been brought from the Mediterranean area to Berenike and Shenshef. The number of subfossil hazels that is recorded from Egypt is limited and, furthermore, confined to the Greco-Roman period. A much earlier record, dated to the predynastic period (fourth–third millennium), concerns pollen that was found at Tell Ibrahim Awad in the Nile Delta (Bottema 1992:126). This location is outside its distribution area. Moreover, hazel is almost confined to the cool mountain slopes in its southern distribution area, like the situation in Crete. Its presence in Tell Ibrahim Awad, just like that in sediments near Carthage, can be explained as a result of long-distance transport, probably from substantial hazel populations in Italy and Turkey. Only fairly large pollen values or an increase in the hazel curve may indicate that the plant was locally cultivated or was part of the natural vegetation (personal communication from S. Bottema).

***Cucumis sativus* L.**

English:	Cucumber, Gherkin
Arabic:	Faqqus, Khiyah, Khiyar, Qath-tha, Qitha
Indian:	Khira
Plant part:	seeds
Trench/midden:	BE: 13 and 14
Period:	first–second and fourth–fifth centuries AD
Preservation:	desiccated
Figure:	-

Based on the distribution of its possible wild relative *Cucumis sativus* ssp. *hardwickii* Royle in the foothills of the Himalayas and other parts of India and in Arabia, it is widely assumed that the cucumber was taken into cultivation in India (e.g, Bates and Robinson 1995: 93; Zohary and Hopf 2000:195). If this is true, then its domestication must have been started earlier than

3000 BC, judging by the archaeobotanical records of cucumber from Sharh-i-Sokhta in Iran (Tosi and Gerster 1983).

Cucumber was cultivated by the Greeks and Romans, who were also responsible for its further spread over the Roman Empire, as is evidenced by subfossil remains from Germany, Belgium, France, and Great Britain. The find of cucumber fruits in Deir el Medineh, which are dated to the Eighteenth Dynasty (1550–1307 BC), indicates that the fruit was introduced in Egypt much earlier. Its identification on the basis of fruits only is, however, rather dubious as fruits of the cucumber are extremely irregular in shape. Theophrastus (*EIP* 7.4.5) already describes three different forms, which are also referred to by Pliny (*NH* 19.23.68): the Laconian (Spartan), the cudgel-shaped (Scytalic), and the Boeotian. Pliny (*NH* 19.23.67) also mentions a quince-shaped fruit that was newly cultivated in Campania. Although the other Egyptian records of cucumber are small in number, they are more reliable as their identification is based on seed morphology and are all dated to the Greco-Roman period.

The juicy cucumbers must have been a highly appreciated food in Berenike and Shenshef. They might have been locally cultivated in kitchen gardens, although a more substantial supply would have been imported from the Nile Valley.

Cucumbers were not only eaten, but also used in other ways. According to Pliny (*NH* 12.35.71), myrrh was adulterated with cucumber juice to give it a bitter taste. As cucumber has an insipid, watery taste, which is in fact mentioned by both Theophrastus (*EIP* 1.12.2) and Pliny (*NH* 19.60.186), it is more likely that the bitter gourd (*C. colocynthis* [L.] Schrad.) is meant. Pliny also mentions a variety of medical uses of pounded cucumber seeds, partly in conjunction with seeds of cumin (e.g. *NH* 20.4.10). Cucumbers were also used in the production of cosmetics, such as a depilatory cream that consisted of boiled, crushed bones of a bird, fly dung, sycamore juice (from *Ficus sycomorus* L.), gum, and cucumbers (Manniche 1989:46). Today, seeds of cucumber are still sold in spice markets in Egypt and are recommended for the treatment of diabetes as well as for the treatment of the swelling of the colon (colitis) and as an antiseptic (Ahmed et al. 1979:89).

***Cuminum cyminum* L.**

Synonym:	*C. odorum* Salisb.
English:	Cumin
Arabic:	Cummun, Kammun, Sannut
Indian:	Chirkam, Jikori, Jira, Jirak, Jire, Safed jira, Safed zira, Zeera suffed, Zira
Plant part:	fruits
Trench/midden:	BE: 13, 14, and 25; SS: 29
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4.38

Figure 4.38. Fruits of cumin (*Cuminum cyminum*) still attached to carpophore (1.4 x 5.4 mm). Photograph by J. Pauptit.

Cumin is a desert plant that grows in oases but cannot withstand severe dry heat or heavy rainfall (Jansen 1981:72). The plant produces many fruits, which contain 2 to 4 percent essential oil. The finely sulcate leaves, on the other hand, are of no special value. Cumin is, therefore, one of the kitchen herbs that is exclusively cultivated for its fruits.

Only a few subfossil remains of cumin have been identified so far. They are recorded from the second millennium BC Tell ed-Der in Iraq (Van Zeist and Vynckier 1984:128), Iron Age Deir Alla in Jordan (Neef 1989:36), and, in addition to Roman Berenike and Shenshef, from three other sites in Egypt, namely, pharaonic (Eighteenth Dynasty) Deir el Medineh (see de Vartavan and Amorós 1997:89), Roman Mons Claudianus (Van der Veen and Hamilton-Dyer 1998:107), and Islamic Kom el-Nana (Smith 2003:52). Furthermore, a dubious identification of an imprint is recorded by Soderstrom (1969:401 and Plate 67) from pre-Islamic Hajar Bin Humeid in south Yemen. Remarkably, the distribution of the subfossil remains does not coincide with that of the wild forms of cumin, which grow in central Asia along the river Kisilikun in Turkestan, considered to be the area of origin of this spice (Becker-Dillingen 1929 [1924]: 843; Zohary and Hopf 2000:206). This discrepancy can be explained by the backlog of archaeobotanical research in central Asia and the poor preservation conditions of the charred etheric fruits.

Pliny (*NH* 20.57.159–162) mentions both cultivated and wild cumin, the latter one distinguished by its slender habitus and four or five serrated leaves. This description of the leaves, however, indicates that we are not dealing with a close relative of the cultivated cumin.

The common name *cumin* is derived from the Greek *kuminion*, which in turn probably originates from the old Babylonian *ka-mu-nu* (Jansen 1981:67). As a common name, cumin is rather confusing as it is used for a variety of species, including the following ones that originate from the Old World and represent no less than three different plant families: *Nigella sativa* L. (black cumin), *Allium* spp. (black cumin), *Cuminum cyminum* L. (cumin), *Pimpinella anisum* L. (sweet cumin), *Trachyspermum ammi* (L.) Sprague (king's cumin), and *Carum carvi* L. (cumin des prés). Obviously, all these species have been evidenced for the Roman period from archaeobotanical remains.

The fruits of cumin found at Berenike and Shenshef might either have been imported from the Nile Valley or have been harvested from locally cultivated plants. They could have been used for flavoring food as well as for all kinds of medical purposes. According to Pliny (*NH* 19.47.160), cumin was one of the most agreeable seasonings. Today, this kitchen herb is largely replaced by caraway (*Carum carvi* L.). Nevertheless, fruits of cumin are still offered for sale in Egyptian spice markets and are recommended for the treatment of intestinal spasms, rheumatoid arthritis, and kidney stones (Ahmed et al 1979).

***Ficus carica* L.**

English:	Fig
Arabic:	Balas, Teen, Tin, Tyn
Indian:	Produmbara vata
Plant part:	accessory fruit (syconium) and fruits (s.s.)
Trench/midden:	BE: 10, 13, 14, and 25; SS: 7 and 29
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figure:	-

Two fig species are cultivated in Egypt: the sycamore fig (*Ficus sycomorus* L.) and the common fig (*F. carica* L.). The fig tree produces so-called accessory fruits. Each false fruit consists of many small fruits (s.s.) surrounded by a hollow, fleshy receptacle, the last part of the flower stalk to which the flowers are attached. Frequently, these plant part names are not used properly, even in archaeobotanical literature. The misunderstanding of the anatomy of the fig has a long tradition. Galen (*On the Powers of Foods*: Book 2), for example, erroneously uses the fig for clarifying the distinction between seeds and fruits (Grant 2000:109–110):

> "Now I will begin with fruits, after making a prior distinction between them and seeds, especially because many people think it makes no difference whether you say fruit or seed. . . . For the fruit of the fig tree is the fig, but the seed of the fig tree is the pip, just as the fruit of the vine as a whole is the grape, yet the pip alone is the seed of the vine. In the same way the fruit of the pear tree and the apple tree are the pear and the apple, but the seeds are the three or four pips in their cores."

In this explanation, only the description of the grape is in concordance with current anatomical descriptions.

Both the sycamore fig and the common fig can only be successfully pollinated by the symbiotic wasp *Ceratosolen arabicus* Mayr. Unfortunately, this wasp has probably not been present in Egypt since the early Holocene (10,000 years BC). Fruit production is, however, still possible by the development of fruits that have not been pollinated, a process that is called *parthenocarpy*. Although in both species specific forms exist that are parthenocarpic, in Egypt the only parthenocarpic forms found are those of the common fig (*F. carica*). The production of accessory fruits without the small fruits (seeds) by the sycamore fig (*F. sycomorus*) in Egypt was already mentioned by Theophrastus (*EIP* 4.2.1). Therefore we can reliably say that the cultivation of the sycamore fig (*F. sycomorus*) in Egypt, which must have already started in predynastic times and is nowadays restricted to the lower Nile Valley, has always been propagated by cutting. The presence of the fruits (seeds) at Berenike and Shenshef indicate, therefore, that we are dealing with the common fig (*F. carica*). Most likely, these figs were cultivated in the Nile Valley, and we must consider them parthenocarpic plants.

The recovery of the fig in many excavations is not only facilitated by its suitable preservation properties and long-distance transport, but also by taphonomic processes. The archaeobotanical remains of the fig mainly concern the small fruits, which are usually called "seeds." These small fruits are swallowed and pass through the intestinal canal largely undamaged. Especially in archaeological feature types where dung is concentrated, such as cesspits, conditions for recovery are favorable.

For two reasons, the number of figs found at Berenike and Shenshef is relatively low. In order to be able to process large quantities of samples, it was decided to sieve only a small number also through a 0.5 mm sieve, which is capable of retrieving the fruits of fig. Furthermore, trash layers that have been investigated so far are located in the built-up areas and it may be assumed that such locations were not considered as suitable latrines. During the excavations, in order to minimize the serious annoyance caused by flies, relieving oneself was facilitated by special latrines or one could go behind the high hillocks of the *Tamarix nilotica*, both situated at some distance from the campsite. Although advanced flushing latrines became a standard accessory of large settlements from the beginning of the Roman period onward, it seems highly unlikely that they were also constructed at Berenike or Shenshef due to the scarcity of water. It may be assumed, therefore, that in Roman times, too, most of the human dung was deposited far beyond the inhabited area.

Due to the high sugar content of the fleshy part, the fig can easily be preserved by drying. In their dried state, figs can be stored for a considerable period and transported over large distances. These properties made possible the easy availability of the fig throughout the Roman Empire, including the northern part, which is outside its distribution area.

Foeniculum vulgare **Miller**

Synonym:	*Anethum foeniculum* L.
English:	Fennel, Finkel, Spingel
Arabic:	Rajianaj, Shamar, Shumarah
Indian:	Barosounf, Madhurika, Mouri, Razianig, Samar, Satpuspa, Sopu, Soumbu, Sounf, Wariari
Plant part:	fruits
Trench/midden:	BE: 9, 14, 19, and 25
Period:	first–second and fourth–fifth centuries AD
Preservation	desiccated
Figure	-

Fennel probably originates from southern Europe and the Mediterranean area. This kitchen herb is very similar to dill (*Anethum graveolens* L.), and Linné even classified fennel in the same genus as dill (*Anethum foeniculum* L.). What is characteristic of fennel are its life span and the fruit morphology, the latter being advantageous for archaeobotanical research. Fennel is a perennial herb and has oblong, channeled fruits. Dill, on the other hand, is an annual and has flatter fruits, although intermediate forms do exist. Jansen (1981:22–24, 31–32), who by the way argues for using its original Latin name, mentions that seed samples offered in Ethiopian markets mostly consist of a mixture of fennel, dill, and cumin (*Cuminum cyminum* L.). Seed samples that were obtained by the author in spice markets of Egypt turned out to be pure.

Fennel and/or dill fruits have been recorded from Roman Italy, Switzerland, Germany, France, The Netherlands, Great Britain, Libya, and Egypt. Obviously, fruits of dill were found in more than twice as many sites than fennel. In a number of sites both herbs were found. This pattern is also reflected in the sparse subfossil record of Egypt. The archaeobotanical evidence of both species supports to some extent the reliability of classical sources that sometimes also list both species together, such as Theophrastus (*EIP* 1.12.2; 7.3.2). On the other hand, it is rather conspicuous that in describing the hair-like leaves of a particular plant, both Theophrastus (*EIP* 4.6.3; 9.9.6) and Pliny (*NH* 13.47.136; 24.95.152; 25.42.82; 25.44.111) only present fennel as an example.

Fennel has been cultivated for its roots, leaves, and fruits, the most valued being the aromatic fruits that contain 2 to 6 percent essential oils. Those from the first-produced umbels are the best. To prevent loss of the essential oil, the fruits should be dried in the shade (Jansen 1981:27). Besides its use for flavoring all kinds of food, in particular fish courses, it has also been used as a medicine.

Because fennel is also cultivated for its fruit, it should have a good chance of recovery in archaeobotanical research. Nevertheless, the subfossil remains are sparse. This is not only true for Berenike, where only three fruits have been found so far, but also for other settlements in Egypt. Apart from some undocumented fruits stored in the Florence Museum, the only other records are from Roman Mons Claudianus (Van der Veen and Hamilton-Dyer 1998:107) and Islamic Kom el-Nana (Smith 2003:53). This might indicate that fennel was only introduced into Egypt since the Greek or Roman conquest. Further archaeobotanical research is, however, needed to confirm this suggestion. Once cultivated, fennel can run wild easily, as has been, for example, recorded from Egypt, Ethiopia, and Yemen.

In Ethiopia, fennel grows so abundantly in the wild that it is hardly even cultivated nowadays (Jansen 1981:27).

Fennel might have been imported to Berenike from the Nile Valley. Additionally, it could also have been locally cultivated in kitchen gardens, although it does not seem likely that fennel would have grown as a perennial or would it have reached its full size of about 2 m high.

***Grewia* L.**

English:	-
Arabic:	*G. tenax*: El-keiseh, Keisa, Moot, Tamoat; *G. villosa*: Dinwaay, Dinwai, Diwal, Katat
Indian:	*G. tenax*: Gangar
Plant part:	endocarps
Trench/midden:	BE: 10, 13–16, and 21; SS: 29 and 53
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4.39

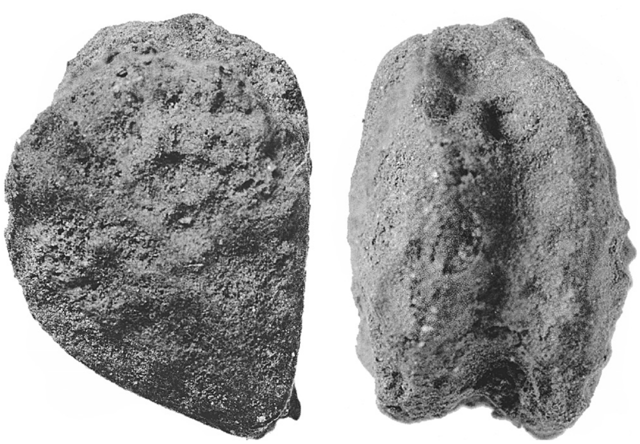


Figure 4.39. Endocarp of *Grewia* in lateral view (left) and in dorsal/ventral view (right) (6.4 x 5.2 mm). Photograph by J. Pauptit.

The genus *Grewia* includes some 150 tropical species that are found widely in Africa, Asia, and Australia. Unfortunately, no modern taxonomical treatment of this genus is available. As a result, a flora can only present provisional distinctions and descriptions, as is explicitly mentioned for the flora of Yemen (Wood 1997:97–98).

For Egypt, three *Grewia* species are recorded: the clearly distinctive *G. villosa* Willd. and the more complex species *G. tenax* (Forssk.) Fiori and *G. tembensis* Fresen. All three species are recorded from the Gebel Elba area, located south of Berenike in the Hailab. Schweinfurth, who was not allowed by the Bisharin nomads to visit the Gebel Elba, only mentions the presence of *G. tembensis* (under the name *G. membranacea* A. Rich) in the coastal area of Mirsa Elei, east of the Gebel Elba (Schweinfurth, 1865a: 341). According to Drar (1936:106–107), both *G. villosa* and *G. tenax* (mentioned as *G. populifolia* Vahl.) are recorded from the Gebel Elba proper, in which the latter is considered to be quite common. *G. tenax* also grows in the Eastern Desert, including the coastal area, and the Sinai (Boulos 1995:91).

Only the stony endocarps of the *Grewia* fruits have been found at Berenike. An identification of these remains to the level of genus is based on a drawing resembling the endocarp of *G. ogadensis* Seb., which grows in Oman (Demissew 1988:531). An identification beyond the level of genus is not yet possible because of the controversial status of some of the described taxa; the restrictive fruit descriptions, which do not include possible differences of the endocarp; and the lack of reference material of the fruits from species being considered.

Fruits of *G. tenax* and *G. villosa* are edible and can be eaten unripe, ripe, and dried, so it might be possible that the fruits from Berenike belong to either of them. In the case of *G. tenax*, the most likely area of origin would have been the Gebel Elba area.

The only other records of *Grewia* from ancient Egypt originate from the Neolithic site Nabta Playa and from Tutankhamen's tomb. Those from Nabta Playa could not be positively identified and do not match the species found at Berenike and Shenshef (Wasylikowa 1997:134–135 and Plate 22). In Tutankhamen's tomb, several baskets filled with fruits were found among the foodstuffs. A sample of this supply is kept at Kew, and these fruits were initially identified as *Grewia* cf. *javescens* Juss. Schiemann, who was able to study a sample from the Egyptian Museum in Cairo, rejected the identification made by Chandler and accepted by Lucas, as this species is native to northern Rhodesia. She identified these fruits instead as the Egyptian species *G. tenax*, which is also accepted by Hepper (Germer 1985:119; 1989:54; Hepper 1990:59). de Vartavan and Amorós (1997:125), of whom the former also had the opportunity to study the specimens kept in Cairo, are however right in arguing that the identifications to the level of species of the Tutankhamen's specimens are still in need of confirmation. Recently, the author was able to check the concerning sample at the Agricultural Museum in Cairo, but could also not suggest an identification beyond the genus level since no reference material was available.

***Hordeum vulgare* ssp. *vulgare* L. (hulled)**

Synonym:	*H. hexastichum* L.
English:	Six-row hulled barley
Arabic:	Sha'ir, Si'yr
Indian:	Barlibiyam, Barliyarisi, Jau, Jav
Plant part:	fruits (s.s.), ears and threshing remains
Trench/midden:	BE: 1–3, 6, 10, 13–16, 19, 21, 23, 25, 31, 33, 37, and 48; SS: 4, 7, 10, 20, 21, 29, 53, 54, and 56
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figures:	3.11 and 4.40

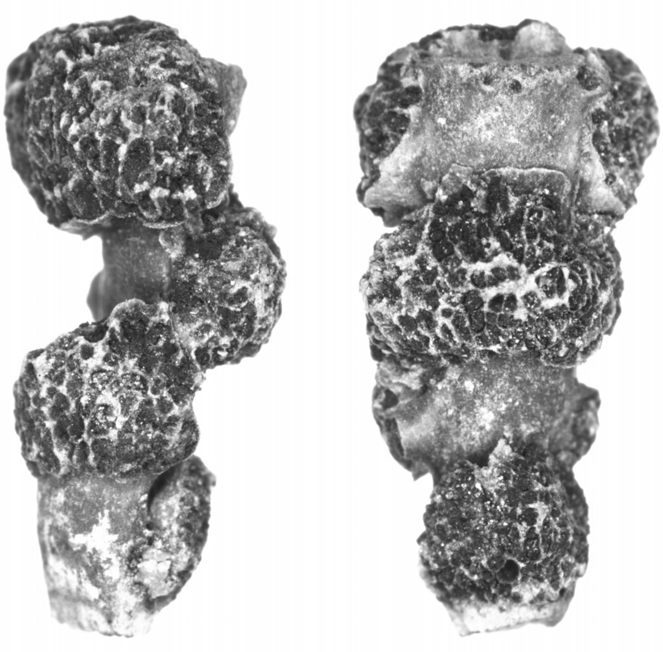


Figure 4.40. Rachis fragment of barley (*Hordeum vulgare* ssp. *vulgare*) infected by covered smut. Left-hand specimen: dorsal/ventral view; right-hand specimen: lateral view (length: 9.3 mm). Photograph by R.T.J. Cappers.

One of the main staple food crops at Berenike and Shenshef was six-row hulled barley. Contrary to naked (free-threshing) cereals, the fruits of hulled cereals are tightly enclosed by their husks (lemma and palea). In six-row barley (ssp. *vulgare*), all three single-flowered spikelets present at one node produce a grain, so that the alternate position of the spikelets along the rachis forms six vertical rows.

Although hulled barley is less digestible than naked wheat, it can be used for human food and stock feeding. When grains are used for making bread or porridge, it is necessary to remove the indigestible husk by grinding. In this way, the aleurone layer is removed, too, which is rich in proteins. The remaining endosperm of barley has a high starch content, but the protein content is low. The absence of gluten (special proteins, namely, gliadin and glutenin, that are insoluble in water and produce a sticky, elastic compound that allows the dough to rise) makes barley grains less suitable for bread making. However, the high starch content works well for the purpose of beer making. During the malting process, the first stage of beer making, the grains are allowed to germinate for some days, in which the starch of the endosperm is converted into simple sugars. This process is stopped after about one week by a special heating process. At a later stage, the remains of the husk are separated from the malt by sieving. Although dehusking is not a necessary pretreatment if hulled barley is used for fodder, whole grains are not completely masticated, and feeding animals with crushed or cracked grains will help their digestion (Langer and Hill 1982:55). It could be demonstrated by Neef and Bottema (1991:75) that, depending on the individual animal, 17 to 40 percent of hulled two-row barley grains (*Hordeum vulgare* ssp. *distichum* [L.] Korn.) were recovered undigested in cow dung. The presence of whole barley grains in camel dung from Berenike indicates that this cereal was used, at least partly, as camel fodder, as can be seen from these undigested barley specimens. Camels were crucial in the transport of commodities and staple food between Berenike and the Nile, and additional fodder would have been given when grazing in the wadis was not sufficient. Other plants that could have been used as forage for camels are sorghum (*Sorghum bicolor*), Johnson grass (*S. halepense*), kodra millet (*Paspalum scrobiculatum*), and even the date palm (*Phoenix dactylifera*). I once saw a couple of tended camels browsing dates hanging down from a young palm tree, much to the annoyance of the local farmer.

In Berenike and Shenshef, barley has been confirmed by many grain kernels and threshing remains. Occasionally, some intact ears and large fragments of ears have been found in trench BE00-33, dated to the first century AD. Of special interest are some rachis segments of barley that are infected with the fungus "covered smut" (*Ustilago hordei* [Pers.] Lagerh.; Figure 4.40). Covered smut leaves the outer part of the fruit (pericarp) intact and eventually parts of the palea, lemma, and glumes. It is only at maturity that these covering tissues split open. Liberated spores become attached to other grains or contaminate the soil and infect new grains when they germinate (Waller and Mordue 1983). Covered smut may cause considerable yield losses.

Table 4.1. Grains and threshing remains from trash deposits of Berenike (BE) and Shenshef (SS) in early and late Roman times (centuries AD). Rachis fragments of barley are partly infected with covered smut.

	BE 1st–2nd	BE 4th–5th	BE 5th	BE 5th–6th	SS 4th–5th
Barley (*Hordeum vulgare ssp. vulgare*)					
- grains	4,697	267	210	106	206
- rachis nodes (normal)	4,525	1,781	2,371	155	769
- rachis nodes (infected)	4	12	63	-	43
Hard wheat (*Triticum turgidum ssp. durum*)					
- grains	347	59	276	4	38
- rachis nodes	5,691	3,689	3,132	202	623
Sorghum (*Sorghum bicolor*)					
- chaff (lemma and palea)	1	1,073	278	354	778

Infected rachis segments are found in early deposits (first to second centuries AD) and late deposits (fifth and early sixth centuries AD) from Berenike and in late deposits from Shenshef (Table 4.1). Although this fungus has a wide distribution and is found everywhere in the world where barley is cultivated, including the whole of Egypt today (CMI Map 460, first edition, 1969), the co-occurrence in both Roman settlements strongly supports that they originated from the same area. The degree of infection can be deduced from the proportion of infected rachis nodes, the place where the three grains are attached to the axis of the ear (rachis). In trenches BE96-13 (first to second centuries AD) and BE96-14 (fifth and early sixth centuries AD) only 0.3 and 1.3 percent of the rachis nodes were infected respectively. The percentage in Shenshef deposits was, however, considerably higher: 11.7 percent. The original percentages may have been even higher, since infected ears are easily detected and removed from the field. Although the high percentage from Shenshef may support the hypothesis of local cultivation, it is still possible that the infected barley was imported from the Nile Valley. Infected ears or spikelets can withstand transport, even if this was done by camel (personal communication from R. Pieters and J. P. Meffort, Plant Protection Service, Ministry of Agriculture, Nature Management and Fisheries, Wageningen).

Recently, the author had the opportunity to check the botanical remains in the Dokki Agricultural Museum in Cairo. It turned out that two samples of hulled six-row barley (*Hordeum vulgare* ssp. *vulgare*) from Karanis (Kôm Aushim) also contained a few rachis fragments that were infected with covered smut (samples 274 and 2057). Also, a few infected rachis fragments have been found from Roman contexts at Quseir al-Qadim (Van der Veen, personal communication).

Other archaeobotanical references to covered smut are related to bodies that have been found in European bogs. Huge quantities of spores were found in the stomach contents of the Tollund Man (Denmark, Iron Age) and Grauballe Man (Denmark, late Iron Age–early Roman period) and spores identified as "similar to" *U. hordei* were recorded from the stomach of one of the Lindow Man bog bodies (England, Roman period) (Van der Sanden 1996:110). Fragments of barley were also found in the intestines of these bog bodies.

Both Theophrastus (*EIP* 8.10.2) and Pliny (*NH* 18.44.154) mention rust, which is in fact another kind of fungal disease caused by the *Puccinia* species. According to Theophrastus, barley is more vulnerable to this disease than wheat. Pliny states that rust is especially prevalent in fields that are subjected to morning dew and are out of the wind. From their limited descriptions, it cannot be concluded, however, that they were actually referring to covered smut instead of rust.

The record of covered smut in ancient Egypt seems to indicate that this plant disease was introduced into Egypt by the Romans, but this suggestion can only be a tentative one as the record is still rather scanty. It is most likely that the infected rachis fragments were not recognized in previous archaeobotanical research. More research of pre-Roman plant material, including the reexamination of earlier-studied material, is necessary to decide upon the history of covered smut in Egypt.

Hyphaene thebaica (L.) Mart.

Synonym:	*Cucifera thebaica* Delile; *H. sinaitica* Furt.
English:	Gingerbread tree; Doam palm, Dom palm, Doum palm
Arabic:	Al-Nakhil al Barry, Daom, Dawm, Dom, Dum, Mama, Shag. el nugl

Indian:	Samanya damatala
Plant part:	fruits (endocarp), seed, and male inflorescence axis
Trench/midden:	BE: 1, 3, 5, 6, 10, 13, 15, 16, 19, 21, 27, 29, 31, 33, 37, and 48; SS: 4, 20, 21, and 29
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figures:	4.29, 4.41, 4.42, and 4.43

The doam palm is one of the three palm trees native to Egypt, and in a strict taxonomic sense, this palm species only occurs in Egypt and Sudan. It is easily identified by its fan-shaped and deeply lobed leaves and the dichotomous branched trunk, the latter feature a rare phenomena among palm trees.

The doam palm is recorded from the Eastern Desert, including the coastal area, the oases in the Western Desert, the Sinai, and the Nile Valley. Large populations are present in the El-Kharga oasis and in the Qena and Aswân provinces in the Nile Valley (Drar 1954:72). It does not grow in the Gebel Elba area.

The archaeobotanical record of the doam palm for ancient Egypt is extensive, starting in the late Paleolithic and ending in the Islamic period. The number of fruits that have been found at Berenike and Shenshef indicates that there must have been a reasonable supply. The doam palm grove in Wadi Gimal, the nearest one to Berenike, is probably too small for an exploitation on this scale. The most likely area of origin, therefore, is the Qena province in the Nile Valley. Located immediately north of Qift, one of the two terminals of the caravan tracks that connected Berenike with the Nile, doam palm fruits could easily have been delivered from Qift as a return cargo.

Two forms of fruits exist: bitter and sweet ones. The sweet form is easily distinguished as it has a pleasant, gingerbread smell and taste, and the seed is not so loosely embedded in the fruit that it rattles if shaken (Von Maydell 1990 [1986]: 304). The seed is only edible when the fruit is still young. Once ripe, the seeds are as hard as ivory and only the pulpy mesoderm can be eaten. An advantage of old doam palm fruits is that they are easily stored and can be prepared whenever needed. Both whole doam palm fruits and fragments of the mesocarp are still sold in markets in Egypt. The sweet mesocarp can be pounded into a meal or made into a syrup. Nevertheless, its taste is not highly appreciated. Wood (1997) reports that in Yemen it is mostly eaten

Figure 4.41. Kohl container from an Ababda made from a seed of the doam palm (*Hyphaene thebaica*), (February 1998). See Color Plates section, page 224.

by children. Doam palm fruits as well as a powdered extract of its fruits were offered as food during one of the excavation seasons of Berenike, but were not eaten. The ultimate destiny of all fruits turned out to be the botanical reference collection.

Besides its use as food, the fruits are also exploited for their ivory seeds. Ababda nomads used to make containers (makhalas) to keep kohl from lead sulphide, although it seems as if this is no longer practiced, and such containers are substituted with modern equivalents made of wood. Such kohl containers have a small opening at the top that is plugged by a piece of cloth or something similar. The kohl is taken out by a small rod made from bone, metal, or plastic and is used as an eyeliner. The containers can be decorated with leather and beads (Figure 4.41). Fruits with an aberrant shape are of special interest. It happens that a single fruit develops two extra particles, which may even become full grown. Such tripartite fruits are used by the Turkanas in northern Kenya for making dolls (Dagan 1990:135–136). Although not on a regular scale, such aberrant fruits are also found in Egyptian markets and originate from Sudan. Seeds of the doam palm are made into beads. Strands of beads consisting of colored figs and whole as well as sliced seeds of the doam palm are currently offered for sale. Yet another use is making embroidered bed hangings from the hard seeds, as is mentioned by Theophrastus (*EIP* 4.2.7). This antique practice resembles the production of buttons, which started as a new industry in Egypt in the middle of the twentieth century, obviously relying mainly on imported seeds (Drar 1954:72).

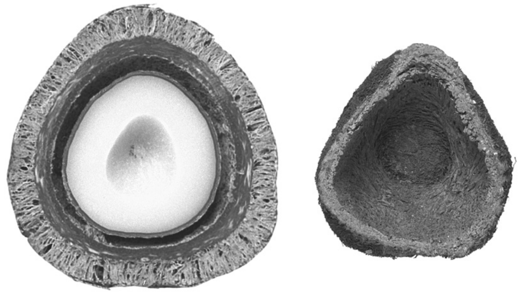


Figure 4.42. Cross section of recent fruit of the doam palm (*Hyphaene thebaica*) with seed (left: 54 x 56 mm) and subfossil fruit (endocarp) (right: 40 x 44 mm; Figure 4.42). Photographs by R. T .J Cappers (left) and J. Pauptit (right).

Several trenches (i.e., 10, 19, 21, 29, and 33) revealed fruits that have been purposely cut into halves with a sharp tool (Figure 4.42, right specimen). Most of these worked fruits were recovered from the debris of trench 21 and date to the mid-fifth century AD and later. The solid construction of the endocarp makes it extremely difficult to cut the fruit into pieces. Unfortunately, only worked endocarp fragments have been found from which we cannot determine the end product.

The only seeds that have been unearthed so far originate from Shenshef and concern one whole specimen and a small fragment of another. The few fruit mesocarp fragments from Shenshef were found in nearby trenches and were fragmented to such an extent that it could not be deduced if they also had originally been cut into halves. The seeds might have been discarded because they were broken during processing. Doam palm fruits that had been sawed open to extract the seed are also recorded from Quseir al-Qadim, though it is not mentioned if these specimens are dated to the Roman or Mamluk period (Wetterstrom 1982:368).

A remarkable find concerns a part of a male inflorescence axis in trench BE96-10.008. Such plant parts are quite rare among the subfossil remains from Egypt. Fragments are recorded from Sheikhs Abd el-Qurna in the necropolis of Thebes (Eighteenth–Nineteenth Dynasties) and from Dra Abu el-Naga (Twenty–Twenty-sixth Dynasties), formerly stored in the Botanical Museum of Berlin but destroyed during the Second World War (Täckholm and Drar 1950:287). The doam palm is dioecious, which means that the inflorescences are unisexual and that male and female flowers are present on different plants. According to Täckholm and Drar (1950:274), a single male tree is capable of fertilizing a great number of female trees, even if these trees are situated far apart. If doam palms are cultivated at an isolated spot, such as Berenike, one might expect that, for practical reasons, several specimens were grown to be sure that at least female trees would be among them. On the other hand, doam palms are difficult to cultivate and grow best in rich sandy loam, a condition not met in the brackish environment of Berenike. An alternative explanation for the presence of the male inflorescence could be that complete trees had been brought to the site. Its timber is more valued than that of the date palm and is applied in a variety of ways.

Juglans regia **L.**

English:	Walnut
Arabic:	Ayn al Jamal, Gawz, Jawz, Joz
Indian:	Samanya aksota
Plant part:	fruits (endocarp)
Trench/midden:	BE: 1, 10, 13–16, 19, 21, 24, 25, 29, 31, 33 and 48; SS: 21, 29 and 56
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	-

The walnut is a deciduous fruit tree that originates from the Balkan, north Turkey, the south Caspian region, the Caucasus, and central Asia (Zohary and Hopf 2000:188). During the Roman period, the walnut expanded throughout the whole Mediterranean area.

Figure 4.43. Outer side (left) and inner side (right) of fragment of endocarp of the doam palm (*Hyphaene thebaica*) (3.2 x 1.8 cm). Photograph J. Pauptit.

The cultivated forms are thin-shelled and contain large, edible cotyledons. Subfossil remains from walnut recorded from Egypt are scanty and confined to the Roman period, indicating that it was probably only temporarily available in Egypt as a luxury food item.

Although only small numbers of fruit remains were found at Berenike and Shenshef, their presence in many trenches indicates that this nut was a valued food and imported from the Mediterranean area on a regular basis.

***Juniperus* L.**

English:	Juniper
Arabic:	*J. phoenicea*: Ar'ar, Djineda; *J. oxycedrus*: Ar'ar, Taga
Indian:	Hapusa
Plant part:	seeds
Trench/midden:	SS: 4, 29, and 53
Period:	fifth–early sixth centuries AD
Preservation:	desiccated
Figure:	-

The only juniper that occurs in Egypt is Phoenician juniper (*Juniperus phoenicea* L.), which is recorded from some locations in the Mediterranean area and the Sinai. Up to 4,000 years ago, the now-isolated relict populations in the Sinai, which dominate the high altitudes of the Gebels Halal, El-Maghara, and Yalaq, had a widespread distribution in this peninsula (Zahran and Willis 1992:301). This species is also recorded from Jordan and some scattered locations along the northwest coast of Saudi Arabia (Miller and Cope 1996:72).

Junipers are valued for their wood and fruits. Both wood and berries have an aromatic resinous flavor, and branches as well as berries can be used in cooking. Juniper berries have also frequently been found in connection with mummies, either stored as a supply or used as an embalming agent together with salt, in both cases probably having a symbolic meaning (Lucas and Harris 1962:311). Berries of the Phoenician juniper have also a tradition in medical application and fumigation. According to Täckholm et al. (1941:65), berries of this juniper are nowadays imported from Europe. Täckholm, who checked the identification of many subfossil remains, including those used for mummification, came to the conclusion that all material identified as Phoenician juniper is in fact prickly juniper (*J. oxycedrus* L.). This juniper is, strangely enough, not native to Egypt but its distribution area does include parts of North Africa (Morocco, Algeria, and Tunis), Italy, Aegean Islands, and Cyprus. Täckholm's identification is based on the number of seeds present in the fruits. The Phoenician juniper contains 3 to 9 seeds, whereas those of prickly juniper have somewhat less. It seems, however, that the number of seeds per berry overlaps (e.g., Zohary 1966:20; Hepper 1990:60), and that probably no clear distinction between these species can be made relying on this feature only. Other juniper species that have been recorded for ancient Egypt are Syrian juniper (*J. drupacea* Labill.), Grecian juniper (*J.* cf. *excelsa* M. Bieb.) and Savin juniper (*J. sabina* L.), all three based on identifications of berries and dated to the Middle Kingdom and New Kingdom.

As only single seeds were found at Shenshef, they could not be identified beyond the level of genus. Species identification is more problematic, the archaeobotanical record tentatively indicating Phoenician juniper or prickly juniper. Judging by the relict status of the Phoenician juniper in Egypt, which would have been the same during the Roman Conquest, it might be very well that those from Shenshef were imported from the Mediterranean area.

***Lagenaria siceraria* (Mol.) Standl.**

Synonym:	*Cucurbita siceraria* Mol.; *L. vulgaris* Ser.
English:	Bottle gourd, Calabash gourd, Club gourd, White-flower(ed) gourd
Arabic:	Duba, Dubbah, Qar' dubba, Qar' duruf, Qar' tawil
Indian:	Dudhi
Plant part:	seeds
Trench/midden:	BE: 13, 16, 25, and 33
Period:	first–second and fifth centuries AD
Preservation:	desiccated
Figure:	-

The bottle gourd is a member of the bryony family (Cucurbitaceae), which is cultivated for its nonedible fruits. The fruit is called "gourd" or "calabash." The word *gourd* is used in many common names of members of the bryony family, whereas the word *calabash* is also used for the calabash tree (*Crescentia cujete* L.), a New World species that belongs to the Bignoniaceae. The bottle gourd is indigenous to tropical Africa, but has now a pantropical distribution that expresses the multifunctional use of its fruit.

As is the case in many species of the white bryony family, both bitter and nonbitter mutants are known from the bottle gourd. The soft mesocarp of the bitter forms is inedible, and plants producing such fruits are especially cultivated for their dried fruits, which are called *gourds*. Bottle gourds have fruits that can reach a considerable length (up to 50 cm) and diameter (up to 60 cm). All kinds of shapes are cultivated, varying from almost-globular ones to elongated cylinders and ones with long, constricted necks. Pliny (*NH* 19.24.70) states that mostly sheaths of plaited wicker were put over the young fruits after the blossoms had been shed in order to manipulate the shape of the fruits.

The fruits are used in all kinds of ways, including household items, music instruments, and containers for transport and storage. Pliny (*NH* 19.24.71) mentions their use as containers in bathrooms and as jars for storing wine by the Romans. As the inner fruit pulp dries easily and shrivels when left in the sun, the gourds can also be used as floating devices. Especially in Egypt, such gourds were used to keep fishing nets afloat, and in Nigeria fishermen even ride on very large gourds while they are fishing (Täckholm 1961:32; Berns and Hudson 1986:43). Their use as containers is extra valued because the hard, woody rind is impermeable to water. Even immature fruits can be harvested, after which the fruit can be modeled into a desired shape. Gourds can be decorated using various engraving techniques in combination with painting.

There are several possible explanations for the presence of seeds of the bottle gourd in two trash trenches of Berenike, namely, BE97-13 and -16. One possibility is that we are dealing with the bitter form and that the fruit was used as a gourd indeed. In that case, the presence of seeds supports the idea of local cultivation. Gourds contain many seeds and these seeds, together with the pulp, have to be removed during the processing of the gourd. Only a small fraction of these seeds is needed as sowing seed for the next season, so most of the inner part would have been thrown away. It is also possible that the seeds originate from the edible, nonbitter fruit. Because such fruits are harvested when they are still unripe, we cannot be sure if these seeds have reached maturity. Although salted seeds of the bottle gourd are sold today as snacks in shops that have a good assortment of such food, this kind of use was probably not practiced in Berenike, judging from the recovery of seeds in trash deposits.

The relatively few subfossil records from Egypt, including those from the Roman period, concern whole gourds or fragments of the thick rind, evidence of their use as containers. Among the fruit fragments that were found by Täckholm (1961:32) in the Coptic monastery of Phoebammon, there is a discarded upper part of a gourd, which is necessary in order to clean out a gourd. Also, the bottle gourd has been recorded among the archaeobotanical remains from Roman France and Germany.

The bottle gourd is also used for medical purposes. Pliny (*NH* 28.58.205), for example, states that the pulp mixed with the ash of a deer's horn or bull's gall and cumin (*Cuminum cyminum* L.) is prescribed for dysentery.

***Lathyrus sativus* L.**

English:	Chickling pea/vetch, Dogtooth-pea, Grass pea, Grass peavine, Indian pea/vetch, Lathyrus pea, Riga pea, Wedge peavine
Arabic:	Gulban, Khullar
Indian:	Chural, Kansari, Karas, Karil, Kassar, Kesari, Khesari dhal/meh, Khesra, Khessary pea, Kisari, Lakh, Lakhodi, Lakhori, Lang, Latri, Matur, Santal, Teora, Tiuri
Plant part:	seeds
Trench/midden:	BE: 25, 31, and 33
Period:	first–second centuries AD
Preservation:	desiccated
Figure	-

The grass pea is native to southern Europe and western Asia, where it belongs to the early domesticated crops. Although it is still cultivated in parts of Europe, Africa, and Asia, it is now only considered a major crop in India, illustrated by its many local names, and Ethiopia. The grass pea can be grown both for human consumption and for fodder for livestock. In Egypt today, the grass pea is only a minor crop, whose cultivation is mostly restricted to southern Egypt (Nassib et al. 1990:51).

The main reason for the fact that today the grass pea is only grown as a minor crop is that it belongs to a group of 21 pulses that may cause lathyrism to develop in people and livestock. Lathyrism is a neurological disorder that especially affects the muscular activity of the lower limbs caused by the specific nonprotein amino acid ODAP. This kind of disease occurs if such pulses are consumed for a considerable period, and extreme concentrations may even be lethal (Kearney and Smartt 1995:267).

The risk of lathyrism is greater in periods of famine, when the grass pea is grown after cereals have failed, and the people are more vulnerable to disease. Because this amino acid is water soluble, it can be extracted from the seeds by soaking them for 24 hours followed by sun-drying. This will result in a 90 percent reduction of the toxic compound, but also in a considerable loss of water-soluble nutrients (Kay 1979:120). Additionally, boiling and baking will reduce their toxic properties.

The grass pea has a well-developed root system and can grow under extreme drought conditions. It tolerates temperatures between 10–25°C, and the plant is therefore grown as a cold-season legume. The grass pea might have been grown on a small scale during the spring in local kitchen gardens in Berenike and Shenshef. Larger supplies would probably have been imported from the Nile Valley. Several trenches yielded only small amounts of this pulse, indicating that it was probably not a staple food in Berenike or Shenshef. Both people and animals might have consumed the seeds. Also, the whole plant can be fed to animals, but it is harmful to horses.

***Lens culinaris* Medik.**

Synonym:	*L. esculenta* Moench
English:	Lentil, Red dhal, Split pea
Arabic:	‘Ads, ‘Ala, ‘Alas, ‘Adas, Balas, Bilsim
Indian:	Chaunangi, Chirisanagalu, Massar, Masser, Mas(s)ur, Misurpappu, Musiripappu, Thulukkappayar
Plant part:	seeds
Trench/midden:	BE: 1, 2, 6, 10, 13–16, 19, 21, 25, 31, 33, 37, and 48; SS: 4, 7, 20, 21, 29, 54, and 55
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figure:	-

Lentil is one of the founder crops that was domesticated in the Fertile Crescent. From there it was introduced in ancient times into southern Europe, western Asia, and Egypt. Before the construction of the Aswan High Dam, lentils were grown on the Nile sludge deposited in the basin lands of southern Egypt (Nassib et al. 1990:58).

Lentils are available on the market as whole seeds, with their seed coat still present, and as split seeds. It is one of the most nutritious of the pulses. Due to the high protein content, which is about 20 percent in dried seeds, lentils can be used as a meat substitute. On the basis of their pods and seeds, two groups, sometimes even ranked as subspecies, are distinguished: *microsperma* and *macrosperma*. The former one has smaller pods and seeds and include the red-cotyledon types (red dhal). The small seeds are still popular in Egypt and are mainly used in soups.

Lentil has been recorded for Egypt from the Neolithic period onward. Though mostly in small numbers, lentils were found in many loci of Berenike and Shenshef, and it can therefore be considered as one of the staple foods. It may be assumed that this pulse crop was imported on a regular scale from the Nile Valley. The seeds from Berenike and Shenshef are small in size. Because they were retrieved in small numbers from trash deposits, their identification to the level of subspecies is, however, not possible. Although they may belong to the *microsperma* group, it is also possible that we are dealing with the small specimens of *macrosperma* group that passed through the sieves during cleaning of the seeds prior to cooking.

Liliaceae

English:	-
Arabic:	-
Indian:	-
Plant part:	bulbils
Trench/midden:	BE: 1, 4, 6, 10, 13–16, 19, 21, 25, and 37; SS: 7, 20, 21, 29, 53, and 54
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4.44

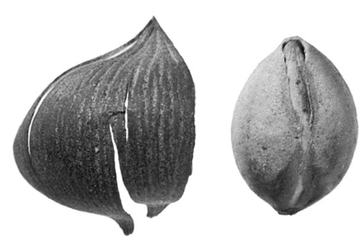


Figure 4.44. Outer bulb coat leaf (left: 9.6 x 7.8 mm) and storage leaf (7.8 x 5.4 mm) of an unidentified bulbil. Photograph by J. Pauptit.

In many samples, from both Berenike and Shenshef, large quantities of bulb-coat leaves were found of a yet-unidentified plant species. These large quantities suggest that it was a valued food plant and that they must have been available on a regular scale. So far, only one intact specimen has been found.

The size of the bulbs is relatively small, not exceeding 1 cm in length. The bulbs either belong to species that have increase bulbs (cloves), produced by the subterranean bulb, or to species, which produce bulbils in the inflorescence instead of the flowers. They could also belong to species that produce only small bulbs.

It is plausible that we are dealing with a species of the genus *Allium*. Some species within this genus, such as the great-head garlic (*A. ampeloprasum* L.), can produce numerous bulbils, which is true for the Egyptian specimens in particular (de Wilde-Duyfjes 1976:66). The morphology and the anatomy of the bulbils from this onion species do not match, however, with the subfossil specimens.

***Linum usitatissimum* L.**

Synonym:	*L. humile* Mill.
English:	Flax, Linseed
Arabic:	Kattan, Kittan, Malsag, Mawmir
Indian:	Alsi, Alsidirai, Atasi, Jawas, Masina, Tisi
Plant part:	seeds and fruit
Trench/midden:	BE: 1, 10, 13, 14, 16, 25, and 31; SS: 4 and 29
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	-

Like lentil, flax also belongs to the first group of crops that were domesticated in the Fertile Crescent. Flax holds a special position because it is not only grown as a food crop, but it is also exploited for its fibers. Today, flax is grown either for its seeds or for its fibers. Seed-yielding plants usually have short, branched stems and produce large seeds, whereas fiber flax has taller, unbranched stems and produces smaller seeds (Zohary and Hopf 2000:126).

The seeds are nutritious and contain 30 to 48 percent oil and 20 to 30 percent protein. Whole seeds can be used for garnishing loaves (Dalby 1996:85). Seeds can also be used as a source of vegetable oil and for making flour. Linseed oil is obtained by cold pressing and can be used as cooking oil. The ancient Egyptians also used linseed oil for embalming bodies. Pounded linseed can be mixed with, for example, pulses and cereals. Pliny (*NH* 18.13.73) describes the making of barley porridge in which ground barley is mixed with pounded roasted coriander (*Coriandrum sativum* L.), salt, and linseed. In present-day Ethiopia, flax seeds are only used for making a stew called *wot*, which is a combination of pounded roasted linseed and pulses (Seegeler 1983:188). Additionally, linseed was also used for all kinds of medical purposes. Pliny (*NH* 20.57.164), for example, states that linseed together with ammi (*Trachyspermum ammi* [L.] Sprague) taken in wine is good for wounds caused by scorpions, creatures that have been frequently found during the excavations at Berenike. Today, linseed is still sold in spice markets for the treatment of abscesses and coughs (Ahmed et al. 1979).

The fibers are extracted from the stem by a special procedure, which includes the bacterial breakdown of the softer tissue in stagnant water during a period of about 8 to 10 days. This is known as *retting*, a process in which the cellulose fibers become separated from each other. Flax fibers are the source of linen, which was used, among other things, for making dresses and sails. According to Pliny (*NH* 18.28.108), sieves and meal sifters were made from flax fibers in Spain, whereas those in ancient Egypt were made from papyrus (*Cyperus papyrus* L.) and rush (*Juncus* sp.).

The use of flax as a source of fibers cannot be reconciled with the presence of flax seeds and a fruit fragment at Berenike and Shenshef. To produce fibers, much fresh water is needed for retting the stems, an essential step in the production process. This is not a problem in the Nile Valley, but is out of the question in desert settlements. The most likely explanation for its presence at Berenike and Shenshef is that the flax seeds were used in cooking, and possibly for oil extraction, and that they were traded.

The latter option is sustained by Pliny (*NH* 19.1.7), who states that the disadvantage of growing flax, as it damages the land, is compensated in Egypt by the fact that it is used there in exchange for import items from Arabia and India. It is not clear from Pliny's description whether fibers or seeds are meant. The *Periplus Maris Erythraei* makes no reference to the trade of flax. Judging by the water requirements on which flax cultivation relies, the Arabian Peninsula seems to be the most likely area to which it was exported.

In trench BE96-14, a so-called twin-seed was found. Such double seeds stick together ventrally and originate from the same carpel. Twin-seeds are described from several samples collected in Ethiopia, including a sample from the Axum market (Seegeler 1983:169). In most of these samples, twins-seeds were only sparsely present. A few samples from Haik (Welo province, Ethiopia), however, consisted predominantly of such twin-seeds. Twin-seeds of these samples were sown in an experimental field plot at Wageningen University (The Netherlands), and those from Haik produced invariably plants with twin-seeds, indicating that this phenomenon is genetically determined.

Although Seegeler could not find any other reference to twin-seeds in literature, we cannot accept his description as conclusive evidence for the assumption that Berenike imported its flax from Ethiopia, in which Avalitês would have been the most likely supplier. This assumption contradicts the aforementioned remark of Pliny concerning the export of Egyptian flax. The location of Berenike excludes the possibility of transit trade of linseed from northeast Africa to Arabia.

***Lupinus albus* L.**

English;	White lupin, Egyptian beans
Arabic:	Baqila shami, Baqilly masri, Tirmis, Turmus
Indian:	Sveta kauskalaya
Plant part:	seeds
Trench/midden:	BE: 1, 10, 13–16, 19, 25, 31, 33, 37, and 48; SS: 21, 29, and 53
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated
Figure:	4.45

Figure 4.45. Seed of white lupin (*Lupinus albus*) with hilum positioned top left (9.7 x 9.3 mm). Photograph by R. T.J. Cappers.

White lupin originates from the Mediterranean area. Its wild progenitor, now classified as *Lupinus albus* ssp. *graecus* (Boiss. & Spruner) Franco Silva, is native to the Aegean region (Zohary and Hopf 2000:123). Apart from a single record from Pompeii, all other finds are recorded from Egypt. The first introduction into Egypt is, however, somewhat disputable. With the exception of a find in Dra Abu el-Naga (Thebes) from the Twenty-second Dynasty (945–712 BC), all other records are dated to the Roman period or later (Germer 1985:67). White lupin is still a popular legume in Egypt.

Almost all legumes are capable of fixing atmospheric nitrogen in their roots in association with bacteria of the genus *Rhizobium*. A precondition is, however, that the particular rhizobial strain is present in the soil. Owing to this capability of fixing nitrogen, legumes are considered natural fertilizers and can grow in poor soils. The ancient Greeks were already familiar with this phenomenon, and it has been explicitly mentioned for white lupin, among some other legumes, by Cato (37.2).

Seeds of white lupin have a relatively high oil content of 11 to 18 percent and also a high protein content of up to 45 percent (Langer and Hill 1982:236). Up until the 1920s, when a sweet alkaloid-free type became available, the steeping or boiling of white lupin seeds was necessary before consumption. According to Dalby (1996:89), this pulse was not considered a high standard food in the Greek diet. White lupin can be fed to animals, but the presence of the bitter alkaloid may cause the disease lupinosis in sheep and horses, especially when these animals consume large concentrations. Seeds of the white lupin are also recommended by Pliny (*NH* 18.36.136) for the treatment of stomach disorders. Even at present-day markets in Egypt, white lupins are sold for medical purposes, such as skin inflammations, acne, diabetes, and liver complaints (Ahmed et al. 1979).

The white lupin has been regularly found at Berenike and Shenshef. There is a marked contrast between whole seeds, which are perfectly preserved but are only seldom found, and damaged seeds, from which a reasonable number of seed-coat fragments are preserved. This difference in frequency can be explained by the way the seeds are eaten. After having been soaked in water, the seeds are cooked and eaten as a snack in which the soft content is sucked out and the leathery seed coats are discarded. Possibly, damaged seeds are less resistant to decay. Because of the unfavorable preservation of the broken seeds, it is possible that the white lupin is under-represented in the archaeobotanical record. The white lupin was probably imported from the Nile Valley.

***Malus domestica* Borkh.**

Synonym:	*M. pumila* auct.; *M. sylvestris* auct.; *Pyrus malus* L.
English:	Apple
Arabic:	Tufah
Indian:	Samanya utkola
Plant part:	seeds
Trench/midden:	BE: 13, 25, and 48
Period:	first–second centuries AD
Preservation:	desiccated
Figure:	-

The primary center of origin of the apple is located in parts of temperate Asia, its real center of origin however is obscured by the many existing varieties of both wild and cultivated apples. Even today, hybridization between wild and cultivated apples still occurs. The apple tree is adapted to cooler temperate climates as a chilling phase is necessary to break bud dormancy so that branches can produce their flowers (Zohary and Hopf 2000:171). In present Egypt, apples are cultivated in the Marsah Matruh, located in the western Mediterranean coastal zone and are among the fruit crops in Egypt whose productivity is increasing (Haagsma 1997:14).

Apples can be propagated by seeds, as is the case with wild apples, or by vegetative reproduction attained by grafting or budding, which is common practice with cultivated races. The advantage of vegetative reproduction is twofold: the life cycle of new trees is shortened, and established features are no longer affected by recombination. The technique of vegetative propagation was already known in classical times. Theophrastus (*EIP* 2.2.4-5), for example, points out that apples, among some other fruit trees, can be best propagated by root suckers, whereas those raised from seeds will only produce inferior fruits.

The presence of some pips at Berenike demonstrates the appreciation of this fruit, which most probably must have been imported from the Mediterranean area. The only other archaeobotanical record of apple, mentioned as *M. sylvestris* Mill, is from Greek-Roman Douch in the Kharga Oasis (Western Desert), where leafy branches, a core fragment, and a pip were found (Barakat and Baum 1992:70).

Mimusops laurifolia **(Forssk.) Friis**

Synonym:	*Mimusops schimperi* A. Rich.
English:	Persea
Arabic:	Barsâ, Labakh, Libakh
Indian:	-
Plant part:	seeds
Trench/midden:	BE: 31, 33, and 48
Period:	first century AD
Preservation:	desiccated
Figure:	4.46

Persea is a member of the Sapotaceae, a plant family that has a pantropical distribution and is not represented in Egypt today. Persea is a tall tree adapted to arid conditions and is especially found on rocky slopes. It is native to Yemen, Saudi Arabia, Ethiopia, and adjacent parts of Somalia, but is also widely cultivated outside this area including Egypt (Wood 1997:130). The oval greenish berries of the persea tree are about 3 to 4 cm long, have a sweet taste, and contain large inedible seeds.

Figure 4.46. Seed of persea (*Mimusops laurifolia*) (20.0 x 12.3 mm). Photograph by R.T.J Cappers.

Theophrastus gives a description of the persea tree which makes sense in most of its details (*EIP* 4.2.5), including that it is fruit bearing in Egypt but has only flowers in Rhodes (*EIP* 3.3.5), which has a Mediterranean climate. According to Theophrastus, the persea tree is abundant in Thebes (*EIP* 4.2.8). His statement that the persea, together with the sycamore fig (*Ficus sycomorus*), the acacia, the sugar date (*Balanites aegyptiaca*), and some others trees are peculiar to Egypt (see Chapter 3, Cultivated Trees), is certainly not true. Strabo (*Geography* 17.2.4) is better informed as he states that the persea tree grows in Egypt and Ethiopia.

The impressive archaeobotanical record of persea is restricted to Egypt. The first records date back to the Third Dynasty and comprise seeds and leaves made into garlands, in particular. It is noticed by Hepper (1990:15) that the folded leaves indicate that the tree once grew in Egypt as such folding is only possible when the leathery leaves are still fresh. Whole fruits were found in Tutankhamen's tomb (see Figure 18.20 in Darby et al. 1977). Until recently, some trees planted by Schweinfurth were still present in the garden of the Agricultural Museum in Cairo (Hepper 1990:15), and currently its presence in the garden of the Egyptian museum could be demonstrated by Germer (Prestel 2004: 43–44). The persea fruits could have been obtained from the Nile Valley or from Adulis or Avalitês (both located along the Red Sea coast of present Eritrea), Muza on the coast of Yemen, or the far-side ports along the Somalian coast.

Moringa peregrina **(Forssk.) Fiori**

Synonym:	*M. aptera* Gaertn.
English:	Bentree, Benoil tree,

	Horseradish tree
Arabic:	Al ban, Al-habbah al-ghaliah, Baan, Elbaan, El-leban, Gos-al-ban, Hab al ban, Habb el-baan, Habb el-yasaar, Habb ghaali, Jasar, Khiaam, Leban, Maee, Roba', Yasaar, Yasar, Yesaar
Indian:	-
Plant part:	seeds
Trench/midden:	BE: 16 and 33; SS: 20
Period:	first–second and fourth–fifth centuries AD
Preservation:	desiccated
Figure:	4.47

Figure 4.47. Fragment of seed coat of the bentree (*Moringa peregrina*) (12.8 x 9.7 mm). Photograph by J. Pauptit.

The bentree belongs to the Moringaceae, a plant family related to the legume family (Leguminosae or Fabaceae). This tree is found in Israel northward up to the Jordan Valley, in tropical northeast Africa, and in parts of the Arabian Peninsula (Baum 1988:130). In Egypt, the bentree grows in upstream wadis of the Red Sea mountains and in the mountains of the Sinai. In these areas, the bentree is restricted to the foothills of mountains higher than 1,300 m, especially if they are located more inland. Although the xerophytic trees have a low water requirement, they are only assured of sufficient supply of atmospheric water if they grow in the vicinity of such high mountains. The trees are quite common between Hurghada and Quseir and are also recorded from the Gebel Nugrus, about 130 km northwest of Berenike. South of Berenike, they are recorded from the Gebel Elba (Zahran and Willis 1992:177).

The tree produces pendulous fruits up to 30 cm long, which contain a row of triangular seeds. The benseeds are highly valued for their oil. Ben oil is sweet, transparent, and odorless. It is the roots that have the same odor of horseradish (*Armoracia rusticana* Gaertn., Meyer & Scherb.) and are sometimes eaten as a substitute for this plant. Ben oil does not become rancid, and, due to its high melting point, it is suitable for use in a hot climate. From both Ababda and Bisharin nomads, it has been recorded that they extract the oil from the seeds that they use for cooking. To extract the oil, seeds are boiled using wood from the same tree. The oil is skimmed off from the surface. It is believed that its extraction is only successful if no other person is present (Osborne 1968:173). In ancient Egypt, ben oil was used for cosmetics and cooking. In modern times, the high-quality oil has also been in demand for lubricating precision instruments.

Classical writers use the word myrobalan in connection with oil-producing plants in particular, but also with tannin-producing plants (Orta 1987:317–318; Lucas and Harris 1962:87). As *myrobalanum* literally means "perfume-nut," its original use makes more sense. According to Orta, the name *myrobalan* has been introduced for the tannin-producing plants by Serapio in translating Avicenna work from Arabic into Latin.

It is difficult to determine the real identity of the bentree in classical sources. In Pliny's *Historia Naturalis* (*Natural History*), for example, its mere enumeration in the ingredients of perfumes and unguents provides us with little grip on the subject. W. H. S. Jones, who compiled an index of plants mentioned in Pliny's *Natural History*, is probably right in his suggestion that *balanos*, normally a term for an acorn, is most probably a word used for the sugar date (*Balanites aegyptiaca* [L.] Del.) in sections 12.121, 13.8, 13.12, 13.13, and 13.15. Translating *balani(no) olea* as "behen oil" instead of "balanos oil," however, confuses the issue, as behen oil seems to refer to oil obtained from the bentree (*Moringa peregrina* [Forssk.] Fiori). In only one of the sections dealing with perfumes and unguents, namely, 13.18, Pliny uses the words *constat myrobalano* (behen-nut juice), and it is suggested by W. H. S. Jones that here the bentree is meant indeed. It is in this particular section that the regal ointment for the Parthian kings is described and obviously the more-esteemed oil from the bentree was in demand.

A description of the *myrobalanum* is given by Pliny in sections 12.100–103 of his *Natural History*. It is stated that the tree grows in the country of Trogodytis, the Thebaidi, and parts of Arabia that separate Judea from Egypt. Although this area roughly coincides with the present distribution of the bentree and excludes another species that is cultivated for its oily seeds (*M. oleifera* Lamk., native to the Indian subcontinent), it is anything but clear that the bentree is meant indeed. The description does not include recognizable features and it is very likely that information of different species have become mixed up. The same is true for section 23.98, which is even more confusing, as the *myrobalanum* is connected with a palm tree, which excludes all species known by the name of *myrobalan*, namely, bentree (*Moringa peregrina* [Forssk.] Fiori), emblic (*Phyllanthus emblica* L.), myrobalans from *Terminalia* spp. (black myrobalan [*T. chebula* Retz.]), beleric myrobalan (*T. bellirica* [Gaertn.] Roxb.) and citrine myrobalan (*T. citrina* [Gaertn.] Roxb. ex Fleming), and myrobalan plum (*Prunus cerasifera* Ehrh.).

According to Hobbs (1990:40), the Ma'aza bedouins still collect the benseeds and sell them to middlemen who, in turn, sell them to druggists in Cairo. Hobbs (1990:100) mentions that two Ma'aza bedouins collected 150 kg of benseeds in 17 days. Overexploitation of bentrees during the drought of the 1950s probably reduced the number of these trees substantially. The combined harvest of benseeds in 1983 was estimated at about 2,000 kg (Hobbs 1990:40). Although dead wood from bentrees is used, among some other woody species, for making charcoal to prepare tea and meals, Zahran and Willis (1992:173) are of the opinion that the tree is not endangered by this practice. Drar (1936:84), however, states that the tree had to be protected because it was heavily exploited for the feeding of cattle.

Thus far, there are only very few archaeobotanical records of the bentree and all are confined to Egypt. The oldest seed, which is identified as *Moringa* cf. *peregrina* by de Vartavan and Amorós (1997:177) originates from the tomb of Tutankhamen. The only other Roman record is from Hawara (see Keimer 1984:27). The current distribution in Egypt suggests that the benseeds from Berenike and Shenshef might have originated either from the northern part of the Eastern Desert, which is currently the territory of the Ma'aza bedouins, or from the Gebel Elba, which is now inhabited by the Bisharin nomads.

Nelumbo nucifera **Gaertn.**

Synonym:	*Nelumbium nelumbo* Druce; *Nelumbo speciosa* Willd.
English:	Chinese water lotus; Egyptian bean, East Indian lotus, Lotus, Lotusroot, Phythagorean bean, Sacred bean, Sacred lotus, Oriental lotus, Water bean
Arabic:	al-nailofar al-gamil, al fûl el masrî, Tomara al Hindus
Indian:	Kanwal
Plant part:	seeds
Trench/midden:	BE: 33 and 48
Period:	first–second centuries AD
Preservation:	desiccated
Figure:	4.48

Figure 4.48. Seed of the sacred lotus (*Nelumbo nucifera*) (12.5 x 11.0 mm). Photograph by R. T.J. Cappers.

The genus *Nelumbo* is closely related to *Nymphaea*, and, although sometimes even classified within the Nymphaeaceae, it is distinctive by, for example, the form and structure of the rhizome, the arrangement of the leaves, and its large fruits and typically shaped receptacle. Flowers and leaves of this water plant are long-stalked and rise above the water surface. About 20 to 30 fruits develop in the flat apacial area of the receptacle, which becomes swollen and spongy and functions as a dispersal unit as it separates from the stalk when the fruits are ripe. The fruits are only released when the floating receptacle gradually disintegrates. The brown fruit coat encloses a large seed, which consists of two cream-colored, sweet-tasting cotyledons enclosing a green, bitter-tasting embryo in a central cavity.

The genus *Nymphaea* is represented by two species in Egypt: *N. lotus* L. (white lotus or white water lily) and *N. caerulea* Savigny (blue lotus or blue water lily). Most probably, both these species have to be considered as the sacred lotus of ancient Egypt and were used as the symbol of the Kingdom of Upper Egypt. The papyrus reed (*Cyperus papyrus* L.), on the other hand, represented the Kingdom of Lower Egypt.

Papyrus is indigenous to tropical central Africa at the upper parts of the Bahr el Abiad (White Nile), from where it penetrates westward into Lake Chad and the Niger region (Täckholm and Drar 1950:99). In Egypt, papyrus reed was restricted to the Nile Delta, where it grew in huge populations, as is for example mentioned by Strabo (*Geography* 17.1.15).

The genus *Nelumbo* is the only genus of the Nelumbonaceae and is represented by two species that have a discontinuous distribution in the tropical zone. *Nelumbo lutea* (Walt.) Willd is found in North America and Mesoamerica, whereas the other species, the sacred lotus, is confined to Southeast Asia and northeast Australia. The sacred lotus is not indigenous to Egypt (Boulos 1995).

Nevertheless, historical sources as well as archaeobotanical remains indicate that during the Greek-Roman time the sacred lotus was probably cultivated in Egypt. Herodotus, who visited Egypt as far south as Aswan, is the first one who unmistakably describes both *Nymphaea* sp. (e.g., "the poppy-like center of the plant . . .") and *Nelumbo nucifera* in his section dealing with dwellers of the Egyptian marshes (*H* 2.92) (e.g., "the fruit of these is found in a calyx springing from the root by a separate stalk, and is most like to a comb made by wasps; this produces many edible seeds as big as an olive-stone . . ."). Both plants are called "lilies" by Herodotus, but he also mentions that the Egyptians use the name "lotus" for *Nymphaea*.

Theophrastus also describes both plants in his section dealing with plants of rivers, marshes, and lakes, especially in relation to Egypt (*EIP* 4.8.7–9). Theophrastus did not visit Egypt, and it is beyond doubt that his description is partly based on Herodotus. According to Theophrastus, the sacred lotus grows in marshes and lakes and is even planted in these suitable habitats. That Egypt is mentioned, indeed, is supported by using the name "Egyptian bean" for its fruits. Other sources, such as Strabo, who visited Egypt in 24–20 BC, Pliny, Columella, and Dioscorides (who studied in Alexandria in about AD 200) are less clear in their descriptions, and it seems as if both plant genera got mixed up or were probably even confused with other species.

The complete absence of depictions of the characteristic leaves and flowers of the sacred lotus (*Nelumbo nucifera*) from the pharaonic period indicates that the plant was most probably introduced into Egypt during the first Persian period (Twenty-seventh Dynasty), as is suggested by Schweinfurth (Woenig 1971:44–45). This is supported by the archaeobotanical remains from Egypt, which seem to be confined to the Greco-Roman period. Some earlier finds are doubted because of their uncertain identification or possible contamination with more recent material (Germer 1985:39–40). The only archaeobotanical records from the sacred lotus outside Egypt originate from Cyprus, from where it is recorded from the fourth century BC (Hjelmqvist 1972:383).

Both seeds and rhizomes are edible. The roots are dried and made into flour from which bread can be baked. The seeds are eaten raw or cooked. Because the embryo is bitter, a feature already mentioned by Theophrastus (*EIP* 4.8.7), it has to be removed before it can be consumed. Today, seeds from the sacred lotus that are exported from China are divided into halves and have their bitter embryos removed. Ripe seeds are very hard, and a strong tool is required to break them. Additionally, rhizomes (*Nelumbinis rhizomatis nodus*) and fruits (*Nelumbinis fructus*) are also used as medicines. Today, dried receptacles are used in bouquets of dried flowers.

Two whole seeds of the sacred lotus were found in the trash dump. The presence of whole seeds in Berenike implies that its residents knew what to eat. It is quite likely that during the Roman period the sacred lotus was still cultivated in Egypt. The most plausible center of origin of the fruits found in Berenike is therefore the Nile Valley or the Delta, but import from India cannot be ruled out.

***Olea europaea* L.**

English:	Olive
Arabic:	Utum, Zaytun, Zet
Indian;	Harivarsa tailabadara
Plant part:	fruits (endocarps) and seeds
Trench/midden:	BE: 1, 6, 10, 13–16, 19, 21, 23, 25, 29, 31, 33, 37, and 48; SS: 7, 21, 29, and 56
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figure:	-

The olive tree is native to the Mediterranean area. With varying success, the olive has also been cultivated in Egypt, including the nonsaline depressions of the western Mediterranean coastal belt, the Sinai, and the oases of Siwa, Dakhla, Bahriya, and Kharga in the Western Desert (Lucas and Harris 1962:334–335; Zahran and Willis 1992: 21).

Some classical sources mention the local cultivation of the olive tree in Egypt. Theophrastus (*EIP* 4.2.9) states that the olive was common in Thebaid (Upper Egypt) and according to Strabo (*Geography* 17.1.35), the olive only grew in the Arsinoite Nome (the Fayum) and in gardens near Alexandria. Elsewhere, Strabo (*Geography* 16.3.6), in referring to the mangrove tree (*Avicennia marina* [Forssk.] Vierh.) along the coast of the Red Sea, mentions its resemblance to the olive tree and the laurel tree (*Laurus nobilis* L.). Strabo would have also meant the mangrove tree in his description of the entrance of the harbor of Myos Hormos (*Geography* 16.4.5) and of the coastal region of Cape Deirê in Djibouti (*Geography* 16.4.14), despite the translation as "olive trees." This interpretation is supported by Strabo's description of the Fayum (*Geography* 17.1.35), in which it is explicitly mentioned that the presence of olives in Egypt is restricted to this fertile area and the gardens near Alexandria. Most probably, the cultivation of olives in Upper Egypt, as mentioned by Theophrastus some centuries before, had been discontinued by then.

The wild ancestor of the olive, now treated at the level of subspecies (*O. europaea* L. ssp. *oleaster* [Hoffm. & Link] Hegi) or variety (*O. europaea* var. *sylvestris* [Mill.] Lehr. = var. *oleaster* [Hoffm. & Link.] DC.), grows in the coastal areas of the Mediterranean Sea, but is not recorded from Egypt (Zohary and Hopf 2000:145–146). The Sudanian flora, however, includes a wild olive, which is recorded from the Sudanian territory in, for example, Yemen and the Gebel Elba area, some 180 km south of Berenike. This species has a high water requirement and in both areas it is, therefore, limited to the higher zones of the mountains. The taxonomic status of this wild olive is still disputed. It is treated both as a separate species (*O. africana* Mill. = *O. chrysophylla* Lam.) and as a subspecies of the cultivated olive (*O. europaea* ssp. *cuspidata* [Wall. ex G. Don] Ciffieri).

It is not quite clear from the *Periplus Maris Erythraei* whether unripe olives from Egypt were exported via Berenike. The Greek word ὄμφακος, which is mentioned in the *Periplus* (7:16–17) means either *unripe grape* or *olive*. Fabricius (1883:45) translated the passage in the *Periplus* as *grapes*: "der Saft herber diospolitischer Weintrauben" (juice of sour grapes from Diospolis). Casson (1989:55) chose unripe olives, following the argument of Giangrande, who assumes that the climate of the area rules out the transportation of grapes. This argument is, however, not convincing. Even if unripe olives and grapes were harvested with immature endocarps and seeds, the presence of a reasonable numbers of mature endocarps and seeds of the olive and grape from Berenike and Shenshef still indicates that transport of both fruits was possible. In fact, the *Periplus* itself supports the possibility of grapevine by mentioning Diospolis, present-day Thebes, as the place from which the unripe ὄμφακος came. Diospolis was located about 40 km south of Koptos (Qift), one of the Nile termini of the Berenike–Nile roads. This close proximity to the trade route would have facilitated the supply of grapes to Berenike.

Olives have an oil content varying from 14 to 25 percent and are used both as table olives and for oil production. Olives contain a bitter substance that is extracted by soaking in lye, water, or a salty brine. Sweet-tasting olives are recorded from the Gebel Elba and parts of southwestern Saudi Arabia (Collenette 1988:37). Full-grown but still unripe olives yield the green variety, whereas black olives are obtained from the ripe fruits.

Olives were served as a whole fruit; as crushed fruit, known as *columbades*; or as stoned and chopped fruits, known as *epityrum* (Brothwell and Brothwell 1969:157). If used for oil production, ripe olives are dried before crushing. Because both the fleshy mesocarp and the seed inside the stony endocarp contain a similar kind of oil, dried fruits are crushed without being first destoned. Olive oil can be kept for a long time if not exposed to air and is mainly used in cooking.

The first archaeobotanical evidence of olive dates back to the Eighteenth Dynasty and includes leaves found in the tomb of Tutankhamen. Not until the fourth century BC, however, did the olive become a substantial part of the diet of the Greeks in Ptolemaic Egypt (Sandy 1989:79). A further increase of its use in Egypt is dated to the Roman period, as is evidenced by the numerous references in literary sources and the substantial archaeobotanical record. Both the number and size of the fruits found at Berenike and Shenshef indicate that we are dealing with the cultivated subspecies and that they were imported from the Mediterranean area or the Fayum. The fruits of the wild species are smaller than those of the cultivated ones. Also the relatively small population at Gebel Elba makes it improbable that olives were imported from this area. The presence of the stony endocarps at Berenike and Shenshef indicate that they were available as table fruits. Salted olives must have been a valuable food in the warm desert as it supplements the loss of salt via evaporation.

***Oryza sativa* L.**

English:	Rice
Arabic:	Aruz, Orz, Ruz, Urz
Indian:	Akki, Ari, Arisi, Bhat(ta), Chal, Chanwul, Chaval, Choka, Dangar, Dhan(ya), Mana, Nellu, Ruz, Syali, Vadlu, Vrihi
Plant part:	spikelets, husks (lemma and palea), and fruits
Trench/midden:	BE: 1, 10, 13–16, 25, 31, and 33
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated
Figure	4.49

Figure 4.49. Spikelet of rice (*Oryza sativa*) in lateral view. Only the upper glume is still present (8.5 x 3.0 mm). Photograph by J. Pauptit.

Two different species of rice have been domesticated: the Asian rice *Oryza sativa* L. and the African rice *O. glaberrima* Steud. Cultivation of Asian rice began in many parts of south and Southeast Asia, including northeastern India. In fact, rice cultivation in India goes back to 2500 BC, making it one of the oldest regions of rice cultivation. The cultivation of African rice, on the other hand, is probably not more than 3,500 years old (Chang 1976:431). Although the original distribution area of the annual *Oryza glaberrima* Steud. spp. *barthii* (A. Chev.) J. M. J. de Wet, the wild progenitor of *Oryza glaberrima*, coincides with the savanna zones south of the Sahara and even extends towards the center of Sudan, its domestication area is limited to West Africa (Harlan 1992:184). Therefore, it is plausible that the rice that has been found in the excavations was imported from India late in the history of Berenike.

The *Periplus Maris Erythraei* frequently mentions grain as a trade item together with rice, suggesting that the taxonomic relationship of rice with wheat and barley was not clear to the author of the Greek text. See for example the enumeration of export commodities of Syrastrênê (the present Kathiawar Peninsula in northwest India): "The region, very fertile, produces grain, rice, . . ." (*Periplus*: 41). The separate status of rice was also expressed in its use in beauty treatments (Warmington 1995:219).

Casson (1989:18) notes that with the exception of textiles, not all items traded from India to Arabia and Africa are mentioned in the list of exports of the *Periplus*. According to Casson, this implies that merchants from Roman Egypt were only interested in the real luxury products that were available at these ports.

The presence of reasonable amounts of rice in both early and late deposits at Berenike, however, makes it very likely that at least for this cereal an indirect trade with India did exist. According to Feliks (see Zohary and Hopf 2000:91), who wrote about rice cultivation in the Roman period, a highly prized large kernel rice variety was cultivated in Israel, probably in the Hula Valley. Feliks's main source is the Mishnah (dealing with Jewish rules), which is considered to be very authentic. This assumption is, however, not yet evidenced by archaeobotanical research. Greek and Roman writers only mention rice cultivation in Syria and Mesopotamia (Lenz, 1859 in Zohary and Hopf 2000:91). Strabo (*Geography* 15.1.18), for example, mentions that rice grew in Bactria, Babylonia, Susis, and lower Syria (the latter region probably coincides with the Hula region.) Others, such as Dalby (1996:141), are of the opinion that rice was never grown within the Roman Empire.

Because fragments of amphoras were found at Berenike that originated from Syria and possibly also from the Gaza-Negev area (Hayes 1996:159), it is possible that the rice found at Berenike was imported from the Near East. With Berenike's southern and southeastern maritime orientation, however, it seems more likely it was an item of the distributive trade with Arabia.

According to the *Periplus*, rice was exported from the country of Parsidai and the Gulf of Terabdoi (37.12.13–15) and the district of Ariakê (41.14.2), which are identified by Casson (1989:182–184,197) as respectively the area around modern Karachi in Pakistan and the area between Broach and Surat in northwest India (Gujarat). From there it was exported to the island of Socotra (*Periplus*: 31.10.22), which is located northeast of Somalia, and to the so-called far-side ports on the northern coast of Somalia (*Periplus*: 14.5.7). The *Periplus* is less clear about the export of rice from Limyrikê, the present-day state of Kerala, which is located along the southwest coast of India. It is mentioned that sailors from both Barygaza (modern Broach) and Limyrikê by chance put in at Socotra and would have exchanged rice, among other commodities (*Periplus*: 31.10.21). This is in line with modern rice cultivation in India, which stretches along the western coast from Gujarat southward to Sri Lanka. Rice is mentioned as one of the trade items of Sri Lanka by Ptolemy (7.4.1).

Ships that called at ports along the Somalian coast could be loaded up with Indian rice brought there by Indians or Arabs. In this way rice was indirectly traded to Egypt. It is even possible that for some Roman ships these ports in Somalia were the final destinations (*Periplus* 14).

The claim that rice import from India must have been expensive, as put forward by Dalby (1996:141), is questionable in the light of intermediate involvement of Indian and Arab traders. Pliny (*NH* 18.20.93) states that rice was imported from the East without further specification and does not mention a price.

Rice could be obtained from harbors along the northern coast of Somalia (i.e., Malaô, Mundu, Mosyllon, Spice Port, and Opônê) and from the island Socotra (*Periplus* 14, 31, and 41). The import of rice to Berenike is in concordance with its earlier mentioned use within the Roman Empire, although the export of grain, probably wheat (*Triticum*), from Berenike to Muziris and Nelkynda in southwest India seems to contradict this. According to Casson (1989:24), grain exported from Egypt to Indian ports was destined for Westerners permanently established in those places, while Indian merchants living in Berenike ate rice. Conversely, perhaps, the import of rice to Berenike indicates the presence there of Indian or other South Asian residents who consumed it.

Although rice cultivation probably began in Egypt between the Arabic conquest (seventh century AD) and the Turkish invasion (sixteenth century AD; Täckholm et al. 1941:411), the archaeobotanical evidence from Berenike indicates that it was already being consumed during the Roman period. Intact spikelets as well as loose chaff remains show that rice was transported in the husks.

In addition to the rice found at Berenike, only three other archaeobotanical records of rice are known from sites within the Roman Empire so far. Small quantities of rice have been found at Quseir al-Qadim, both from the Roman and the medieval period (Van der Veen 2003:210). A still unpublished record is mentioned by A. R. Furger from Zurzach in Switzerland (Konen 1999:37). Roman rice consumption has also been documented by Knörzer (1970:28–29) for the first quarter of the first century AD in Novaesium (Neuss, Germany). In this fortress along the Rhine River, altogether 196 charred kernels were found. Whether this rice originated from the East or was imported from Arabia, perhaps via Berenike, cannot be determined. All other archaeobotanical records from Europe are dated to the Middle Ages and modern times.

Papyrological evidence of the availability of rice in Egypt is extremely scanty. Only four out of the approximately 34,230 published documents, dating from the third century BC to the eighth century AD, mention rice. Three of them are dated to the early Roman period, the other to the sixth century AD (Konen 1999:34–35). Two of these documents originate from the Fayum; one mentions the purchase of rice, the other the control of the rice trade. According to Konen, such a monopoly indicates that, at least temporarily, rice trade must have been quite important.

Strabo (*Geography* 15.1.53) states that most of the Indian food consisted of rice porridge and that Indians made a beverage from rice that is known as *arak*. In India, rice has also a tradition in being used in offerings at all kinds of religious and auspicious ceremonies. Only new rice is used for this purpose, whereas old rice is used for cooking. It is also believed that rice gives strength and makes one more fertile, which is, for example, expressed in throwing rice on a bridal couple (Gupta 1991 [1971]: 73). Possibly, rice was only used on a limited scale within the Roman Empire and in particular for medical reasons. In some of the recipes in the Apicius cookery book, rice is used as a thickening agent for sauces, making use of the waxy consistency of rice flour. A kind of rice cake (*oryzítes plakoûs*) is mentioned by Chrysippus of Tyana (Dalby 1996:141). Additionally, it was mixed with beans and used by women for preserving the smoothness of the skin (Warmington 1995:219).

***Phoenix dactylifera* L.**

English:	Date palm
Arabic:	Balah, Hish, Khulas, Khunayzi, Nahl, Nakh(i)l al-balah, Nakhl, Ruzayz, Wahalan
Indian:	Pinda khajura
Plant part:	fruits, seeds, perianth, and flower bud
Trench/midden:	BE: 1–4, 6, 10, 13–17, 19, 21, 23,

	25, 29, 31–33. 37, 41, and 48; SS: 4, 7, 20, 21, 29, and 53
Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated, charred, and mineralized
Figures:	4.29, 4.50, and 4.51

The main distribution area of the date palm lies between lat 15°N and 30°S and extends from the Spanish Sahara toward Pakistan. To the north it follows the coastal area of the Mediterranean Sea as far as southern Spain, and to the south it is recorded from the coastal area of Sudan, Eritrea, and Somalia. In this southern part of its distribution area, however, most of the date palms grow in the northern provinces of Sudan (Bircher 1995:126). The date palm is recorded from all the phytogeographical districts of Egypt, although the most numerous groves can be found in the oases of the Western Desert and in the cultivated land along the Nile. Date palm groves along the Red Sea coast are recorded by Schweinfurth (1865a: 294) from the Wadi Gimal estuary, some 100 km north of Berenike, and from Abu Nechle south of Ras Hadarba (Cape Elba), some 300 km south of Berenike. The groves in Abu Nechle were not used anymore when Schweinfurth visited the area. Also in the near vicinity of Berenike, several date palms were observed by the author recently. All these specimens were, however, still immature and not fruit bearing.

Being a monocotyledon, the date palm has only adventitious roots, which do not grow deeper than 2 m. Its presence, therefore, is confined to localities where sufficient fresh water is available. Although it is not a halophyte, the date palm can withstand considerable concentrations of salt and can be found near the sea, as is the case with some specimens in the estuary of Wadi Gimal. Several freshwater springs are present in this coastal area, which enable the date palms to survive. Schweinfurth (1865a: 294) links the palm grove in the Wadi Gimal estuary with human interference, suggesting a relict vegetation from an ancient settlement or a plantation initiated by pilgrims or sailors. Mandaville (1990:397–398), however, is of the opinion that such palm groves along the coast might also concern true relict populations of wild specimens. Propagation from seeds is indicated by equal numbers of male and female plants.

The date palm is dioecious, just like the doam palm. One single male date palm can fertilize on average about 25 females date palms. Cross-pollination is achieved either by wind, and eventually insects, or by humans. The advantage of artificial pollination over wind pollination is that a higher yield is obtained. This is not only because more flowers become fertilized, but also because artificially pollinated flowers produce on average larger dates. Unfertilized flowers of the date palm are also capable of producing fruits, a phenomenon that is known as *parthenogenesis.* Although dates

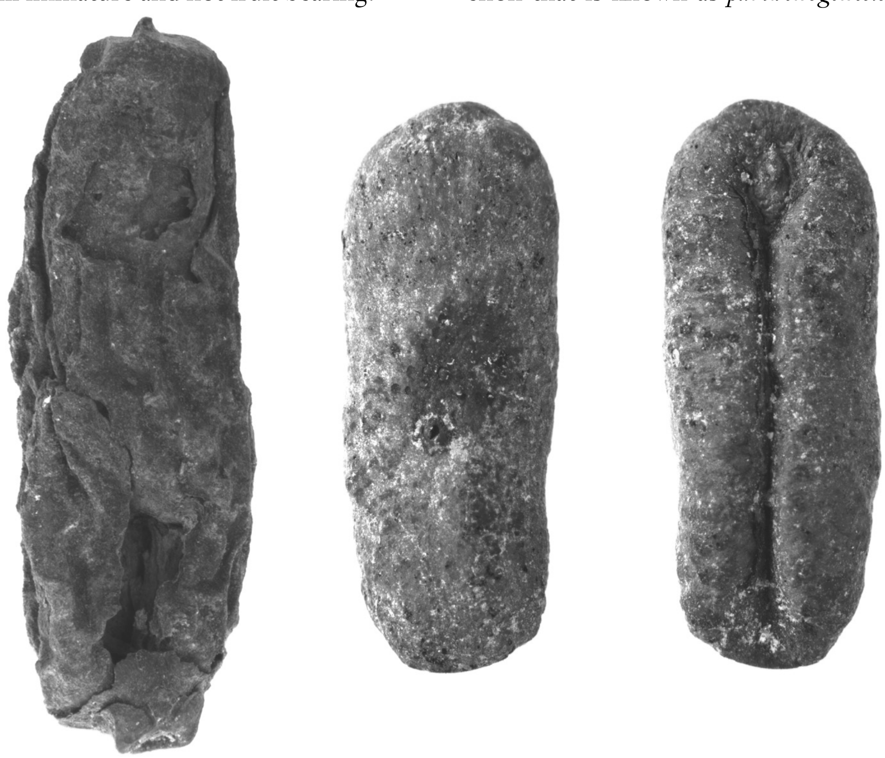


Figure 4.50. Date palm fruit (*Phoenix dactylifera*) with perianth (left: 33.0 x 10.7 mm) and charred seed from ventral view (middle: 19.5 x 8.3 mm) and from dorsal view (right). Photograph by R. T.J. Cappers.

Figure 4.51. Inner side (left: 6.8 x 5.3 mm) and outer side (right) of perianth the date palm (*Phoenix dactylifera*). Photograph by R. T.J. Cappers.

from such flowers are as sweet as the ones that develop in fertilized flowers, they are significantly smaller (Wrigley 1995:401).

Artificial fertilization has been described as early as ca. 2300 BC in a cuneiform text of Ur (Wringley 1995). The knowledge of artificial fertilization was probably introduced into Egypt during the Middle Kingdom (Täckholm and Drar 1950:215–218). This assumption partly rests on the rare occurrence of date fruits or seeds dated before the Middle Kingdom, whereas dates are frequently found from this period onward. We must bear in mind, however, that the total number of archaeobotanical records concerning the remains of the date palm of the pre-Middle Kingdom period is still relatively small, which is, for example, also true for the sycamore fig (*Ficus sycomorus* L.), another fruit tree native to Egypt. Another problem is that no comprehensive analysis of the variation in seed size is available on seeds dated from the Middle Kingdom onward. In fact, such an analysis could illustrate a shift in the proportion of smaller to larger seeds, demonstrating an increase of outbreeding. And even if such an increase could be demonstrated, it still remains to be seen whether the increase of outbreeding, which is responsible for the increase in seed size, could be considered as the result of artificial pollination or of a more favorable proportion of male palms to female ones in a population.

The interpretation of the variation in seed size may be further obscured by the presence of palms that have been propagated by seeds. Both seeds and basal suckers are used for propagating the date palms, as is, for example, mentioned by Theophrastus (*EIP* 2.2.2). Preference is given to the basal suckers, as they guarantee both the sex of the tree and the quality of the dates (Täckholm and Drar 1950:173). In contrast, a seed will either produce a male or a female plant and because cross-fertilization has occurred, an unpredictable genetic variability will be produced. The combination of outbreeding pollination and vegetative propagation has resulted in many local varieties and just as many date varieties.

The size of the seeds from Berenike proved to be quite variable. Seeds that were retrieved from the 1995 season measured (1.43-) 2.27 (-3.40) cm (N = 376, s.d. = 0.36) (Cappers 1996:327). This indicates that the dates originated from groves that were at least partly propagated by seeds. The smallest seeds possibly even originated from unfertilized flowers.

Trees developing from discarded seeds appear to be half female and half male specimens. If plants are intentionally propagated by seed, several seeds might be put together to ensure the appearance of female plants. According to Täckholm and Drar (1950:172), this is especially practiced in the Aswân province. It has also been observed by the author in the southern part of the Eastern Desert. Theophrastus (*EIP* 2.6.1) gives another explanation for planting several seeds together. Both roots and stems will become entangled and in this way prevent the development of a weak tree. Theophrastus does not take into consideration the dioecy of the date palm, although he is aware of this character.

A concrete building near the old settlement of Berenike was established, which is used as a working space, a temporary stockroom for archaeological finds, and it also offers accommodation to a museum in which a standing ethnographic collection of the Ababda nomads is displayed. After the building was finished, an experiment followed to grow some date palms. Permanent guards were to take care of the water supply. Unfortunately the young trees died, probably because the soil was overmanured and not watered enough.

That dates were highly prized by the Romans is evidenced by the number of dates that have been found at Berenike and Shenshef. The sugar content of ripe dates ranges from 70 to 80 percent, making it a tasty and nutritious food. It also lends itself well to preservation, a favorable condition in a desert environment.

Spread over 284 samples, some 2,700 seeds of date palm have been found. As this amount of seeds only represents the proportion that has been subsampled from a small area of both Roman settlements, it is clear that dates have to be considered as one of the staple foods. It is even possible that dates were partly used as a ballast commodity. From more recent periods, it is known that dates were used as ballast by ships on their way to India, Africa, and southeast Africa (Chaudhuri 1985:184).

Judging by the huge amount of dates found at Berenike and Shenshef, it seems likely that most of these fruits originated from the Nile Valley. It may not be excluded, however, that groves in the Eastern Desert also were exploited in an opportunistic way. In this respect the substantial grove in the Wadi Gimal estuary may have been visited, as it is located along the coastal route that connected Berenike with Quseir al-Qadim. Furthermore, import from northern Sudan may not be ruled out. Despite the huge production of dates in Egypt today, which are partly meant for export, Egypt also imports dates from northern Sudan (Täckholm and Drar 1950:170–171; Bircher 1995:105).

Only a fraction of the recovered subfossil seeds are charred. They were not concentrated or found near ovens or fireplaces, ruling out the possible use of date seeds as charcoal. Their use as fuel could be demonstrated in a (fifth through seventh centuries AD) monastery at Kom el-Nana in the Nile Valley, where charred date rachilla and perianth were found in an oven (Smith 1998:195). The use of date seeds for making charcoal is recorded from Iraq, were they are in demand by silversmiths (Townsend and Guest 1985:264). It is noteworthy to mention that this practice had already been described by Strabo (*Geography* 16.1.14) for the bronzesmiths of this area.

Phyllanthus emblica **L.**

Synonym:	*Emblica officinalis* Gaertn.
English:	Emblic, Emblic myrobalan, Indian gooseberry, Malacca tree, Myrobolan
Arabic:	Amlag, As sananir
Indian:	Aamlan, Amla, Amalak, Amalaka, Amalakam, Amlaki, Amlika, Amloki, Anavala, Anvale, Aonla, Aora, Aura, Chukna amlaki, Dhatri(ca), Nelli, Nellika(y)i, Nillikai
Plant part:	fruit (endocarp)
Trench/midden:	BE: 13 and 33
Period:	first-second centuries AD
Preservation:	desiccated
Figures:	4.52 and 4.53

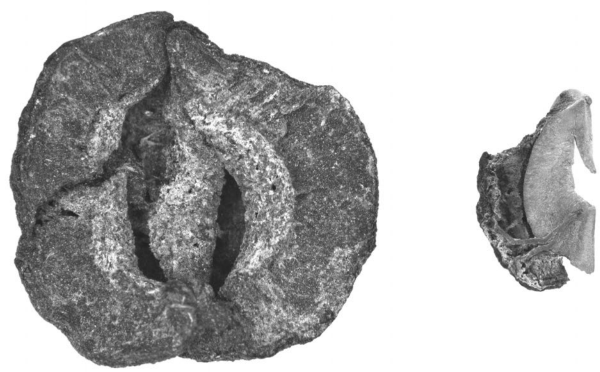


Figure 4.52. Dried fruits of emblic (*Phyllanthus emblica*) obtained from a spice shop in Khan al-Khalili (Cairo 1998). Mesocarp fragment (left: 18.3 x 17.2 mm) and endocarp fragment (right: length, 14.5 mm). Photograph by R. T.J. Cappers.

Figure 4.53. Outside view (left) and inside view (right) of subfossil endocarp fragment of emblic (*Phyllanthus emblica*) (12.3 x 6.0 mm). Photographs by J. Pauptit.

The emblic is a member of the spurge family (Euphorbiaceae). The Latin name *Phyllanthus*, which means "leaf-flower," is in fact misleading because the sessile flowers, and at a later stage the fruits, are not attached to the stalk of a pinnate leaf, but to a branch that bears many small leaves that are arranged in two rows. Wild fruits have a diameter of 1.5 to 2.5 cm; cultivated ones are larger. The fruit is classified as a drupe. The thick mesocarp is edible. The hard endocarp consists of six carpels that form three compartments, each of which contains two seeds. A total of eight endocarp fragments were found in a trash dump of Berenike.

The genus *Phyllanthus* comprises some 500 tropical and subtropical species. Three species of this genus are native to Egypt: *P. reticulatus* Poir, *P. maderaspatensis* L., and *P. rotundifolius* Willd. All three species grow in the Gebel Elba area and the last one also in other parts of Egypt (Boulos 1995:84). The fruit fragments found at Berenike are similar to those of the edible fruits of the emblic (*P. emblica*), which are much larger than those of the Egyptian species of the genus *Phyllanthus*. Emblic grows in the Maskarenen, India, China, Indochina, and Malaysia. It is common in most parts of India, extending from the base of the Himalayas to Sri Lanka. It is especially abundant in deciduous forests of Madhya Pradesh and Uttar, located in central India (Jain 1968:79). As a sacred tree for the Hindus, emblic is associated with Vishnu, Shiva, Parvati, and Lakshmi (Gupta 1991 [1971]: 38). For this reason, it is also planted on the south side of a temple or home. But most fruits of emblic are today gathered from wild populations. Another edible species is *P. acidus* (L.) Skeels. Although this species is cultivated in gardens today throughout India, it is considered to be native to the coastal region of northeast Brazil and has erroneously been ascribed to Indian, Madagascar, and Malaysian origin (Burkill 1994:119).

The fruits of emblic belong to the ones with the highest content of vitamin C: 100 g of juice contains 600 to 1,300 mg vitamin C (Van Schaik-van Banning 1992:106). A similar amount of orange juice, for example, only contains 35 to 50 mg vitamin C. The extremely high vitamin C content is responsible for its acidic, astringent, and somewhat acrid taste and is expressed in its Indian name *amlika*, which means "acid, sour." Fresh fruits are almost too sour to eat raw but can be made into pickles, preserves, and candy. Pickling, however, results in the loss of much of the vitamin C, although most can be retained by boiling the fruits and adding a large amount of salt (Hayes 1957:426). Due to the presence of tannin, the oxidation of vitamin C is prevented or retarded. Probably, the consumption of emblic during the long sea voyages protected sailors against scurvy. Scurvy was successfully treated in the Indian army in Rajputana in 1837 with fruits of the emblic (Hayes 1957:426).

Unripe fruits, bark, and leaves of the emblic are used for tanning. The pulp of unripe fruits may contain up to 35 percent tannin, which is more than the concentration in the other parts of the tree. The fruits of the emblic are often used as a tanning material in combination with fruits of two other so-called *myrobalans*: beleric myrobalan (*Terminalia bellirica* [Gaertn.] Roxb.) and black myrobalan (*Terminalia chebula* Retz.). All three species have the same distribution area. In India this mixture of fruits is known as *triphala* or *tinepala*, which means "three kinds" (Orta 1987:317). *Triphala* is also a well-known medicinal preparation of the Ayurvedic system, which developed during the Vedic period, about 500 BC (Dey 1980:151).

In present-day bazaars with a good assortment of herbal drugs, including ones in Khan al-Khalili in Cairo, emblic is still offered for sale. It is traded as dried fruit, known as *Myrobalani emblicae*. A whole dried fruit consists of 40 percent gray-blackish mesocarp, 40 percent endocarp, and 20 percent seeds. As only the mesocarp of the fruit is of economic importance, *Myrobalani emblicae* samples predominantly consist of mesocarp particles, endocarp fragments being only a minor contamination. In a sample of 100 g, obtained from an India-Pakistan shop in Amsterdam, only seven carpels were found corresponding with 1 1/6 fruit. The total number of fruit specimens of that sample was estimated at 70. Assuming that the emblic at Berenike was also traded with the endocarps and seeds removed, this implies that the eight carpels found stand for a more substantial number of fruit specimens. Today, perishable emblic fruits are also sold in tins or pickled in glass jars, in which most specimens are still intact.

So far, emblic is only known from Berenike and four other archaeological sites in India: Neolithic Budihal, Chalcolithic Inamgaon and Navdatoli, and from Narhan in historical times (Kajale 1991:160–167, 1996:68).

***Pinus pinea* L.**

English:	Pignolia-nut pine, Stone pine, Umbrella pine
Arabic:	Sanawbar, Sonobar
Indian:	-
Plant part:	seeds and cone fragments (scales and axis)
Trench/midden:	BE: 1, 3, 6, 10, 13–16, 19, 21, 23, 25, 29, 31, 33, and 48; SS: 21, 29, and 53

Period:	first–second and fourth–early sixth centuries AD
Preservation:	desiccated and charred
Figures:	4.54 and 4.55

Figure 4.54. Dry-sieving of debris sample over 5.0, 2.0, 1.0, and 0.5 mm sieve (last one not shown). In the coarse sieve, pottery shards, dung pellets of goat and sheep, as well as some seeds of *Pinus pinea* can be seen. See Color Plates section, page 224.

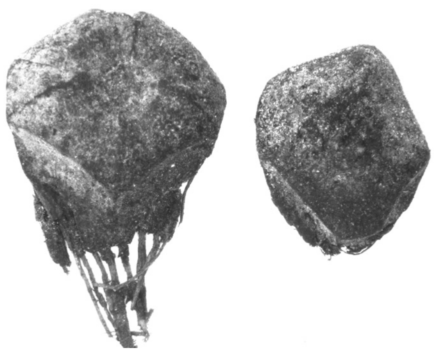


Figure 4.55. Cone scales of the stone pine (*Pinus pinea*) (right specimen: 16.3 x 13.5 mm). Photograph by R. T.J. Cappers.

Many pine species are of economic importance, especially valued for their wood, which gives good timber, and their resin, which can be used as an adhesive, as an ingredient of perfumes, and was formerly used in mummification. Only a few species yield edible seeds rich in proteins and oil, including the stone pine (*Pinus pinea* L.) with its characteristic, umbrella-shaped crown. In fact, the quality of the wood from this particular pine is poor and was therefore not used much in antiquity (Meiggs 1998:44). The stone pine occurs in the northern and eastern coastal part of the Mediterranean area, extending into Syria, and the southern coastal part of the Black Sea. In Egypt, only a few specimens are present in gardens (Täckholm et al. 1941:58).

Mature cones of the stone pine are about 10 to 15 cm long and 10 cm across. On the upper side of each cone scale, two unwinged seeds develop. One cone consists of about 100 scales so that it produces some 200 seeds. Cones can be harvested when they are still green and have to be exposed in the sun for further ripening. In this way the yield is maximized since no seeds are lost during harvesting. Alternatively, seeds can be gathered easily under the trees because the unwinged seeds are not dispersed over long distances.

Most archaeological finds of the stone pine date back to the Roman period and are frequently reported from countries where the tree is not indigenous, such as Egypt and England (Kislev 1988:75–76). Kislev points to the religious significance of the tree on the evidence of archaeological contexts and literary sources. In Egypt, as well as in England, whole cones and scales have been found in connection with temples. It is possible that at Berenike the stone pine was also used in religious ceremonies. However, in trenches BE95-4 and 7 in a putative temple area and BE95-6 in which religious effects were found (see Sidebotham 1996:53–76, 82–93; Sidebotham et al. 1996:229–243), no remnants of this species were recovered.

Besides its religious use, whole cones or seeds of the stone pine also may have been traded for consumption. The Roman cookery book attributed to Apicius frequently calls for stone pines in recipes. The nuts were not only used as garnish or filling, but also as a substitute for the expensive condiment *asafoetida*, obtained from the roots of the Persian umbellifer *Ferula assa-foetida* L. The Romans used *asafoetida* as a substitute for the highly valued North African plant *laserpitium* (Greek name: *silphium*), after *laserpitium* became extinct in the second half of the first century AD due to intensive gathering. In order to make use of the desirable taste on a larger scale, Apicius recommended mixing some *asafoetida* with pine seeds so that the latter could absorb the flavor of *asafoetida* (Vehling 1977:50). The Roman predilection for the taste of *laserpitium* and *asafoetida* could explain the concentration of pine nuts from archaeological contexts dated to the Roman period. After the fall of the Roman Empire, it seems that pine nuts ceased to be used as a substitute for these condiments. Today, shelled seeds of the stone pine are offered for sale as a rather expensive delicacy.

Seeds of the stone pine were frequently found at Berenike and Shenshef and must have been a common import food from the Mediterranean area. In addition to seeds, cone scales also were found on a regular scale. It is most likely, therefore, that whole cones were imported.

***Piper nigrum* L.**

Latin	*Piper nigrum* L.
English	Black pepper
Arabic	Felfel, Filfil aswad, Fulful aswad
Indian	Dakhnimirch, Golmarich, Gol mirch, Kalamari, Kalimirch, Kalluvalli, Kaphvirodhi, Kari, Marich, Milagu, Milaku, Miri, Miriyalu
Plant part	fruits
Trench/midden	BE: 1, 5, 10, 13–16, 19–21, 23, 25, 29, 31, 33, 37, and 48; SS: 4, 20, 21, 29, 54, and 55
Period	first–second and fourth–early 6th centuries AD
Preservation	desiccated and charred
Figures	4.56–4.61

Pepper Species

Pepper is a name used for many hot spices, including several species of the genus *Piper* and *Peperomia* of the Pepper family (Piperaceae), as well as members of the Annone family (Annonaceae: *Xylopia aethiopica* [Dunal] A. Rich), the Bay family (Lauraceae: *Litsea* spp.), the Orange family (Rutaceae: *Zanthoxylum* spp.), the Nightshade family (Solanaceae: *Capsicum* spp.), the Myrtle family (Myrtaceae: *Pimenta dioica* [L.] Merr.), the Vervain family (Verbenaceae: *Vitex agnus-castus* L.), and the Ginger family (Zingiberaceae: *Aframomum melegueta* K. Schump.; Macarthur 1993; Wiersema and León 1999). Fragrant red peppers, matching the size of peppercorns of *Piper nigrum*, are fruits of either the California peppertree (*Schinus molle* L.) or the Brazilian peppertree (*Schinus terebinthifolius* Raddi), which belong to the Sumach family (Anacardiaceae). Despite their different taxonomic status, these red peppers are offered for sale in blends of whole peppercorns including the black and white peppercorns of *Piper nigrum*.

Three kinds of pepper are mentioned in historical sources dealing with ancient trade with India: black pepper, white pepper, and long pepper. They belong to two different pepper species: black pepper (*Piper nigrum* L.) and long pepper (*Piper longum* L.). Black and white pepper concern fruits from the same plant species, and the common name “black pepper” for *Piper nigrum* is, therefore, somewhat confusing. Whether black or white pepper is harvested depends on the ripeness of the fruit. Each pepper fruit consists of a relatively large seed surrounded by a thin, pulpy fruit layer. Fruits of black pepper are harvested from the central axis when they are full grown. To obtain black pepper, the spikes are harvested when most of the fruits on the spikes are still unripe and green. After one day, the fruits are rubbed off the spike and spread out on the ground and become sun-dried. During this process, the outer fruit wall remains attached to the seed, turns black, and becomes more or less wrinkled: the less wrinkled, the better the taste.

White pepper is obtained by harvesting spikes with ripe, red-colored fruits. The fruits are allowed to ferment for several days, making it possible to remove the outer part of the soft fruit layer allowing the characteristic radial vessels, embedded halfway in the mesocarp layer of the fruit, to become visible. Fruit stalks of *Piper nigrum* are only sporadically present as a contamination in black or white pepper. Today, freeze-dried unripe fruits of *Piper nigrum* are also available as green peppers, as well as red colored and green colored white pepper kernels.

Fruits of long pepper are also harvested when they are unripe, but they remain on their fruit stalk. The elongated spikes have a totally different appearance than the separated peppercorns of black and white pepper, ruling out misidentifications. Another species that produces long peppers, namely, *Piper retrofractum* Vahl, is a native of China, Indochina, and Malaysia. Although there is still no evidence that *P. retrofractum* was known by the Romans, it is possible that this oriental spice was obtained via indirect trade since trade routes to India were connected with branches of the Silk Road (Cappers 2003:198).

Black pepper is native to the forests of the Western Ghats in the state of Kerala in southwestern India, and long pepper grows wild at the foot of the Himalayas in northern India. Black pepper was introduced in Southeast Asia as early as 100 BC (de Waard 1989:225). It is adapted to a hot, damp climate and can only be successfully cultivated in the tropics. Long pepper is cultivated chiefly in the northern parts of India.

The sharp taste of pepper is caused by piperine, which is present in special cells of the seed, whereas the scent of pepper is produced by oil cells that are concentrated in the inner layer of the fruit. Therefore, both white and black pepper have the same flavor, if not too much of the fruit layer has been removed during the processing of white pepper. Oil cells are absent in the seeds of *P. longum* (Hohmann and Deutschmann 1989:261).

Black pepper is mainly used for flavoring food. Long pepper is said to be more pungent than black pepper. In India, long pepper is mainly used in pickles. Although long pepper is still available at spice markets in North and East Africa and the Near East, the supply is only a fraction of the amount of black pepper that is offered. Obviously, long pepper has the same status as, for example, emblic (*Phyllanthus emblica* L.), which was introduced into this area by the ancient trans-oceanic trade.

Pepper in Historical Sources

Theophrastus (*EIP* 9.20.1) describes both black and long pepper with respect to their distinctive size, shape, and color:

> Τὸ δὴ πέπερι καρπὸς μέν ἐστι διττὸν δὲ αὐτοῦ τὸ γένος· τὸ μὲν γὰρ στρογγύλον ὥσπερ ὄροβος, κέλυφος ἔχον καὶ σάρκα καθάπερ αἱ δαφνίδες, ὑπέρυθρον· τὸ δὲ πρόμηκες μέλαν σπερμάτια μηκωνικὰ ἔχον·

> Pepper is a fruit, and there are two kinds: one is round like a bitter vetch [*Vicia ervilia* (L.) Willd.], having a case and flesh like the berries of bay [*Laurus nobilis* L.], and it is reddish: the other is elongated and black and has seeds like those of poppy [*Papaver somniferum* L.].

Remarkably, Theophrastus mentions the red color of the fruits of black pepper instead of the black color that only appears during the drying process and is the color of the traded peppercorns. Probably, his description relies on oral tradition rather than on his own observation of peppercorns.

Pliny (*NH* 12.14.26–28) distinguishes black, white, and long pepper and mentions that the price of white pepper was 1.75 times that of black pepper and as much as 3.75 times as much as that of long pepper. Pliny's descriptions of these plants are, however, less clear and he obviously must have misinterpreted his sources:

> "*passim vero quae piper gignunt iuniperis nostris similes, quanquam in fronte Caucasi solibus opposita gigni tantum eas aliqui tradidere. semina a iunipero distant parvulis siliquis, quales in phasiolis videmus; hea priusquam dehiscant decerptae tostaeque sole faciunt quod vocatur piper longum, paulatim vero dehiscentes maturitate ostendunt candidum piper, quod deinde tostum solibus colore rugisque mutatur.*"

> "But trees resembling our junipers that bear pepper occur everywhere, although some writers have reported that they only grow on the southern face of the Caucasus [Hindu Kush]. The seeds differ from those of juniper by being in small pods, like those which we see in the case of the kidney-bean; these pods when plucked before they open and dried in the sun produce what is called 'long pepper,' but if left to open gradually, when ripe disclose white pepper, which if afterwards dried in the sun changes color and wrinkles up."

The comparison of black, white, and long pepper with both *iunipero* and *phaselos* does not make sense. Most probably, *iunipero* can be identified with juniper (*Juniperus*), but identification with cedar (*Cedrus*) may not be ruled out (Meiggs 1998:410–416). Juniper and cedar have completely different leaves, seeds, and growth forms. Although the translation of *phaselos* is still disputed, and suggested names partly concern New World species, it is evident that it is a pulse. The pod of a pulse consists of a folded carpel in which seeds are arranged in rows. The fruits of black and long pepper, on the other hand, are exposed as they are arranged in a spike, as mentioned previously. Moreover, Pliny erroneously is of the opinion that black, white, and long peppers originate from the same plant species. It can be deduced from this description that he had never seen long peppers, which originate from the tree that is now identified as *Piper longum*. Strangely enough, Pliny (*NH* 12.14.28) also mentions the use of the root of pepper, which in fact seems to refer to *P. longum*, as this is still practiced by the natives of India (Ridley 1983:316). We may forgive Pliny's mistake if we realize that even Garcia da Orta, a Portuguese scientist who lived in the sixteenth century and had spent some 25 years in India, was of the opinion that black and white pepper came from two different trees (Orta 1987:376).

It has been suggested by W. H. S. Jones, who compiled an index of plants mentioned in Pliny's *Natural History*, that in some cases perhaps Ethiopian pepper (*Xylopia aethiopica* [Roxb.] A. Rich) might have been meant instead of *P. longum* or *P. nigrum*. The fruit of Ethiopian pepper bears some resemblance to the legume of a pulse, but they are indehiscent and the seeds are different in shape. Ethiopian pepper occurs in the savanna zones of central and West Africa, and its occurrence at Berenike as part of the inward commerce from northeast Africa may not be excluded.

Pliny (*NH* 6.26.105) states that pepper was transported in canoes made of hollow tree trunks from Cottonara to Bakarê. Cottonara is identified as Kottanarikê, which includes the valley of the Pambiyar River. According to *Periplus* (56), Cottonara is one of the major areas where the pepper grows. Both Bakarê and Nelkynda were very likely located along this river

(Casson 1989:221). It is evident from their location on the Malabar coast of the state of Kerala that both Pliny and the author of the *Periplus* were dealing with black pepper. According to the *Periplus* (49:16.30), long pepper was available at Barygaza on the northwest coast. The Alexandrian Tariff does mention long and white pepper, but makes no reference to black pepper.

The Indian connection is well known for the spice trade and the import of pepper, in particular, which is still among the important spices traded today (Figure 4.56). Together with Chinese silk, African ivory, German amber, and Arabian incense, Indian pepper was among the five essential luxuries of the Roman foreign trade (Tannahill 1973:90). Several historical sources mention the pepper trade. Plato (ca. 429–347 BC) wrote that "pepper is small in quantity and great in virtue," and Pliny (*NH* 12.41.84) complained about the hard-currency drain in exchange for peppercorns, emphasizing both its substantial and expensive character. *Horrea piperataria*, storehouses principally used for the storage of pepper, were erected in the vicinity of Rome and could contain thousands of pounds of pepper (Meijer and van Nijf 1992:129). Unfortunately, excavations of *horrea piperataria* are not well documented and do not allow a reconstruction of their exact volume (Rickman 1971:105). That substantial supplies must have been available in Rome even in a relatively late period is illustrated by Alaric who, in AD 408 as part of the ransom of Rome, demanded and also obtained three thousand pounds of pepper. Judging by the nonoccurrence of long pepper in Berenike after a total of seven excavation seasons, it seems most likely that we are dealing here with black pepper. The Romans' love of pepper can also be deduced from the many recipes in Apicius' cookery book mentioning this spice and the *piperatoria*, special pepper pots for presenting the exotic spice (Warmington 1995:183). Mixed with cumin (*Cuminum cyminum* L.), pepper was the most frequently used spice in the Apician sauce (Solomon 1995:116). Additionally, pepper is also recommended for a wide range of medical purposes.

The existence of special pepper mills (*molae piperatariae*), as mentioned by Warmington (1995:183), may suggest that on its arrival in Rome, the spice was pounded and traded in a powdered form. Although it seems that the recovery of whole peppercorns in German sites is evidence to the contrary, one has to realize that pounded pepper can only be demonstrated in archaeobotanical research if it is found as an almost unmixed supply. From this point of view, it is therefore difficult to decide upon the contribution of pounded peppercorns in the pepper

Figure 4.56. Sack of black pepper (*Piper nigrum*) on sale in Khan al-Khalili, Cairo (December 1996). See Color Plates section, page 225.

trade within the Roman Empire. Nevertheless, some arguments can be put forward in favor of the transport of whole peppercorns, which fits in with the idea that in antiquity the trade of unpulverized spices was the rule rather than the exception (Solomon 1995:116–117). First, it is common knowledge that whole peppercorns will keep their flavor better. Some of the Apician recipes also explicitly mention the pounding of pepper preceding the mixing of ingredients. Furthermore, it may be assumed that trading whole peppercorns also hampers adulteration. Pliny (*NH* 12.28-29), for example, states that black pepper can be adulterated with juniper berries (*Juniperus*) as they absorb its pungency very well, and that there are also several ways to adulterate black pepper with respect to its weight, whereas long pepper can be easily adulterated with *Alexandrino sinapi*, which is either a mustard (*Sinapis*) or a cabbage (*Brassica*) species. As juniper berries and the seeds of both mustards and cabbages are in fact easily distinguishable from peppercorns and pepper spikes, this implies that advanced knowledge of more-exotic commodities was not on a high level if unpulverized spices were mixed. Adulteration of grounded pepper is much easier, as the additives adsorb the flavor, and only examination on a microscopic level reveals the fraudulent practice. Nonetheless, all kinds of substances have been used to adulterate pepper, such as dough, animal bones, sawdust, fruitwall, and seed,coat of, for example, buckwheat (*Fagopyrum esculentum* Moench), walnut (*Juglans regia*

L.), almond (*Amygdalus communis* L.), hazel (*Corylus avellana* L.), seeds of olive (*Olea europaea* L.), and poppy (*Papaver somniferum* L.; Moeller 1905:347).

Pliny's statement, that pepper can be adulterated in several ways in the matter of weight, indicates that at least traders were acquainted with the relationship between volume and weight. Old pepper (*piper vetustum*) becomes lighter, and to simulate a fresh supply, another substance can be added.

A piece of lead that was used for labeling a supply of pepper originates from the border area of the Roman Limes in Germany. This early Roman label was found in Trier and mentions an amount of eight Roman pounds, which corresponds to about 2,620 g (Schwinden 1983:22). This amount is almost one third of the pepper supply found at Berenike and was most probably meant for wholesale trade. That this pepper was not adulterated is indicated by listing it as fresh pepper (*novellum piper*).

The Archaeobotanical Record of Berenike and Shenshef

Until recently, the importance of the pepper trade as evidenced by written sources contrasted sharply with the archaeobotanical records. The excavations at Berenike in particular, however, altered the opinion based on written sources rigorously. The very first peppercorns that were picked from the sieves were cherished as they represented the ultimate concrete confirmation of the pepper trade. An extra payment of 1 Egyptian pound to the nomads as reward for each peppercorn they found had to be abolished when their appearance surpassed our expectations.

During seven seasons, an amount in excess of 3,000 black peppercorns were found, spread over some 180 soil samples. This huge number of peppercorns, more than twice that of lentils, which are considered one of the staple foods at Berenike, clearly shows that the pepper trade must have been enormous, all the more so because only a fraction of the total site has been excavated. So one may expect tens of thousands of peppercorns to be present in the area as a whole. The large-scale transoceanic pepper trade is also supported by the large ships that sailed to the ports of Limyrikê (modern Malabar coast), where black pepper could be obtained (*PME* 56).

Only 1percent of all peppercorns originate from Shenshef. These peppercorns were scattered in several middens, were all preserved by desiccation, and can be considered as specimens that got lost. The peppercorns found at Berenike, on the other hand, can be interpreted in a different way. Most of them were unearthed from trenches that revealed buildings either connected with trade or used for religious ceremonies (Figure 4.57). Obviously, these peppercorns were predominantly charred and represent 80 percent of all peppercorns found so far.

The peppercorns that were found in the southeastern part of Berenike can be related to storage and were probably lost in transfer. Excavations in trench BE95/96/97-5 revealed that this area was leveled in the late first century BC to the first century AD and that a warehouse or storehouse was present during the fourth and fifth centuries AD, which was intensively used (Sidebotham 1999:5–13). A smaller number of charred and desiccated peppercorns was retrieved from a late Roman dump area (trench BE96-15), some 60 meters to the west.

A second area in which many peppercorns were found is located in the northwestern part of Berenike. Less than one-third of these peppercorns are desiccated and were mainly unearthed from dump areas. The other part concerns charred peppercorns and were unearthed from trenches that revealed religious shrines and temples in the vicinity of the Serapis temple. Trench BE96-16 evidenced pagan cult practices from the late second or early third to the late fourth to early fifth centuries AD. Relics that were found concern stone and bronze sculptural dedications, altars, inscriptions, and about 100 wooden bowls, which were used for the worship of both the Roman imperial cult and the Palmyrene deity Yarhibol/Hierobol (Sidebotham 1999:79). In connection with one of the altars, a reasonable amount of charred peppercorns was found. To the author's knowledge, black pepper has no tradition in religious ceremonies of India.

The two other trenches, viz. BE94/95-1 and BE96/97/98/99-10, revealed installations that were probably connected with the Serapis temple. A spectacular find concerns a large supply of uncharred black peppercorns inside a large dolium (storage jar) in trench BE96/97/98/99-10 (Figure 4.57). The peppercorns had a total weight of well over 7.5 kg and filled up 42 percent of the dolium, whose volume is calculated at about 31 l (Figure 4.58). According to R. S. Tomber (personal communication), the dolium is highly likely of Indian origin, suggesting that we are dealing with the original packing.

In fact, this is the first food item that has been unearthed at Berenike that is clearly a stock item. Together with another empty, large jar, they were buried in

Figure 4.57. Map of Berenike showing the distribution of charred and desiccated peppercorns in relation to dump areas and locations with religious contexts (C: number of charred peppercorns; D: number of desiccated peppercorns). See Color Plates section, page 226.

what appeared to be the courtyard floor of the Serapis temple sometime in the late first century BC. or early first century AD.

Judging by the price of pepper mentioned by Pliny, this amount of pepper had a value equivalent to enough wheat to supply the average Roman for two years. Although this pepper supply represents a considerable sum, it was obviously left behind. An explanation might be that the inhabitants had to choose what to take with them and what to leave behind when leaving the city. The capacity of their beasts of burden would have forced them to make choices. Leaving behind such a stock of pepper could indicate that large supplies were present indeed. It is also possible that the pepper was meant for offering and that prohibitory rules prevented other use.

Judging from the concentration of charred peppercorns in connection with religious shrines and

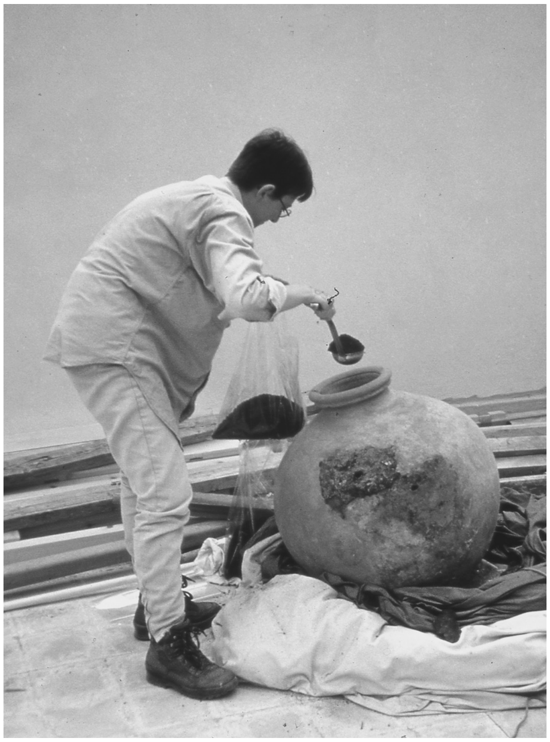


Figure 4.58. Emptying a dolium filled with 7.5 kg black pepper (*Piper nigrum*) (1999). See Color Plates section, page 225.

temples, it is very likely that most of them were once sacrificed at the sanctuaries found at Berenike rather than spoiled in food preparation. If used for flavoring food, pepper is ground without heating, and the chance that whole peppercorns become charred is very small. Apicius reports only the grilling or roasting of some smaller seeds before pounding, such as sesame (*Sesamum indicum* L.) and cumin (*Cuminum cyminum* L.; Solomon 1995:116). Once the peppercorns had been sacrificed, they were of no use anymore and would have been discarded. Their use as an offering is also supported by the relatively high percentage of charred peppercorns in relation with the total subfossil record of Berenike. In fact, only 7 percent of all subfossil fruits and seeds were preserved by charring, in which the peppercorns account for 47 percent of the complete charred assemblage. Offerings would have been connected with the risky life in the desert and the likewise dangerous long sea voyages. Ceremonies to propitiate the gods before departure and to thank them for a safe return have obviously left their marks, partly as charred peppercorns.

Plant-food offerings from Roman funerary contexts consist predominantly of cereals, pulses, nuts, and stone fruits. In addition to local food plants, some exotic species were also regularly found, in which olive (*Olea europaea* L.), fig (*Ficus carica* L.), and date (*Phoenix dactylifera* L.) and possibly stone pine (*Pinus pinea* L.) are mentioned (Marnival 1993:58; Petrucci-Bavaud and Jacomet 1997:583). Spices and condiments, on the other hand, are underrepresented as offerings, despite their availability. Only garlic (*Allium sativum* L.), celery (*Apium graveolens* L.), coriander (*Coriandrum sativum* L.), gold-of-pleasure (*Camelina sativa* [L.] Crantz), and common verbena (*Verbena officinalis* L.) are reported, whereas others, including black pepper (*Piper nigrum*), are only known as food for the living.

Only *Piper nigrum* has so far been found at Berenike and Shenshef. It seems as if all peppercorns have to be categorized as black pepper. Some specimens lack the characteristic folded fruit wall, but they are always accompanied with specimens that still have the wrinkled fruit wall. The absence of the fruit layer may be the result of preservation conditions. Besides large specimens, immature ones were also frequently found (Figures 4.60 and 4.61). This phenomenon is not

Figure 4.60. Fertile fruits of black pepper (*Piper nigrum*) (mean surface: 21 mm²). Photograph by J. Pauptit.

Figure 4.61. Sterile fruits of black pepper (*Piper nigrum*) (mean surface: 6 mm²). Photograph by J. Pauptit.

exceptional, as fruits from a single spike do not ripen at the same time. As a result, all stages of development are present on the same spike, although in good spikes all fruits are about the same size when they are nearly ripe (Ridley 1983:283). Present evidence does not allow us to determine whether peppercorns were traded in different size classes only to be mixed in the deposits found at Berenike or whether they were imported from India unsorted.

Leaving the liquids aside, long pepper is the only food product mentioned in written sources that has not been found so far, despite its characteristic morphological features. Obviously, the differences in price between long and black pepper, as mentioned by Pliny, does not bespeak their real share in trade, for not a single spike of long pepper has been found so far. Apparently, long pepper was not one of the staple articles of Rome's trade with India. In fact, long pepper has never been found so far in any archaeobotanical research.

Archaeobotanical Evidence Outside Berenike and Shenshef

The recorded number of peppercorns from Berenike and Shenshef sharply contrasts with the archaeobotanical evidence of black pepper from other areas of the ancient world. First of all, it is striking that until now peppercorns have not been recorded from India by subfossil remains. One reason is that only a limited number of historical sites have been excavated in India so far (Kajale 1991:177,180). Additionally, the very humid climatic conditions in the pepper-producing areas of India may have impacted on the preservation of pepper.

In addition to Berenike and Shenshef, other Egyptian sites that have yielded peppercorns are Quseir al-Qadim, Mons Claudianus and Quasr Ibrim. Excavations at Quseir al-Qadim, located about 300 km north of Berenike, unearthed 25 peppercorns from deposits dated to the late Islamic period, and a smaller number was recovered from a Roman context (Wetterstrom 1982:371–372 and n.d.). The Roman quarry settlement at Mons-Claudianus, about 100 km northwest of Quseir al-Qadim, yielded only two desiccated peppercorns (Van der Veen and Hamilton-Dyer 1998:107). Finally, one peppercorn was found in Qasr Ibrim (personal communication from A. Clapham).

Pepper was a staple article of commerce between Rome and India, and the quantities passing through Berenike must have been enormous, allowing some waste of this spice as can be deduced from its presence in organic dumps. The presence of peppercorns at Shenshef, Quseir al-Qadim, Mons Claudianus, and Qasr Ibrim indicates that not all the pepper was transported to Alexandria for onward transportation to other Mediterranean ports. Although Quseir al-Qadim could have been supplied via the coast route by which it was connected with Berenike, the food mentioned in a shopping list on an ostrakon from Quseir al-Qadim, dated to the first or early second century AD, suggests import from the Nile Valley (Bagnall 1986: ostrakon no. 28):

"Μάξιμος .πα.ρο...ωι τῷ ἀδελφῷ χα(ίρειν)·
συγνὸς ἥ ὅτι......θων σημεῖον κομίσαι
παρὰ Σαβίνου τοις η........οἴνου κράμβης
....ας
τρῖς καὶ μάτιν πίσου καὶ φακοῦ μάτιν
καὶ ἶπον τὸ κα.ηπεμον περὶ τοῦ ὄξου[ς],
καὶ ἐὰν χρέαν ἔχῃς. ἔρως(ο).
περὶ τοῦ πιπεριδίου μῆ ἐπιλάθου."

"Maximus to his brother X, greetings.
Having recognised that . . . carrying a token
from Sabinus . . . of wine, cabbage (x, a measure)
three and a measure of peas and a measure of beans
and I mentioned x about the vinegar,
and if you need it. Farewell.
About the small amount of pepper, do not forget it."
[Translation: J. P. Wild]

Mons Claudianus was not located along one of the main trade routes connecting Berenike with the Nile River, suggesting that the delivery of pepper was not accidental. Perhaps, Koptos (Qift) or Qena (Kainopolis) played a role in the distribution of pepper to this settlement.

The same is true for Qasr Ibrim in Lower Nubia, some 50 km north of Abu Simbel. From this site pepper is evidenced from archaeobotanical remains as well as from a Coptic letter dated to ca. AD 450:

ϯⲧⲁⲙⲟ ⲇⲉ ⲙ̄ⲙⲟⲕ ⲡⲁϫⲟⲓ̈ⲥ ⲛ̄ⲥⲟⲛ ϫⲉⲙ̄ⲡⲓⲡⲉⲣ
ⲑⲕⲧⲛ̣ⲛⲟⲟⲩ ⲛⲁⲛ ⲉⲡⲗⲁⲕ ⲁⲩⲱ [ⲛ]ⲕ̣ⲟⲟⲩⲉ
ⲑ̣ⲕⲧ͡ⲛⲛⲟⲟⲩⲥⲉ ⲛ̄ⲧⲟⲧϥ̣ ⲛⲁⲡⲁ ϩⲁⲡⲓ ⲉⲥⲓⲟⲟⲩⲧ̄
ϩⲁⲡ̣ⲁⲥⲟⲛ ⲡⲁⲡⲛⲟⲩⲧⲉ ϥⲓⲧⲟⲩ ⲉⲡⲑⲩ

"I inform (*de*) you, my brother-lord, that (as for) the pepper which you sent to us to Philae and [the] other things which you sent through Apa Hapi to Asyut, my brother Papnute took them."

Obviously, pepper was sent from Nubia to Philae, south of Aswan. Considering Berenike as the prime

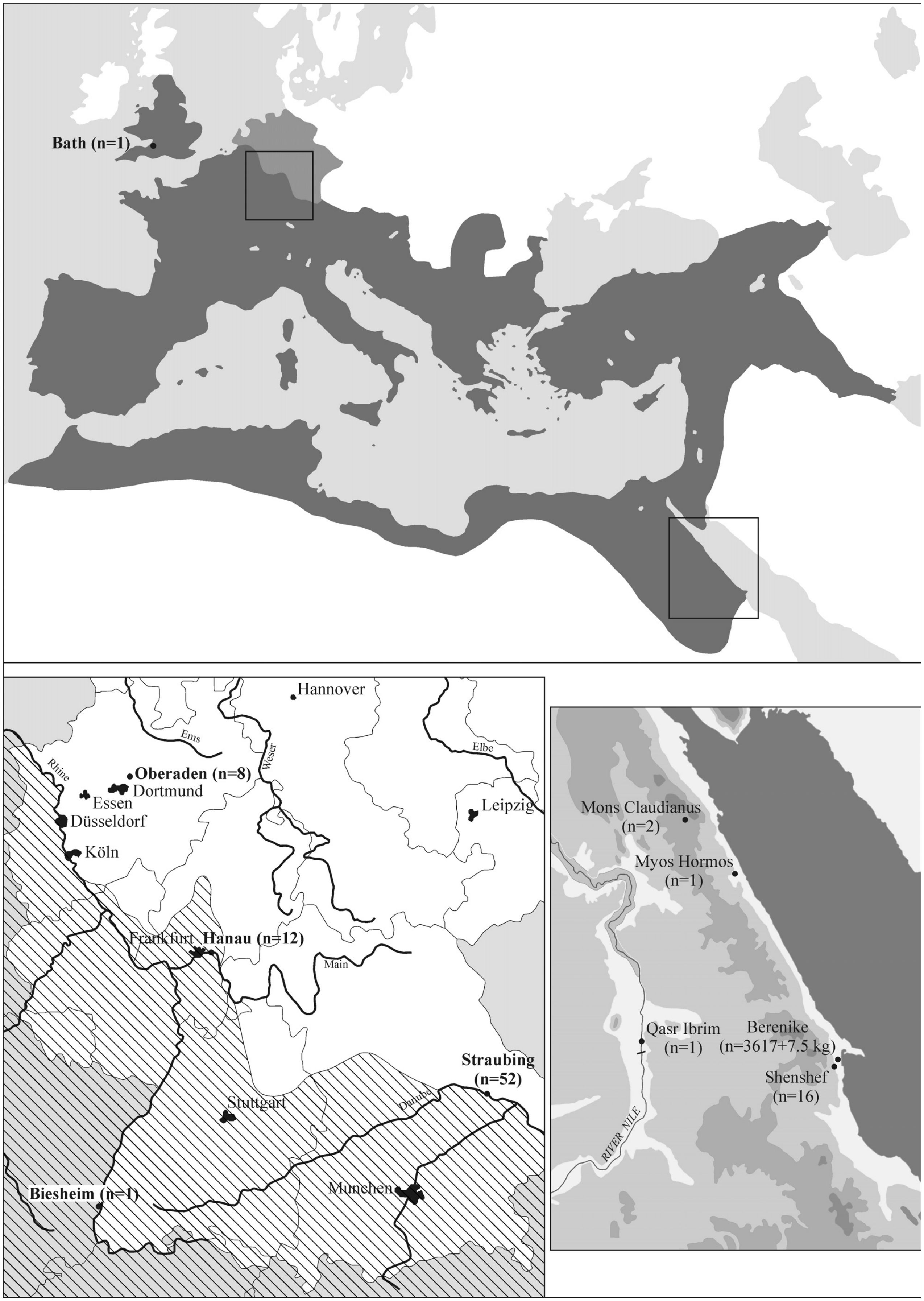


Figure 4.59. Number of peppercorns (*Piper nigrum*) that have been recorded from sites within the Roman Empire. This map shows the Roman Empire at its greatest extent, during the reign of Emperor Trajan, AD 116 (hatched area: northern limit during the reign of Augustus, AD 9). Data from Myos Hormos are not yet available.

source, this seems a bit strange, as one would expect transport of pepper in the reverse direction.

A remarkable find of peppercorns was made during a medical examination in Paris of the mummy of Ramses II, which was aimed at protecting this mummy from further decay by microorganisms. Several peppercorns were found inside the body of the mummy and identified as *P. nigrum* (Plu 1985:174). The most likely explanation for this early find, which is dated to 1290–1224 BC (Nineteenth Dynasty), is that black pepper was occasionally available via trade routes over land or via the transoceanic trade. In the latter case, peppercorns from the Malabar coast must have been brought to the coastal area of northeast Africa, either by Indian or Arab seafarers. From there, the pepper must have been traded further to Egypt.

Archaeobotanical evidence of Roman peppercorns outside Egypt are so far only available from a comparatively limited area of the Rhine-Danube Limes in Germany and France and from the Roman spa town of Bath in Great Britain (Figure 4.59). The earliest find of pepper dated to the Roman period comes from the legionary settlement north of Oberaden (Kučan 1984:52–55). Eight peppercorns were found in cesspits, which are believed to represent both black and white pepper, as only part of the peppercorns were whole fruits. The legionary settlement only existed from 11–8/7 BC. If peppercorns found here were imported via Berenike or Myos Hormos, this would imply that the seaborne trade in peppercorns started not long after the Roman annexation of Egypt by Octavian in 30 BC. A second pepper find is recorded from Straubing (Küster 1995:137). The 52 peppercorns found in the harbor were most probably lost while being unloaded. From a well in a Roman vicus at Hanau (Hessen), 12 peppercorns were found (Kreuz 1995:70). Nine specimens had still their wrinkled fruit wall present, indicating that we are dealing with black pepper. Obviously, all three German records are borderline cases. In this respect it is striking that pepper was not found in Neuss or Xanten, Roman frontier settlements where botanical remains have been thoroughly investigated. A single peppercorn from Biesheim-Kunheim, west of Freiburg, represents the only record from France and is dated to the second part of the first century AD (Jacomet and Schibler 2001:65–66). Again, this site is located along the Roman limes and is related to the presence of garrisons. Also related with the presence of the Roman army is the single peppercorn from the Roman spa town of Bath. It was found, among other food plants, namely grapes, figs, and coriander, in a ditch related to a building that was probably the headquarters of a high-ranking military administrator and dates to the late first or early second century AD (Durrani 2004:105).

All peppercorns from Germany, France, and Great Britain concern waterlogged specimens. Like the desiccated ones found in Shenshef, Quseir al-Qadim, and Mons Claudianus, they concern relatively small amounts that ended up unintentionally in the deposits from which they were retrieved. Possibly, people could not afford to use pepper as an offering, and its use as such at Berenike is explainable in the light of the presence of huge supplies.

Basically the identification of white pepper in an archaeological context can only be assured to be correct if a substantial assemblage of subfossil peppercorns predominantly consist of specimens that lack the outer fruit layer, as is the case in modern samples. Because fruits do not develop at the same time, even samples of black pepper do contain small amounts of white peppercorns. Furthermore, the outer fruit wall of black peppercorns may disappear in the course of time due to preservation conditions. It seems, therefore, that at least the samples of peppercorns unearthed from Oberaden and Hanau concern black pepper indeed, despite the presence of some smooth specimens.

***Pisum abyssinicum* Braun**

Latin	*Pisum abyssinicum* Braun
Synonym	*P. sativum* var. *abyssinicum* (A. Br.) Alef. ex Engl.
English	Abyssinian pea; Ethiopean pea
Arabic	-
Indian	-
Plant part	seeds
Trench/midden	BE: 14, 31, 33, and 48
Period	first–second and fourth–fifth centuries AD
Preservation	desiccated
Figures	4.62

Figure 4.62. Whole seed (left: 6.3 x 5.3 mm) and cotyledon with cavity for embryo (right: 6.0 x 5.0 mm) of the Abyssinian pea (*Pisum abyssinicum*). Photographs by R. T. J. Cappers (left) and J. Pauptit (right).

The pea (*Pisum sativum* L.) is one of the founder crops that was taken into cultivation in the Near East, where the first farmers appeared. The most likely progenitor of the pea is the *humile* pea (*P. sativum* ssp. *humile* [Holmboe] Greuter et al.), which still grows in the Fertile Crescent and Turkey (Zohary and Hopf 2000:105). This wild pea is also recorded from Egypt (Boulos 1999:354).

The pea is adapted to both warm and cool climates and is now cultivated in temperate zones throughout the world. It must have been introduced into Egypt during the early Neolithic. The oldest record originates from Merimde in the Nile Delta and is dated to about 5000 BC (Zohary and Hopf 2000:107). Together with the fava bean (*Vicia faba* L), the chickpea (*Cicer arietinum* L.), and the lentil (*Lens culinaris* Medik.), the pea is still a staple pulse in Egypt (Nassib et al. 1990:58).

Dry peas consist of 22 percent crude protein, which is not very high compared to fava beans (Langer and Hill 1982:243). It is more likely, therefore, that peas are used as a basic source of calories rather than protein, particularly if animal protein is available. Their relatively wide environmental tolerance, rate of maturation, ease of threshing and storage, and ease of preparation for food all contribute to its popular status (personal communication from A. Butler).

A total of 39 desiccated peas, party whole specimens and partly fragmented, were found in four different trenches. Many varieties of pea are known today, varying in all plant parts, including the size, the shape, and the color of the seeds. The specimens of Berenike are characterized by a pronounced hilum. Initially, they were identified as pigeon pea (*Cajanus cajan* [L.] Millsp.), a pulse that is native to India (Cappers 1999:188) and *P. sativum* (Cappers 2001:308). Further examination of both morphological and anatomical features revealed, however, that this identification was incorrect and that they looked very similar to the Abyssinian pea (*P. sativum* var. *abyssinicum* [A. Br.] Alef. ex Engl.). Only recently, the Abyssinian pea is recognized as a separate species (*P. abyssinicum* Braun), based on micromorphological and biomolecular studies (Butler 2003:45). The original geographical distribution of this pea is limited to the highland regions of Tigre and Wollo in northern Ethiopia, where relatively highly priced peas of several cultivars are still available in local markets (Westphal 1974:182). Today, the Abyssinian pea is also a common crop in Yemen.

It may not be excluded that peas with a similar shape were once also cultivated in Egypt. Import from the Nile Valley is the most likely option, as peas are very sensitive to water stress, making it unlikely that they were cultivated in local kitchen gardens at Berenike. It is also possible that they originate from Ethiopia or Yemen. In that case, they might have been obtained from Adulis or Avalitês, both located along the Red Sea coast of modern Eritrea, or from Muza on the coast of Yemen.

Prunus cerasifera Ehrhart

Latin	*Prunus cerasifera* Ehrhart
Synonym	*P. myrobalana* (L.) Loisel
English	Cherry plum; Myrobalan plum
Arabic	-
Indian	-
Plant part	fruits (endocarp)
Trench/midden	BE: 19, 33, and 48
Period	first–second centuries AD
Preservation	desiccated
Figure	4.63

Figure 4.63. Endocarp of cherry plum (*Prunus cerasifera*) (13.2 x 9.2 mm). Photograph by R. T.J. Cappers.

The wild cherry plum (*Prunus cerasifera* ssp. *divaricata* Ledeb.) grows in western and central Asia and probably also in the Balkan area. The cultivated cherry plums (ssp. *cerasifera*) are quite resistant to frost and drought and are widespread in Europe and Anatolia (Woldring 2000: 535). The fruits of the cherry plum can be eaten fresh, dried, or can be converted into compote, marmalade, or alcoholic beverages. The endocarps are tightly connected with the flesh of the fruits. For that reason, endocarps will be present in dried fruits and partly also in the compote, which can be made from whole fruits. Even halved, destoned fruits can be processed into compote.

As the taxonomy of plums still has to take a definite shape, it may not be surprising that historical sources are difficult to interpret with respect to this group of species. Classical writers use the word *myrobalan* only in connection with oil-producing plants, such as sugar date (*Balanites aegyptiaca*) and bentree (*Moringa peregrina*). The use of *myrobalan* in connection with the cherry plum is of more recent date. It was first applied by the botanist Carolus Clusius (1526–609). As is expressed in the epithet of one of the synonyms (*myrobalana*), the fruits of the cherry plum bear resemblance in both size and color, as far as the red-colored specimens are concerned, to those of the cherries (*Prunus* subg. *Cerasus*) and the mirabelle (*P. domestica* ssp. *insititia* var. *syriaca*). Today, this name is especially used for cherry plums used as stocks for grafting plums, apricots (*Armeniaca vulgaris*), and peach (*Prunus persica*).

That the Romans did cultivate the cherry plum could be evidenced, however, from archaeobotanical records. So far, three Roman sites have revealed the diagnostic endocarps: Bad Homburg, Ellingen, and Köngen, all located in southern Germany (Stika and Frank 1989:70). Other records concern much earlier periods and include charred endocarp fragments from the Middle Palaeolithic Douara Cave in Syria, identified as wild cherry plum by means of chemical analysis (McLaren 1995:200–211) and Neolithic remains from Russia, Moldavia, and Slovakia). More recent records are unearthed from medieval contexts such as those from Poland, Czechoslovakia, Hungary, Italy, and Germany (Körber-Grohne 1996:219; Kroll 1999, 2000, 2001; Stika and Frank 1989:70). The cherry plum endocarps from Berenike are the first archaeobotanical finds outside its distribution area. Because the fruits are not adapted to the arid conditions of Egypt, their presence in Berenike certainly points to import from the Mediterranean area or beyond.

Prunus domestica* L. *s.s.

Latin	*Prunus domestica* L. *s.s.*
English	ssp. *domestica*: Domestic plum; European plum; Gage; Garden plum; Plum; Prune plum ssp. *insititia*: Bullace plum; Damson plum
Arabic	ssp. *domestica*: Barquq; Iggass; Injas ssp. *insititia*: Barquq zurur
Indian	ssp. *domestica*: Alucha ssp. *insititia*: -
Plant part	fruits (endocarp)
Trench/midden	BE: 31, 33, and 48
Period	first century AD
Preservation	desiccated
Figure	4.64

Figure 4.64. Endocarp of domestic plum (*Prunus domestica*) (19.5 x 12.9 mm). Photograph by R. T. J. Cappers.

The taxonomy as well as the domestication of plums are still in discussion owing to their vegetative reproduction and hybridization. The vegetative reproduction of plums has a long tradition in its domestication history. Domestic plum varieties (*Prunus domestica*) can be propagated from root suckers and by grafting, in which grafts of the desired species are unified with the stock of a host species called *scion*. This kind of reproduction, in addition to cross-pollination and hybridization, has resulted in a highly varied polyploid complex of plum taxa. The variability of the plum species is also expressed in their endocarps and, therefore, hampers the identification of these mostly well-preserved fragments from archaeological contexts.

Woldring (2000:548–549) suggests that the black-fruited damson plum (*Prunus domestica* ssp. *insititia*) originates directly from sloe (*P. spinosa*). The damson plum itself is considered to be the main progenitor of the domestic plum (*P. domestica* ssp. *domestica*). Another possible domestication history is proposed by Körber-Grohne (1996:208–211), who is of the opinion that the hexaploid domestic plum (*Prunus domestica*; 2n = 48) is a hybrid of the tetraploid sloe (*Prunus spinosa*; 2n = 32) and the diploid cherry plum (2n = 16). A third possibility is discussed by Zohary and Hopf (2000:179–180), who state that the domesticated plum evolved directly from the variable cherry plum (*Prunus cerasifera*) and consider both taxa therefore as a single species (*P. domestica* L. *s.l.*).

Five endocarps have been unearthed in Berenike that belong to *Prunus domestica*, three of them bearing resemblance to the domestic plum (ssp. *domestica*); the other two show more similarity to modern endocarps of the damson plum (ssp. *insititia*). The endocarps partly originate from trenches 33 and 48, which also revealed the cherry plum, suggesting that these two fruits belonged to the same assemblage of food supply.

In point of fact, the endocarps of *P. domestica* in Berenike are the first evidence of its use as food in Egypt. The two other Egyptian records of plum concern its wood, originating from Thebes (Eighteenth Dynasty), and its leaves made into a garland, which was found in a Greco-Roman grave in Antinoë (Germer 1985:61). This scanty Egyptian record contrasts with the sizeable archaeobotanical record of *P. domestica* from Europe in particular.

Certain groups of plums of the subspecies *domestica* and *insititia* are easily dried and become prunes, which can be easily stored and transported. The import of plums as prunes from the Mediterranean area, where plums were cultivated in orchards, would have been easy and would have been a nourishing food supply in Berenike. That only a small number of fruit remains has been found might indicate that the supply was limited. But it is also possible that most of the delivered prunes had been already destoned, which is quite easily done with fruits of *P. domestica*. If so, endocarps of plums would only occasionally have ended up in the dump areas of Berenike.

***Prunus persica* (L.) Batsch**

Latin	*Prunus persica* (L.) Batsch
Synonym	*Amygdalus persica* L.; *Persica vulgaris* Mill.
English	Peach
Arabic	Dorraq, Firsikh, Khawkh, Khokh
Indian	Aru; Aruka vatama
Plant part	fruit (endocarp)
Trench/midden	BE: 1
Period	fourth–fifth centuries AD
Preservation	desiccated
Figure	-

The peach is a latecomer in the tradition of horticulture. Originating from the mountainous areas of Tibet and western China, it reached Greece through Persia about 300 BC. Dilphilus of Siphnos, who lived from 340–289 BC, is the first Greek author who undeniably mentions this tree (Dalby 1996:144). The only archaeobotanical record from Greece originates from Samos and is dated to the seventh century AD (Kučan 1995a: 22). The Romans did not cultivate the peach until the first century AD (Zohary and Hopf 2000:182).

Most varieties of peach require 500 to 1,000 hours of cold temperatures below 7°C to bloom naturally in the spring. So its distribution is restricted to temperate regions of the world with cold, but not severe, winters (Hancock 1992:266). The climatic conditions in most parts of Egypt are, therefore, not favorable for the cultivation of peaches. In present-day Egypt, peach cultivation is mainly confined to the Bahriya Oasis and the northern Sinai (Haagsma 1997:43).

The oldest Egyptian record of the peach originates from Ptolemaic el-Hibeh in the Nile Valley, some 60 km south of the Fayum (Wetterstrom 1984:60). Other finds are dated to the Roman and early Byzantine periods and are recorded from the Fayum (Karanis, Tebtynis, and Hawara), the Dakhla Oasis (Kellis), the Nile Valley (Saqqara, Kom el-Nana, and Thebes), and the Red Sea coastal area (Abu Sha'ar, Quseir al-Qadim, and Berenike). The concentration of finds in the Fayum supports the claim that peach was one of the new crops introduced to the Fayum (Crawford 1979:138–139).

The find of just one single part of the inner fruit wall of a peach in Berenike may reflect that this luxury fruit was probably only sporadically available, although it may not be excluded that destoned peaches also were brought to Berenike. Peaches may have originated from Egyptian plantations or from a more remote distant area to the north of Egypt. The recovery from a late context argues for the import of peaches produced in Egypt. According to Pliny (*NH* 6.26.103), the journey from Koptos (Qift) to Berenike took 12 days, and the same period was necessary to travel from Alexandria to Koptos (Qift). Thus, imported either from Egyptian orchards or from the Mediterranean area, the long-distance transport and storage of the perishable peaches would only have been feasible if the peaches were conserved as syrup or as pickles.

Although seeds of peaches contain a considerable amount of oil, it is unlikely that they were transported to Berenike especially for this nutriment only. If this was the case, one would expect to find only some spoiled seeds and not remnants of the relatively large fruit stones.

***Punica granatum* L.**

Latin	*Punica granatum* L.
English	Pomegranate

Figure 4.65. Outer surface (left) and inner surface (right) of peel fragment of the pomegranate (*Punica granatum*) (2.3 x 1.9 cm). Photograph by R. T.J. Cappers.

Arabic	Al lufan, Orman, Romman, Rumman, Ruman
Indian	Anar, Dadima, Dalim, Dalimma, Madalai
Plant part	seeds and peel fragments
Trench/midden	BE: 14, 25, and 33
Period	first–second and fourth–fifth centuries AD
Preservation	desiccated
Figure	4.65

The wild forms of the pomegranate are abundantly present in two areas: to the east in the south Caspian belt and northeastern Turkey and more to the west in the Balkan area, including Albania and Montenegro (Zohary and Hopf 2000:170–171). Wood (1997) suggests that the tree might be native to Arabia as the only other member of the family, namely, *P. protopunica* Balf. f., is endemic in Socotra. Archaeobotanical evidence, however, points to the eastern Mediterranean area as the core area of its domestication.

Textual records and wall paintings in Egyptian tombs that make reference of horticultural practices of the pomegranate are dated to the New Kingdom (1550–1069 BC), whereas the first archaeobotanical records are dated to the preceding Second Intermediate Period (1650–1550 BC). There is some doubt about the dating of small fruits of the pomegranate recorded from the Twelfth Dynasty at Dra Abu el-Naga, and it is suggested that they probably belong to the Eighteenth Dynasty (Keimer 1967 [1924]: 47, 104). In addition to the archaeobotanical finds, which include whole fruits, rinds, seeds, leaves, and flower (parts), ceramic imitations and dinnerware designs based on the whole fruit, also express the appreciation of the highly prized tree. The main production area of pomegranates in present-day Egypt is the lagoon of Marash Matruh in the western Mediterranean coastal strip, about 170 km west of El-Alamein (Haagsma 1997:15).

Fruits of wild specimens are sour and relatively small; those of domesticated ones are large and more appetizing. The fleshy fruit consists of (3-) 8–12 carpels, each containing many seeds. The fruit is often called a "berry," but this is incorrect because the juicy, edible part is in fact the seedcoat. Pliny (*NH* 13.34.113) distinguishes five different tastes: sweet, sour, mixed, acid, and vinous. The fruits can be eaten fresh, and the somewhat bitter seeds are not swallowed, or their juice can be drunk as grenadine or used for fermentation into *shedeh* or *rhoites* wine (Pliny *NH* 14.19.103; Darby et al. 1977:744). The root and bark are used for expelling tapeworm, and the rind is used as an astringent for the treatment of, for example, diarrhea and bleeding (Kamal 1975:535). Several parts of the plant are also used for tanning and dyeing. According to Pliny (*NH* 13.34.113), the rinds of unripe fruits are especially used for tanning leather for clothing. This kind of use is recorded from North Africa, including Tunis and Morocco, and from the Near East (Dekker 1906:160; Hepper 1992:116). The rind provides a yellow dye, which can be used as ink and for dyeing textiles. Whole, desiccated fruits or particles of the leathery rind are still available in Near Eastern shops with a good assortment of herbal products. In addition, the fruit was also considered as a symbol of fertility, based on the large number of seeds in a single fruit. This number has been estimated by Kučan (1995a: 20) at 250 to 400 seeds per fruit.

The specimens from Berenike would have been imported from the Nile Valley. Fully ripe fruits keep well and can be transported over considerable distances if bruising is prevented.

***Senna alexandrina* Mill./*holosericea* (Fresen.) Greuter**

Latin	*Senna alexandrina* Mill./*holosericea* (Fresen.) Greuter
Synonym	*S. alexandrina*: *Cassia acutifolia* Del.; *C. angustifolia* Vahl.; *C. senna* L.; *C. lanceolata* Forssk. *S. holosericea*: *Cassia holosericea* Fresen.
English	Alexandrian senna, Arabian senna, Cassia, Indian senna, Senna
Arabic	Alsana-al-Makki, At tarbah, Kasyah, Sana, Sana hejazi, Sana-makkak
Indian	Rangalata
Plant part	fruits
Trench/midden	BE: 10, 13, 15, 19, and 33
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated
Figure	-

Several trenches from Berenike yielded fruits that could be identified to either Italian senna (*Senna italica* Mill.), with a characteristic flaplike crested vein on both sides of the fruit, or to Alexandrian senna (*S. alexandrina*) and *S. holosericea*, whose fruits lack this pronounced vein. Although their leaves easily distinguish *S. alexandrina* and *S. holosericea*, an identification on the basis of their fruits is not possible. For that reason, the subfossil fruits from Berenike lacking the crested veins have been attributed to both these species. The fruits of coffee senna (*S. occidentalis*) do not come into consideration, as they are small and narrow.

The above-mentioned species were formerly classified within the genus *Cassia* and may not be confused with the cassia frequently mentioned by classical writers with respect to the bark of certain cinnamon species, which also bear the name "cassia" in some of their vernacular names, such as cassia (*Cinnamomum aromaticum* Nees = *C. cassia* auct.), Indian cassia (*C. tamala* [Buch.-Ham] Nees Eberm.), and Padang cassia (*C. burmannii* [Nees & T. Nees] Blume).

Both *S. alexandrina* and *S. holosericea* are desert plants and are recorded from the Eastern Desert, including the Red Sea coastal strip. Only Italian senna grows in the near vicinity of Berenike, whereas *S. holosericea* has been found in the late Roman settlement Qariya Mustafa 'Amr Gama in Wadi Umm Athl, some 40 km south of Berenike. The fruits of these species must have been deliberately collected as it seems unlikely that they once grow at Berenike's site proper or that their fruits were blown into the site from populations growing in the nearby wadis. Only Alexandrian senna has some economic value. It provides tannin, and both dried leaves and fruits are used as a purgative and are still sold by herbalists in the Near East.

Other archaeobotanical evidence from Egypt of *Cassia* and *Senna* concern threaded seeds of *Cassia* cf. *absus* L. found in Gebelein and charcoal of *S. alexandrina* found at Nabta Playa, dated to the late Palaeolithic. The glossy, rhomboid seeds of *C. absus* are still available at bazaars in the Near East, including Egypt.

***Sesamum indicum* L.**

Latin	*Sesamum indicum* L.
Synonym	*S. orientale* L.
English	Beniseed, Benneseed, Gingelly Sesame
Arabic	Juljul, Pron-semsem, Simsim
Indian	Ellu, Gigili, Gingelly, Gingilly, Gubbulu, Til, Tila, Tili
Plant part	seeds
Trench/midden	BE: 13, 14, 19, 25, and 33
Period	first–second and fourth–fifth centuries AD
Preservation	desiccated
Figure	4.66

Figure 4.66. Sesame (*Sesamum indicum*) seeds embedded in an unidentified matrix (14.2 x 9.2 mm). Photograph by R. T.J. Cappers.

Wild species of sesame occur in India and Africa. Referring to the large number of wild species in Africa, it has been frequently suggested that the cultivation of sesame started in the African continent (e.g., Pursglove 1968:431; Weiss 1971:311; Schuster 1992:128).

Interspecific hybridization and chemical studies now indicate that sesame was first brought into cultivation in India, in which *Sesamum orientale* var. *malabaricum* Nar. is proposed as the crop progenitor (e.g., Bedigian and Harlan 1986:140; Bedigian 2003; Fuller 2003b: 128–129). Bedigian and Harlan (1986) and Bedigian (2004a) summerized the archaebotanical, philological and historical evidence. From India, the crop would have been introduced both eastward to China and westward to the Near East and the Mediterranean region. Archaeobotanical remains are recorded from India, Pakistan, China, the Near East, Turkey, Yemen, and Egypt. So far, the oldest find of sesame is recorded from Harappa in Pakistan, which is dated to 3500–3050 BC.

Sesame is cultivated for its edible, lightly aromatic seeds and its odorless oil. The fruits are produced in the axils of the leaves and on the upper portion of the stem and branches where they ripen in an upward direction. Owing to the long period of fruit ripening and the fact that the capsules remain open during ripening, seed losses can be sizeable during harvesting. Strictly speaking, varieties that still have open capsules are not fully domesticated. To prevent seed losses, the plants can be uprooted before the first fruits start to scatter their seeds. The uprooted plants are shocked and left to dry, a process in which the water and minerals present in the stem allow further ripening. Drying and threshing of sesame is done at suitable spots that may be found at quite some distance from the fields before harvesting. This is still practiced in Egypt today.

The color of the seeds varies from white to black. Fried seeds can be eaten in soups and, after removal of the seedcoat, they are also frequently used to garnish bread and the like. From the dried ground white seeds, a paste called *tehinah* (also spelled as *tahini* or *malava-tahinga*) or *halva* is made. The oil, traded as oil of benne, can be kept for a long period owing to its resistance to oxidation and rancidity, subject to temperatures being rather stable. Also the high vitamin E content, high-grade protein, and good taste attribute to its quality (Schuster 1992: 129). Sesame oil is used as a salad and cooking oil. Furthermore, both seeds and oil are also used in medicine. Pliny (*NH* 22.64.132), for example, recommends them for a variety of disorders, including the bite of a gecko and inflammation of the ears. Strabo (*Geography* 16.1.20) mentions that it was a custom in Mesopotamia to anoint the body with sesame oil. The uprooted sesame stems, which are leftover after threshing, have little stock-feeding value and are used as fuel, as is still practiced, for example, in Egypt and Syria. In India, sesame seeds have a long tradition in religious ceremonies. Depending on the associated food products with which it is offered, it gratifies ancestral souls (*Pitris*) for one month, with for example rice (*Oryza sativa*) and barley (*Hordeum vulgare*), and for infinity if combined with rhinoceros flesh (Gupta 1991 [1971]: 86).

Literature dealing with the origin of sesame is incomplete in its compilation of archaeobotanical records, that of Egypt being no exception. All Egyptian finds are dated from the New Kingdom onward with the exception of two records from Naqada, located some 25 km north of Luxor. One record concerns unspecified remains and is dated to the First Intermediate Period (2181-2055 BC) or even to predynastic times (5500–3100 BC). The other record concerns pollen from either *S. indicum* or *S. alatum* Thonning and is dated to the predynastic period (Emery-Barbier 1990:324). *S. alatum* is a wild species from Sudan, but is also locally cultivated for its edible seeds, which are sometimes used as an adulterant of sesame (Pursglove 1968:430; Bedigian 2004b). If both records from Naqada concern Predynastic *S. indicum* indeed, they predate the one from Harappa.

Papyrological evidence of sesame in Egypt does not exist before the fourth century BC (Sandy 1989:71). Historical sources indicate that the Greek and the Romans also were very well acquainted with sesame. During the Greco-Roman period, sesame was especially cultivated for the consumption of the whole seeds rather than for oil production (Zohary and Hopf 2000:140; Bedigian 1998:96).

According to the *Periplus Maris Erythraei*, only sesame oil could be obtained from the so-called far-side ports along the Somalian coast, this oil originating from Skythia, the alluvial plain of the Indus in northwest India (Casson 1989:77). Obviously, the import of sesame oil to Berenike would have been on a modest scale. The seeds found at Berenike were probably imported from the Nile Valley and used as a garnish, among other things. Of particular interest is a piece of what might be a sesame cake, found in trench 33. It consists of an indefinable matrix in which many sesame seeds are incorporated. According to Galen (*On thePower of Foods*: Book 1), such a cake was made of raw honey and sesame seeds (Grant 2000:105–106).

Sorghum bicolor* (L.) Moench ssp. *bicolor

Latin	*Sorghum bicolor* (L.) Moench ssp. *bicolor*
Synonym	*S. vulgare* Pers.; *Andropogon sorghum* (L.) Brot.
English	Broomcorn, Durra, Feterita, Great Millet, Kaffir-corn, Milo, Shallu, Sorghum
Arabic	Dukhnal Hind, Dhurah, Dura ‘uwaigah, Gharib
Indian	Jowar
Plant part	fruits (s.s.) and threshing remains

Trench/midden	BE: 1, 6, 10, 14–16, 21, 25, and 37; SS: 4, 7, 20, 29, and 53–56
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated and charred
Figures	3.12, 4.67, and 4.68

Figure 4.67. Tasseled necklace (*muqlar*) of plaited leather strings, decorated with glass beads and filled with seeds of sorghum (*Sorghum bicolor*), (February 1998). See Color Plates section, page 227.

Figure 4.68. Floret of sorghum in ventral view (left; 4.8 mm) and fruit in dorsal view (right; width: 5.0 mm). Photograph by J. Pauptit.

Sorghum is a typical domesticated grain in the African savanna belt, south of the Sahara where the wild sorghum is still widely distributed (Harlan 1992:143–146). The plant has a C_4-metabolic pathway, making its photosynthesis very efficient in an environment characterized by high temperatures and intense light. In comparison with other cereals, such as barley, wheat, and rice, it has a considerable yield.

Two subspecies are distinguished: wild sorghum (*S. bicolor* ssp. *arundinaceum* [Desv.] de Wet & Harlan) and domesticated sorghum (*S. bicolor* ssp. *bicolor*). Additionally, four races of wild sorghum and five races of domesticated sorghum have been described.

The start of sorghum domestication is still disputed. Some are of the opinion that sorghum is a latecomer and opt for a domestication not earlier than the late first millennium BC (e.g., Rowley-Conwy et al. 1999:58). Others, such as Harlan (1993:54–55) and Fuller (2002:288–291, 2003a: 251–256), do not rule out the possibility of a much earlier African domestication and accept the validity of some of the records from Pakistan and northern India, dating to the first half of the second millennium BC. This would imply that soon after its domestication, sorghum reached this area through coastal trade.

The oldest record of Egyptian sorghum comes from the early Neolithic site Nabta Playa (ca. 7000 BC) and is considered as wild sorghum (Wasylikowa 1997:119–124). Several records of *s*orghum are dated to the New Kingdom (1550–1069 BC), without further indication on its wild or cultivated status. From several of these finds, the dates are doubted. It should be realized, however, that the tough and glossy husks of sorghum may retain a surprisingly fresh appearance, comparable with that of well-preserved rachis fragments from barley and wheat, as is the case with many specimens from Berenike.

The abundant remains of cultivated sorghum that have been excavated from Berenike indicate that this cereal played a substantial role in the food supply in the city from the fifth century AD onward. There are several possibilities with regard to the origin of the sorghum found at Berenike: import from the East African coast south of the Sahara, import from the Nile Valley, and from local cultivation.

Import from Ethiopia and Eritrea might have been possible via Adulis, which according to the *Periplus* was the nearest port south of Berenike. It was the only port of the Axsumite kingdom. Recent excavations at Axum, the capital of the kingdom and located some 150 km southwest of Adulis, have so far revealed only one single grain of *Sorghum* cf. *bicolor* (Boardman 1999:142).

As far as the Nile Valley is concerned as an area from which sorghum was obtained, it is possible that sorghum originated from Nubia. Archaeobotanical evidence from this area is relatively rich and indicates that sorghum was cultivated here at the start of the Christian era. Clapham and Rowley-Conwy (in press) found cultivated sorghum, race *bicolor*, in Qasr Ibrim from the Roman period onward. Trade contacts between Berenike and this important urban site is also evidenced from black pepper (*Piper nigrum*). Furthermore, most of the amphora vessels unearthed from trench BE95/96/97-5 are very similar to those recorded from Qasr Ibrim (Tomber 1999:130).

Direct or indirect import of sorghum from India seems unlikely, as we are dealing with a cereal that predominates in late Roman Berenike and is, therefore, probably related to the presence of native populations. Moreover, the crop was available from neighboring areas and was probably also cultivated locally on a small scale.

Both humans and animals may have consumed sorghum. Because the seeds do not contain gluten, it cannot be used for making bread. Mostly, the flour is mixed with water or fat and made into a porridge. Schweinfurth (1865d: 311) mentions that camels thrived if fed on sorghum (Durra). The sorghum that is occasionally cultivated near Arab Saleh, some 10 km northwest of Berenike is also used as camel fodder.

An old necklace (*muqlar*) obtained from an Ababda nomad, made of woven leather strands and decorated with glass beads and braided tassels, proved to be filled with sorghum seeds (Figure 4.67). Other specimens were stuffed with fibers or fenugreek (*Trigonella foenum-graecum*. Such necklaces were formerly worn by Ababda women and girls.

***Sorghum halepense* (L.) Persoon**

Latin	*Sorghum halepense* (L.) Persoon
Synonym	*S. miliaceum* (Roxb.) Snowden
English	Aleppo grass, Cuba grass, Johnson grass
Arabic	Al garrad, Djarrau, Garaw(a)(o), Gerau, Hashîsh el faras
Indian	Mrdubija yavanala
Plant part	fruits (s.s.)
Trench/midden	BE: 10, 13–16, 19, 21, and 25; SS: 4, 20, 21, and 29
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated
Figure	4.2

Johnson grass is a perennial species that grows in the Mediterranean area and eastward to India. Its exact native range is unknown, but is probably confined to the Mediterranean region. It is recorded in Egypt from the Nile Delta, the Mediterranean coastal area, the Nile Valley, and the oases in the Western Desert (Täckholm 1974:762; Cope and Hosni 1991:54).

Johnson grass might have been imported to Berenike as animal fodder, probably from the Nile Valley. It is still occasionally cultivated in Egypt as fodder. Some prudence is called for, however, since poisonous dhurrin is produced in the plant when it grows under drier conditions. This poison may affect younger animals especially (Bor 1968:550).

Alternatively, Johnson grass can be considered as an arable weed in barley and wheat fields. The co-occurrence with cultivated sorghum in samples from Berenike is, on the other hand, limited and makes it unlikely that both these species originated from the same fields. Because it is capable of propagating by rhizomes, it may become a noxious weed.

So far, the specimens from Berenike are the only ones recorded from Egypt. Other finds are recorded from Neolithic Kadero in Sudan (Klichowska 1983) and early Iron Age Gradina Klisura Kadica Brdo in Bosnia Herzegovina (Kučan 1995b:171–172).

***Tamarindus indica* L.**

Latin	*Tamarindus indica* L.
English	Kilytree, Tamarind
Arabic	‘Arandib-in Sudan, Hawmar, Humar, Subbar, Tamarindi, Tamr-hindi, Thamar al-Hind
Indian	Amilam, Amli, Amlika, Chincha, Chintapandu, Humar, Imli, Pali, Tentul, Tintrina, Tintrini
Plant part	seeds
Trench/midden	BE: 13, 19, 25, 31, 33, and 48
Period	first–second centuries AD
Preservation	desiccated
Figure	4.69

The area from where tamarind originates is still unknown. The tree is native to the dry savannas of tropical Africa, including central and southern Sudan and Ethiopia, where it is often accompanied by the baobab (*Adansonia digitata* L.). It is assumed that the plant was brought to India in ancient times, where it is found today in all parts of the continent. The tree plays an important part in Indian mythology in which, for example, an explanation is given for its finely divided

Figure 4.69. Whole seeds and cotyledons with embryos on the right side of tamarind (*Tamarindus indica*) (size: ca. 11–17 x 10–13 mm). Photograph by J. Pauptit.

leaves and for the use of tamarind juice instead of salt for seasoning food in the month of Chet (Gupta 1991 [1971]:91).

The tamarind is a tall tree that produces long, somewhat curved, flat fruits. At maturity, the fruit wall becomes brittle and opens easily, exposing the inner pulp. Imbedded in this sticky, brownish pulp are 1 to 10 large seeds. Trees are very productive in their natural environment and can produce considerable yields; therefore making it unnecessary to cultivate them in special plantations.

Although both seeds and the pulpy part of the fruits are edible, it is mainly the fruit pulp that is used. This pulp contains much sugar and is a rich source of vitamin C and calcium. The presence of several organic acids is responsible especially for the acidic taste of premature fruits, in which the sugar content is low. The pulpy part of the fruit can be eaten fresh or made into drinks by adding water and sugar. The pulp also has laxative properties. Fruits are also used for a variety of medical purposes, including preparations of the Indian Ayurvedic system. Seeds are only edible if the hard seedcoat is removed by roasting and soaking. Ground seeds can be used as animal fodder and are also made into a gum.

Classical writers do not seem to make a reference to the tamarind. The suggestion that one of the trees from the island of Tylos, the modern Bahrain, described by Theophrastus (*EIP* 4.7.8) could be the tamarind is only based on a description of the leaves and is not convincing as this description also applies to other members of the legume family (*Leguminosae* or *Fabaceae*).

Also the archaeobotanical record is scanty. The specimens unearthed at Berenike are the first ones from the African continent. Additionally, only two archaeobotanical finds are recorded from India. They originate from Nevasa and Kolhapur, both located in the northwest coastal area of India in the vicinity of Bombay and are dated to the Satavahana period (150–50 BC; Kajale 1977:104–105).

The 66 tamarind seeds from Berenike were found in 11 different loci spread over 3 trenches. Assuming that the fruit part was consumed, the presence of its seeds indicates that the fruits of tamarind were at least partly traded without the seeds removed. Ripe fruits can be kept for a long time and are easily traded if compressed together in cakes or balls. Such tamarind balls are still offered for sale in Egyptian bazaars. According to Von Maydell (1986:385), it is recommended that besides the inedible fruit wall and the fibers, the seeds also should be removed from fruits meant for storage over a long period of time, as the seeds may contain seed-feeding insects that can cause heavy losses. Because the seeds themselves also have an economic value, and the production of pulp without seeds would have increased the price, it seems likely that whole fruits were brought to Berenike.

The fruits might have been imported from either northeast Africa or India. Deducing from the information available, it seems most likely that they were obtained from the southern savanna of Sudan and Ethiopia, from where they might have been shipped to Berenike via Adulis.

Trachyspermum ammi (L.) Sprague ex Turrill

Latin	*Trachyspermum ammi* (L.) Sprague ex Turrill
Synonym	*Ammi copticum* L.; *Carum copticum* (L.) C.B. Clarke; *T. copticum* (L.) Link
English	Ajowan, Ammi, Bishop's weed, Ethiopian cumin, King's cumin
Arabic	Anisu barri, Cunul muluki, Kammun, habashi, Nakhwah, Naxwa hindi
Indian	Ajawa, Ajava, Ajma, Ajowain, Ajowan, Amam, Jowan, Omam, Omum, Yamani
Plant part	fruit
Trench/midden	BE: 13

Period	first–second centuries AD
Preservation	desiccated
Figure	-

Ajowan occurs in south Europe, northeast Africa, and west and central Asia, but it is only recorded as a cultivated plant or as one that has strayed from cultivation. Archaeobotanical remains could be helpful in identifying its area of origin, however, records are scarce, probably due to the small size of the otherwise characteristic fruits. The only subfossil remains of ajowan that are known so far originate from Egypt. Besides the fruit from Berenike, it has been recorded from Mons Claudianus in the Eastern Desert (Van der Veen and Hamilton-Dyer 1998:107), Amarna in the lower Nile Valley (Samuel 1995:372), and there is a sample of unknown origin and date stored at the Florence Museum (Germer 1985:138). The find from Mons Claudianus is contemporary with the one from Berenike, whereas the fruits from Amarna are dated to the Eighteenth Dynasty (1550–1295 BC). Although the find of ajowan at Amarna suggests that the plant probably already had a long tradition in Egyptian horticulture, it remains unclear whether the plant once belonged to the native flora.

The many synonyms that have been used for this plant indicate its close resemblance with several other umbelliferous plant species, such as khella (*Ammi visnaga* [L.] Lam.), carrot (*Daucus carota* L.), caraway (*Carum carvi* L.), black caraway (*Bunium persicum* [Boiss.] B. Fedtsch.), and stone parsley (*Sison amomum* L.). Most of these plants, including ajowan, are still used for flavoring food. Among others, Dalby (1996:139) assumes that ajowan is already mentioned by classical writers such as Pliny, Galen, and Dioscorides. But the descriptions of the concerning plant mainly deal with its uses, which are quite universal, and do not mention diagnostic features specific to ajowan. Nevertheless, we cannot know for sure if ajowan was meant indeed.

Ajowan is mainly cultivated for its fruits, which are used both as a flavoring spice for food and as a medicine, for example, in the treatment of kidney calculi and dysentery. Its medical properties can be attributed to the presence of thymol, a powerful antiseptic that can be used both internally and externally (Grieve 1931:811). Several plant species are exploited as a source of thymol, but ajowan is the most favored one as it yields the highest percentage of this valued compound. Today, however, thymol can be prepared synthetically, which decreasing the demand for natural sources.

Ajowan could have been imported from the Nile Valley, but it is also possible that it was grown in local kitchen gardens at Berenike. Although it takes 5 to 6 months before the fruits are ripe, they can be harvested earlier to prevent loss due to seed dispersal, without a reduction in quantity of the fragrant oil (Jansen 1981:118).

***Trigonella foenum-graecum* L.**

Latin	*Trigonella foenum-graecum* L.
English	Fenugreek, Greek hay, Greek clover
Arabic	Fariqah, Helba, Helbah, Hilba, Hulbah
Indian	Mar, Mentula, Methi, Vendayam
Plant part	seeds
Trench/midden	BE: 13, 14, 16, 25, and 31; SS: 29
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated
Figure	4.9, 4.70

Figure 4.9. Personal belongings of a dead sheikh in an acacia tree (*A. tortilis*) in Wadi Shenshef, (January 1997). See Color Plates section, page 221.

Figure 4.70. Seeds of fenugreek (*Trigonella foenum-graecum*) in piece of cloth as part of the sheikh's estate (January 1997). See Color Plates section, page 227.

The wild relatives of fenugreek grow in the Mediterranean area and in the Near East, and it is assumed that this pulse crop had been cultivated somewhere within this area (Zohary and Hopf 2000:122).

The green plant can be eaten as a vegetable and the seeds are used as a spice and as a medicine. In Egypt it has a tradition of being added to bread, mixed with the flour of sorghum (*Sorghum bicolor*) in particular (Kamal 1975:680). A popular dish in Yemen is "hulbah," which is made from pounded fenugreek mixed with meat broth and various vegetables (Wood 1997:143-44). Fenugreek is often eaten with white lupine (*Lupinus albus*), which is already mentioned by Galen (Grant 2000:101). The seeds are also used for making fenugreek tea (helba), which is still served in Egypt. Medical treatments include promoting lactation; healing inflammations; regulating digestion; relieving coughs, asthma, and emphysema; and its use as an aphrodisiac (Kamal 1975:680; Ahmed et al. 1979). Duke (1981:268) states that in Punjab (India), whole plants are added to stored grains as insect repellents and that seeds are used locally for a yellow dye. It is not known if this was also practiced in ancient Egypt.

During a botanical field trip, a sample of fenugreek seeds was found by the author among the belongings of a dead Ababda sheikh, who was buried on a terrace of Wadi Shenshef near the Roman ruins (Figures 4.9 and 4.70). The author discovered these belongings high up between the branches of an Acacia tree, well safeguarded against incidental water currents. I visited the tree again the following day with some Ababda nomads who allowed me to inspect part of the find, including a tin that appeared to contain an almost-empty packet of Nefertiti cigarettes, indicating that the belongings must have been deposited in the tree at least ten years earlier. Also present were three boxes of matches, an illegible piece of paper, a small medicine bottle, and two tied-up pieces of cloth in the form of a purse. The fenugreek seeds were present in one of these purses; the other one contained seven topped cowrie shells. These shells could be used by gifted people for fortune-telling and for consulting to plot out a proper route during a journey. It could not be determined whether the fenugreek seeds were used as a spice or as a medicine.

The archaeobotanical records of fenugreek are scattered and include Spain, Bulgaria, Germany, Egypt, Israel, Jordan, Iraq, and India. The oldest finds originate from Iraq (4000 BC), Israel (early Bronze Age), and Jordan (early Iron Age). Archaeobotanical records from Egypt almost equalize the number of all other finds, the oldest one originating from predynastic Ma'adi (3000 BC). In Berenike, fenugreek might have been cultivated in locally constructed garden plots. It is adapted to sandy soils and can even withstand some salinity. Seeds can be harvested about three to five months after planting. Alternatively, the seeds could have been imported from the Nile Valley.

***Triticum turgidum* ssp. *durum* (Desf.) Husn.**

Latin	*Triticum turgidum* ssp. *durum* (Desf.) Husn.
English	Durum wheat, Hard wheat, Macaroni wheat
Arabic	Qamh 'arabi, Qamh dakar, Samrah
Indian	Vajra godhuma
Plant part	fruits (s.s.), threshing remains
Trench/midden	BE: 1, 3, 6, 10, 13–16, 19, 21, 25, 29, 31, 33, 37, and 48; SS: 4, 7, 20, 21, 29, 53, 54, and 56
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated and charred
Figure	-

The general picture from the Egyptian archaeobotanical record is that the hulled emmer wheat (*T. turgidum* ssp. *dicoccon* [Schrank] Thell.) predominated during the pharaonic period and was largely replaced by free-threshing wheat during the Ptolemaic period. A reexamination of the published records revealed that we are predominantly dealing with hard wheat in the Greco-Roman period, and not with bread wheat (*T. aestivum* L.). Both free-threshing wheats can easily be distinguished by their threshing remains, whereas the identification of fruits can be problematic (Maier 1996; Hillman 2001:28–31). Although hard wheat is well adapted to relatively warm climates, and for that reason is the dominant wheat in the Near East and the Mediterranean area, it has quite recently been replaced in Egypt by bread wheat on a large scale. The cultivation of hard wheat is now confined to small areas in the Delta and the Fayum. Nevertheless, a new variety of hard wheat (Beni-Suef 1) has recently been brought into cultivation.

The yield of durum wheat is larger than that of emmer wheat, but less than that of bread wheat. The name *hard wheat* refers to the very hard endosperm, which makes it unsuitable for bread making. After grinding, the gluten-rich flour is made into a stiff, unleavened dough that is used for all kinds of pastas, such as spaghetti, noodles, and macaroni.

The identification of the Berenike specimens is based on the morphological features of the rachis fragments

(1996). It appeared that almost all the rachis nodes unearthed belong to durum wheat. Only a few spikelets of emmer wheat and some rachis fragments of bread wheat were found. Both species were always found mixed up with the predominant durum wheat and are therefore considered as contaminants.

Durum wheat has been recorded in reasonable quantities in both early and late Roman deposits of Berenike and would have been one of the staple grains for human consumption. Most probably, the hard wheat was obtained from the productive Nile Valley. The delivery of mainly modest quantities of wheat from Koptos to Berenike is evidenced by an ostraka archive found at Koptos, dated from 18 BC to AD 69 (Casson 1989:13–14).

Vicia ervilia (L.) Willd.

Latin	*Vicia ervilia* (L.) Willd.
English	Bitter vetch, Ervil
Arabic	Karsanah, Kirsanna
Indian	-
Plant part	seeds
Trench/midden	BE: 10, 13–16, 19, 31, and 33; SS: 29
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated and charred
Figure	-

The bitter vetch is a pulse crop native to the Near East and the Mediterranean area. Also from Egypt, it has been recorded as a wild plant species, where it grows on cultivated grounds in the Mediterranean coastal area (Boulos 1999:346). From this area it moved westward to the Balkan area and to the countries along the Mediterranean Sea, where it has been recorded from many Neolithic sites. Records from Egypt date back as far as predynastic times (5500–3100 BC). The bitter vetch belongs to the first group of domesticated crops of the Fertile Crescent and central Anatolia, although it is considered of less importance than the lentil (*Lens culinaris* L.) or the pea (*Pisum sativum* L.; Zohary 1996:143).

Seeds of the bitter vetch can be eaten by ruminants such as cows and sheep and by birds such as chickens, but they are toxic for other animals such as donkeys, horses, and pigs. The seeds are only fit for human consumption if they are soaked in water for some time. According to Zohary and Hopf (2000:116), bitter vetch was mainly used as forage for animals, at least from Roman times onward and was only eaten by man in times of famine.

Originally a weed in lentil (*Lens culinaris*) fields, the bitter vetch is still difficult to eliminate once it has become established in such fields. The correlation between the bitter vetch and the lentil in samples from Berenike and Shenshef is weak and assumes that the bitter vetch had been purposely brought to the site. Considering the availability of a broad spectrum of high-quality food products in both these sites, the bitter vetch was probably imported as animal fodder from the Nile Valley. According to Becker-Dillingen (1929:127), seeds of the bitter vetch have also been used to adulterate black pepper (*Piper nigrum* L.), but such a practice at Berenike is not conceivable.

Vicia faba L.

Latin	*Vicia faba* L.
Synonym	*Faba vulgaris* Moench
English	Broad bean, Celtic Bean, Faba bean, Fava bean, Field bean, Horse bean, Pigeon bean, Tick bean, Windsorbean
Arabic	Baqila, Fol, Ful
Indian	Bakla, Double bean
Plant part	seeds
Trench/midden	BE: 13, 16, 19, 25, 31, 33, and 48; SS: 29 and 54
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated and charred
Figure	4.71

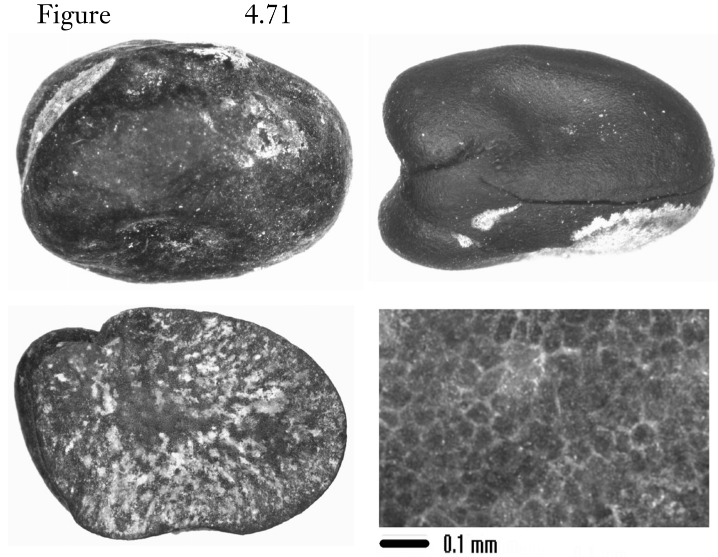


Figure 4.71. Seeds of the fava bean (*Vicia faba*). Seed in lateral view (top left: 8.8 x 5.8 mm), seed from above with seed coat removed (top right: 7.8 x 5.4 mm), seed in transverse section (7.5 x 5.1 mm, bottom left) and detail of cotyledon surface (bottom right). Photograph by R. T. J. Cappers.

The wild ancestor of the fava (faba) bean has not yet been identified and the archaeological evidence from early Neolithic settlements is also still scanty. For these reasons the fava bean is not considered as one of the founder crops of early agriculture (Zohary 1996:144). The oldest finds are recorded from the Levant, from where the crop spread westward into the Mediterranean area and eastward into India and China. The oldest Egyptian archaeobotanical find, unequivocally identified to the level of species, is dated to the Old Kingdom (2686–2181 BC) and originates from Abusir (Germer 1985:81).

Today, the fava bean belongs to the most important food legumes produced in Egypt (Nassib et al. 1990:57). The fruits have a white and velvet coating on the inside and contain some 3 to 6 seeds. Dry beans have a protein content of about 25 percent, which is comparable with that of the pea (*Pisum sativum* L; Langer and Hill 1982:247). Fava beans are grown for both green and dry consumption. If consumed as immature green beans, the plants are harvested several times. To obtain dry beans, the whole plant is harvested as soon as the first fruits turn black. Green beans are eaten after boiling, whereas dried beans are often baked first, a meal that is called *foul midamis* (or *foul medammes*). *Taamiah* (or *taamiya*) is a fried ball of paste made of germinated fava beans, and is a popular snack in Egypt.

In the eastern Mediterranean, a part of the human population is hypersensitive to the consumption of fava beans, which can cause a condition known as *favism*. Pollen may also bring on this disease, and it is probably for this reason that Pythagoras advised against eating flowers of this plant (Langer and Hill 1982:245). A variety of chemical compounds is responsible for the oxidation of red blood corpuscles and hemoglobin, resulting in anemia and jaundice (Van Genderen and Schoonhoven 1996:144).

Unless they are stored in a cool environment, harvested beans will quickly deteriorate. This may explain why the fava bean was frequently found among crops cultivated in the small kitchen gardens present in settlements in the Eastern Desert. Obviously, this pulse is easily grown under controlled conditions, and it is most likely that it was also cultivated in local kitchen gardens in Roman Berenike and Shenshef. Such plants might concern special garden cultivars, which are distinguished from field cultivars. The garden cultivars are especially grown on a small scale throughout Africa, Southeast Asia, and parts of India for its green pods (Westphal 1974:206). The green pods can be harvested for human consumption, and the remaining plant parts are suitable for use as stock feed.

Despite their relatively thick seedcoat, only a few small fragments of the fava-bean seeds have been unearthed in Berenike and Shenshef, indicating that their presence in the archaeobotanical records is probably underrepresented. This could be explained in several ways. First, large seeds will have less chance of getting lost in the sieving process in food preparation. This is in line with the predominance of small, aborted fava-bean seeds frequently found in waterlogged samples from The Netherlands. In addition, it may be assumed that if large seeds do indeed get lost, they have a better chance of being eaten by browsing animals than smaller ones such as lentils (*Lens culinaris* L.) that will easily sink down in the trash. Furthermore, large seeds of pulses easily disintegrate and, in this state, are easily susceptible to further organic decay. As only seed fragments were found, it was not possible to measure the size of the seeds, which would enable an identification to the level of variety.

Vigna radiata (L.) Wilczek

Latin	*Vigna radiata* (L.) Wilczek
Synonym	*Phaseolus aureus* Roxb.; *P. radiatus* L.; *P. sublobatus* Roxb.; *P. trinervius* Wight & Arn.
English	Golden gram, Green gram, Mung bean
Arabic	Mash
Indian	Cherupayaru, Dord, Mag, Mash, Moong, Mudgaha, Mug, Muneta, Pachapayaru, Passi payaru, Passipayeru, Patcha-payru, Pesalu
Plant part	seeds
Trench/midden	BE: 19, 25, and 33
Period	first–second centuries AD
Preservation	desiccated
Figure	4.72

Figure 4.72. Whole seeds and seeds without seed coat of the mung bean (*Vigna radiata*) (length: 3.3–4.2 mm). Photograph by J. Pauptit.

The mung bean is a domesticate of the Indian subcontinent. Its wild progenitor, *Vigna radiata* ssp. *sublobata* (formerly *Phaseolus sublobatus* Roxb.), is found in the western Himalayan foothills and extends throughout the Western Ghats into Sri Lanka. Apart from the discovery of the mung bean in Roman Berenike, the only other archaeobotanical records so far originate from India and date at least to the start of the second millennium BC (Fuller 2003a:312). Together with black gram (*V. mungo* [L.] Hepper), the mung bean is highly valued, the former being particularly prized by high-caste orthodox Hindus (Langer and Hill 1982:247).

Today, the mung bean is mainly produced in Southeast Asia, including India. According to Westphal (1974:152), the mung bean has been introduced relatively late in East Africa and is still not fully accepted there as a pulse crop.

Mung beans are grown primarily for their dried pulses. They can be eaten whole, split into *dhal*, or ground into flour. Whole or split seeds are eaten after boiling, and the flour of mung beans can be used for all kinds of baking products. Additionally, germinated bean sprouts (known as *taugé*) are eaten, which are obtained from the green-colored seeds. Their protein content is well over 25 percent.

Almost 70 mung beans have been unearthed from several loci in two trenches, located in the northwest part of the center of Berenike. They were traded as whole seeds. Subfossil mung beans from India that coincide with the Roman trade with India have been recorded from Narhan (Uttar Pradesh) and Taradih (Bihar), both located in north India, and from Nevasa (Maharashtra), east of Bombay (Kajale 1991:160–167). This would suggest the import of mung beans from Barygaza. On the other hand, it has to be realized that the Indian archaeobotanical record is still biased in favor of prehistorical sites found in the southern part of India. Prehistorical finds of the mung bean are recorded from Hallur and Sangankallu in Karnataka (Fuller, 2002:313–314). Assuming a continuation of the mung bean cultivation, this means that import from the more-southerly ports of Muziris and Nelkynda must also come into consideration.

Vitis vinifera L.

Latin	*Vitis vinifera* L.
English	Grape, Grape vine, Wine grape
Arabic	'Enab, 'Inab, Karm, Kashalmish, Keshmesh, Zebib, Zibib
Indian	Angur, Dhak, Draksha, Kothani
Plant part	seeds, fruits, and pedicels
Trench/midden	BE: 1, 5, 10, 13–16, 19, 21, 25, 31, 33, and 48; SS: 4, 7, 10, 20, 21, 29, and 53
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated and charred
Figure	4.73

Figure 4.73. Charred fruits of grape (*Vitis vinifera*) (seed visible in bottom right specimen; ca. 10.0 x 9.5 mm). Photograph by J. Pauptit.

The progenitor of the cultivated grape is *Vitis vinifera* ssp. *sylvestris*, which grows in the Mediterranean area and eastward to Turkmenistan and Tadzhikistan where isolated populations are present. As far as the North African Mediterranean coastal strip is concerned, the distribution of this wild grape is confined to Morocco and Algeria. Grape cultivation started in the Levant in the early Bronze Age, making it one of the first classical fruits of the Old World (Zohary and Hopf 2000:151).

The earliest records from Egypt are predynastic and early dynastic. These earliest grapes originate partly from sites located in the Nile Delta (Tell el-Fara'in, Tell Ibrahim Awad, and Abusir el-Meleq), whereas others are recorded from Abydos and Naqada, located in the upper Nile Valley. This implies that either wild grapes once grew in the Nile Delta or that cultivated grapes entered Egypt at a very early stage.

Although Egypt lies outside the optimal climatic zone, viticulture is possible if vineyards are constructed on well-drained, irrigated land. Proper locations are found outside the inundated area, such as the Nile Delta and the oases (Murray 1999:155–157). At present, the most productive grape regions in Egypt are located in the Nile Delta (Beheira and Gharbia) and, owing to the construction of the Aswan High Dam, also in the lower Nile Valley (Minya, south of el-Fayum) (Haagsma 1997:14).

The number of seeds found in Berenike and Shenshef indicates that grapes were available on a regular base. They would have been imported from the Nile Valley, possibly even fresh from the Mediterranean area.

Grapes could have been transported in a fresh condition, with whole bunches carefully packed in pottery by using soft packing material. Alternatively, they could have been preserved by drying, in which state they can be kept for a considerable period. The presence of a reasonable number of fruit stalks (pedicels), restricted to samples dated to the first to second centuries AD, seems to indicate that at least part of the grapes were imported as whole bunches indeed. The presence of seeds, on the other hand, is not indicative of the state in which grapes were transported. Although especially seedless types of grapes are appreciated for the production of raisins, such as currants originating from Corinth in northeastern Peloponnisos, grapes containing seeds are also preserved by drying. Today, such dried grapes are still produced but they do not enter the international trade anymore.

The cultivation of plants that produce seedless fruits can be considered an ultimate success in plant domestication. Real domesticated plants have become dependent on humans for their dispersal. In most domesticated plants, this has been obtained by prohibiting the release of the dispersal units (diaspores), such as, for example, the change from a brittle to a nonbrittle rachis in cereals. Natural seed dispersal has been replaced by the sowing of seed by humans. From a biological point of view, the absence of seeds in a fruit can be considered as an undesired abnormality as it prohibits sexual reproduction, which in turn eliminates its potential to adapt to changing environmental conditions. Although the earliest plant domestication dates back to the start of the Holocene period, the production of full-grown seedless fruits, such as bananas and some grape and citrus varieties, is more the exception than the rule.

In addition to the many seeds, some whole fruits of grapes have also been found in Berenike. In one particular context, the fruits had become charred and swollen, as a result of which they regained their original shape (Figure 4.73).

***Ziziphus spina-christi* (L.) Desf.**

Latin	*Ziziphus spina-christi* (L.) Desf.
English	Christ's-thorn, Kurna
Arabic	'Alb, 'Arj, As sidr, Bu'ar, Nabaq, Nabiq, Nabq, Sadar, Shagar, Sidr, Ulb
Indian	-
Plant part	seeds and fruits (whole fruits and endocarps)
Trench/midden	BE: 1–6, 10, 13–16, 19, 21, 23, 25, 29, 31, 33, 37, and 48; SS: 4, 7, 10, 20, 21, 29, and 53–56
Period	first–second and fourth–early sixth centuries AD
Preservation	desiccated and charred
Figure	4.74

Figure 4.74. Fruit fragments of the nabq (*Ziziphus spina-christi*). Exterior view of the whole endocarp; septum between two seed compartments has become detached (top left: 8.0 x 8.6 mm), apacial part broken off, displaying both seed compartments (top right), isolated septum (bottom left), and inside view of seed compartment (bottom right). Photograph by R. T.J. Cappers.

The Arabic name *nabq* is preferred instead of the more commonly used "Christ's-thorn," as the latter is also in use for other species, such as *Paliurus spina-christi* Mill., *Euphorbia milii* Des Moul., and *Carissa carandas* L.

The distribution area of *nabq* extends from the Sahara and the Sahel in Africa to Arabia and the Near East. In Egypt, it is recorded from all phytogeographical regions (Boulos 1995:90).

The archaeobotanical record of *nabq* is extensive, dating back to predynastic times (5500–3100 BC) and includes fruit remains, seeds, wood, and pollen. Fruits are eaten fresh and were formerly made into bread. Fruits, leaves, and wood also have a tradition in folk medicine (Manniche 1989:157–158). The former exploitation of *nabq* has resulted in a scattered distribution of specimens with a mostly shrubby appearance (Baum 1988:169).

Fruits have a stony endocarp, which is surrounded by a mealy and somewhat slimy outer fruit layer. Cleaning endocarps for the reference collection turned out to be a rather unpleasant and laborious job. The taste of the fruits is nothing special, though Drar (1936:95) is of the opinion that fruits of cultivated trees taste better than those gathered from the wild. In Yemen, fruits of *nabq* are mainly eaten by children (Wood 1997:192). Nevertheless, some 3,350 fruit stones have been unearthed from early through to late Roman levels, with the greater part unearthed in Berenike.

Nabq is frequently found among the trees present in settlements in the Eastern Desert, and it is, therefore, also possible that this tree was once cultivated in Roman Berenike and Shenshef. According to Hobbs (1990:92), the Ma'aza bedouins regard the *nabq* trees in their territory (located in the northern part of the Eastern Desert) as "antiquities" and suggest that they might have been planted by the Romans.

Wild Plant Species

The wild plant species that have been found at Berenike and Shenshef are summarized in Table 4.2 in systematic order. This table includes species from the Eastern Desert, the Red Sea coastal plain, and the Gebel Elba area that were exploited by humans and can be considered as cultivated plants. These wild plant species with an economic value are marked in the second column and treated separately in the previous section. The geographic distribution is mainly based on Boulos

Table 4.2. Presence of wild plant species, including (potentially) cultivated species, in the archaeobotanical records of Berenike and Shenshef, and their geographical distribution in Egypt. Abbreviations: CU = cultivated; BE = Berenike; SS = Shenshef; M = Mediterranean coastal strip; N = Nile Region including delta and Fayum; O = Oases; Dw = Western Desert; De = Eastern Desert; R = Red Sea coastal strip; S = Sinai; GE = Gebel Elba.

	Cult	Sites		Geographical Distribution							
Taxon	CU	BE	SS	M	N	O	Dw	De	R	S	GE
Forsskålea tanacissima		•	•				•	•	•	•	•
Rumex		•	•								
Rumex cf. pulcher		•	•	•		•					
Boerhavia		•									
Aizoon canariense		•		•			•	•	•	•	•
Beta vulgaris	•	•	•	•	•	•		•		•	
Chenopodium album			•	•	•	•	•	•		•	
Chenopodium murale		•		•	•	•	•	•	•	•	•
Cornulaca monacantha		•		•		•	•	•	•	•	
Amaranthaceae		•	•								
Amaranthus		•									
Aerva javanica		•	•		•	•		•	•	•	•
Achyranthes aspera		•			•						•
Caryophyllaceae		•									
Nigella		•	•								
Cocculus pendulus	•	•	•		•		•	•		•	•
Capparis spinosa	•	•	•	•		•	•	•		•	
Dipterygium glaucum		•	•				•	•	•		•
Cruciferae		•	•								
Lepidium			•								
Brassica		•	•								
Sinapis		•	•								
Sinapis arvensis		•		•	•	•		•		•	
Raphanus raphanistrum		•	•	•	•						
Zilla spinosa		•	•	•	•		•	•	•	•	•
Resedaceae		•									
Moringa peregrina	•	•	•					•		•	
Neurada procumbens		•		•		•	•	•	•	•	•
Leguminosae		•	•								
Astragalus		•	•								
Astragalus vogelii		•			•	•	•	•	•	•	
Astragalus eremophilus		•				•	•	•	•	•	•
Lathyrus hirsutus		•	•	•	•	•					
Melilotus messanensis/sulcatus		•		•	•	•		•		•	
Trigonella		•									
Trigonella hamosa		•		•	•	•				•	
Medicago		•	•								
Medicago minima		•		•			•			•	
Medicago polymorpha		•	•	•	•	•	•	•		•	
Hippocrepis		•									
Acacia tortilis	•	•	•		•	•		•	•	•	•
Crotalaria		•									
Crotalaria aegyptiaca		•	•		•		•	•	•	•	

Table 4.2. (continued)

	Cult	Sites		Geographical Distribution							
Taxon	CU	BE	SS	M	N	O	Dw	De	R	S	GE
Lotononis platycarpa		•									
Scorpiurus muricatus		•	•	•	•	•		•		•	
Indigofera		•									
Indigofera cf. articulata		•			•	•		•	•		•
Senna		•									
Senna italica		•			•	•	•	•	•	•	•
Geraniaceae		•									
Monsonia nivea		•	•			•	•	•	•	•	•
Fagonia		•									
Zygophyllum coccineum		•					•	•	•	•	
Tribulus terrestris		•	•	•	•		•	•	•	•	
Balanites aegyptiaca	•	•	•		•	•	•	•	•	•	•
Euphorbiaceae		•	•								
Euphorbia		•	•								
Chrozophora		•	•								
Commiphora gileadensis	•	•	•								•
Polygala cf. irregularis		•							•		
Ziziphus spina-christi	•	•	•	•	•	•	•	•	•	•	•
Grewia	•	•	•					•	•	•	•
Malva		•	•								
Malva nicaeensis/parviflora		•		•	•	•	•	•	•	•	
Tamarix nilotica		•		•	•	•	•	•	•	•	•
Cucurbitaceae		•	•								
Citrullus colocynthis	•	•	•	•	•	•	•	•	•	•	•
Umbelliferae		•	•								
Asclepiadaceae		•	•								
Glossonema boveanum		•						•	•	•	
Rubiaceae		•									
Galium		•	•								
Convolvulaceae		•									
Convolvulus arvensis		•	•	•	•	•		•		•	
Cordia nevillii/sinensis	•	•	•			•					•
Boraginaceae		•									
Echium			•								
Echium rauwolfii		•	•	•	•			•		•	
Heliotropium		•									
H. bacciferum/ramosissimum		•			•		•	•	•	•	•
Arnebia		•	•								
Arnebia hispidissima		•	•		•			•	•	•	•
Trichodesma		•	•								
Trichodesma cf. africanum			•	•	•	•		•	•	•	•
Avicennia marina	•	•							•	•	
Labiatae		•	•								
Teucrium		•	•								
Solanaceae		•	•								
Compositae		•	•								
Pulicaria undulata		•		•	•	•	•	•	•	•	•
Anthemis			•								
Matricaria		•									
Liliaceae		•									
Asphodelus tenuiflorus		•		•	•	•	•	•	•	•	•
Gramineae		•	•								
Lolium temulentum		•	•	•	•	•		•		•	
Bromus		•									
Avena fatua		•	•	•	•	•	•	•		•	
Avena sterilis		•		•	•	•		•		•	
Phalaris paradoxa		•	•	•	•	•	•	•			
Panicum turgidum		•	•	•	•	•	•	•	•	•	•
Setaria		•									
Setaria pumila		•	•	•	•	•	•			•	•
Aeluropus lagopoides		•		•	•	•	•	•	•	•	•
Paspalum scrobiculatum		•									
Cenchrus ciliarus		•	•	•	•		•	•	•	•	•
Dichanthium foveolatum		•	•		•		•	•	•	•	•
Gramineae tribe Andropogoneae		•									
Phoenix dactylifera	•	•	•	•	•	•	•	•	•	•	•
Hyphaene thebaica	•	•	•		•	•		•	•	•	
Cyperaceae		•									
Cyperus conglomeratus		•	•	•	•	•		•	•	•	•

(1995, 1999), Cope and Hosni (1991), and the author's own perceptions.

A total of 63 taxa of wild plants could be identified to the level of species, including 14 (potentially) cultivated ones. In some cases, this identification is of a tentative nature or concerns a combination of two allied species. More than half of the subfossil species recorded from Berenike and Shenshef are still part of the current flora of both the Eastern Desert and the Red Sea coastal area and about a quarter is recorded from the mountainous Eastern Desert only. The mangrove tree (*Avicennia marina*) and *Polygala* cf. *irregularis* are confined to the coastal area along the Red Sea. This means that altogether 84 percent of the subfossil plants identified to species level are so far still present in the vegetation of the Eastern Desert and the Red Sea coastal plain.

A comparison of the archaeobotanical record with the botanical inventories near Berenike and Shenshef, as presented in Tables 2.1 and 2.2, reveals even more precise correlations. Species that have been evidenced by both subfossil and recent specimens at Berenike and Shenshef are *Forsskålea tanacissima*, *Aerva javanica* (Figure 3.8), *Zilla spinosa*, *Acacia tortilis* (Figures 4.10 and 4.11), *Tribulus terrestris* (Figure 7.23), *Citrullus colocynthis* (Figure 4.24), *Arnebia hispidissima* (Figure 7.3), *Panicum turgidum*, *Cenchrus ciliarus* (Figure 7.15), and *Cyperus conglomeratus* (Figure 7.9). Plant species only recorded by both subfossil and recent specimens for Berenike are *Cornulaca monacantha* (Figure 7.6), *Neurada procumbens* (Figure 7.21), *Senna italica*, and *Polygala irregularis*. Another category concerns plants present around Berenike and Shenshef today, but have so far only be evidenced by subfossil remains from either one of those sites: *Aizoon canariensis*, *Astragalus eremophilus*, *Astragalus vogelii*, *Zygophyllum coccineum*, *Tamarix nilotica*, *Glossonema boveanum*, *Heliotropium bacciferum/ramosissimum*, *Pulicaria undulata*, and *Asphodelus tenuiflorus* (Figure 7.20). A last category is formed by two plants evidenced by subfossil remains from both Berenike and Shenshef, but have only been found in the present vegetation around one of these sites: *Dipterygium glaucum* (Figure 7.5) and *Dichanthium foveolatum* (Figure 7.16).

On a wider scale, a group of 11 wild plant species evidenced by subfossil remains can be recognized which are not present in the Eastern Desert and the Red Sea coastal plain today. This group includes two cultivated species that were probably exploited in the Gebel Elba area, namely, *Cordia nevillii/sinensis* (Figure 4.37) and *Commiphora gileadensis* (Figure 4.35), and species that must have entered both sites as a weed. With the exception of *Paspalum scrobiculatum* (Figure 7.17), the present distribution area of these wild plant species include the Nile Valley or, in the case of *Medicago minima*, the Mediterranean region. *Achyranthes aspera* and *Setaria pumila* are also recorded from the Gebel Elba area by Boulos (1995), although the record of the latter is not confirmed by a herbarium specimen. *Setaria pumila* is not included in the enumeration of plants by Drar (1936), based on two botanical expeditions to this area. Also the present author did not find *Setaria pumila* during his visit to the Gebel Elba in February 1999, but did find several specimens of *Achyranthes aspera* (Figure 4.75).

Figure 4.75. *Achyranthes aspera* on a mountain slope of the Gebel Elba (February 1999). See Color Plates section, page 228.

From *Achyranthes aspera*, two varieties are described: var. *sicula* L. and var. *pubescens* (Moq.) C.C. Towns (Boulos 1999:139). The former one is cultivated and naturalized in the Nile Valley at Cairo and is considered not successful. It is now only found naturally in the Gebel Elba area, where it is abundant on the sandy plains around the mountains and in the edges of the wadis (Drar 1936:5). Variety *pubescens*, on the other hand, is only recorded once from the Nile Valley at Aswan. On the basis of the perianth length, the subfossil specimen from Berenike is attributed to var. *sicula* and it is most likely that it originated from the natural populations of the Gebel Elba area. The ripe fruits of *Achyranthes aspera* remain enclosed by their spine-tipped bracts and perianths, and, as a result, they are easily dispersed by humans and animals (Figure 7.1).

A wild plant that originates from even a more southern location is kodo or kodra millet (*Paspalum scrobiculatum*). This grass probably originated from Sudan or further southward. The plant is well adapted to waterlogged soils but has only a limited drought tolerance (Baki and Ipor 1992:186). Some spikelets and also a rachis segment were found in Berenike (trench BE96-14). Kodo millet provides useful forage and is cultivated for its grain, but may also occur as a weed. It could have been imported from the south as fodder, though it is usually consumed in its fresh state by grazing animals.

Wild plant species considered as weeds that originate from the Nile Valley are *Lathyrus hirsutus*, *Raphanus raphanistrum*, *Medicago minima*, *Trigonella hamosa* (Figure 7.19), and *Setaria pumila*. Though their current distribution includes the Eastern Desert and/or the Red Sea coastal plain, the following ruderal species may also be rated among this assemblage: *Malva nicaeensis/parviflora*, *Tribulus terrestris*, *Melilotus messanensis/sulcatus*, *Chenopodium album*, *C. murale*, *Sinapis arvensis*, *Phalaris paradoxa*, *Lolium temulentum*, *Beta vulgaris* (Figure 4.1), *Echium rauwolfii* (Figure 7.4), *Convolvulus arvensis* (Figure 7.7), *Scorpiurus muricatus*, *Medicago polymorpha*, *Aeluropus lagopoides* (Figure 7.11), *Avena fatua* (Figures 7.12 and 7.13), *A. sterilis* (Figure 7.14), *Galium* sp., *Anthemis* sp., *Matricaria* sp., *Bromus* sp., and *Brassica* spp.

A wild plant species that is well represented in the archaeobotanical record of Berenike and Shenshef is *Echium rauwolfii*. The subfossil fruits proved to be more similar to those from herbarium specimens collected in the Nile Valley than to those collected in the Sudan (Figure 7.4). Fruits were recovered in many samples, including ones in which cereals were absent. This might indicate that this weedy species was successful in growing at the sites proper, most probably in plots used for cultivating vegetables and pulses. Other weed species that might have colonized such kitchen gardens are *Aristida* spp., *Chenopodium album*, *C. murale*, and *Boerhavia repens* (Figure 7.22). The last-mentioned species is often found on waste ground near a cultivated area. As a trailing perennial plant, it may have easily been introduced with other plants to the site.

The weed assemblage of the Berenike samples differs to some extent from those of Shenshef. Weeds especially associated with samples from Berenike are *Medicago minima*, *M. polymorpha*, *Trigonella hamosa*, *Sinapis arvensis*, *Avena sterilis*, *Lolium temulentum*, and *Galium* sp. More typical for samples from Shenshef are *Raphanus raphanistrum*, *Chenopodium album*, *Brassica* spp., *Convolvulus arvensis*, and *Scorpiurus muricatus*.

El-Hadidi and Kosinová (1971) have characterized the Egyptian weed flora in relation to crop and phytogeographical region. It appears from their study that none of the above-mentioned potential weeds is, in fact, typical for the rain-fed Mediterranean coastal strip, which is now mainly used for barley cultivation. In the same study, *Asphodelus tenuiflorus* and *Melilotus sulcatus* are mentioned as typical weed plants for the oases. The frequent occurrence of the former species in the current vegetation of Wadi Shenshef, however, points to a nonweedy status of the subfossil specimens. Considering them as nonweeds, these results reinforce the opinion that the import area would have been the Nile Valley, most probably from either Koptos or Edfu.

CHAPTER 5

Peaches in the Desert

"It is a harmless fruit, in demand for invalids, and peaches have before now fetched thirty sesterces each, a price exceeded by no other fruit—which may surprise us, because there is none which keeps worse: the longest time that it will last after being plucked is two days, and it compels you to put it on the market." [Pliny the Elder, *Natural History*: 15.11.40]

Long-Distance Trade

Located at the desert edge along the southeastern fringe of the Roman Empire, Berenike was involved in long-distance transport, not only in connection with international trade, but also with food supply because the arid environment was unsuitable for subsistence farming.

Departure and arrival of ships and caravans were not without obligations. Both had to be geared to one another and were determined by sailing schedules and the inevitable replenishment of the food supply for the inhabitants of Berenike.

An estimate of the time taken by a voyage between trade centers not only depends on the distance but also on the moment of departure, the time of the day that could be used for traveling, the time needed for visiting ports, and the changing weather conditions. Ships heading for Africa south of the Sahara (Rhapta) and southwest India (Muziris) had to deal with the monsoon winds, which determined both the departure and arrival time. Those that made return trips between Berenike and the ports along the Somalian coast did not suffer from these cyclic events.

The rough estimates of the voyages presented in Figure 5.1 are based on interpretations by Warmington (1995:6–34) and Casson (1989:278–282). Commodities loaded in Ostia or Puteoli could reach Berenike in about 45 days. The voyage from Berenike to Muziris took some 50 days and to Rhapta as many as 90 to 140 days. As ships leaving for Rhapta could not depart from Cape Guardafui earlier than mid-October or the beginning of November because of the prevailing winds, their prolonged voyage in the Red Sea and the Gulf of Aden could have been used for visiting ports along the coast (Casson 1989:286–287). A return voyage between Berenike and Muziris would have lasted three-quarters of a year, including a stay at Muziris for three up to four months, which could have been used for collecting new cargo. A return voyage to Rhapta, on the other hand, would have lasted a year and a half and included a forced stay of about eight months in its destination port. To trade with ports along the Red Sea coast and the Gulf of Aden must have been an attractive alternative for the Berenike traders, considering the availability of a wide range of commodities brought there by Arab and Indian traders. Such return voyages would have taken not more than two months.

The Nile Valley and the Gebel Elba area can be considered as the most important areas where food was

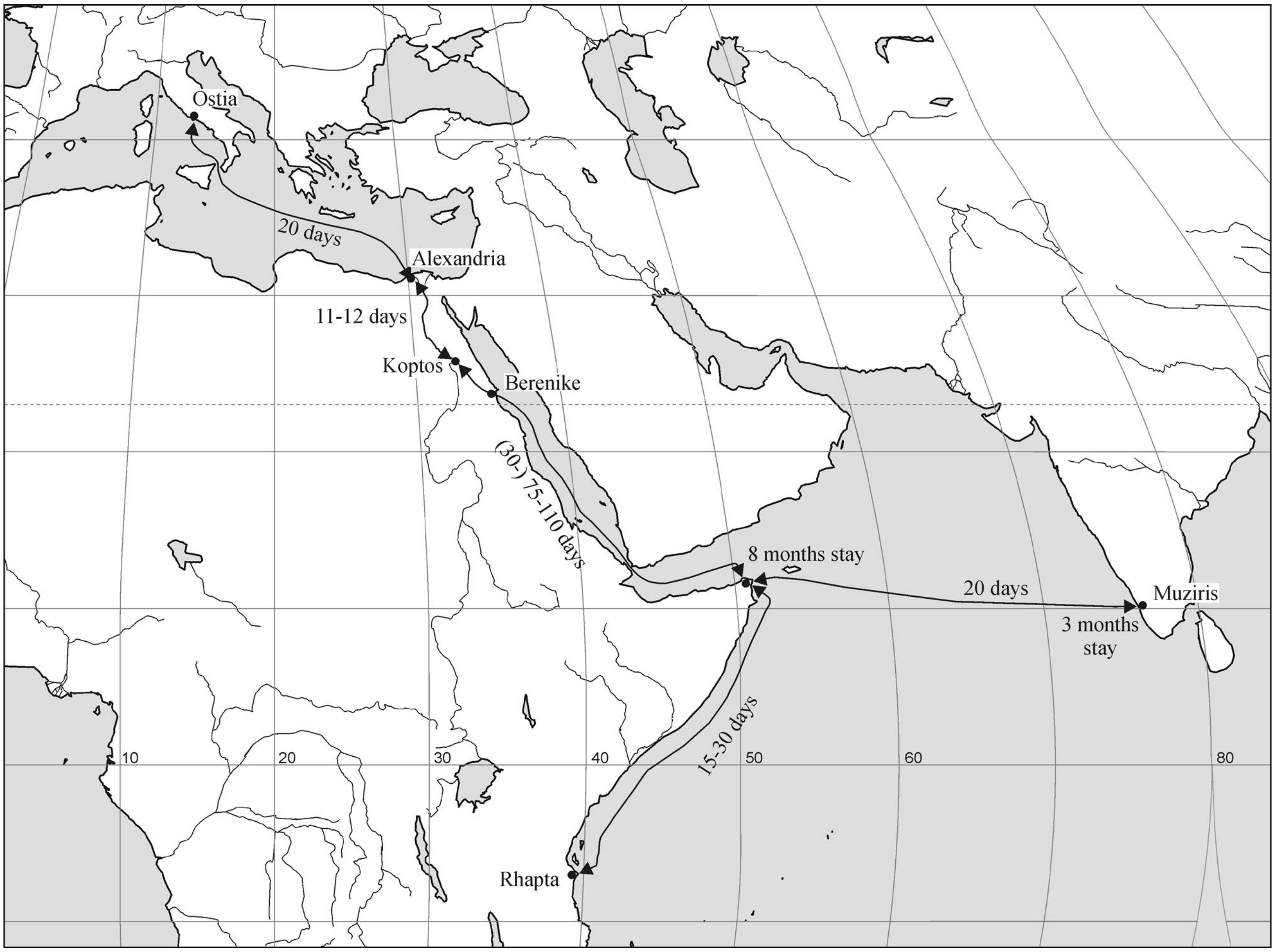


Figure 5.1. Duration of voyages.

obtained. Staple food was accessible within short time periods and with low risk from both locations . Import from the Mediterranean area, on the other hand, took almost the same time span as from India. Such long-distance transport, combined with the continuous demand of food supply, must have had implications for the preservation of the food items. On a limited scale, these logistic problems could have been overcome by local cultivation of some food plants.

LOCAL CULTIVATION

Herbs

Small-scale cultivation practiced by dwellers of the Eastern Desert, described in Chapter 2, highlights the question whether the inhabitants of Berenike also cultivated plants themselves. This consideration is supported by classical sources, which suggest that agriculture was more respected than trade (Meijer and van Nijf 1992:15). Furthermore, the inhabitants of Berenike had lived with the tradition of agriculture, and living on the desert fringe would not automatically have blocked experiments in the field of subsistence farming.

The most likely groups of plants that come into consideration for local cultivation are vegetables and some desert trees that produce edible fruits. Fresh vegetables, tubers, and condiments could have been cultivated in kitchen gardens. Several species that were found in Berenike could have been grown in those kitchen gardens: garlic (*Allium sativum*), fenugreek (*Trigonella foenum-graecum*), fennel (*Foeniculum vulgare*), coriander (*Coriandrum sativum*), dill (*Anethum graveolens*), cumin (*Cuminum cyminum*), watermelon (*Citrullus lanatus*), cucumber (*Cucumis sativus*), and, revalued as a cultivated plant, also beet (*Beta vulgaris*). This may be especially true for plants from which the surplus value is determined by its fresh condition, such as coriander and dill. Additionally, also pulses such as the faba bean (*Vicia* *faba*) could have been among the garden plants, as is still the case in modern kitchen gardens in the desert.

The presence of several fruit fragments of the caper bush (*Capparis spinosa*) just outside the walls of some buildings indicate that this plant once grew out of the walls, probably beyond the reach of browsers. But its weedy character does not rule out its penetration into kitchen gardens.

Just like today, protection against browsing and grazing must have been necessary. Archaeozoological research has revealed that camels, donkeys, horses, sheep, goats, chickens, domestic fowl, cattle, and probably also pigs were locally bred or imported on the hoof from the Nile Valley (Van Neer and Lentacker 1996:348). The scattered pattern of trenches and the complex architecture within these trenches make it as yet unable to judge possible locations of kitchen gardens.

Trees

Conclusive evidence for the presence of trees in ancient Berenike, such as plant parts that have no direct economic value, has not yet been found. The only indication of tree growth at Berenike concerns two independent observations of a coconut tree (*Cocos nucifera*) by two seamen somewhere at the end of the nineteenth century, but most likely one or more date palms were mistaken for this exotic palm, as is argued in the section dealing with the coconut.

One might suspect that in classical times the date palm was cultivated at Berenike. Dates were appreciated very much by the Romans as can be deduced from the recovery of date palm seeds in many Roman settlements throughout the Empire. In Berenike, the date palm is represented by many different plant parts; not only seeds but also flowers, vessels, and woody parts from the leaves were frequently found. Furthermore, the date palm can withstand brackish conditions to a certain extent, an advantage in this coastal settlement.

Although two attractive reasons for planting trees are the shade that they provide and their edible fruits, it should be realized that the local cultivation of trees was not always possible and might have been hampered by the salty condition of the water. The original surface on which Berenike was built appears to be no higher than +2 to +3 m above sea level with the lowest levels at about sea level (Harrell 1996:104). In addition to this relatively shallow, brackish groundwater table, there might also have been a considerable influx of windblown salt crystals into the soil from flat areas along the sea during low tide, as could be demonstrated by Aldsworth and Barnard (1998a: 10). Today, the salt marsh extends several hundred meters inland, as can be judged by the presence of the halophyte *Zygophyllum coccineum*.

Leaving the influence of the possible brackish condition around the site in classical times aside, one might wonder that other trees might have grown in Berenike. Based on the present-day practices and also on the number of subfossil plant remains (although this number is by no means in itself indicative of local cultivation), the following species come into consideration: *nabq* (*Ziziphus spina-christi*), fig (*Ficus carica*), and possibly the Egyptian plum (*Cordia myxa*), the balsam tree (*Commiphora gileadensis*), and *Cordia nevillii/sinensis*.

Cereals

Because of the limited storage life of vegetables and condiments, local cultivation would have had an advantage over their import. Grains, however, can be stored for longer periods, and for this reason importing them was also a viable option. Cultivating cereals locally would only have been carried out if the logistics of import were too complex, which is not plausible for Berenike, which depended on an established trade system between the Nile Valley and the Red Sea. If local grain cultivation was practiced on a reasonable scale, yields would have placed large demands on the water supply. Possible water sources that may have been used in Roman times were the large watering station of Kalalat, 8.5 km southwest of Berenike, and the surface water present in Shenshef, which could have been supplied over a distance of more than 25 km.

The most likely area for crop cultivation near Berenike is the western part of the coastal plain, out of reach of the salt spray and sea seepage. It is in this particular part of the plain that Ababda nomads cultivate sorghum today when winter rains have been sufficient.

Possible areas for crop cultivation in Shenshef are located near the narrowing of the wadi where surface water is exposed and at the eastern part of the settlement, where a flat elevated area is present, which conspicuously does not contain remnants of buildings. Two corings in the latter location did not reveal remnants of a tilled layer, but it is questionable if changes in the soil texture would have developed in the loose sand. Moreover, the plant cover that developed after the heavy rainfall in October and November 1996 was relatively poor and was dominated by *Zygophyllum simplex*, a species with a wide ecological range with respect to moisture content. Inquiries to some Ababdas about the possibility of sorghum cultivation at that particular spot produced the following dialogue:

> "Is it possible to cultivate sorghum near Shenshef?" I asked.
>
> "No, that is not possible," they answered after careful consideration.
>
> "But why not?" I asked.
>
> "Wild donkeys will eat the sorghum."

This could make sense, as wild donkeys were living nearby.

> "But if you take care of the field by guarding the area?" I tried again.
>
> "That is not possible; it would be too expensive." was their counterargument, probably pondering on the fact that the area is uninhabited today.
>
> "But in Roman times, people were living here. That would not have cost any investment." I replied.
>
> "But it would still be impossible. The soil is infertile."

The last argument is of particular interest as it is the only one offered that related to edaphic factors. They may be right in this respect, but dung could have been used as a fertilizer, assuming that it was available in sufficient amounts.

An argument against local cultivation of cereals is also found in the *Periplus Maris Erythraei* (Casson 1989). Several times it mentions the export of grain from Berenike to harbors along the African and Arabian coasts and even to India, with wheat particularly mentioned for Muza (*Periplus*: 24) and Kanê (*Periplus*: 28), both located on the coast of modern Yemen. Thus, the supply of grain to Berenike was not only meant for local consumption, but also for export. Despite the presence of threshing remains of wheat at Berenike, it is naïve to assume wheat cultivation near Berenike, Kalalat, or Shenshef under unfavorable conditions, even though this type of grain is exported. A more plausible explanation is wheat import from the Nile Valley, part of which was consumed by the Berenike dwellers and part used as an export item. The interpretation of the subfossil remains of sorghum and barley is less clear.

An archaeobotanical clue to determine the ultimate origin of the cereals may be found in the analysis of the weed flora. Because sorghum, barley, and wheat were already cultivated over a large area for some millennia during the Roman period, the detection of the possible area(s) of origin, either local or from remote areas, is facilitated by the identification of weed species having a more restricted dispersion. For this purpose it is necessary to have samples at one's disposal in which one of the grain species predominates and also in which some diagnostic weed species are present. When several samples meet this condition, it is possible to determine the associated weed flora of each of the cereals. Unfortunately, samples from all excavation seasons that were rich in both cereal remains and weed species were not characterized by a predominance of one of the grain species. Although the archaeobotanical record contains a reasonable number of (possible) weed species, their indicative value is still limited. Fifteen weed species have been found so far that are still growing in the surroundings of Berenike. It is, however, unclear as to what extent they can be considered as weed species from local fields. Another 15 were found whose present geographical distribution in Egypt is especially concentrated in the Mediterranean coastal strip, the Nile Valley, and the oases in the Western Desert (Cappers 1998:326). Taking into consideration the trade route between Berenike and Rome, it is most likely that they are indicative of grain supply from the Nile Valley. A possible weed with a more southerly distribution is kodo or kodra millet (*Paspalum scrobiculatum*), represented by some spikelets and a rachis segment.

Weighing the arguments, it seems most likely that local cultivation of cereals was only practiced on small plots because yields could not have been in proportion to investments, limitations, and risks. Most probably, local cultivation of cereals was mainly limited to sorghum and barley and had an opportunistic character, as the water supply was critical.

Threshing remains of cereals were mainly extracted from dump areas and middens. Surprisingly, threshing remains of barley and wheat were mostly found together with some of their grains. It is conceivable that even in the case of the delivery of so-called clean grain samples, threshing remains may still have been present to some degree. After the final cleaning of these grain samples at Berenike, small amounts of threshing remains could have accumulated in special deposits such as dump areas in the course of time. It is also possible that grain was, at least partly, transported in the ear. This would not have been a problem judging by the capacity of the caravan transport between Berenike and the Nile Valley.

Another possibility is that threshing remains were imported as such. It is valued for its use as a filling material, which could have been in great demand in trade centers such as Berenike. It is also used as a fodder, fuel, and temper for building materials such as wall plaster, mortar, and mud bricks.

Its use for tempering building materials could be demonstrated for the Roman quarry settlement Mons Claudianus, also located in the Eastern Desert, about 400 km north of Berenike. This specific use is evidenced in Mons Claudianus by the analysis of wall plaster and mud bricks, while an ostrakon confirms the delivery of chaff (Van der Veen 1996:139–140). The ostraka that have been found so far at Berenike do not mention the use of threshing remains for building purposes. Moreover, the buildings in Berenike are constructed of coral and anhydrite/gypsum (calcium sulfate), which are locally available (Sidebotham 1996:7). A mud-brick wall, which was found during the 1997 excavation season, lacked botanical temper.

The nutritional value of chaff as animal fodder is limited. That of wheat is more nutritious than that of barley, whereas the presence of awns, which is most conspicuous in barley, makes it almost inedible for animals. Dry barley chaff may even cause a fatal kind of constipation and actinomycoses (Ter Haar 1915:9).

FOOD PRESERVATION

Abiotic and Biotic Factors

Knowledge of food preservation is absolutely vital if people want to adapt to a sedentary way of life. The basic principles of preservation techniques were probably evolved by hunter/gatherers but became more advanced as agriculture developed, and, at a later stage, horticulture. Settled people are for the most part dependent on the bulk supplies that are obtained during relatively short periods of harvesting. The food should then be kept in stock until the next yield can be obtained from the fields.

Basically, food preservation has to deal with two kinds of hazards. One is related to environmental factors that are abiotic in character, and concern damage as a result of food handling and changes caused by chemical processes such as oxidation. The other is related to organisms and manifests itself in predation and decay. Seeds, fruits, and other plant parts capable of producing new offspring, such as bulbs of garlic and onion, form a class of their own as metabolic processes continue, which results in ageing. The storage life of these food products is closely connected with the speed with which these reactions take place.

Both of these hazards can be experienced before and after harvesting. Because food production is concentrated in fields, a considerable loss caused by predating insects, mites, birds, and rodents may, in addition to unfavorable weather conditions, result in crop failures and periods of famine. Also the infection with bacteria or fungi, such as ergot (*Claviceps purpurea*) and smut (*Ustilago* spp.), may cause a serious yield reduction. The only indication from the archaeobotanical record of Berenike of yield reduction previous to harvesting is evidenced by the recovery of rachis fragments of barley infected with the fungus-covered smut (*Ustilago hordei*; Figure 4.40).

Once stored in special storage facilities, food supplies are exposed to further spoilage, and special care is necessary to reduce this to a minimum. Cereals have the advantage over pulses in that they are only threatened by animals that can get access to the storage facility from the outside. During each excavation season, small rodents found their way to the kitchen tent, indicating that they must also have been a problem in Roman Berenike. Only if a storage room is well sealed can it prevent yield loss as a result of these animals. But for pulses, the well-sealed buildings would not have guaranteed their preservation. Unlike cereals, the seeds of pulses may also be infected with eggs of a particular insect. In this way, the development of such a host during storage may cause a considerable loss of seeds.

Food might also spoil by decomposition, a process in which complex compounds are transformed by microorganisms into simple nutrients that become available again for assimilation processes. It is clear that some food products are more perishable than others. This is true for both foods of animal and vegetable origins and is tied up with their biological functions. Milk and meat, for example, easily decompose and need immediate care after milking and slaughtering. Eggs, on the other hand, are well protected by a solid shell, by which they are not only adapted for a considerable breeding period but also for a storage period for at least several weeks without a cooling system. Although Romans were familiar with salting and drying meat, cattle bones found at Berenike suggest that these animals were imported on the hoof from the Nile Valley, and pig bones indicate that they were bred locally (Van Neer and Lentacker 1996:348). With respect to products of plant origin, differences in preservation can be illustrated in vegetables and fruits. Vegetables start withering soon after being harvested due to the loss of water. Fruits are adapted to dispersal, and some of them also survive a certain period of time in the soil and are less perishable in such cases. Galen (*On the Power of Foods*: Book 2) makes the distinction between summer and autumn foods (Grant 2000:110). Summer food, such as cereals, can be stored easily without changing their basic properties. Autumn fruits, such as gourds (*Lagenaria siceraria*), mulberries (*Morus nigra*), melons (*Cucumis melo*), and peaches (*Prunus persica*), rot quickly and can only be stored in a dried state at the expense of their original shape, taste, and flavor.

Decomposition of food not only changes its taste and flavor, which is in most cases undesired, but may also produce harmful waste products of metabolic pathways of microorganisms, which render the food inedible. Preservation techniques aimed at preventing this include three different strategies: inhibition, inactivation, or avoidance of recontamination (Rahman 1999:6–8). These approaches can also be recognized in preservation techniques used in classical antiquity, though it is obvious that at that time people were unaware of the ultimate explanations.

Methods of Food Preservation

The Amount of Water: Preservation methods are affected by the availability of free water (expressed as water activity: A_w), and dissimilation processes including enzyme activity. Preservation techniques can be subdivided in relation to these biological and chemical processes (Table 5.1).

Table 5.1. Food preservation methods in relation with environmental conditions that effect microbic growth.

Environmental Conditions	Food Preservation Methods
Water activity (A_w)	• drying • smoking • pressing
	• salting • sweetening
Gas composition	• sealing
Alcohol	• alcoholic fermentation
Acidity (pH)	• lactic fermentation (pickling)
Temperature	• cooling/freezing • heating

Being an excellent solvent and transport medium, water is one of the major components of organisms and their environment. Arid environments or environments with a high concentration of dissolved molecules are unfavorable for the growth of microorganisms. In both environments, water from the microorganisms moves into the solution. Dehydration of the microorganisms in a strong solution is caused by water movement into the direction of the environment with the highest molecule concentration (the most negative water potential).

Food preservation by affecting the water balance is based on two different principles: extracting water and adding solvents. Water can be extracted by drying, pressing, and smoking. Food can be dried under the sun, in the wind, or with heat from a fire. Sun-dried and wind-dried food will be especially successful in climates with high temperatures and lots of sunny days. In this way subtropical fruits such as dates, figs, and grapes are easily treated for preservation. In central Anatolia, for example, bunches of red grapes are sun-dried on paper sheets in the vineyards, whereas the white grapes are used for winemaking. These sun-dried grapes are for local consumption and still contain their pips, a feature that has become extremely rare in raisins and currants produced for export. Columella (*RR* 12.14.1) describes a special construction of stakes covered with reed on which figs can be dried without being exposed to morning dew and rain that would spoil the figs. Also grain is sun-dried after threshing on pieces of textile or plastic. Large fruits, such as apples, pears, and figs, could be cut in two or three parts before sun-drying (Columella: *RR* 12.14.1; 12.15.5). The pressing of vegetables is mentioned by Columella (*RR* 12.7.3) as an additional method of extracting water. Drying food with smoke not only causes dehydration but also has antibiotic qualities due to the presence of bacteriocidal chemicals in the smoke. The smoking method was especially applied to animal products. The use of smoke in preserving meat is first described by Cato in his section dealing with hams (Dalby 1998:225). The use of smoke from a fire of apple-tree wood for flavoring cheese is described by Columella (*RR* 7.8.7).

Sugar and Salt: Immersing food in water with very high concentrations causes dehydration of microorganisms, which will consequently die. This can be achieved by adding considerable amounts of solvents that influence the osmotic value, such as salt, sugar, and honey. Ignorance in classical times of microorganisms is illustrated by Columella, explaining that adding some salt as a preservative is necessary to prevent spoilage of food by worms and other animals (Columella: *RR* 12.10.3).

Salt was available in reasonable quantities and could be stored in a special saltcellar (*salinum*), although such a cellar has not been recognized in Berenike. Food could either be dry-salted or covered by saltwater, such as brine, which could be made by filling a jar with rainwater or spring water and adding salt to it until a point is reached when the salt does not dissolve anymore (Columella: *RR* 12.6.2). Meat and fish especially were treated that way, although salting was also applied to vegetables such as whole cucumbers and olives. The Romans produced salted fish and meat (*salsamentha*) in special factories. *Garum* or *liquamen*, a fish sauce based on the fermentation of salted fish, was also produced on a large scale. A concentration of small fish remains in an Aswân-produced vessel found at Berenike could be identified as the remains of this fish sauce (Van Neer and Ervynck 1998:380). Although the identification of the fish bones ruled out a Mediterranean origin, and salt crusts were available in large quantities along the shore, the production of this sauce at Berenike proper could not be established with certainty. According to Van Neer en Ervynck, drying fish by wind would have been another possibility of food preservation in the windy and hot environment of Berenike.

Sugar was imported by the Romans from India and traded at the ports along the present-day coast of Somalia. It was distilled from sugarcane and, judging from the expression "cane honey" in the *Periplus Maris Erythraei*, it was probably traded as a kind of cane juice (Casson 1989:133). Sugar was scarce and used only in medical remedies and never for sweetening food or food preservation (Warmington 1995:209). Only from the thirteenth century on did sugar become available on a large scale, but even then it was not used for preserving fruit as is practiced nowadays (Van Winter 1988:59).

Honey was, however, a good alternative during the preceding period. According to Columella (*RR* 12.2.5) all kinds of fruit can be preserved in honey and he even proclaimed this as a general principle. Jars filled with fruit preserved in honey were found in Pompeii (Thorne 1986). Especially in Egypt, apiculture was well developed and ensured a continuous supply of preservatives. Not only was honey used for this purpose, but also a liquor (called *mella*) made with fresh beeswax, which was steeped in water and then boiled. Additionally, food rich in sugar, such as raisins, dates, and figs, could be used as sweeteners.

Air Control: Another way to inactivate microorganisms is to create an anaerobic environment by the exclusion of air or changing the composition of the gas. Most microorganisms living in food require oxygen for their metabolic pathways and will die if it is absent, though some species such as bacteria belonging to the genus *Clostridium* are strict anaerobes and can live without oxygen. Vacuum packaging, pasteurization, and sterilization are effective methods, but have only become available recently. Columella (*RR* 12.4.5) strongly recommends the use of broadly shaped storage vessels that facilitate the pressing of food below the surface of the preserving liquid so that the food will be kept fresh. Cato (*De Re Rustica:* 99) advises to store dried figs in earthenware vessels coated with boiled-down *amurca*, the black by-product of pressing olives. As this waste product was allowed to run off from the press into the fields, it not only colored the soil black but sterilized it also, if sufficient quantities were produced (Dalby 1998:149). This observation would certainly have initiated the use of this liquid in preservation methods.

Amphoras, the most frequently found pottery at Berenike and used for transporting liquids as well as dry commodities, lend themselves to close-fitting covers. Making amphoras airtight prevents the penetration of fresh air and prolongs the storage life of its content. This is certainly true for amphoras that contain alcohol, which will evaporate over time. As long as the alcohol percentage is at least 12 to 14 percent, it can be preserved for a considerable period if the container remains closed after bottling. According to Cato (*De Re Rustica*: 120), grape juice could be kept in an amphora for a year if the cork was sealed with pitch and immersed in cold water for one month. It is questionable to what extent this accuracy was also applied to amphoras containing solid merchandise. If the foodstuffs in these sealed containers had not been preheated, their preservation life would have been limited.

Some of the stoppers that have been found at Berenike were made from the cork layer of the cork oak (*Quercus suber*) and must have originated from the Mediterranean (Vermeeren 1999a: 311–313). Strangely enough, they were not cut in such a way to take advantage of the direction of the lumina. To prevent air from coming into the amphora or moisture leaking out of it, the lumina should be at right angles to the neck of the bottle or amphora. They were oriented in the longitudinal direction of the bottleneck instead. An explanation is that the stoppers were of a reasonable size (up to ca. 8 cm in diameter) making it almost impossible to cut them in the proper way from a cork layer, which is limited in thickness. No other examples of cork stoppers are known from such an early period.

Before filling the vessels, the inside could have been daubed with pitch, as is described by, for example, Columella for the storage of figs (*RR* 12.15.2), pears (*RR*

12.10.4), and vinegar (*RR* 12.17.1). Apicius recommends the same treatment for the storage of pot herbs (chapter 1.25). Like present-day coating of cans with tin, this daubing with pitch prevents the exchange of air and microorganisms, too. But such a treatment could not be performed in a sterile environment, and therefore the storage life of the content remained limited.

Special attention has to be paid to fruits such as pomegranates, grapes, apples, and pears that produce the gas ethylene, a natural end product of respiration. This gas effects fruit maturation, which is disadvantageous if the fruit has to be stored for a good while. Today, special precautionary measures are taken against this undesired maturation by influencing the atmosphere of storage rooms and by not reusing the same packaging material. The storage life of such fruit is benefited by removing specimens that have already started to decay, as is frequently mentioned in classical sources dealing with food preservation (e.g., Columella: *RR* 12.44.4). Of special interest is Columella's statement of "a general rule that above all things apples and grapes should not be laid up in the same place or near one another that the odor of the apples can reach the grapes. For exhalations of this kind quickly spoil the grapes." (Columella: *RR* 12.44.8). In fact, this empirical advice almost expresses present-day knowledge on this particular maturation process.

Alcohol Acid and Spices: Alcohol is a waste product of fermentation processes and is typical of anaerobic yeasts. Food and fruit juices can be preserved by encouraging the growth of such microorganisms because the alcohol can reach a lethal concentration for all kinds of microorganisms. Alcoholic drinks can be used to preserve fruit, although they will lose color unless they are sterilized.

Lactic fermentation is another useful means of food preservation. Incomplete fermentation of sugar results in the production of lactic acid. As a result, the food acidity is lowered. The degree of acidity/alkalinity is expressed as the negative logarithm of the hydrogen ion concentration in moles (pH). Most enzymes are proteins, which are especially sensitive to relatively mild changes in pH. As both molecules are main components of organisms, their inactivity or destruction is vitally important. Enzyme activity increases the rate of all kinds of chemical reactions in a cell; the enzymes are highly specific in the reactions they catalyze. Enzymes are only active in a certain range of acidity with a specific optimum. Outside this temperature range the enzyme takes on a different three-dimensional form and loses its biological activity. A similar damage to enzymes is caused by changes in temperature.

Wine, vinegar, and most fruits have low pH values at which most microorganisms will not grow. The normal storage life of fruits is one to two weeks. Changing the acidity of food can be achieved by adding sour mediums, such as sour milk, wine vinegar, beer vinegar, and even fig vinegar. Vegetables and fruits are the major foods that are preserved in this way.

Lactic acid not only delays the growth of microorganisms, but it also improves the taste of the food. Adding salt is not essential, and aromatic herbs are added to improve the flavor. Columella (*RR* 12.7.1-2) enumerates a number of vegetables that can be preserved in a mixture of vinegar and brine.

The use of spices is also effective in the preservation of food. Billing and Sherman (1998:20), who studied the use of spices in relation to meat-based recipes, could demonstrate that spices inhibit or even kill food-spoiling microorganisms. Spices that proved to be very effective were, among others, garlic (*Allium sativum*), onion (*A. cepa*), cinnamon (*Cinnamomum* spp.), cumin (*Cuminum cyminum*), and lemongrass (*Cymbopogon* spp.). The most effective one was garlic, a plant that is well represented in the Berenike record. Black pepper, on the other hand, was among the least effective bacteriocides: it inhibited only 38 percent of the bacteria studied. The use of spices as preservatives as well as for improving the flavor is mentioned, for example, in the cookery book of Apicius.

Extreme Temperatures: Cooling and heating are methods that block the biological activity of the enzymes by exceeding the temperature range. In temperate regions one could take advantage of the cold winters and food could be preserved in snow. According to Columella (*RR* 12.4.3), vessels containing food should not be exposed to the sun, but stored as cold and dry as possible to prevent food from becoming moldy and decaying. In the distant past, food was stored in icehouses, whereas today refrigerators and deep freezers are used instead. The dolium with peppercorns found in Berenike was, probably for similar reasons, buried in the ground.

Although lowering the temperature of food is a most effective way of slowing down the process of aging without affecting the characteristic features such as taste and color, it is not realistic for most of the year in Berenike. Therefore, other treatments that prolonged the storage life must have been applied to especially perishable fruits. Heating food is only effective in combination with preservation methods that void recontamination. Boiling food for some time will not make it germfree, and as the food cools down, microorganisms will duplicate again as the temperature nears the optimum for microorganisms.

Combining Methods of Food Preservation: Preservation methods often combine several of the previously mentioned principles. A good example is provided by Apicius in describing the preservation of grapes (*Vitis vinifera*) in his cookery book (chapter 1.12):

> "Take perfect grapes from the vines, place them in a vessel and pour rain water over them that has been boiled down to one-third of its volume. The vessel must be pitched and sealed with plaster, and must be kept in a cool place to which the sun has no access. Treated in this manner, the grapes will be fresh whenever you need them. . . . Also, if you cover the grapes with barley [bran] you will find them sound and uninjured."

By selecting only perfect specimens, a quick decomposition resulting from contagious diseases is prevented. Further contamination with microorganisms is prevented by using rainwater that has been boiled for a considerable time and by sealing the storage vessel. A cool place obviously slows down the increase of the microorganisms.

With respect to apples, pears, quinces, plums, cherries, and figs, Apicius states that the fruit should be picked with stems (chapter 1.7). A similar procedure is recommended by Columella for every fruit that has to be stored for a long time (*RR* 12.46.7). He states that grapes may remain green for as much as a year if the pedicels are treated immediately with hot, hard pitch (*RR* 12.44.1–2). In this way there is no opening through which air could penetrate that would initiate the fermentation process. Pliny (*NH* 15.18.65) describes the plucking of apples together with the branches, the ends of which were thrust into elder pitch and then buried. The pedicels of figs, however, were removed, after which they were sun-dried and mixed with condiments and then made into a paste by trampling (Columella *RR* 12.15.3). Ripe apples, pears, quinces, plums, cherries, and figs can be preserved in honey or, as far as quinces are concerned, in a mixture of honey and boiled wine. Whole bunches of grapes were carefully placed in vessels that were compartmentalized with pieces of wood so that the grapes could not touch each other or the vessel itself. Sawdust or chaff was used for covering the bunches of grapes. The large fruits of the pomegranate (*Punica granatum*) and quince (*Cydonia oblonga*) even facilitate the embedding in a thick layer of well-kneaded potter's clay, which can be removed later on by plunging it in water so that the clay dissolves to release the perfectly preserved fruits (Columella: *RR* 12.41.5; 12.43.1).

The drying of grapes is also combined with dipping them into a solution of alkali and olive oil as is, for example, described from Syria (Jabbur 1995). The alkali is extracted from the ashes of saltwort (*Salsola kali* Willd.), a desert plant gathered by uprooting it when it is still green. After burning the saltwort, the ashes are soaked in water and exposed for an extended period to the sun. Then the water is strained and some olive oil is added to it. According to Jabbur, the mixture should contain the right proportions of both ingredients. The use of a preserving mixture for grapes, consisting of a balanced combination of salt, oil, and cinder lye, is also described by Columella (*RR* 12.16.3). The solution serves a dual purpose: it cleans the grapes and by softening and cracking the peel of the grapes, water more easily evaporates so that they dry and turn into raisins.

There does not seem to be a general rule with respect to stoning fruits as part of the preservation procedure. According to Columella (*RR* 12.47.4) it was the practice of many people to cut up quinces and take out the seeds, because it was thought that the seeds were harmful. But very often, whole fruits were dried or pickled. This may be partly due to the difficulty of removing the stones from the flesh.

The Storage Life of Plants

The storage life of products that reached Berenike, either commodities, provisions for ships, or food products meant for their inhabitants, must have being given special attention as most were imported over long distances and were exposed to high temperatures. Markets that could offer perishables such as fruits and vegetables were not present, but some of these products could be grown in kitchen gardens.

At Berenike itself, preservation conditions can be considered modest. The temperatures that allow microorganisms to grow are present during most part of the year. The aridity and the salty air, on the other hand, act as severe limiting factors for microbiological activity. This can be deduced from the present-day conservation conditions of archaeobotanical food remains. Much of the desiccated plant material, also erroneously mentioned as mummified, is still in an excellent condition, including pulses that tend to disappear in moister environments. But the atmospheric humidity, resulting from the presence of the Red Sea, is responsible for the morning dew during the winter and early spring and might have been problematic for optimizing storage facilities. This is especially true for dried food as it easily absorbs moisture.

Cereals, Pulses, Oil Plants, Vegetables, and Spices: The transport of grain to Berenike would not have been problematic. Wheat and barley could have been obtained from the Nile Valley, a short trip as such. Rice and Job's tears were transported over large distances as they were obtained from Indian harbors. Rice is well known for its good preservation conditions. Contrary to wheat, it is not susceptible to insect damage, can be kept for several years, and will even improve in taste (Chaudhuri 1985:29). Storage of grain for a long period certainly requires special conditions, but the turnover at Berenike would have been relatively quick.

Pulses consumed or transshipped in Berenike would have been more problematic. A valuable feature of domestic pulses is that pods do not open quickly, which means that dispersal is prevented. Nevertheless, seed loss is still experienced during harvesting, and this can be limited by harvesting pods when they are still not completely ripe. A consequence of this is that the seeds are not completely dry, a condition not optimal for storage, as is mentioned by Theophrastus (*EIP* 8.11.3). But special treatments of individual fruits or their individual characteristics could perhaps cope with this early harvesting. Cato (*De Re Rustica* 116), for example, describes a method for treating lentils. First, the lentils have to be soaked in silphium vinegar. Next they are exposed to the sun, rubbed with oil, and finally dried. Some members of the pea family, including pea (*Pisum sativum*), contain phytoalexines in their seeds, which have an antimicrobial activity (Smid and Gorris 1999:288). Other members of the pea family, namely, *Abrus*, twisted acacia (*Acacia tortilis*), Nile acacia (*A. nilotica*), carob (*Ceratonia siliqua*), tamarind (*Tamarindus indica*), and senna (Senna alexandrina/holosericea), have hard seeds or well-dried fruits that may only suffer from insect damage.

For storing oil containing seeds, such as flax (*Linum usitatissimum*) and safflower (*Carthamus tinctorius*), it is important that the seeds remain intact during harvesting. Otherwise the oil will be liberated, causing rancidity in storage (Nash 1985:55).

Vegetables grown for their leaves are vulnerable in an arid climate. Garlic, which was available on a regular scale, could easily be transported in a dried condition. Eventually, brine and vinegar could be added to the sun-dried garlic, as is mentioned by Columella (*RR* 12.10.2).

Spices and condiments can be kept as long as they contain flavorings. These flavorings not only improve the taste of the food, but also protect the food against vermin. Black pepper (*Piper nigrum*) is the most important one found in Berenike. Black peppers are either sun-dried or dried in special smoke rooms. Black pepper is very vulnerable to damage from mold and should be dried quickly and thoroughly. If peppercorns are stored in a dry environment, they may be kept for many years without losing their quality. Maybe it is for that reason that traders of Berenike chose to leave behind a large supply of black pepper safely stored in a buried dolium on the assumption that they would return within a few years.

Fruits and Nuts: The group of fruits and nuts is well represented in the archaeobotanical record of Berenike, both qualitatively and quantitatively. The classification of raw food is mostly based on its use in food preparation, but its categorization is not unequivocal, as can be seen for food products classified as fruits and nuts. Some fruits, such as okra (*Abelmoschus esculentus* [L.] Moench) and tomatoes (*Lycopersicon lycopersicum* L.) are even classified as vegetables. The matter is even more confused by the inclusion of seeds such as stone pine (*Pinus pinea* L.), pigeon pea (*Cajanus cajan*), and chickpea (*Cicer arietinum*) within the group classified as nuts (Menninger 1977). From a biological point of view, nuts are a special group of fruits. A classification of fruits, nuts, and a single seed based on their anatomy and moisture content makes more sense with respect to their storage life and will serve here as a guideline.

A group that is easily preserved concerns nutlike seeds and nuts: stone pine (*Pinus pinea*), hazel (*Corylus avellana*), and sacred lotus (*Nelumbo nucifera*). The first two were imported from the Mediterranean and the last one from the Nile Valley. Long-distance transport of these food products would not have been problematic as they can be stored for considerably long periods without spoilage. It is striking that very often seed coats of stone pine were found together with cone scales, implying that they were transported as whole cones on a regular basis. A reason for this might be that in this way all seeds could be transported, whereas after threshing some seeds would become damaged and unsuitable for transportation. It should be realized that import and consumption of seed contents only cannot be ruled out, but their possible share cannot be established as no traces are left.

The baobab (*Adansonia digitata*) and the bentree (*Moringa peregrina*) have dry fruits that contain many seeds. Trading whole fruits of the baobab makes sense as both seeds and pulp are edible, and the indehiscent fruit does not easily shed its seeds. The fruit of the bentree is a three-valved capsule that bursts open when ripe. To prevent seed loss, it is believed that fruits were threshed to release the seeds. This kind of processing is still practiced by the Ma'aza bedouins living in the northern part of the Eastern Desert (Hobbs 1990:40). No information on storage life is available, but it is assumed that both fruits can be stored for considerable periods.

Most fruits found at Berenike are classified as drupes. This fruit type is characterized by one or more seeds enclosed by a fruit wall that consists of three different layers. A dichotomy between dry and fleshy drupes is based on the moisture content of the middle layer of the fruit: the mesocarp. The coconut (*Cocos nucifera*), the almond (*Amygdalus communis*), the walnut (*Juglans regia*), and the fruit of the balsam tree (*Commiphora gileadensis*) are classified as dry fruits. Only the first three are edible, and it is the seed that is consumed. All three species are evidenced by their hard endocarps, indicating that these fruits were, at least partly, traded destoned. The presence of the hard endocarp is advantageous as it protects the seeds against decay and insects. The fibrous mesocarp of the coconut is highly valued as crude material for mats and ropes and explains the import of whole fruits to Berenike. The coconut was traded over long distances as whole fruits and maybe also as dried copra, although the presence of the latter could not be demonstrated. With or without the fibrous husks, coconuts can be kept until the liquid endosperm has completely transformed into solid "meat," as is mentioned for example by Cosmas. For long-distance transport, fruits must therefore have been harvested in an unripe condition. The drying process of coconuts depends on the temperature to which they are exposed, but will take at least several months. Although coconuts should be harvested at intervals of two months from a particular tree, in practice a yield of coconuts can be obtained from a coconut plantation every month. The logistics of transporting coconuts from India to Rome were, therefore, not problematic with respect to the short, fixed period during which Roman ships visited the Indian ports (September until December/January) but may have been critical with respect to the duration of the voyages from Muziris to Rome, which would have taken some three months without any unforeseen delays.

The fruits of the sugar date (*Balanites aegyptiaca*) and doam palm (*Hyphaene thebaica*) are semisoft and take up a middle position in terms of preservation. The mesocarp of both species is sugary and edible. The archaeobotanical remains of both species indicate that they were transported as whole fruits. Although the seeds of both species also have an economic value, there is clear evidence for the latter species only that the seeds were extracted from the fruits. Both species are adapted to desert conditions and could be obtained from reasonable short distances. Hence their preservation might not have been problematic. It should be noticed, however, that fruits of the sugar date were partly infected by an insect that feeds on the seeds. Such infected fruits are still among the fruits offered for sale at markets today, which implies that the consumer does not discriminate in this case.

Fruits having a soft mesocarp make up the largest part of those categorized as a drupe. The only fruit that could have been gathered from short distances, even from locally cultivated specimens, is *nabq* (*Ziziphus spina-christi*). Three other species originate from the Gebel Elba area or beyond: *Cordia nevillii/sinensis*, *Grewia*, and *Cocculus pendulus*. All others must have been brought from more-remote areas. Transported from the Mediterranean were the cherry plum (*Prunus cerasifera*), the domestic or bullace plum (*Prunus domestica*), the olive (*Olea europaea*), the apricot (*Armeniaca vulgaris*), the peach (*Prunus persica*), and the Egyptian plum (*Cordia myxa*). The last four species might also have been obtained from orchards in Egypt, for example in the Fayum. Finally, the soft fruits of the emblic (*Phyllanthus emblica*) had their origin in India. Although the high vitamin C content of emblic fruits has an antiscorbutic property and may have been transported in syrup, it is more likely that the dried fruits were traded.

Very perishable fruits are the apricot and the peach, ones that are only sweet and juicy if harvested in a ripe condition. Galen (*On the Powers of Foods*: Book 2) states that the juice and flesh of apricots rot easily and that these fruits are bad in general (Grant 2000:124–125). He even advises against the consumption of these perishable fruits after other foods, as they will initiate rotting. A similar warning is given by Pliny (*NH* 15.11.40), cited earlier. From his remark it can be concluded that fresh, sweet peaches were offered for sale, and people must have appreciated their sweet taste. The only way to transport such a fruit in an unspoiled condition is to add preservatives. A recipe for keeping hard-skinned peaches is described by Apicius (chapter 1.28):

> "Select the best and put them in brine. The next day remove them and rinsing them carefully set them in place in a vessel, sprinkle with salt and satury and immerse in vinegar" [Vehling 1977:54].

Today, pickled peaches still consist of whole fruits that are peeled but not destoned. When apricots and peaches are dried, the stones can be removed. Dried apricots that are sold in Egypt today are available with or without stones. Those containing the stone are strongly dehydrated and have lost their characteristic color and are cheaper as a result. This kind of preservation also occurs quite easily under natural conditions after windfalls. Many well-preserved fruits can be collected under trees without any extra effort. The presence of a stone (endocarp) fragment in Berenike from a peach could be indicative of pickled fruit which must have been a rare item judging by the single fragment found so far. Considering the same fragment as a contamination in a load of dried peaches, it would leave open the possibility that they were available on a more regular scale. The apricots could originate from either pickled or dried specimens. The few remains indicate that the fruit probably was not commonly available.

Plum stones, especially those of the cherry plum, are better represented in the archaeobotanical record of Berenike than peach and apricot and indicate that plums most probably were traded with their stones. Whole plums are easily dried but were also preserved in honey, as is mentioned by Apicius (chapter 1.22). The storage life of dried plums depends on the moisture content. Well-dried plums, having lost two-thirds of their weight, can be stored for about three years.

Members of *Cordia* would have been preserved in a similar way. Some whole specimens were found, in addition to calyxes and huge numbers of stones, and support the assumption that they were transported as dried fruits. Dried fruits were among the products offered for sale in Iran (Ahmed et al. 1979:34), but are probably no longer part of the assortment in Egyptian bazaars. According to Theophrastus (*EIP* 4.2.10), the inhabitants of Thebes made dried destoned fruits of the Egyptian plum into cakes.

Fruits of the emblic can be preserved by drying or by pickling in a sugary syrup. Pickled fruits concern whole specimens, whereas recent samples of dried fruits that have been analyzed consist for the most part of fragments of the mesocarp. Segments of the stony endocarp were only present as a contamination. Thus, the few inedible stone fragments found in Berenike indicate a substantial import of the emblic if we assume that they were traded in a dried condition.

Berries are fleshy, mostly indehiscent fruits and are represented by the date (*Phoenix dactylifera*; Figure 4.50), the pomegranate (*Punica granatum*; Figure 4.65), the grape (*Vitis vinifera*; Figure 4.73), the persea (*Mimusops laurifolia*; Figure 4.46), the caper bush (*Capparis spinosa*; Figures 4.20 and 4.21) and members of the Cucurbitaceae. The date contains a single seed; with all other berries the seed count ranges from a few to many. The date and grape have a long tradition in preservation by drying. The less-juicy varieties of the date are easily sun-dried and have a suitable sugar-to-water proportion of two to one. When they are kept for a long period, they become candied and lose some quality. Dry varieties are known from the Sudan and are easily transported and stored. Mostly, dried dates still have their seed inside, which explains the large quantities of seeds in the trash dumps of Berenike. Seeds may also be present in a paste made from compressed, soft dates, which is called *agwah* (Bircher 1995:106).

The storage life of fresh grapes is limited, but raisins and currants, being a Greek variety from Corinth, can easily be transported and stored. Whole fresh bunches stored in clay jars with chaff were also transported in classical times and they could keep for a long time. However, both jars and such fruits were vulnerable, which is why we may consider the grape more of a luxury item.

Due to their sturdy leathery skin, pomegranates can be stored for several weeks despite their juicy content. It is important that carefully picked, unbruised fruits are selected for long-distance transport. Special treatments, such as dipping the fruit in tar or seawater before drying, will benefit the longevity of the fruit (Columella: *RR* 12.46.5; Leisten 1993:68). Saltwater also prevents discoloration of the fruit. Fruits that are kept too long will become completely dehydrated and inedible. Transport of pomegranates by caravan trade was possible over quite long distances, as is demonstrated by the trade between Kabul and Peshawar in Afghanistan, a distance of about 250 km (Frederiksen 1996:139).

No particular information is available on the preservation of the persea fruits. Judging by their less-juicy consistency and their availability within relatively short distances, it is assumed that preserving the persea would not have caused many problems. Galen (*On the Powers of Foods*: Book 2) mentions that fruits were transported from Persia to Egypt, and were ripe and became edible when they reached the land of destination (Grant 2000:135).

Although it is the unripe flower buds of caper bush that enter the commercial trade today, ripe fruits are also edible. Gathering ripe fruits should be done before they burst open. Once the pulp is exposed, the fruits are eaten by animals, most probably by birds that are attracted to the red-colored pulp. Caper fruits are juicy and easily rot when they are ripe. Galen (*On the Powers of Foods*: Book 2) mentions that fruits subjected to transport are sprinkled with salt as a means of preservation (Grant 2000:134). When used as food, the salt is removed by washing or soaking in water. The recovery of fruit fragments just outside some buildings in Berenike suggests local growth of the plant, which would have eliminated the need for preservation.

Members of the white bryony family are very juicy in a fresh condition and cannot be dried successfully. Four species are evidenced in Berenike by their seeds: the colocynth (*Citrullus colocynthis*), the watermelon (*C. lanatus*), the cucumber (*Cucumis sativus*), and the bottle gourd (*Lagenaria siceraria*). The colocynth grows in the Eastern Desert, where it is easily gathered and remains fresh for at least a couple of weeks. Ripe water melons can only be stored for five up to eight days and must have been available from local kitchen gardens or harvested in an unripe condition if they were imported. The ripening process continues after harvesting if the fruits are exposed to warm air, preferably between 20 to 25°C. Methods of preserving gourds until the next yield are available, is described by Pliny (*NH* 19.24.74). One way is to add brine and another is to store them in a trench floored with sand and covered with dry hay and earth. In this way, gourds will remain in a green condition.

The fruits of the subfamily Maloideae (Rosaceae) are classified as pomes. The seeds are enclosed in a cartilaginous structure in the center of the soft, indehiscent fruit. Apples (*Malus domestica*) can be preserved in several ways: fresh, dried, or kept in a preservative liquid, such as honey, as described by Apicius (chapter 1.22), or in a mixture of vinegar and brine as mentioned by Columella (*RR* 12.10.2). Fresh, juicy apples might have been the most desirable ones. Dealing with the preservation of fresh fruits, Varro, cited by Pliny (*NH* 15.17.60), says that fruits such as apples should be separately wrapped in fig leaves. According to Galen (*On the Powers of Foods: Book* 2), properly ripened apples can be stored for the winter and the following spring (Grant 2000:126). Windfall specimens were not used for storage. The storage life of fresh apples is prolonged if stored in a cool environment. Although this condition is not met while on the way to Berenike, the transport of fresh apples to this remote destination would not have been problematic from September to October, just after harvesting. Today, dried apples produced on a commercial scale are peeled, cored, and sometimes cut into rings. But small apples can be dried as whole specimens or simply cut into segments, as described by Columella (*RR* 12.12.2). In the latter case, fruits evaporate quicker and spoilage is reduced. Such halved apples, preserved by charring, are frequently found in archaeological contexts. The presence of pips in Berenike leaves open all aforementioned kinds of preservation methods.

The last group of fruits and nuts to be dealt with concerns false fruits. They are represented by the juniper (*Juniperus*) and the fig (*Ficus carica*). The berry-like fruit of the juniper is easily dried and can be kept for a considerable period. Fresh accessory fruits of the fig are juicier but can also be dried easily. Due to the high sugar content, they can be kept until the next harvest. Long-distance transport is no problem, as is evidenced by the recovery of figs throughout the Roman Empire. Fresh figs can only be kept for a couple of days, as they are vulnerable to mold, which results in lactic fermentation. It is possible to preserve fresh figs in honey, as is mentioned by Apicius (chapter 1.22). Fig paste, made from trampled figs mixed with sesame (*Sesamum indicum*), anise (*Pimpinella anisum*), fennel (*Foeniculum vulgare*), and cumin (*Cuminum cyminum*), was made into balls and kept in jars covered with pitch or was heated in vessels in order to reduce the moisture content (Columella: *RR* 12.15.4).

CHAPTER 6

Interpretative Summary and Conclusion

"Am nächsten Morgen stiefs ein auf einer Eierreise begriffener Ababde halb verhungert zu uns und erbot sich, mich zu den Ueberbleibseln der alten Stadt zu geleiten. (...) Nicht die vorhandenen Fundamente der Häuser, denn diese bedecken etwa nur den vierten Theil des heutigen Kossêr, wohl aber die Unzahl von Thonscherben, verschiedenfarbigen Glasstücke, zum Theil kunstvoll geschliffener, kupferner Zierrathen, Münzen, Glasperlen, Agatstücken etc., die den Vielfach durchwühlten Boden bedecken, geben uns Zeugniss davon, dass wir uns an der Stelle befinden, wo vor Zeiten eine nicht unbedeutende Stadt gestanden hat." [G. Schweinfurth 1865a: 381]

Methodological Considerations

The archaeobotanical record of Berenike and Shenshef, based on samples from seven excavation seasons, comprises 68 cultivated plants that could be identified in most cases to the level of species. As much as 28 cultivated plant species are evidenced from Berenike but are absent from the archaeobotanical record from Shenshef. Juniper (*Juniperus*) is, on the other hand, a plant species that has been found only in Shenshef. Most certainly, the discrepancy between these records is partly affected by the unbalanced excavations at both sites. The wild plants are represented by some 110 wild plant taxa and could only partly be identified to the level of species.

Some of the botanical remains are still unidentified, and it is assumed that they concern both cultivated and wild plant species. A part of these still-unidentified remains have clear diagnostic features and may even concern whole seeds or fruits. Their identification is hampered by the incompleteness of the reference collection. The cultivated plants were obtained from an extended geographical area, and for this reason a large number of economic plants from remote areas have to be taken into consideration. As far as the reference collection of the wild plants is concerned, the incompleteness is caused by the difficulties met in collecting the seeds and fruits of desert plants, their presence largely dependent on the fluctuations in the humidity.

The first step to a successful identification of the unidentified cultivated plants would be the compilation of lists of potential plant species that were traded from specific areas. Such a valuable checklist was presented by Warmington (1995:220–221), who selected medicinal plant products traded by the Arabs on the assumption that they were perhaps also known to the earlier Romans. Although the number of species is limited, this list includes the coconut (*Cocos nucifera*), the emblic (*Phyllanthus emblica*), and the tamarind (*Tamarindus indica*), three species evidenced at Berenike by the current archaeobotanical research as real trade products. Although these three species were already present among the botanical remains unearthed in Berenike during the first excavation seasons, the identification of emblic was only successful several years later, when a sample of this food plant containing some of the characteristic endocarp fragments was obtained from a spice shop in Cairo. Consultation of Warmington's list at an earlier stage would have been of great help. Recently, a more extensive list of plant species that might have been traded from tropical Asia and China has been compiled

Figure 6.1. Goat visiting an organic dump near a wayside restaurant between Ras Banas and Marsa Alam (March 1998). See Color Plates section, page 229.

(Cappers 2003:202–204). The matter is urgent as spice shops in the Near Eastern bazaars are becoming increasingly threatened. Their broad and exotic selection is being replaced more and more by a limited and more standardized supply as a result of globalization. But it is still possible to get a glimpse of the range of goods offered for sale during the past and to collect relevant reference material.

From the uneven distribution of many plants over the trenches as well as the still-untouched large habitation and industrial areas of both settlements, we can expect more plant species to be unearthed in future excavations, which in turn may shed new light on the subsistence and trade economy. This is not to say that a more elaborate sampling will ultimately result in a representative picture of subsistence and trade. Despite the excellent preservation conditions, archaeobotanical research is faced with the transfer and consumption of plants that have left no visible marks and of which all traces are vanished. Wastage of expensive commodities would have been the exception rather than the rule. Food may also have been prepared in such a way that allowed for no inedible leftovers. Other food is completely digested, and therefore no identifiable remains would have been excreted in the feces.

Despite their botanical richness, a similar warning is called in for the analysis of dump areas. Most of the botanical remains that have been investigated originate from organic dumps, which appeared to be predominantly middens and flat dump areas in the proximity of stone buildings. It should be realized that in the course of time even such concentrated and well-preserved archives become only a faint reflection of the organic waste once deposited. Several processes are responsible for the reduction of this organic archive.

Although it is conceivable that at least part of the habitation area was inaccessible to straying animals, as was the case, for example, with locally constructed garden plots, it seems most likely that organic dumps in particular were frequently visited by browsing animals, as is evidenced by the many dung pellets especially of sheep and goats and, to a lesser extent, from camels. Archaeozoological research (Van Neer and Ervynck 1998:365–368, 1999a: 330–332; 199b: 433–436) and recent observations of trash deposits have attested to the presence of the following animals: cattle, pigs, chickens, sheep, goats, donkeys, black rats, dogs, Egyptian vultures, and brown-necked ravens (Figure 6.1). On a smaller scale, small creatures, such as beetles and larvae, also eat organic material. This kind of reduction may even last for thousands of years, as could be observed when special attention was paid to this process while analyzing a Roman trash deposit in Karanis (Kôm Aushim). It was found that such small animals are present at least in the upper 10 cm of the trash.

The reduction of the archaeobotanical archive may also be the result of burning the trash. During the excavations campaigns, such burning is still frequently practiced to get rid of the stench and to control as far as possible the number of flies, rats, and other such vermin, which in turn attract predators such as snakes. For safety reasons, such burning would mainly have taken place outside the settlement. This explains why most of the plant remains from the trash dumps inside the settlement have been preserved by desiccation, those used for offering ceremonies being an exception.

The wind would also have been a factor in the reduction of the trash deposits. When trash dries out during high temperatures, it may be easily blown away. Only those remains that were sufficiently covered would have been protected from further losses due to wind

Figure 6.2. Trash deposit rich in organic debris exposed in trench BE96-13 (January 1996). See Color Plates section, page 229.

and other factors, and these deposits constitute the actual archive that has been sampled (Figure 6.2).

Some prudence is called for when numbers of plant remains are compared. A quantitative approach is not only obscured by the different plant parts we are dealing with, which is even true for seeds and fruits, but also because numbers of seeds and fruits differ highly among plants. Additionally, taphonomic processes bias the number of subfossil remains. Some fruits may serve as examples. It appeared that the endocarp fragments of the almond (*Amygdalus communis*) easily fall apart in an arid environment. This is caused by the relatively thick veins that are present in the middle of the inner fruit layer. The fragile fragments that are created in this way will only be partly retrieved by sieving soil samples (Figure 4.54). Differences in the fruit anatomy also cause a discrepancy in counts. Each consumed date (*Phoenix dactylifera*) and olive (*Olea europaea*), for example, will produce only a single leftover, either a seed (from the date) or a fruit stone (from the olive). Other (accessory) fruits contain many seeds, such as a pomegranate (*Punica granatum*) with has some 250 to 400 seeds (Kučan 1995a: 20) and the fig (*Ficus carica*), whose number of "seeds" ranges from about 700 to 1,800 (Condit 1947:40). A simple conversion of the number of subfossil seeds that have been found to the original number of fruits that were consumed is therefore impossible. The comparison of the retrieved plant remains is further complicated by differences in the consumption of fruits. Seeds of the date and fruit stones of the olive are not consumed and have a good chance of ending up in the trash deposits. On the other hand, the small seeds of the pomegranate and the fig (officially fruits) are consumed and excreted and are therefore less likely to be found in trash layers.

The consumption of whole, destoned fruits at the sites proper would have been the main source of recovered fruit-stone fragments. The concentration of these remains in middens or dump areas will partly depend on the way the fruits are eaten. Eating olives with an Egyptian colleague in a courtyard, I observed that I just threw the fruit stones on the ground, while my colleague collected all the fruit stones carefully but simply discarded the packing material of his cigarettes. From an archaeobotanical point of view, a possible recovery of my discarded fruit stones during a hypothetical excavation is most unlikely, whereas in excavating the trash deposit, one would have a good chance of finding some of my companion's, which most probably will have been deposited there by the kitchen help.

A reliable interpretation of date consumption based on the number of seeds can also be hampered by the possibility of trading crushed dates. Such dates might have been destoned, as could be demonstrated by the Kellis agricultural account book, which mentions a price of 2.5 times that of ordinary dates (Bagnall 1997:42). Crushed dates with their seeds still present were found in the Coptic monastery of Phoebammon (Täckholm 1961:8). Finally, we also have to consider the possibility of the supply of destoned dates and olives. Such fruits will leave no trace and cannot be evidenced by archaeobotanical analysis.

The recovery of secreted plant remains is facilitated by the sampling of concentrations of feces, such as found in cesspits. Judging by the scarcity of water, it is not likely that flushed latrines were present in Berenike and Shenshef. During the excavation seasons, relieving oneself is done either in special tents used as lavatories or behind tamarisk hillocks, both situated at isolated spots to diminish the nuisance of flies. If this was practiced in a similar way in Roman times, it implies that only a fraction of fruits such as pomegranate and fig would be retrieved later on by archaeological research from the dump areas in the city proper.

The Former Natural Vegetation

The original vegetation in the vicinity of Roman Berenike would not have differed much from the present one. Climatic change that resulted in modern aridity came about between the First and Fourth Dynasties, in which the period from 2350 to 500 BC, prior to the Persian and Greek rule, was exceptionally dry (Ayyad and Ghabbour 1986:182). In the Eastern Desert, most of the vegetation would have been confined to the wadi branches and the coastal plain. Wadi branches offered occasional runoff water and had a more permanent supply of underground water, and in the coastal plain the vegetation could benefit from seepage and morning dew. Just like today, the sparse herbaceous vegetation had a limited carrying capacity for wild and domestic animals in most years. This picture is supported by the description of the Eastern Desert by Theophrastus (*EIP* 4.7.1) and Pliny (*NH* 13.49.139), who stated that there were no trees except the acacia, which was even sparsely present due to the lack of water.

Although the analysis of wood samples from Berenike, Shenshef, and Kalalat does not allow a quantitative interpretation of possible shifts in the arboreal part of the local vegetation, some interesting conclusions can be deduced from the composition of the samples. The charcoal analysis from an early Ptolemaic industrial dump area of brick-making debris (trench BE96-11) revealed that the dominant species was mangrove (*Avicennia marina*), in association with a minor proportion of members of the goosefoot family (Chenopodiaceae; Vermeeren 1998:346). It is most likely, that we are dealing here with *Suaeda monoica*, the only woody chenopod of a reasonable size that is still present in small populations on the coastal plain. Its massive exploitation for firewood during the earliest habitation period of Berenike can be explained by the clearance of the local area to facilitate the layout of the area meant for habitation and harbor facilities. This cutting down offered a temporary supply of low-quality firewood, as was evidenced by several fire experiments. This kind of exploitation is supported by the puffing structures in the charcoal of the Goosefoot species, which indicates that fresh, living wood was used (Vermeeren 2000:338). Also in Roman contexts, charcoal and even worked wood and wood chips of *Avicennia marina* are represented in reasonable quantities. A second mangrove species, *Rhizophora mucronata* Lam., is also evidenced by wood remains (Vermeeren 2000:332), confirming that a mixed mangrove vegetation was present, possibly even at a closer distance to Berenike than that of today.

The most dominant tree in Roman contexts that has been used for making charcoal is the acacia. This tree is still highly valued by nomads as its dense wood easily ignites, has a high caloric value, and does not easily fall apart in a charred condition. Judging by the present vegetation, it is most likely that *A. tortilis* was used as a local source of fuel. Additionally, charcoal from other acacia species might have been imported from the relatively densely wooded Gebel Elba.

It remains an open question as to what extent local acacia trees were exploited. If only dead branches were gathered, as is the current practice among the nomads, the exploitation would have had no impact on their proportion in the vegetation. At the same time, such a selective exploitation would not have matched the demand. Harvesting of most of the tree is even possible, as the plant coppices well, so that there is no need for replanting. But if trees are exploited that way, a harvesting schedule based on a 10-year rotation period is necessary (National Academy of Sciences 1979:138). Moreover, a reasonably dense population should have been available to fulfill the demand, a situation that certainly did not exist. Overexploitation of trees would have resulted in their virtual disappearance within a short period of time. In that case, the current trees have to be considered as recolonized specimens, whose spread must have been a gradual process because the mountain ridges are natural barriers for wind dispersal, and the alternative dispersal by camels takes some time. According to Oedekoven (1970:89), many wadis in the Eastern Desert and the Sinai still bear names of trees that once grew there but were intensively cut in the distant past when forests in the Nile Valley were cut in favor of agricultural land. The relict character of the sugar date (*Balanites aegyptiaca*), the twisted acacia (*Acacia tortilis*), and the leafless tamarix (*Tamarix aphylla*) in the Eastern Desert is mentioned by Zahran and Willis (1992:146, 169, 206). The relict nature of these trees is supported by Hobbs (1990:98–99), who refers to bedouins who remember former times in which many more trees were present in particular parts of the desert. Large-scale cutting by local tribes is considered the main reason for overexploitation of densely wooded areas, and prolonged drought periods have a negative impact on the tree cover as well.

It is conceivable that the Greek and Roman inhabitants of Berenike did realize that exploitation of local trees on a large scale would allow them to be self-sufficient for only a short period and that, therefore, local trees should remain undisturbed. The isolated trees could provide animals with their nutritious pods and could also provide shade for shepherds and their flocks during the dry season. Possibly, the supply of firewood, which was probably more in demand than wood used for construction, was organized in a similar way as the supply of food that had to be obtained for the most part from remote distances.

The Cultivated Plants

The Diversity of Cultivated Plants. The cultivated plant species that have been found at Berenike and Shenshef can be categorized according to their possible use: cereals, pulses, vegetables, edible fruits, condiments, oil-yielding plants, and plants used for dyeing and tanning (Table 6.1). This categorization is based on the proxy value of the recovered plant remains Although many species can be used in medical treatments, this category is left aside as no clear evidence is available as yet for such use. This is not to say, of course, that as the occasion arose, particular plants might have been used in such a way.

Five different cereals have been found at Berenike and Shenshef: hulled six-row barley (*Hordeum vulgare* ssp. *vulgare*), hard wheat (*Triticum turgidum* ssp. *durum*), sorghum (*Sorghum bicolor*), Johnson grass (*Sorghum halepense*), and rice (*Oryza sativa*). Barley, hard wheat, and sorghum can be considered as staple foods. Despite the relatively low numbers of Johnson grass that were recovered from both sites, the correlation between this potential weed and sorghum is weak, so that it is justifiable (for the time being) to consider it as an independent crop. Also the number of rice kernels and rice chaff is limited, but their presence in both early and late habitation layers indicate that this exotic cereal must have been of special importance. The supply of rice might partly have been intended for an Indian community that possibly dwelled at Berenike in the early Roman period, as suggested by substantial quantities of unearthed Indian-made fine wares and a Tamil-Brahmi graffiti (Sidebotham and Wendrich 1998:89). Papyrological evidence, on the other hand indicates that, at least in the early Roman period, rice was also available in the Fayum. Transport of rice from Berenike further northward to Rome seems, therefore, most likely.

Both barley and wheat are represented by grains and threshing remains. The threshing remains consist of chaff (rachis fragments, lemmas, and paleas) and sometimes also fragments of the culm. A quantitative comparison between barley and wheat can be done with respect to both the grains and the rachis nodes. The lemma and palea of both cereals are heavily fragmented in most samples, making it almost impossible to use these fragments for a quantitative comparison of barley and wheat.

As for rachis fragments as a basis of comparison, it makes sense to quantify the rachis nodes and not the rachis internodes because the spikelets, in which the grains develop, are attached to the rachis nodes. Therefore, the number of rachis nodes is interchangeable with the number of grains. In comparing six-row barley with hard wheat, each rachis node of barley corresponds with three-grain kernels and each rachis node of hard wheat with an average number of three-grain kernels that develop within a spikelet. As shown in Table 4.1, the numbers of grains and rachis nodes are not consistent. The numbers of grains are relatively low with the exception of barley grains from the early habitation period, which even outnumber the rachis nodes. The rachis nodes seem to present a more reliable picture, all the more so because their numbers are much higher. Based on these rachis nodes, the general picture for Berenike is that the proportion of barley to wheat is 0.6 to 0.8. In Shenshef, barley predominates and its proportion to wheat is 1.2 to 1.0.

In contrast with barley and wheat, the inflorescence of sorghum is a panicle in which the fertile spikelets are almost sessile. With the exception of a single grain kernel, all the threshing remains of sorghum that were found consisted of lemmas and paleas only. Lemmas and paleas of sorghum are tougher than those of barley and wheat and for this reason are mostly complete specimens. Hence, the quantification of sorghum could be based on the counting of the lemmas and paleas (Table 4.1). Sorghum was only available during the second habitation period. The single chaff fragment recovered from an early context is considered as an intrusion.

Judging by the absolute numbers of barley and wheat, the highest consumption of these cereals can be ascribed to the first and second centuries AD. In the second habitation period, barley and wheat were partly replaced by sorghum. Although there is some overlap with respect to the dating of fourth to early sixth centuries AD, it seems that the consumption of cereals had diminished in the last part of this habitation period,

Table 6.1. Classification of cultivated plants from Berenike (BE) and Shenshef (SS) according to their possible use as indicated by the recovered plant remains. Abbreviations: CE = cereals, PU = pulses, VT = vegetables and tubers, FP = fruit plants, CS = condiments and spices, OF = oil, incense and fiber crops, DT = dye- and tannin-producing plants, MI = miscellaneous.

	Sites		Possible Use							
	BE	SS	CE	PU	VT	FP	CS	OF	DT	MI
Hordeum vulgare ssp. vulgare	•	•	•							
Oryza sativa	•		•							
Sorghum bicolor	•	•	•							
Sorghum halepense	•	•	•							
Triticum turgidum ssp. durum	•	•	•							
Cicer arietinum	•			•						
Lathyrus sativus	•			•						
Lens culinaris	•	•		•						
Lupinus albus	•	•		•						
Pisum abyssinicum	•			•						
Vicia ervilia	•	•		•						
Vicia faba	•	•		•						
Vigna radiata	•			•						
Allium sativum	•				•					
Beta vulgaris	•	•			•					
Liliaceae	•	•			•					
Adansonia digitata	•					•				
Amygdalus communis	•	•				•				
Armeniaca vulgaris	•					•				
Capparis spinosa	•	•				•				
Ceratonia siliqua	•	•				•				?
Citrullus lanatus	•	•				•				
Cocculus pendulus	•	•				•				
Cocos nucifera	•					•				
Cordia myxa	•	•				•				
Cordia nevillii/sinensis	•	•				•				
Corylus avellana	•	•				•				
Cucumis sativus	•					•				
Ficus carica	•	•				•				
Grewia	•	•				•				
Hyphaene thebaica	•	•				•				•
Juglans regia	•	•				•				
Lagenaria siceraria	•					•				
Malus domestica	•					•				
Mimusops laurifolia	•					•				
Nelumbo nucifera	•					•				
Olea europaea	•	•				•				
Phoenix dactylifera	•	•				•				
Phyllanthus emblica	•					•			?	
Pinus pinea	•	•				•				
Prunus cerasifera	•					•				
Prunus domestica	•					•				
Prunus persica	•					•				
Punica granatum	•					•			?	
Tamarindus indica	•					•				
Vitis vinifera	•	•				•				
Ziziphus spina-christi	•	•				•				
Anethum graveolens	•	•					•			
Coriandrum sativum	•	•					•			
Cuminum cyminum	•	•					•			
Foeniculum vulgare	•						•			
Juniperus		•					•			
Piper nigrum	•	•					•			
Trachyspermum ammi	•						•			
Trigonella foenum-graecum	•	•					•			
Sesamum indicum	•						•	?		
Carthamus tinctorius	•	•						•		
Commiphora gileadensis	•	•						•		
Linum usitatissimum	•	•						•		
Moringa peregrina	•	•						•		
Acacia nilotica	•	•							•	
Senna alexandrina/holosericea	•								?	•
Abrus	•									•
Acacia tortilis	•	•								•
Avicennia marina	•									•
Balanites aegyptiaca	•	•						?		•
Citrullus colocynthis	•	•						?		•
Coix lacryma-jobi	•									•

which is especially true for Berenike. Although cereals might have been locally cultivated on a limited scale, in which sorghum in particular might have produced some decent yields in years with sufficient winter rains, the bulk of these staple grains would have been obtained from the productive Nile Valley.

Based on the analysis of the cereals and their accompanying weed flora, it appears that samples from Berenike that resemble those from Shenshef the most originate from trench BE94-1 (loci 7, 21, 25, 36, and 47), trench BE95-10 (loci 2 and 8) and trench BE96-16 (loci 8 and 041). These trenches are located in the dump area in the northwestern part of the site and all samples are dated to the fifth century and early sixth centuries AD, the period that coincides with the occupation of Shenshef.

The group of pulses is represented by the lentil (*Lens culinaris*), the white lupin (*Lupinus albus*), the faba bean (*Vicia faba*), the bitter vetch (*Vicia ervilia*), the mung bean (*Vigna radiata*), the grass pea (*Lathyrus sativus*), the chickpea (*Cicer arietinum*), and the Abyssinian pea (*Pisum abyssinicum*). Only the lentil, the white lupin, the faba bean, and the bitter vetch are recorded from both Berenike and Shenshef, and their number of plant remains indicates that the lentil and the white lupin were the primary staple. So far, the other four pulses are only found at Berenike and include import from abroad. This is true for the mung bean, which originates from India, and the Abyssinian pea, which originates from Ethiopia. Like the cereals, the pulses that were part of the staple foods also would have been brought in from the Nile Valley.

Vegetables are underrepresented at Berenike and Shenshef, as is the case in most archaeobotanical records. This is especially true for green vegetables, which are mostly harvested before seeds are produced, such as lettuce (*Lactuca sativa* L.). Seeds from this species have been found only occasionally and might concern seed stock or, more likely, are produced by bolted lettuce. This makes it difficult to decide to what extent such vegetables were available to the inhabitants of Berenike and Shenshef. The presence of green vegetables in present-day kitchen gardens in the Eastern Desert of Egypt suggests that such vegetables were also grown in Roman times. Only four species from Berenike and Shenshef are characterized as vegetables: beet, garlic (*Allium sativum*), and a still-unknown type (Figure 4.44).

Garlic has only been found at Berenike and it is most likely that it was locally grown. The unidentified bulbous plant does not permit a suggestion on its origin. Considering the beet as a vegetable is still open to debate. Beet is frequently found in both Berenike and Shenshef, and it is possible that we are dealing with a weed plant, which might additionally have been exploited for its edible leaves. Today, beet is a common winter weed plant in Egypt and is found, for example, in cereal fields, faba bean (*Vicia faba*) fields, and Egyptian clover (*Trifolium alexandrinum*) fields (Abd El-Ghani and Amer 1990:17–18; Abd El-Ghani and El-Bakry 1992:1232). The wild beet is a successful invader of fields, which can be explained by its seed dispersal in relation to its growth form. Wild beet plants have a long, erect main stem, which may reach a height of 80 cm, and several decumbent stems. Both types of stems produce many fruit clusters. Those from the decumbent stems fall off as soon as they are ripe and, despite their large size, may easily become buried in the mud cracks that are formed in the soil surface during the weeks prior to the harvest since no irrigation water is brought into the fields anymore. Only the fruit clusters of the erect stems will be harvested together with the cereal crop. It is striking that beet rather than other food items that were delivered to Berenike is among the very few plant commodities that are mentioned in the Berenike ostraka; onions and an unknown medical herb are the other ones (Bagnall et al. 2000:23). All these three plant commodities are only mentioned once on an ostrakon, and it is assumed by Bagnall et al. that the beet was probably pickled and could be used as a food for long sea voyages. If beet was delivered as a pickle indeed, the fruit clusters that were found would certainly have belonged to weedy plants.

A fourth group of plants found at Berenike and Shenshef concerns those with edible fruits. With 28 different species, including both herbs and trees, this is the best-represented group. The plants are diverse with respect to origin, period, and number of fruit remains. Predominant plants are the olive (*Olea europaea*), the date palm (*Phoenix dactylifera*), the Egyptian plum (*Cordia myxa*), the caper bush (*Capparis spinosa*), the *nabq* (*Ziziphus spina-christi*), the grape (*Vitis vinifera*), and the stone pine (*Pinus pinea*). The stone pine is an exclusive Mediterranean plant, whereas the olive, the Egyptian plum, and the grape may have been imported from either the Mediterranean area or the Nile Valley. The date palm, the caper bush, and the nabq are Egyptian species and originate from the Nile Valley or from the Eastern Desert. In the latter case, such plants may have grown even locally, as is suggested for the caper bush and the *nabq*. The number of fruit remains from these indigenous plants is considerable during the second habitation period.

A similar increase in the number of plant remains is shown by the doam palm (*Hyphaene thebaica*), *Cordia nevillii/sinensis*, and *Grewia*. The doam palm fruits would have been collected from trees growing in the Eastern Desert, whereas fruits from the other two plants most probably were obtained from the southerly Gebel Elba area and beyond. Three other species that point to import from the south are the tamarind (*Tamarindus indica*), the baobab (*Adansonia digitata*), and *Cocculus pendulus*. A relatively large number of tamarind seeds have been unearthed from early deposits, and the possibility of Indian import may, therefore, not be excluded. The single seed from the baobab, dated to the fourth and fifth centuries AD, makes one wonder about the extent of its trade. Limited supplies, possibly dictated by opportunistic purchasing, may point to import from north Yemen or the Horn of Africa. More substantial quantities, however, would probably have been imported from east tropical Africa. Fruit remains of *C. pendulus* have been found in small quantities in both early and late deposits from Berenike as well as from Shenshef and indicate trade connections with the Gebel Elba area. Conclusive evidence of Indian import is represented within this category by the coconut (*Cocos nucifera*) and the emblic (*Phyllanthus emblica*). So far, both species are only evidenced from Berenike, with fragments of the coconut frequently found in both early and late deposits, whereas the emblic is only represented by a few remains from an early context. The watermelon (*Citrullus lanatus*), the bottle gourd (*Lagenaria siceraria*), and the cucumber (*Cucumis sativus*) are also arranged under this heading and could have been cultivated in local kitchen gardens.

The group of condiments and spices is represented by nine plant species. Coriander (*Coriandrum sativum*), fennel (*Foeniculum vulgare*), cumin (*Cuminum cyminum*), fenugreek (*Trigonella foenum-graecum*), ajowan (*Trachyspermum ammi*), and dill (*Anethum graveolens*) would have been obtained from the Nile Valley or could have been grown in kitchen gardens. Coriander is conspicuously represented by its large number of fruits and seeds in early and late deposits. Sesame (*Sesamum indicum*) is also found in early and late deposits, though in small numbers, and it was probably obtained from the Nile Valley. Berries of juniper (*Juniperus* sp.) are only represented by small numbers of seeds from fifth and early sixth centuries AD contexts at Shenshef and are considered as an import from the Mediterranean area. The most exotic spice is also the best represented one: huge quantities of peppercorns (*Piper nigrum*), including well over 7.5 k of desiccated black peppercorns inside a large dolium (storage jar) of Indian origin, testify to the importance of the pepper trade during the whole Roman period.

Oil-yielding plants are represented by safflower (*Carthamus tinctorius*), flax (*Linum usitatissimum*), and bentree (*Moringa peregrina*). Plants that yield oil have been valued since ancient times and are used for cooking as well as all kinds of technical uses, including its use in oil lamps and perfumes. The seeds, in particular, contain reasonable amounts of oil. Classifying plants with oily seeds is difficult and very often comes under discussion, as the recovery of such seeds in an archaeological context does not by definition point to their exploitation for oil. Moreover, plants with oily seeds may also have been used in another way, as could have been the case with safflower and flax. These plants are also cultivated for their dye-containing flowers and stem fibers respectively, but their archaeological contexts do not support such uses either. For the moment, it seems most likely that only the seeds of safflower and bentree were used for extracting oil, whereas flax seeds could also have been processed in other ways.

Some other plants that have been found could also have been used for the production of oil, but their exploitation for oil is even less clear. They are the sugar date (*Balanites aegyptiaca*), yielding balanos oil; the olive (*Olea europaea*), yielding olive oil; the colocynth (*Citrullus colocynthis*), yielding colocynth oil; the almond (*Amygdalus communis*), yielding almond oil; and the sesame (*Sesamum indicum*), yielding sesame oil. The incense trade is only evidenced by the presence of fruit remains of the balsam tree (*Commiphora gileadensis*). Resinous substances have been frequently found, and it is very likely that they include real incenses indeed. Unfortunately, it is only by chemical analysis that their true identity can be confirmed. Because the fruits of the balsam tree are a regular occurrence at Berenike and Shenshef, it is assumed that the fragrant fruits were obtained, at least partly, from the nearby Gebel Elba area.

The last well-defined group of cultivated plants concerns plants used for dyeing and tanning. At least one species can be attributed unequivocally to this category: the Nile acacia (*Acacia nilotica*). Other species that might have been used for tanning are the emblic (*Phyllanthus emblica*), the pomegranate (*Punica granatum*), and the Alexandrian senna (*Senna* *alexandrina*). In the case of the pomegranate, the presence of peel fragments and seeds indicate that whole fresh fruits were imported. The use of the pomegranate for tanning purposes is then considered as secondary, but if it was used for tanning leather, indeed, it would have made more sense to import large quantities of the dried fruit rinds. That this group of tannin-producing plants, including an Indian import, might have been used as a source of tannin underlines the importance of leather in the everyday life of these former communities. This is well illustrated by the present-day Ababda nomads, who still use leather in the production of all kinds of objects, although the practice is decreasing. The fruits of the Nile acacia (*Acacia nilotica*) are used for the tanning of leather. The use of fruits as a source of tannin is preferable to other plant parts, such as the bark, which contains a much higher concentration of tannin than the fruits, as this kind of exploitation will not threaten the populations of the Nile acacia. Overexploitation of tannin-producing mangrove vegetation, for example, has been recorded from several parts of the world (Lemmens et al 1992:31).

A miscellaneous group of six cultivated plant species cannot be attributed to only one of the above-mentioned categories and includes four desert plants that might have been exploited for different purposes. Mangrove (*Avicennia marina*) was, most probably, harvested in the near vicinity of Berenike during the first habitation period and used as fodder and for the production of charcoal. The many spines of the twisted acacia (*Acacia tortilis*), in addition to its fruits and seeds, indicate that whole branches of this tree were brought to Berenike and Shenshef. Most probably, they were used for fencing in areas vulnerable to browsers such as gardens, which is still practiced by desert dwellers. The many seeds of the colocynth (*Citrullus colocynthis*) that have been found are difficult to explain just by natural seed dispersal. Unripe fruits might have been gathered as fodder for donkeys, who can tolerate the extreme bitter taste of the fruits. Another possibility is that the seeds of the colocynth were used for oil extraction, to be used for the healing of wounds. Archaeological findings for such a use, for example, in the form of special ovens, have not been evidenced. The many fruits of the sugar date (*Balanites aegyptiaca*) that have been unearthed do not show clear evidence of oil extraction. This implies that they were gathered for the sweet, outer layer of the fruit, but the way this was consumed remains obscure. The large numbers found in deposits that belong to the second habitation period indicate deliberate collecting, and they might have been eaten by humans or animals or used for making alcoholic drinks.

The two other species from the miscellaneous group, *Abrus* and Job's tears (*Coix lacryma-jobi*), concern exotic ones. Both the exact origin and the use of *Abrus* are problematic. Judging by the absence of a red spot, which is characteristic for the Indian rosary pea (*A. precatorius*), it seems most likely that we are dealing with seeds from an African species. The use as a bead seems unlikely, as no piercings are present, leaving open other uses, such as medical applications or its use as a gold weight. Job's tears (*Coix lacryma-jobi*), on the other hand, unequivocally points to an Indian origin, and its piercing shows that it was used as a bead indeed.

Cultivated Plants and Habitation Period

The presence of plant species in relation to the habitation periods of Berenike and Shenshef is presented in Table 6. 2. The plant names are arranged in numerical order, in which the number of plant specimens is transformed into a range from 1 to 8. Basically, only seeds or fruits are quantified for this purpose. Plant remains that have been unearthed at Berenike represent an early habitation period (first to second centuries AD) and a late habitation period (fourth to early sixth centuries AD). The excavations at Shenshef, on the other hand, have only revealed plant remains of the fourth to fifth centuries AD, a period that coincides with the late habitation period of Berenike.

A clear difference in early and late Roman occupation, including the difference between the late Roman occupation of Berenike and Shenshef, is demonstrated by the degree to which indigenous plant species are represented. It is of particular interest that certain Egyptian-Sudanese species are rare or even completely absent in the first to second centuries AD. Sorghum (*Sorghum bicolor*) is conspicuous by its absence as a cereal, whereas fruits from *Cordia nevillii/sinensis*, the sugar date (*Balanites aegyptiaca*), the *nabq* (*Ziziphus spina-christi*), the doam palm (*Hyphaene thebaica*,) the bentree (*Moringa peregrina*), the Nile acacia (*Acacia nilotica*), the balsam tree (*Commiphora gileadensis*), and *Grewia* are dominant in, or even restricted to the fifth and early sixth centuries AD.

One possible explanation for the presence of these species is that the Romans became more engaged in trade with these native people, who had access to local markets and probably also maintained trade relations with northern Sudan. It is also possible that a native desert population lived in Shenshef and, during the

Table 6.2. Presence of fruits, seeds and bulbs from cultivated plants at Berenike (BE) and Shenshef (SS) in relation to the habitation period.

1 = 1 specimen
2 = 2–5 specimens
3 = 6–10 specimens
4 = 11–50 specimens
5 = 51–100 specimens
6 = 101–500 specimens
7 = 501–1000 specimens
8 = 1,001–5,000 specimens
x = not quantified

Plant	Centuries AD			
	BE 1-2	BE 4-5	BE 5	BE and SS 5-6
Liliaceae (bulbil)	x	x	x	x
Allium sativum	x	x		
Avicennia marina	x			
Hordeum vulgare ssp. vulgare	8	6	6	6
Olea europaea	8	5	4	4
Phoenix dactylifera	7	7	6	7
Lens culinaris	7	5	5	6
Cordia myxa	7	4	3	4
Capparis spinosa	6	8	7	6
Ziziphus spina-christi	6	8	6	6
Piper nigrum	6	8	6	4
Triticum turgidum ssp. durum	6	4	6	4
Coriandrum sativum	6	4	4	4
Vitis vinifera	6	4	3	3
Pinus pinea	6	4	2	3
Citrullus colocynthis	5	6	5	7
Citrullus lanatus	5	4	2	4
Carthamus tinctorius	5	2	2	3
Tamarindus indica	5			
Vigna radiata	5			
Sorghum halepense	4	5	4	4
Amygdalus communis	4	5	3	
Lupinus albus	4	4	5	4
Beta vulgaris	4	4	4	2
Corylus avellana	4	4	3	3
Oryza sativa	4	4	2	2
Ficus carica	4	4		4
Abrus	4	4		
Juglans regia	4	3	1	2
Foeniculum vulgare	4	1	1	
Lathyrus sativus	4			
Mimusops laurifolia	4			
Prunus cerasifera	4			
Balanites aegyptiaca	3	7	4	6
Hyphaene thebaica	3	5	2	4
Ceratonia siliqua	3	4	1	2
Pisum abyssinicum	3	4		
Cuminum cyminum	3	3		2
Trigonella foenum-graecum	3	2	1	3
Sesamum indicum	3	2		
Vicia faba	3		1	2
Lagenaria siceraria	3		1	
Phyllanthus emblica	3			
Commiphora gileadensis	2	6	4	6
Cordia nevillii/sinensis	2	5	2	4
Senna alexandrina/holosericea	2	4		1
Acacia tortilis	2	3	3	6
Linum usitatissimum	2	3	1	2
Vicia ervilia	2	2	1	2
Cocculus pendulus	2	2	1	2
Cocos nucifera	2	1	1	1
Punica granatum	2	1		
Malus domestica	2			
Nelumbo nucifera	2			
Prunus domestica	2			
Sorghum bicolor	1	8	6	8
Grewia	1	4	4	4
Cucumis sativus	1	1		
Armeniaca vulgaris	1			1
Trachyspermum ammi	1			
Acacia nilotica		4		
Anethum graveolens		3		
Moringa peregrina		1	2	
Adansonia digitata		1		
Prunus persica		1		
Cicer arietinum		1		
Coix lacryma-jobi		1		
Juniperus				4

latest occupation period, also in Berenike, and that these people introduced their own food preferences. A similar conclusion can be drawn from a shift in the relative importance of animal groups over time and the presence of locally produced pottery in Berenike in the latest phase of its occupation (Van Neer and Lentacker 1996:346–348; Sidebotham and Wendrich 1995:105–106).

Trade with India could be evidenced for both early (first to second centuries AD) and late (fourth to early sixth centuries AD) habitation periods. Only three commodities represent both periods: black pepper (*Piper nigrum*), rice (*Oryza sativa*), and coconut (*Cocos nucifera*). Black pepper clearly predominates, but rice and coconut also give the impression that they were among the regular supplies. The import of the mung bean (*Vigna radiata*) and the emblic (*Phyllanthus emblica*) is almost limited to the early habitation period, whereas the beads from Job's tears (*Coix lacryma-jobi*) were unearthed from both early and late contexts. This might indicate that, though Indian trade was maintained during both periods, it was more diverse during the first habitation period.

Cultivated Plants and Their Source of Supply

Located at the desert edge along the southeastern fringe of the Roman Empire, Berenike was involved in long-distance transport in connection with both international trade and the supply of food. A key question with respect to the interpretation of the archaeobotanical record of Berenike is where all these plant products came from. Determining the area from which a certain plant product was imported may, however, be problematic. Besides the original area of origin, which in most cases can be recognized by the high diversity of wild relatives, a species may also have been introduced in new areas. Although the spread of cultivated plants outside their original distribution area had already started in the early Holocene, it was during the Greek-Roman period especially that the spread of cultivated plants received a new impetus as is, for example, illustrated by the spread of horticulture. In Egypt, the import of exotic plant species, such as the pomegranate (*Punica granatum*), the Egyptian plum (*Cordia myxa*), the carob (*Ceratonia siliqua*), the olive (*Olea europaea*), celery (*Apium graveolens*), black cumin (*Nigella sativa*), and dill (*Anethum graveolens*), is also evidenced from the pharaonic period (Murray 2000:612–614). The success of the introduction of exotic species is determined by their specific environmental requirements. Environmental conditions that may play a role include both biotic factors, such as the presence of a pollinating organism; and abiotic factors, such as the humidity, the salinity, and the nutrient availability and acidity. Taking plants into cultivation under conditions that differ much from their optimum may be possible, but places great demands on the knowledge and skills of the breeder.

In Table 6.3, plant species from Berenike and Shenshef are arranged according to their possible area of origin. This labeling includes the possibility of cultivation of some plants in local kitchen gardens at Berenike and Shenshef, but does not express the possibilities of indirect trade. Almost one-third of the plant species is classified in two columns, which consists mainly of desert plants and potential garden plants.

Import that is unambiguously linked to the Mediterranean area is mainly concerned with edible fruits and is evidenced by the stone pine (*Pinus pinea*), the almond (*Amygdalus communis*), the walnut (*Juglans regia*), the apricot (*Armeniaca vulgaris*), and the juniper (*Juniperus*). The stone pine and the almond in particular are well represented in both the early and late habitation period of Berenike.

The Nile Valley guaranteed the delivery of a variety of cereals and pulses, including staple food crops such as hulled six-row barley (*Hordeum vulgare* ssp. *vulgare*), hard wheat (*Triticum turgidum* ssp. *durum*), lentil (*Lens culinaris*), and white lupin (*Lupinus albus*). Supplementary plant products from this productive area include edible fruits, such as the fig (*Ficus carica*), and oil containing fruits or seeds, such as safflower (*Carthamus tinctorius*), flax (*Linum usitatissimum*), and sesame (*Sesamum indicum*). Sesame may also have been used as a condiment.

It speaks for itself that the inhabitants of Berenike and Shenshef also have exploited desert plants with an economic value. As far as such edible fruit-producing plants are concerned, they are partly of an inferior quality, which might explain the import of more-valued fruits from the Nile Valley and the Mediterranean area. Nevertheless, the considerable number of fruit remains from species indigenous to the Eastern Desert indicates local cultivation, as is suggested for the *nabq* (*Ziziphus spina-christi*), or import from more remote areas, which is probably true for the sugar date (*Balanites aegyptiaca*) and the doam palm (*Hyphaene thebaica*). Also the mangrove (*Avicennia marina*) and the bentree (*Moringa peregrina*) would have been harvested from more-remote populations. The date palm (*Phoenix dactylifera*) is an exceptional case as it produces highly prized fruits. Dates were not only consumed in Egypt

Table 6.3. Classification of cultivated plants from Berenike (BE) and Shenshef (SS) according to their possible area of origin. Abbreviations: ME = Mediterranean area, including Nile Delta, NV = Nile Valley, including oases and Fayum, ED = Eastern Desert, LO = local exploitation and production, GE = Gebel Elba, EA = East Africa south of Egypt, IN = India, including Sri Lanka.

	Sites		Possible Area of Origin						
	BE	SS	ME	NV	ED	LO	GE	EA	IN
Amygdalus communis	•	•	•						
Corylus avellana	•	•	•						
Juglans regia	•	•	•						
Juniperus		•	•						
Pinus pinea	•	•	•						
Prunus cerasifera	•		•						
Prunus domestica	•		•						
Olea europaea	•	•	•	•					
Prunus persica	•		•	•					
Armeniaca vulgaris	•		•	•					
Vitis vinifera	•	•	•	•					
Malus domestica	•		•	•					
Cordia myxa	•	•	•	•					?
Ceratonia siliqua	•	•	?					?	
Carthamus tinctorius	•	•		•					
Cicer arietinum	•			•					
Ficus carica	•	•		•					
Lens culinaris	•	•		•					
Linum usitatissimum	•	•		•					
Lupinus albus	•	•		•					
Punica granatum	•			•					
Sesamum indicum	•			•					
Sorghum halepense	•	•		•					
Triticum turgidum ssp. durum	•	•		•					
Vicia ervilia	•	•		•					
Acacia nilotica	•	•		•	•				
Hyphaene thebaica	•	•		•	•				
Phoenix dactylifera	•	•		•	•				
Anethum graveolens	•	•		•		•			
Citrullus lanatus	•	•		•		•			
Coriandrum sativum	•	•		•		•			
Cucumis sativus	•			•		•			
Cuminum cyminum	•	•		•		•			
Foeniculum vulgare	•			•		•			
Lagenaria siceraria	•			•		•			
Sorghum bicolor	•	•		•		•			
Trachyspermum ammi	•			•		•			
Trigonella foenum-graecum	•	•		•		•			
Vicia faba	•	•		•		•			
Hordeum vulgare ssp. vulgare	•	•		•		?			
Lathyrus sativus	•			•		?			
Mimusops laurifolia	•			•				•	
Nelumbo nucifera	•			•					•
Acacia tortilis	•	•			•				
Avicennia marina	•				•				
Citrullus colocynthis	•	•			•				
Moringa peregrina	•	•			•				
Senna alexandrina/holosericea	•				•				
Ziziphus spina-christi	•	•			•	•			
Balanites aegyptiaca	•	•			•		•		
Allium sativum	•						•		
Beta vulgaris	•	•					•		
Capparis spinosa	•	•					•		
Cocculus pendulus	•	•					•		
Commiphora gileadensis	•	•					•		
Grewia	•	•					•		
Cordia nevillii/sinensis	•	•					•	•	
Pisum abyssinicum	•							•	
Adansonia digitata	•							•	
Tamarindus indica	•							•	?
Abrus	•							?	?
Piper nigrum	•	•							•
Coix lacryma-jobi	•								•
Phyllanthus emblica	•								•
Oryza sativa	•								•
Cocos nucifera	•								•
Vigna radiata	•								•
Liliaceae	•	•	?	?	?	?	?	?	?

but were also exported to the provinces of the Roman Empire where the palm could not thrive. It is plausible that the export of dates was organized on a large scale as they can be easily preserved without losing much of their taste. The residents of Berenike and Shenshef might have exploited palm groves in the Eastern Desert, but most of the dates would have been obtained from the extensive plantations in the Nile Valley.

Several plant products originate from the southern part of the East African coast, stretching from the Gebel Elba area, some 200 km south of Berenike, to present-day Tanzania. Although this area is also characterized by arid and semi-arid environments, its floral aspect differs from that of the Eastern Desert of Egypt. The Sudanese flora has its northern limit in the Gebel Elba area, and it is plausible that part of the plant products that originate from the East African coast were obtained from this area. The rich vegetation of the Gebel Elba most certainly was exploited for products from the balsam tree (*Commiphora gileadensis*), *Cordia nevillii/sinensis*, *Cocculus pendulus*, and *Grewia*. The Gebel Elba mountains are located some 20 km inland, and from here the Red Sea is reachable but the route is difficult, as is indicated by the name of its main wadi, Aizhab, which means "difficult to travel." The same is true for the small harbor Aizhab, which is only accessible for small vessels. Therefore, the easiest way of transporting plant products from the Gebel Elba area would have been by beasts of burden and not by ships.

Fruits of the baobab (*Adansonia digitata*) and possibly also those from the *Abrus* and the tamarind (*Tamarindus indica*) were probably imported from even more southerly harbors along the East African coast, as can be judged from their present distribution. Other plant species that are indicative of import from the south are *Achyranthes aspera*, a weed species; flax (*Linum usitatissimum*), which includes twin-seeds; and the Abyssinian pea (*Pisum abyssinicum*).

So far, six species have been found that originate from India: black pepper (*Piper nigrum*), mung bean (*Vigna radiata*), rice (*Oryza sativa*), coconut (*Cocos nucifera*), emblic (*Phyllanthus emblica*), and Job's tears (*Coix lacryma-jobi*). All these Indian species were found at Berenike, whereas only peppercorns were also unearthed in Shenshef. In addition to these plant species, which were all evidenced by their fruits and/or seeds, two other Indian species were evidenced by wood analyses (Vermeeren 1996:335, 340–342; 1998:343; 1999a: 321–324; 1999b: 428–429). Surprisingly, teak (*Tectona grandis* L.f.) predominates among the desiccated wood remains, and the highly valued wood is even evidenced by charcoal. According to the *Periplus*, teakwood was only transported from Barygaza (northwest India) to Omana (the border region between modern Iran and Pakistan) and Apologos (at the head of the Persian Gulf, north of modern Basra). In Berenike, planks of teakwood are still present as supports in the stony walls of some buildings, in which both the illogical traces of working and pitch layers strongly indicate the recycling of ships' timbers. On the other hand, indirect trade of teakwood may not be excluded, as the *Periplus* clearly mentions teak among the trade items.

Formerly, teak was one of the favorite timbers for dhow building in the many ports along the Indian Ocean, the Persian Gulf, and the Red Sea, including Bahrein, and was imported principally from the Malabar coast in southwest India, the Maldives, Mombasa, Lamu, and the Zufar district (Yajima 1976:31). This is supported by Theophrastus (*EIP* 5.4.7), who states that at the island of Tylos, located in the Persian Gulf and identified as present-day Bahrain (Bunbury 1959:461), a kind of wood was used for shipbuilding that was virtually resistant to decay in seawater, as it lasts for more than 200 years if kept under water.

A second species identified among the wood samples by Vermeeren is bamboo (*Bambusa* sp.). Bamboos are native to the Indian subcontinent, China, Indochina, and Malaysia and are especially widespread in the monsoon region. The woody stems are suitable for all kinds of solid construction. A badly preserved bamboo pole was found in trench BE98-23. Its culm diameter points to a limited number of species, including *B. bambos* (L.) Voss., a species that grows in India, China, and Indochina. It is, therefore, very likely that the specimen found at Berenike originated from India. Whether we are dealing with a rarely imported attribute or with a relict of a regular supply is difficult to determine.

Staple Food and Luxury Food

A well-considered characterization of the complete archaeobotanical record with respect to subsistence and trade items in Berenike is rather problematic. This is partly caused by the fact that all botanical remains, with the exclusion of wood, have been unearthed from refuse layers and secondary fillings in buildings. Although part of the plant remains were found in a storage building, the only real food supply which has been found so far is an Indian dolium filled with 7.5 kg of black pepper. This means that all recovered plant remains from Berenike, imported as trade items, were appropriated for personal use. Discarded or lost specimens became part of the subfossil assemblage, the target population of the current archaeobotanical research.

Unraveling subsistence and trade is also complicated by the difficulties met in determining both the origin and the final destination of some of the plant products. In the nature of things it may be assumed that import items from more-remote areas were meant for long-distance transport, either to Rome or to foreign harbors. The presence of foreign trade delegations in certain harbors might be partly responsible for local consumption of items imported through long-distance trade. This might have been the case with rice transport to Berenike, as it was partly meant for an Indian community that possibly dwelled at Berenike, or with wheat loaded on vessels with Kanê as their destination.

Most of the food for the dwellers of Berenike would have been obtained from the Nile Valley. This relatively short route guaranteed a regular supply, which was of vital importance in such a desolated environment deprived of the necessities of life. An archive of almost 90 ostraka found at Koptos, dating from 18 BC to AD 69, enumerates the food and drink that was delivered to Myos Hormos and Berenike. Wheat is mentioned in 38 instances and barley only in 5. Most quantities were of a modest size and were delivered year-round, indicating that it was meant for the inhabitants of both harbors (Casson 1989:14).

Import commodities, on the other hand, would primarily have been meant for further transport into the interior of the Roman Empire. Nevertheless, the exotic plant products that became available in Berenike when vessels moored in its harbor would have made a welcome change to the ordinary food. Especially those products that were delivered in large quantities, such as black pepper, were allowed to be locally consumed to a certain extent.

It may be assumed that most export items were delivered intentionally to Berenike. Even staple foods, such as cereals or dates, could have been partly delivered for shipment. These articles might have been meant for harbors where trade dealers were active. There might also have been a market for cereals in harbors along the Red Sea coast and the Horn of Africa as wheat and barley cultivation in these areas is only marginal due to the arid climate. Harvest failures were likely to occur and would, therefore, offer a market, though with an opportunistic character. This is explicitly mentioned in the *Periplus* (24) for Muza. The merchandise for which Muza offered a market included limited quantities of wheat because the region produced moderate quantities itself. The *Periplus* (17) even states that considerable quantities of grain were among the principal imports of Rhapta not for trade but as an expenditure for the goodwill of the Barbaroi. Furthermore, staple food could also have been used as a ballast commodity. Less-valued food items, such as sugar dates (*Balanites aegyptiaca*), *nabq* (*Ziziphus spina-christi*), or doam palm fruits (*Hyphaene thebaica*), would probably not have been among the export commodities.

The large-scale transfer of all kinds of commodities at an isolated port on the desert fringe such as Berenike puts a different complexion on the concept of "luxury." Luxury is, in fact, a relative notion and is primarily determined by supply and demand. Usually, exotic products are labeled as luxury items due to the long-distance transport involved, their storage life, the additional expenses incurred, and the irregular supply of such items. But in trade centers such as Berenike, engaged in the transfer of huge quantities of exotic products, these commodities could have been temporarily available in even larger numbers than staple food. In such cases, the status of the luxury food would certainly have depreciated.

Three different kinds of food may serve as an example. Perishable crops from garden plots were available without much difficulty at rural settlements in Italy, but successful yields from local kitchen gardens at Berenike could only have been obtained at the expense of much effort. The cultivation of figs was well developed in Roman Italy, and abundant crops could be obtained. Therefore, figs were not only a delicacy for humans, but could also be used as animal fodder, especially to obtain the so-called "fig-forced" livers from pigs. The consumption of figs improved the taste of the liver, as is mentioned by Galen (*On the Powers of Foods*: Book 3; Grant 2000:162). Columella even states that dried figs were used as supplementary feeding for fish during the winter period when there was an abundant supply (*RR* 8.17.15) and that a mixture of dried figs and raisins were used as additional feeding for bees that suffered from hunger in the wintertime (*RR* 9.14.15-16). The figs transported to Berenike, on the other hand, most probably originated from the Nile Valley and would have been exclusively dished up as a kind of luxury food. An even more exceptional example is provided by black pepper. Although reputed to be a luxury import item from India, it has so far not been evidenced by archaeobotanical research in Rome and seems to have vanished almost without a trace within the Roman Empire. The sparse archaeobotanical record that is available from the imperial metropolis reflects only an average compilation of food products, for the most part obtained from locally grown plants. This sharply contrasts with the thousands of peppercorns found in Berenike, partly in dump deposits and religious contexts, with these showing evidence of spoilage and offerings.

A Comparison with Written Sources

An objective comparison of the archaeobotanical record with the enumerations in written sources is hampered by the various shortcomings of both sources. First of all, written sources often mention plant parts other than seeds and fruits, and it is precisely this category of plant products that is difficult to deal with in archaeobotanical analyses that are mainly focused on morphological and anatomical features. A second problem is that amorphous products, such as liquids, resins, gums, and plant parts traded as powder, are only identifiable with the aid of chemical analysis, and were, therefore, as far as resins and gums are concerned, left for the time being. Other plant parts, such as roots, wood, bark, leaves, and flowers, are basically suitable for an identification on the basis of their morphology and/or anatomy if they are not too fragmented. Furthermore, their identification is not always possible in the absence of diagnostic differences on a species level, which is especially true for vegetative plant parts such as roots, stems (including wood), and leaves, and the incompleteness of reference collections. Another problem is that the description of the trade products in written sources is also selective to some extent. Sometimes only generic terms are used, for example, "other spices and aromatics" (*Periplus*: 10) and "the rest of its exports are through its connections with the other ports of trade" (*Periplus*: 28). It is also possible that items that were traded in small quantities or those with a more opportunistic character were not taken into consideration.

Plant products mentioned in either the *Periplus* or the Alexandrian Tariff that can be evidenced by fruits or seeds, are amomum (*Amomum* sp.), cardamom (*Elettaria cardamomum*), dates (*Phoenix dactylifera*), grapes (*Vitis vinifera*), black pepper (*Piper nigrum*), long pepper (*Piper longum*), rice (*Oryza sativa*), and wheat (*Triticum* sp.). Remarkably, amomum, cardamom, and long pepper (listed in the Alexandrian Tariff) are conspicuously absent in the archaeobotanical record of Berenike. Of these three products, only long pepper is also mentioned in the *Periplus*. White pepper, the ripe fruits of *Piper nigrum*, is also included in the Alexandrian Tariff, but absent in the *Periplus*. White pepper has not been evidenced with certainty as yet among the many peppercorns found at Berenike. A possible explanation for the absence of amomum, cardamom, and long pepper in Berenike could be that products listed in the Alexandrian Tariff (being assessed for tax), were highly valued luxury items and thus meant for transportation beyond Berenike. Judging by the prices mentioned by Pliny, however, only amomum can be considered as a real luxury item; its price—depending on the processing—12 to 15 times that of black pepper (*NH* 12.5.49). Another possibility is that long pepper was only a minor trade item because Roman merchants were primarily interested in Limyrikê on India's southwestern coast, where black pepper was produced and traded. This is in accordance with the opinion of de Romanis (1997:85–86), who states that the gradual shift of the transoceanic voyages toward southwest India was dictated by Rome's interest in the commodities in this part of India. Black pepper was the principle article of commerce on the southeast coast of India, while long pepper was traded in northwest India. The southward shift of the transoceanic voyages took place during the first century AD and coincides with the experiences of the author of the *Periplus*, dated between AD 40 and 70. Mentioning both long and black pepper in the *Periplus* is therefore not surprising. The fact that both kinds of pepper are also included in the much later dated Alexandrian Tariff indicates that long pepper was nevertheless a commodity of interest.

The archaeobotanical record, on the other hand, includes many trade items not mentioned in the historical sources. One explanation could be that some of those plant products were not intended for transfer from harbors along the African, Arabian and Indian coasts to Rome. Plant products that were exclusively meant for the inhabitants of Berenike would consequently be absent in both the Alexandrian Tariff and the *Periplus*, the latter not giving the impression that it included import items meant exclusively for the local economy of Berenike. There is strong evidence that this could be true for at least Indian teak.

Other products, such as the baobab (*Adansonia digitata*), the coconut (*Cocos nucifera*), the emblic (*Phyllanthus emblica*), mung beans (*Vigna radiata*), and Job's tears (*Coix lacryma-jobi*), however, are possible transfer items. As far as Indian products are concerned, their presence in several archaeological sites in India contrasts sharply with their total absence within the

Roman Empire. This can be explained by their luxury status, comparable with that of black pepper and rice, which are scarcely represented in the archaeobotanical records within the Roman Empire. Luxury products were treated with care, and they would have been discarded only in exceptional cases. The coconut is a special case because of its inedible "shell" (the endocarp of the fruit), which increases the chance of finding either worked or unworked fragments. Likely places for finding remains of such commodities are transshipment harbors and markets along trade routes, such as Berenike, Myos Hormos, Edfu, Koptos, Alexandria, Ostia, and Puteoli, and large cities such as Rome. So far, only excavations at Berenike and Myos Hormos (Quseir al-Qadim) have been accompanied by serious archaeobotanical research.

Exotic Plants from Other Egyptian Sites

Import of exotic plant remains from Africa south of the Sahara, the Arabian Peninsula, and Southeast Asia is also evidenced from other Egyptian sites (Germer 1985; de Vartavan and Amorós1997). Plants recorded from Egypt that are indicative of trade along the coasts of East Africa and the Arabian Peninsula, are the olibanum tree (*Boswellia sacra* Birdw.), the African blackwood (*Dalbergia melanoxylon* Guill. & Perr.), and the m'nyemvee (*Mimusops kummel* Bruce ex DC.). Another early introduction into Egypt from the south was the cowpea (*Vigna unguiculata* [L.] Walp.), the only record so far coming from Abusir, where some seeds were found as a contamination in an offering sample of barley in the sun temple of Sahure (Fifth Dynasty; Germer 1985:87–88). It is possible that this species entered Egypt via the Nile route.

Doubtful records of plants imported from either East Africa or the Arabian Peninsula concern *Cocculus hirsutus* (L.) Theob., the cape myrtle (*Myrsine africana* L.), the raffia palm (*Raphia farinifera* [Gaertn.] Hyl.), the shea-butter tree (*Vitellaria paradoxa* Gaertn.), and the African myrrh (*Commiphora myrrha* [Nees] Engl.; Germer 1985; de Vartavan and Amorós 1997).

Exotic imports from Southeast Asia include, apart from the aforementioned bentree (*Moringa oleifera* Lam.) and black pepper (*Piper nigrum* L.), citron (*Citrus medica* L.), Arabian jasmine (*Jasminum sambac* [L.] Ait.), nux-vomica (*Strychnos nux-vomica* L.), Ceylon-olive (*Elaeocarpus serratus* L.), nalta jute (*Corchorus olitorius* L.), and the banana (*Musa x paradisiaca* L.). Of particular interest are records of pigeon-pea (*Cajanus cajan* (L.) Millsp.), identified by Schweinfurth, from the necropolis of Dra Abu el-Naga and dated to the Twelfth Dynasty, and of ebony wood (*Diospyros ebenum* Koenig ex Retz.), which has been recorded from as early as the Fifth Dynasty (Germer 1985:94; de Vartavan and Amorós 1997:106).

A reasonable number of fruits from myrobalan (*Terminalia* sp.) were found in Quseir al-Qadim, though probably only in Islamic deposits (Wetterstrom n.d.). Several *Terminalia* species, such as black myrobalan (*T. chebula*), beleric myrobalan (*T. bellirica* (Gaertn.) Roxb.), Indian almond (*T. catappa* L.), and citrine myrobalan (*T. citrina* [Gaertn.] Roxb. ex Fleming), contain high concentrations of good-quality tannins. The dried fruits contain the highest concentration and are traded as *myrobalans*. These true *myrobalans* must not be confused with the fragrant fruits used for making oils and are also classified as *myrobalans* by classical writers. This name has been formerly used in both generic names (*Myrobalanus* Gaertn. and *Myrobalanifera* Houtt.) and family names (Myrobalan[ac]eae Juss.).

Black myrobalan is native to India, Sri Lanka, and Southeast Asia. In India, it is especially abundant in northern India southward to Deccan (Hooker 1990:446). All parts of the plant contain tannin, with the fruits yielding the highest concentration. The tannin content of dried fruit pulp varies from 20 to 40 percent and depends on the place of origin. The fruits are harvested when they are still unripe and are traded as whole fruits, crushed, or as an extract. Today, most of the black myrobalan originates from India and that from Salem is considered as having the best tanning properties (Fundter et al. 1992:123).

The fruits of several *Terminalia* species are used in dyeing, tanning, and also in medicine. A well-known mixture for dyeing or tanning and also for medical purposes is *triphala*, which consists of black myrobalan, beleric myrobalan (*Terminalia bellirica*), and emblic (*Phyllanthus emblica* L.). When used as a pure sample, the tannin gives a greenish tinge to the leather. In combination with other tannins, the color will become darker. At spice shops of North Africa, Arabia, and the Near East, such as in Morocco, Egypt, Yemen, Syria, and Iran, mature as well as immature fruits of *Terminalia* are still available. Both immature and mature fruits are recommended for the treatment of high blood pressure, whereas immature fruits are also used against pimples and fevers, and mature fruits as a medicine for bile congestion, cholagogue, and stomach ache (Ahmed et al. 1979).

Black myrobalan might have been obtained from either northern India, from where it could have been traded via Barbarikon or Barygaza, or from Sri Lanka. The only other archaeobotanical records of true *myrobalans* concern beleric myrobalan. They are recorded from three different sites in India: Adam (Iron Age, ca. 3000–2500 BP) and Inamgaon and Verrapuram (Chalcolithic, ca. 3500–3000 BP), all three located in Deccan (Kajale 1994:160–167).

Several other Egyptian records of Asian plant species have to be discarded because of their unreliable identification and/or their dating. Records of nutmeg (*Myristica* sp.) are mentioned from an Egyptian mummy of unknown origin and from a pit filled with offerings in Deir el-Bahri. According to Germer (1985:15), both records probably concern fruits from the rare argun palm (*Medemia argun* Württ. ex Wendl.). A chip of sandalwood (*Santalum album* L.) found in the abdomen of an undated mummy is unreliable because its identification is not based on microscopic analysis (Germer 1985:27). Rosary peas (*Abrus precatorius* L.) from the Schweinfurth collection lack the red spot that is characteristic for the Indian species, so it may not be excluded that we are dealing with an East African species, as is also suggested for the completely black seeds found at Berenike. A second sample of rosary peas, stored in the Louvre, is of unknown date and origin. The identification of wood from the mango (*Mangifera indica* L.), used in the boat of Cheops (Fourth Dynasty), is doubted by Germer (1985:111). Fruits of three-leaf soapberry (*Sapindus emarginatus* Vahl.) probably originate from the Islamic period, but Roman import might not be excluded (Germer 1985:114, 1988). The identification of the benzoin tree (*Styrax benzoin* Dryand.) is only based on the recognition of the smell of two burned resin samples from an undated mummy (Germer 1985:146). This destructive analysis does not permit a refutation or a confirmation. Two records are available from medlar (*Mimusops elengi* L.). Their documentation is poor, and it is only known that one of the samples originates from Thebes. According to de Vartavan and Amorós (1997:173), they probably concern persea (*M. laurifolia* [Forssk.] Friis). Schweinfurth identified a piece of palmwood as belonging to *Calamus viminalis* Willd., but its Greek-Roman date is, however, doubted (Germer 1985:236). And an accessory fruit of the sycamore fig (*Ficus sycomorus* L.) was erroneously identified as possibly belonging to the bitter orange (*Citrus aurantium* L.; Germer 1985:105).

A comparison of Berenike with Myos Hormos (Quseir al-Qadim) can be allowed on the basis of archaeobotanical research that has been carried out during the 1980 and 1982 campaign and the recent excavations that started in 1999. The botanical remains encountered in Roman occupation layers of Myos Hormos, dated according to the excavators to the first two centuries AD, produced 24 different cultivated species (Wetterstrom 1982:356–363, n.d.). Unfortunately, this archaeobotanical record is partly biased in favor of large plant products, as fine-sieving was only practiced during one excavation season, and the number of plant remains is relatively small in comparison with those from Islamic deposits, hindering a reliable quantitative approach. Nevertheless, the assemblage bespeaks a variable diet, including cereals, pulses, edible fruits, condiments, and oil-yielding seeds, a subset of the Berenike assemblage. Sorghum was only recovered from the Mamluk period (ca. 1250–1500).

As far as exotic plant products are concerned, only the coconut (*Cocos nucifera*) is mentioned from Roman Myos Hormos. Contrary to the recovery at Berenike, this species has only been evidenced by a single fragment. More fragments of coconut shells as well as peppercorns (*Piper nigrum*) were found in deposits dated to the Mamluk period (Wetterstrom n.d.).

Recently, excavations at Myos Hormos have been continued, but have produced botanical remains mainly from the Mamluk period during the first seasons. Nevertheless, coconut, black pepper, and rice (*Oryza sativa*) could be evidenced from Roman contexts (Van der Veen 2003:209–210, 2004:126–127). Future archaeobotanical research dealing with the Roman period will certainly enlarge our knowledge of subsistence and foreign trade at Berenike and Myos Hormos.

CHAPTER 7

CATALOGUE OF TAXA

In this section, a selection of the subfossil specimens from Berenike and Shenshef is depicted and described. The selection of the specimens is based on their low frequency in archaeobotanical records and on their fragmentation. Incomplete specimens may show almost no resemblance to whole specimens, but in most cases a positive identification is still possible as specific morphological and/or anatomical features are still detectable. In addition to the subfossil remains, a few recent specimens are presented to support the identification of the subfossil ones.

Amaranthaceae

Achyranthes aspera
Dispersal unit consisting of fruit, perianth, and bracts (4.4 x 1.6 mm). Photograph by J. Pauptit (Figure 7.1).

The diaspore of *A. aspera* consists of bracts and a perianth enclosing the fruit that contains a single seed. The bracts are spinescent. The perianth consists of 5 segments and is clearly visible.

Aerva javanica
Woolly bracts and perianth (1.9 x 2.3 mm). Photograph by R. T. J. Cappers (Figure 3.8).

The diaspore of *A. javanica* consists of bracts and a perianth enclosing the fruit that contains a single seed. Both bracts and perianth are covered with long, white hairs that cover the fruit completely.

Figure 7.1. Dispersal unit of *Achyranthes aspera* consisting of fruit, perianth, and bracts (4.4 x 1.6 mm). Photograph by J. Pauptit.

Asclepiadaceae

Seed (3.3 x 5.6 mm). Photograph by R. T. J. Cappers (Figure 7.2).

A flat, obovate, and glabrous seed. A large ventral groove is present, which is widened at the base. Without hairs.

Figure 7.2. Seed of *Asclepiadaceae* (3.3 x 5.6 mm). Photograph by R. T.J. Cappers.

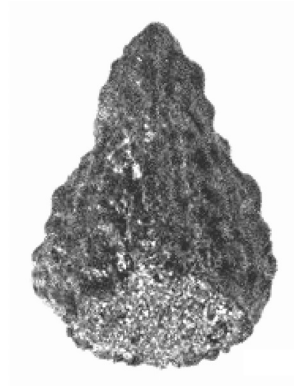


Figure 7.3. Ventral view of fruit of *Arnebia hispidissima* (0.7 x 1.9 mm). Photograph by J. Pauptit.

Balanitaceae

Balanites aegyptiaca

Fruit (endocarp) with an exit hole of an insect (3.2 x 1.2 cm). Photograph by J. Pauptit (Figure 4.19).

Subfossil specimens from Berenike and Shenshef always concerned whole or fragmented endocarps. The development of insects, feeding themselves with the seed, can be detected from the small exit hole that is always positioned at a rather fixed distance from one of the ends. The elongated fruit consists of five carpels. As is the case with the depicted specimen, the number of carpels becomes clearly visible as the fruit bursts open. The edges of each carpel are covered with a thick layer of longitudinally oriented fibers. The size of subfossil endocarps from Berenike are, on average, smaller than recent specimens, the latter ones having been collected under a tree in Wadi Gimal. Subfossil endocarps measure (1.72-) 2.98 (-4.03) x (0.82-) 1.35 (-1.95) mm (N=124, s.d.: 0.44 and 0.19). Recent endocarps measure (2.47-) 3.33 (-3.99) x (0.98-) 1.27 (-1.64) cm (N=255; s.d.: 0.28 and 0.13) (Cappers 1996:327).

Bombacaceae

Adansonia digitata

Seed (10.8 x 8.3 mm). Photograph by R. T. J. Cappers (Figure 4.12).

The seeds of the baobab are kidney-shaped. Most of the hard, black seed coat was missing from the only subfossil seed that was found. Its shape is, therefore, somewhat aberrant.

Boraginaceae

Arnebia hispidissima

Ventral view of fruit (0.7 x 1.9 mm). Photograph by J. Pauptit (Figure 7.3).

Relatively small, pyramidal fruits with a triangular top. Ventrally keeled and granulose to verrucose or smooth. When present, the papillae are especially conspicuous in the upper part of the fruit.

Echium rauwolfii

Fruit in lateral (left) and ventral view (right; 4.1 x 2.3 mm). Photograph by R. T. J. Cappers (Figure 7.4).

Relatively large, pyramidal fruits with triangular to oval top. Ventrally keeled and almost smooth, sometimes pitted, and glossy.

Figure 7.4. Fruit of *Echium rauwolfii* in lateral (left) and ventral view (right; 4.1 x 2.3 mm). Photograph by R. T.J. Cappers.

Burseraceae

Commiphora gileadensis

From left to right: whole fruit (7.9 x 4.2 mm); ventral and dorsal view of fertile part of the endocarp (5.0 x 3.8 mm); ventral view of sterile part of the endocarp (4.3 x 2.8 mm). Photograph by R. T. J. Cappers (Figure 4.35).

The fruit of the balsam tree is ellipsoid and partially four-valved. It differs from *C. quadricincta* by the absence of the longitudinal wings. The calyx is persistent. The endocarp consists of a fertile loculus and a sterile loculus reduced to a flat specimen. The fertile loculus has an oval cross section and has a large ventral groove. The sterile loculus is curved and has only a thin cavity. Whole fruits as well as fertile and sterile loculi were found among the subfossil plant remains.

Capparaceae

Capparis spinosa

Inner part of fruit with pulp and seeds (5.5 x 1.7 cm; Figure 4.20) and seeds (single seed ca. 3.0 x 2.5 mm; Figure 4.21). Photographs by J. Pauptit.

The fruit of the caper bush is obovate to ellipsoid and consists of three to four valves. The seeds are embedded in the red, edible endosperm. When the fruit has ripened, the valves strongly reflex, exposing the inner part of the fruit with the seeds. If not consumed, such fruit contents may drop out and become preserved as a whole. Additionally, many separate seeds were found in Berenike. The seeds are somewhat kidney-shaped and smooth.

Dipterygium glaucum

Outer side (left) and inner side of a fruit with the remains of a seed still visible (right) (2.8 x 3.8 mm). Photograph by J. Pauptit (Figure 7.5).

The elliptic fruit contains a single seed. The fruit is surrounded by a wide, membranous margin. The whole outer surface is coarsely wrinkled. Although fruits are indehiscent, the subfossil specimens were frequently divided into halves. Seed remains were only preserved in whole fruits.

Figure 7.5. Outer side (left) and inner side of a fruit of *Dipterygium glaucum* with the remains of a seed still visible (right) (2.8 x 3.8 mm). Photograph by J. Pauptit.

Chenopodiaceae

Beta vulgaris

Two-germ receptacle cluster of beet (3.6 x 3.2 mm). Photograph by J. Pauptit (Figure 4.1).

The receptacle clusters found in Berenike and Shenshef predominantly concerned two-germ clusters. Such two-germ clusters have the shape of a diabolo. The scar (not visible in the depicted specimen) at the center of the narrowest point shows attachment to the stem. One of the lids has fallen off, displaying the fruit.

Cornulaca monacantha

Stem fragment with three leaves (length: 6.7 mm). Photograph by J. Pauptit (Figure 7.6).

The leaves are sessile, triquetrous, with a broad rounded base. It can be distinguished from the only other Egyptian species (*C. ehrenbergii*) by the nondecurrent leaves.

Figure 7.6. Stem fragment with three leaves of *Cornulaca monacantha* (length: 6.7 mm). Photograph by J. Pauptit.

Compositae (= Asteraceae)

Carthamus tinctorius

Convex view (left) and concave view (right) of fruit with exocarp only partly preserved (5.2 x 7.4 mm). Photograph by J. Pauptit (Figure 4.22).

The fruit is irregular and pear-shaped. The grey-white, rather glossy surface is partly corroded in the subfossil specimens from Berenike and Shenshef. Also the pappus was not present anymore.

Convolvulaceae

Convolvulus arvensis

Ventral (left) and lateral view (right) of seed (2.7 x 4.4 mm). Photograph by R. T. J. Cappers (Figure 7.7).

The ovoid seeds are three-angled. Both lateral sides are flat; the dorsal side is strongly convex. The oval scar is well exposed. The surface is coarsely roughened.

Figure 7.7. Ventral (left) and lateral view (right) of seed of *Convolvulus arvensis* (2.7 x 4.4 mm). Photograph by R. T.J. Cappers.

Cucurbitaceae

Citrullus colocynthis

Outside (left) and inside (right) of seed coat (4.2 x 8.3 mm). Photograph by J. Pauptit (Figure 4.24).

Elliptic, compressed seed. Unripe seeds are cream-colored; the ripe seeds become brownish. The surface is smooth, whereas in subfossil specimens the outer cell layers may have disappeared. Slightly protruding rims are visible on both sides at the top of the seed. The seed size shows little variation, despite the difference in fruit size: (59-) 71 (-79) x (36-) 43 (-46) mm (N=120; s.d.: 4 and 2 mm; Cappers 1996:325).

Citrullus lanatus

Outside (left) and inside of seed coat (whole specimen: 11.7 x 6.7 mm). Photograph by J. Pauptit (Figure 4.25).

The seeds are variable in size, but significantly larger than those of the colocynth. Another distinctive feature is presented by both rims at the top of the seed. These are more protruding and, as a result, the top of the seed is more pronounced.

Unidentified seed

Seed (2.4 x 4.2 mm). Photograph by J. Pauptit (Figure 7.8).

Small, elliptic, and glabrous seed. Both sides are slightly convex. The base of the depicted specimen is slightly damaged; the top is somewhat oblique.

Figure 7.8. Unidentified seed of the *Cucurbitaceae* (2.4 x 4.2 mm). Photograph by J. Pauptit.

Cyperaceae

Cyperus conglomeratus

Spikelet (left; length: 10.0 mm) and fruit (right; 1.7 x 1.5 mm). Photograph by J. Pauptit (Figure 7.9).

The spikelet is broadly lanceolata, flat, and pointed (the top of the depicted specimen is missing). The glumes are acuminate and weakly keeled. The fruit is three-sided, broadly obovate, with a narrowed base.

Ehretiaceae

Cordia myxa

Outside view (left: width: 8.3 mm) and inside view (middle: width: 8.3 mm) of calyx and endocarp (right: 12.7 x 9.2 mm). Photograph by J. Pauptit (Figure 4.36).

Whole fruits are ca. 15 mm in diameter. The very flat endocarp consists of four coarsely ridged sides. Each side has a separate valve. Valves may be missing, exposing the cavities that contain the seeds. The base, as well as the top, is notched. The enlarged and hardened

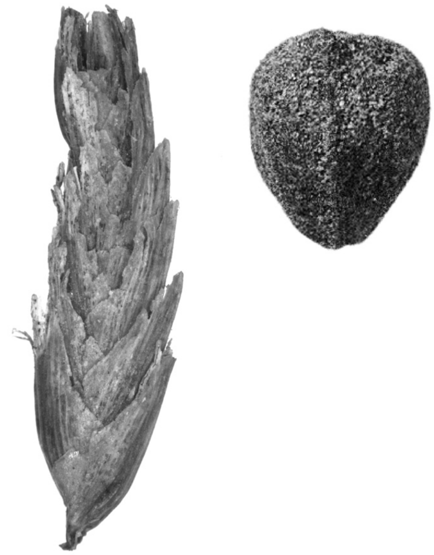


Figure 7.9. Spikelet (left; length: 10.0 mm) and fruit of *Cyperus conglomeratus* (right; 1.7 x 1.5 mm). Photograph by J. Pauptit.

calyx is persistent and is even present with some of the whole fruits that have been found. The calyx is wide, funnel-shaped, and shallowly lobbed; the calyx teeth are very short and irregular.

Cordia nevillii/sinensis

Whole endocarp (left: 9.8 x 5.0 mm), longitudinal section of incomplete specimen, and cross section of endocarp. Photograph by J. Pauptit (Figure 4.37).

Whole fruits are about 1 cm in diameter and have a stony endocarp in which 1 to 2 (-3) seeds develop. The sides of the endocarp are somewhat equilateral, not flat like those of *C. myxa*. The widest point is at or slightly above the middle of the endocarp.

Euphorbiaceae

Chrozophora plicata

Seed (4.2 x 3.1 mm). Photograph by J. Pauptit (Figure 7.10).

The seed is obovate, and the surface is covered with deep wrinkles. Both sides are somewhat protruding above the middle of the seed.

Figure 7.10. Seed of *Chrozophora plicata* (4.2 x 3.1 mm). Photograph by J. Pauptit.

Phyllanthus emblica

Dried fruits obtained from a spice shop in Khan al-Khalili (Cairo 1998). Mesocarp fragment (left: 18.3 x 17.2 mm) and endocarp fragment (right: length, 14.5 mm). Photograph by R. T. J. Cappers (Figure 4.52). Outside view (left) and inside view (right) of subfossil endocarp fragment (12.3 x 6.0 mm). Photographs by J. Pauptit (Figure 4.53).

The fruits of the emblic are drupes. Each fruit consists of six valves, enclosing a stony endocarp. When the soft mesocarp is removed, three bristly bundles of stigmas are exposed. The endocarp splits into six parts, each containing a seed. Each segment has a pointed top and a rounded base, the top connected with a reduced, oblique septum. It was these pointed fragments of the endocarp that were found at Berenike.

The dried destoned fruits consist, for the most part, of fragments of the thick, edible mesocarp. Dried fragments of the mesocarp are strongly wrinkled and blackish. Although shriveled up, the imprints of the stony endocarps are still visible on the inside of the mesocarp fragments.

Gramineae (= **Poaceae**)

Aeluropus lagopoides

Spikelet (left: 3.0 x 7.8 mm) and floret (right: 2.0 x 3.8 mm). Photograph by J. Pauptit (Figure 7.11).

A single spike contains 4 to 18 flowers. The lemmas are strongly 9 to 11-nerved, with long hairs on the margins. Both lemmas and glumes are unawned.

Figure 7.11. Spikelet (left: 3.0 x 7.8 mm) and floret (right: 2.0 x 3.8 mm) of *Aeluropus lagopoides.* Photograph by J. Pauptit.

Avena fatua

Spikelet with part of the awn still attached (left: length without awn, 9.6 mm), ventral view of fruit (right: 6.9 x 1.7 mm), and spikelet with broken scar (8.3 x 2.5 mm). Photographs by J. Pauptit (Figures 7.12 and 7.13).

The lemma has a long, spiral, and geniculate awn and an oval scar that is intact, indicative of the wild grass species. The fruit is covered with hairs. Although subfossil specimens may lack most of their hairs due to unfavorable preservation conditions, their former hairy appearance is mostly still detectable by the scars of the hairs.

The left-hand specimen still has a smooth, horseshoe-shaped basal scar that is typical for wild oats. In the right-hand specimen, this scar is broken and has an irregular appearance. Traditionally, such an irregular scar is considered to be indicative of domesticated oats (e.g., *A. sativa* and *A. strigosa*). Recent observations of spikelets of wild oats in threshing remains have revealed, however, that a minor fraction of these spikelets are seriously damaged both in the upper and lower part similar to that of the right-hand specimen. It can therefore be concluded that when a few small heavily damaged specimens are present among the spikelets with a smooth scar, they all have to be considered as being wild oats.

Figure 7.12. Spikelet of *Avena fatua* with part of the awn still attached (left: length without awn, 9.6 mm) and ventral view of fruit (right: 6.9 x 1.7 mm). Photograph by J. Pauptit.

Figure 7.13. Spikelet of Avena fatua with broken scar (8.3 x 2.5 mm). Photograph by J. Pauptit.

Avena sterilis

Lateral view of spikelet (10.4 x 2.4 mm). Photograph by J. Pauptit (Figure 7.14).

In this wild oat species, the flowers from a single spikelet keep together as one diaspore. Only the lowest lemma disarticulates from the pedicel. The depicted spikelet has two fertile florets. The basal part of the awn of the lower flower is still present.

Figure 7.14. Lateral view of spikelet of *Avena sterilis* (10.4 x 2.4 mm). Photograph by J. Pauptit.

Cenchrus ciliarus

Ventral view (left) and dorsal view of spikelets (2.9 x 5.8 mm). Photograph by J. Pauptit (Figure 7.15).

A cluster of two to three spikelets is surrounded by many scabrid bristles that form two circles. The bristles of the outer circle are slender and are fused halfway up the diaspore, whereas those of the inner one are more flat and stay connected only up to about 0.5 mm above the rim of the disc.

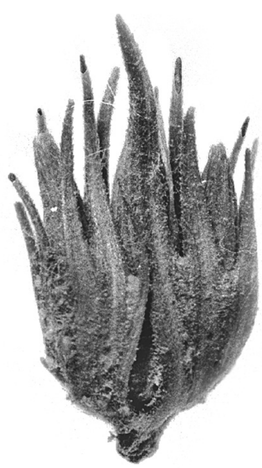


Figure 7.15. Ventral view (left) and dorsal view of spikelets of *Cenchrus ciliarus* (2.9 x 5.8 mm). Photograph by J. Pauptit.

Coix lacryma-jobi

Utricle (8.3 x 4.8 mm). Photograph by J. Pauptit (Figure 4.32).

The utricle is drop-shaped to globular. It is derived from a metamorphous leaf sheath, which encloses one fertile and two sterile female florets. The shiny coating is partly or completely eroded in the subfossil specimens. The base is flat and artificially pierced for stringing. The top is oblique and has a natural opening.

Dichanthium foveolatum

Part of inflorescence (length: 8.6 mm). Photograph by J. Pauptit (Figure 7.16).

The inflorescence is characterized by the densely pubescent rachis and pedicels and by the circular pit above the middle of the glume of the sessile spikelets. The lemmas of the sessile spikelets are awned. The twisted, double geniculate awn easily falls off and is no longer present in subfossil specimens.

Figure 7.16. Part of inflorescence of *Dichanthium foveolatum* (length: 8.6 mm). Photograph by J. Pauptit.

Hordeum vulgare ssp. *vulgare*

Rachis fragment infected by covered smut. Left-hand specimen: dorsal/ventral view; right-hand specimen: lateral view (length: 9.3 mm). Photograph by R. T. J. Cappers (Figure 4.40).

The rachis fragments of barley that are infected with the fungus-covered smut (*Ustilago hordei* [Pers.] Lagerh.) have acquired a completely deformed shape. In some fragments, the rachis internodes can be even completely covered by the deformed nodes. The basal parts of the spikelets are swollen and are still attached to the rachis nodes. They are clearly compartmentalized, each compartment filled with black spores.

Oryza sativa

Spikelet of rice in lateral view. Only the upper glume is still present (8.5 x 3.0 mm). Photograph by J. Pauptit (Figure 4.49).

The spikelets of rice are one-flowered. Two small glumes are present at the base. In the depicted specimen only the lower glume is still present. Both the lemma and the palea have regular, coarse surfaces, which are dentate in the upper part.

Paspalum scrobiculatum

Left: rachis with one spikelet left (length: 15.5 mm); top right: spikelet in dorsal view (2.9 x 2.0 mm); bottom right: floret in ventral view (3.2 x 2.4)). Photograph by J. Pauptit (Figure 7.17).

The spikelets are in two rows along one side of the rachis, as can be judged from the orientation of the rachilla. The spikelets are oval and rather flat.

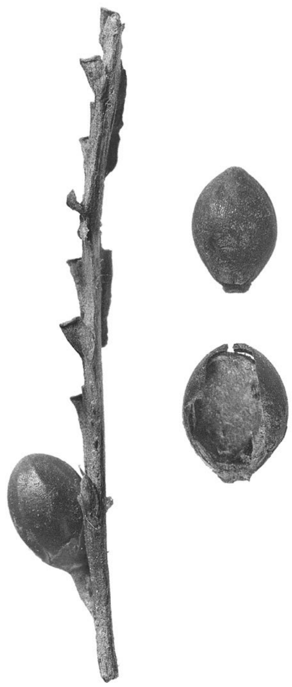


Figure 7.17. Remains of Paspalum scrobiculatum. Left: rachis with one spikelet left (length: 15.5 mm); top right: spikelet in dorsal view (2.9 x 2.0 mm); bottom right: floret in ventral view (3.2 x 2.4). Photograph by J. Pauptit.

Sorghum bicolor

Floret of sorghum in ventral view (left; 4.8 mm) and fruit in dorsal view (right; width: 5.0 mm). Photograph by J. Pauptit (Figure 4.68).

The spikelets are obovate. The lower glume partially envelops the upper glume. The outer surface of both glumes is shiny. The lemma is unawned. The fruit is almost round and has a large scuttelum.

Sorghum halepense

Sessile spikelet in ventral view (right) and in dorsal view (left) (6.3 x 2.1 mm). Photograph by J. Pauptit (Figure 4.2).

The spikelets are elongated. The lower glume partially envelops the upper glume. The outer surface of both glumes is covered with small hairs. The sessile spikelet is bordered with two long rachillae. The two smaller, pedicellate spikelets are much smaller and are missing in the depicted specimens.

Leguminosae (= Fabaceae)

Abrus

Whole seed (left: 7.4 x 5.6 mm) and seed without seed coat (right: 5.0 x 4.4 mm). Photograph by R. T. J. Cappers (Figure 4.6).

Whole specimens, as well as parts of the black seed coat and the dark colored cotyledons, were found, the cotyledons sometimes still attached to each other. The seeds are somewhat oblong and characterized by a protruding rim around the large hilum. The cotyledons are characterized by a large and typically shaped depression where the hilum is positioned.

Acacia

Whole seed with pleurocarp (left: 7.1 x 4.1 mm), cross section showing multilayered seed coat (middle: 6.3 x 3.9 mm), and cotyledons with embryo and grooves (right: 5.1 x 3.2 mm). Photograph by R. T. J. Cappers (Figure 4.10).

The compressed seeds are elliptic to ovate. A pleurogram is present on the seed coat, which is not completely closed at the apex. In subfossil specimens, the pleurogram is mostly still visible, though sometimes with difficulty. The area inside and outside the pleurogram is smooth and similar in appearance. Different layers of the seed coat are clearly visible in a cross section. The top of both cotyledons is split and basally groined. Most of the embryo is covered by the cotyledons; only the embryo tip protrudes from the cotyledons. From a top view, the tip of the embryo is in the middle of a cross. Most probably, the bulk of the subfossil seeds belongs to the twisted acacia (*Acacia tortilis*).

Acacia nilotica

Fruit fragment (width: 14.0 mm) Photograph by R. T. J. Cappers (Figure 4.8).

The fruit is straight or slightly curved and constricted between the seed chambers. These constrictions are irregular in shape and range from almost entire margins to small joints. Small joints easily break, resulting in single-seeded pod fragments. Such pod fragments are somewhat asymmetric. The surface of the fruit has no clear vein pattern.

Acacia tortilis

Fruit fragment seen from the outside (left) and the inside (right) (largest width: 5.4 mm). Photograph by J. Pauptit (Figure 4.11).

The fruit of the *A. tortilis* is spirally twisted, usually for more than one coil. Contrary to the Nile acacia, the fruits are only slightly constricted between the seeds. Seed chambers are therefore not always clearly distinctive, as is the case with the depicted fragment that consists of four seed chambers. Small fruit segments of the twisted acacia are distinguishable from the Nile acacia by their veined surface.

Ceratonia siliqua

Whole seed (left: 10.5 x 7.3 mm) and cotyledons with embryo, with only fragment of the seed coat left (right: 9.2 x 6.7 mm). Photograph by R. T. J. Cappers (Figure 4.23).

The compressed seeds are ovate to oblong. The tip of the hilum is visible in the depression. The seed coat is covered with a fine pattern of fracture lines. These fracture lines are still visible in part of the subfossil specimens. The endosperm is well developed, contains storage tissue, and encases the embryo. The main function of the thin cotyledons is photosynthesis. In a cross section, they appear as three distinct layers.

Crotalaria aegyptiaca

Fruit (8.8 x 4.2 mm). Photograph by J. Pauptit (Figure 7.18).

The fruits are about 8 mm long. The dehiscent fruits are inflated and smooth. Subfossil fruits were still complete and some of them still have their seeds inside.

Figure 7.18. Fruit of *Crotalaria aegyptiaca* (8.8 x 4.2 mm). Photograph by J. Pauptit.

Lupinus albus

Seed with hilum positioned top left (9.7 x 9.3 mm). Photograph by R. T. J. Cappers (Figure 4.45).

The seeds have a somewhat rectangular outline. Modern specimens are white or cream colored; the subfossil seeds have become reddish brown. The large hilum is located in one of the corners (depicted specimen: upper right). Very often, only fragments of the hard but fragile seed coat were found. Fragments without a hilum can still be positively identified by their shape, thickness, and color.

Pisum abyssinicum

Whole seed (left: 6.3 x 5.3 mm) and cotyledon with cavity for embryo (right: 6.0 x 5.0 mm). Photographs by R. T. J. Cappers (left) and J. Pauptit (right; Figure 4.62).

The shape of the seed is globose to angular due to the marked hilum rim. According to Westphal (1974:180), who documented pulses from Ethiopia, seeds from both the Abyssinian pea (*P. abyssinicum*) and the field pea (*P. sativum*) are globose to globose-angular in shape, and have no clearly distinct features that can be used for distinguishing each species. A positive identification could have been made by A. Butler (University College London), who recognized the characteristic reticulate pattern of the palisade cells on the testa at magnifications of x 1.5K and above.

Tamarindus indica

Whole seeds and cotyledons with embryos on the right side (size: ca. 11–17 x 10–13 mm). Photograph by J. Pauptit (Figure 4.69).

The seeds are trapeziform to rhombic or irregular, their sizes varying from 11–17 mm x 10–12 mm. The irregular shape and size can be related with the pulpy endocarp of the fruit, which does not form a fixed shape. The surface of the seed coat has a closed pseudopleurogram. The inner part (areola) is characterized by a reticulate pattern, whereas the outer side has a pitted appearance, especially close to the pseudopleurogram. The seed coat of the tamarind is clearly distinguished from that of the faba bean (*Vicia faba*) by this pattern. Another typical feature is presented by the embryo, which is completely concealed by the cotyledons. Only when a part of the cotyledon is removed will the embryo become visible.

Trigonella hamosa

Fruit (6.3 x 2.7 mm). Photograph by J. Pauptit (Figure 7.19).

The fruit is flat and falcate and about 8–15 mm long. It has a characteristic pattern showing reticulate veins.

Figure 7.19. Fruit of *Trigonella hamosa* (6.3 x 2.7 mm). Photograph by J. Pauptit.

Vicia faba

Seed in lateral view (top left: 8.8 x 5.8 mm), seed from above with seed coat removed (top right: 7.8 x 5.4 mm), seed in transverse section (7.5 x 5.1 mm, bottom left) and detail of cotyledon surface (bottom right). Photograph by R. T. J. Cappers (Figure 4.71).

Whole seeds of the faba bean are characterized by their shape, typically broad on both sides of the long hilum. This thickening is also visible when the seed coat has disappeared. Most subfossil remains, however, concern fragments of the seed coat and cotyledons. The seed coat around the hilum is the most solid part, and fragments of the seed coat with a hilum are easily preserved and recovered. But fragments that lack the hilum also have a good chance of becoming preserved. Such subfossil specimens can be recognized by their thickness, their black color, and, as far as larger fragments are concerned, the fact that they have coiled up. The inner side of the cotyledon is characterized by the reticulate pattern and the position of the depression for the embryo, located at some distance from the outer side.

Vigna radiata

Whole seeds and seeds without seed coat (length: 3.3–4.2 mm). Photograph by J. Pauptit (Figure 4.72).

The oval seeds of the mung bean are 3.3–4.2 mm long. The seeds look quite similar to those of black gram (*V. mungo* [L.] Hepper), but lack the lip around the hilum, which is a characteristic feature of the latter one. Also the hilum is much shorter and narrower in the mung bean. Its length is usually around one-third that of the seed, whereas in black gram it is around one-half. The width of the hilum in the mung bean is one-fifth to one-fourth the thickness of the seed whereas in black gram it is about one-third. Another Indian species, the moth bean (*V. aconitifolia* [Jacq.] Maréchal) has a much smaller hilum, which is off center. Other aspects of size and proportion are less reliable. However, on the split cotyledons, the relative size of the embryo of the moth bean differs on average from the mung bean, being longer in the latter (information provided by D. Q. Fuller; University College London).

Liliaceae

Allium sativum

From left to right: top view of bulb base with characteristic scars and bottom view with remnants of roots, whole clove of garlic (length: 18.4 mm), and shriveled content of clove (length: 13.0 mm). Photographs by R. T. J. Cappers (bulb base and whole clove) and J. Pauptit (shriveled content; Figure 4.13).

The bulb base of garlic is characterized by separate impressions for each of the cloves. Also the desiccated contents of cloves have been found. These shriveled, dark-colored specimens may look very much like immature specimens of *Terminalia chebula*, which are still a commercial commodity. Initially, they were published as such (Cappers 2001, 308–309).

Asphodelus tenuiflorus

Fruit (left: 3.8 x 4.6 mm) and seed (right: 1.1 x 2.5 mm). Photograph by R. T. J. Cappers (Figure 7.20).

The fruit capsule consists of three valves, each with distinct transverse ribs. The capsule is broadly obovoid. The seeds are triangular in cross section. The top of the seed is rounded, the base pointed. The seed surface has characteristic diagonal wrinkles.

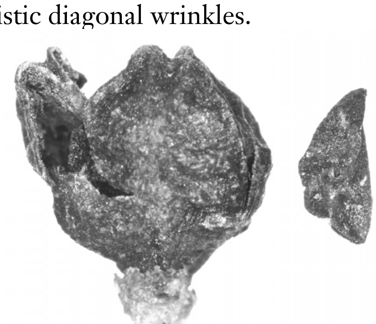


Figure 7.20. Fruit (left: 3.8 x 4.6 mm) and seed (right: 1.1 x 2.5 mm) of *Asphodelus tenuiflorus*. Photograph by R. T.J. Cappers.

Unidentified bulbil

Outer bulb coat leaf (left: 9.6 x 7.8 mm) and storage leaf (7.8 x 5.4 mm). Photograph by J. Pauptit (Figure 4.44).

Only one specimen of this unknown species has been found intact. This specimen has been dissected and both a fragment of the outer bulb-coat leaf and the solid content are depicted. The bulbil consists of a solid content (storage leaf) with a relatively large scar at the base and the embryo on top, and a number of protective bulb-coat leaves. The inner ones are light brown and papery, whereas the outer ones are almost black and sturdier. These outer bulb-coat leaves especially are well preserved and have been found in large quantities. They have a diagnostic pattern of longitudinal ribs connected at right angles by many small ribs.

Lythraceae

Punica granatum

Outer surface (left) and inner surface (right) of peel fragment (2.3 x 1.9 cm). Photograph by R. T. J. Cappers (Figure 4.65).

The subfossil peel fragments of pomegranate are 1.7 mm thick. The outer surface has small papillae; the inner surface has a characteristic pattern of coarse meshes, bordering the location of the peripheral seeds. The seeds found in an archaeological context have either lost their juicy, edible seed coats (only the inner part of the seed, namely, the embryo and the cotyledons, being preserved) or their seed coats have become dehydrated.

Menispermaceae

Cocculus pendulus

Fruit (endocarp) (4.3 x 3.4 mm). Photograph by R. T. J. Cappers (Figure 4.26).

The ornamentation of the endocarp surface of members of the genus *Cocculus* provides diagnostic features to the level of species (Forman 1974:477–481). The broad dorsal ridge is only slightly raised and sometimes grooved along the median line. The surface is decorated with a distinct pattern of broad, rounded convolutions. The central part of the endocarp can be perforated or not.

Moringaceae

Moringa peregrina

Fragment of seed coat (12.8 x 9.7 mm). Photograph by J. Pauptit (Figure 4.47).

The seeds are triangular in cross section, with concave sides and slightly pronounced ridges. The seeds of the Indian bentree (*M. oleifera*) are similar in size and shape, but are distinctive in their broad longitudinal wings along the ridges.

Nelumbonaceae

Nelumbo nucifera

Seed (12.5 x 11.0 mm). Photograph by R .T. J. Cappers (Figure 4.48).

The seeds are oblong. The basal part is rounded and the top truncated with a protruding top (right side of the depicted specimen). The large embryo is located in the central cavity of the seed, which is almost as long as the seed itself. The surface of the seed coat is striate and covered with a powdery white tissue that easily comes off.

Neuradaceae

Neurada procumbens

Strongly eroded receptacle (diameter: 9.3 mm). Photograph by J. Pauptit (Figure 7.21).

The receptacles are disc-shaped. They have a flat bottom with a central scar connected to the pedicel and a rounded spiny top. A receptacle has 5 loculi to 10 loculi, with one seed developed in each loculus. Ripe receptacles are woody and release their seeds while tumbling over the desert soil. Subfossil specimens are mostly perforated and have lost their seeds.

Figure 7.21. Strongly eroded receptacle of *Neurada procumbens* (diameter: 9.3 mm). Photograph by J. Pauptit.

Nyctaginaceae

Boerhavia

Fruit (1.7 x 3.3 mm). Photograph by J. Pauptit (Figure 7.22).

The fruit is ellipsoid and covered with prominent longitudinal, white ridges. The surface between the ridges is covered with small sticky glands. The depicted specimen is slightly damaged at the top.

Figure 7.22. Fruit of *Boerhavia* (1.7 x 3.3 mm). Photograph by J. Pauptit.

Palmae (= Arecaceae)

Cocos nucifera

Outer and inner view of a perforated fruit fragment (endocarp: 9.2 x 6.6 cm) and segment of outer part of fruit (exocarp and mesocarp). Photographs by J. Pauptit (Figure 4.30) and R. T. J Cappers (Figure 4.31).

Endocarp fragments are 2.5 mm thick. The inner side is smooth and may show the impression of branched veins. The outer surface is coarsely grooved and may include part of the three ridges that connect the carpels or one of the three germination holes (eyes). The hole in the depicted fragment (diameter: 37 mm) is artificial. Fragments of the outer part of the fruit (mesocarp and exocarp) were cut out in a longitudinal direction, parallel to the direction of the vascular bundles that densely penetrate in the parenchymatous mesocarp. The thin exocarp is lignified and glossy on the outside.

Hyphaene thebaica

Cross section of recent fruit with seed (left: 54 x 56 mm) and subfossil fruit (endocarp) (right: 40 x 44 mm; Figure 4.42). Outer side (left) and inner side (right) of fragment of endocarp (3.2 x 1.8 cm; Figure 4.43). Photographs by R. T .J Cappers (Figures 4.42, left, and 4.43) and J. Pauptit (Figure 4.43, right).

The fruit of the doam palm consists of three layers. The outer thin and glossy exocarp is not preserved in the desiccated specimens. With only a few exceptions, the spongy thick mesocarp is also mostly absent in the subfossil specimens. Most of the fruit remains concern the extremely solid endocarp. This inner part of the fruit consists of several layers in which the directions of the fibers are at right angles to each other, bearing resemblance to plywood. The seed has a smooth brown seed coat and a white, very hard endosperm with a hollow center.

Phoenix dactylifera

Fruit with perianth (left: 33.0 x 10.7 mm) and charred seed from ventral view (middle: 19.5 x 8.3 mm) and from dorsal view (right, Figure 4.50) and inner side (left: 6.8 x 5.3 mm) and outer side (right) of perianth (Figure 4.51). Photographs by R. T. J. Cappers.

Whole fruits were only sporadically found; the bulk of the remains of this species unearthed were the inedible seeds, partly still covered by the white, papery endocarp. The desiccated fruits have become wrinkled due to complete dehydration. Whole seeds of date are easily recognized by the ventral groove and the dorsal scar in the middle of the seed. But desiccated dates easily fall apart and have to be identified on the basis of a combination of size, shape, and radial pattern inside the seed. Prudence is called for establishing the mode of preservation, as desiccated specimens may become completely black when they are exposed to bright sunlight for some time and bear resemblance to charred specimens. Subfossil seeds differ much in size: (1.43-) 2.27 (-3.40) x (0.46-) 0.84 (-1.08) x (0.43-) 0.73 (-0.99) cm (N=376; s.d.: 0.36, 0.09 and 0.08; Cappers 1996:327). The perianth of the date consists of a cup-shaped three-toothed calyx and has an inner ring of three petals. The petals are strongly veined, elongated and alternate with the calyx lobes.

Pedaliaceae

Sesamum indicum

Sesame seeds embedded in an unidentified matrix (14.2 x 9.2 mm). Photograph by R. T. J. Cappers (Figure 4.66).

Seeds of sesame are slightly flat and ovate, the top somewhat contracted. The edges of the seed are angular to round. Especially in specimens with angular edges, both the upper and the lower edge may be accentuated by a thin ridge. One soil sample yielded an unidentified substance in which many sesame seeds were embedded.

Pinaceae

Pinus pinea

Cone scales (right specimen: 16.3 x 13.5 mm). Photograph by R. T. J. Cappers (Figure 4.55).

Whole cone scales are easily recognized by their typical shape and size. On the upper part of a cone scale, there are the impressions that mark the position of the two seeds. The other end of the scale is thick and angular and consists of several segments around a circular scar. If preservation conditions had been less favorable, only these thick parts of the scales would have been preserved, with the possibility of some veins.

Piperaceae

Piper nigrum

Fertile fruits (Figure 4.60, mean surface: 21 mm²) and sterile fruits (Figure 4.61, mean surface: 6 mm²). Photographs by J. Pauptit.

Black pepper can be positively identified by the presence of the fruit layer, which is still intact. The outer part of the fruit (exocarp and outer half of the mesocarp) shows the reticulate pattern of wrinkles as a result of the drying process of unripe harvested fruits. In white pepper, the outer half of the fruit layer has been removed, and its smooth surface shows a pattern of 10 to 16 veins connecting the protruding top and flat base of the fruit. The identification of white pepper might be problematic in an archaeological context as the loose fragile outer pericarp may still come off. In addition to fertile well-developed specimens, also small peppercorns were found, which concern aborted specimens. Such peppercorns are smaller and concern mainly the wrinkled fruit.

Rhamnaceae

Ziziphus spina-christi

Exterior view of the whole endocarp; septum between two seed compartments has become detached (top left: 8.0 x 8.6 mm), apacial part broken off, displaying both seed compartments (top right), isolated septum (bottom left), and inside view of seed compartment (bottom right). Photograph by R. T. J. Cappers (Figure 4.74).

The woody, spherical endocarp of nabq has a wrinkled surface and contains two small seeds that develop in a separate seed chamber. A thick, lignified septum separates both seed chambers and may become visible when the endocarps start falling apart. Both sides of the flat septum show a shallow depression for the seed. In exceptional cases, the fruit consists of three carpels, and subsequently three seeds are developed. Fragments of nabq differ from those of olive (*Olea europaea*) by the absence of branched veins at the surface and their thickness, which is much thinner than that of the olive.

Rosaceae

Amygdalus communis

Three fragments of the endocarp. Outside (top left) and inside (top right) view of the outer endocarp layer (12.2 x 8.3 mm) and outside (bottom left) and inside (bottom right) view of the inner endocarp layer (12.5 x 7.5; Figure 4.14). Extreme point of the endocarp without the outer layer (11.7 x 8.6 mm; Figure 4.15). Photographs by R. T. J. Cappers.

The relatively thick endocarp of almond consists of two layers. The outer layer consists of parenchyme tissue with scattered stone cells. The inner layer predominantly consists of different types of stone cells and is more solid. Between both endocarp layers, a network of thick veins is present, partly penetrating through the outer later, resulting in the characteristic perforation. Very often, the desiccated endocarps split into two halves, separating the soft and hard tissues. The fragile outer endocarp layer becomes completely perforated, whereas the sturdier inner layer has contrasting surfaces: a vaulted pattern on the outer side, marking the veining, as apposed to the smooth brownish inner side.

Armeniaca vulgaris

Endocarp of apricot (17.6 x 15.0 mm). Photograph by R. T. J. Cappers (Figure 4.16).

The endocarp of the apricot is flat and rather wide. The ventral rim is well developed. Contrary to endocarps of almond (*Amygdalus communis*), those of apricot have an almost smooth outer surface, lacking the pitted structure, and they do not split into two layers.

Prunus cerasifera

Endocarp of cherry plum (13.2 x 9.2 mm). Photograph by R. T. J. Cappers (Figure 4.63).

Endocarps of the cherry plum have a sharp-angled ventral suture. The lateral grooves are shallow and indefinite, resulting mostly in smooth lateral faces. However, some Mediterranean cherry plums do have elevated lateral ridges (Woldring 2000:540).

Prunus domestica

Endocarp of domestic plum (19.5 x 12.9 mm). Photograph by R. T. J. Cappers (Figure 4.64).

Endocarps of the plums are rather variable and may represent locally cultivated varieties. The relatively broad lateral sides are domed-shaped to some extent. The surface may be rather glabrous or may show a

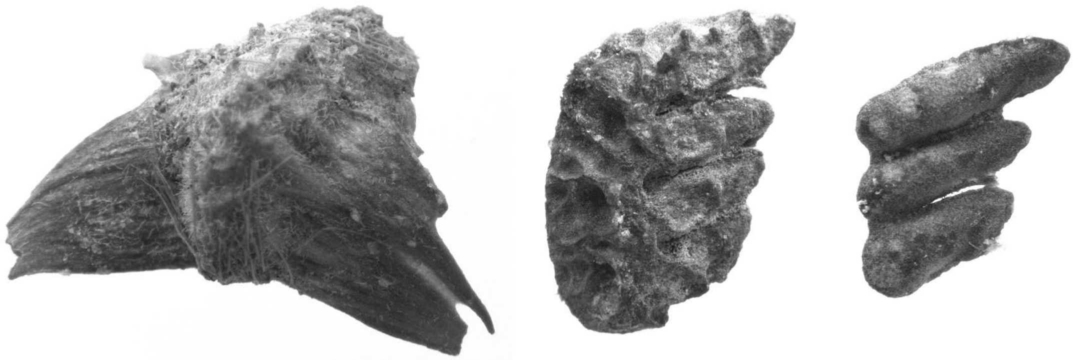


Figure 7.23. Winged fruit (left; 7.1 x 5.0 mm), unwinged fruit (middle; 6.3 x 4.2 mm) and seed chambers of *Tribulus terrestris* s.l. (right; 3.8 x 3.6 mm). Photograph by R. T.J. Cappers.

distinctive surface pattern of pits, differing in both size and depth, with one or more longitudinal creases that start from the base.

Sapotaceae

Mimusops laurifolia

Seed (20.0 x 12.3 mm). Photograph by R. T. J Cappers (Figure 4.46).

The seeds of persea have a brown, hard, shiny testa and a large hilum. Most of the subfossil seeds from Berenike have retained this appearance. The thickness of the testa varies depending on the location. The inside of the testa is characterized by thick branching veins. The variability of size and shape of the seeds can be attributed to their development inside the soft berry.

Tiliaceae

Grewia

Endocarp in lateral view (left) and in dorsal/ventral view (right) (6.4 x 5.2 mm). Photograph by J. Pauptit (Figure 4.39).

The shape of the endocarp is obovate, with a pointed base. The ventral side is flat and angled; the dorsal side has a prominent groove. The lateral sides are rugose and somewhat curved.

Umbelliferae (= Apiaceae)

Cuminum cyminum

Fruits still attached to carpophore (1.4 x 5.4 mm). Photograph by J. Pauptit (Figure 4.38).

The elongated fruits are slightly dorsally compressed. Five main narrow ribs are present: one dorsal rib, two lateral ribs, and two ribs between the dorsal and lateral ones. The ribs are mostly hairy and oil bodies alternate with the ribs.

Vitaceae

Vitis vinifera

Charred fruits (seed visible in bottom right specimen; ca. 10.0 x 9.5 mm). Photograph by J. Pauptit (Figure 4.73).

Occasionally, charred fruits of the grapevine were found. The fruit tissue of such specimens has a puffed structure and is easily damaged, resulting in a somewhat irregular shape. A positive identification is facilitated if the characteristic seeds are visible.

Zygophyllaceae

Tribulus terrestris s.l.

Winged fruit (left; 7.1 x 5.0 mm), unwinged fruit (middle; 6.3 x 4.2 mm) and seed chambers (right; 3.8 x 3.6 mm). Photograph by R. T. J. Cappers (Figure 7.23).

The taxonomic status of some *Tribulus* species is still problematic, including that of *T. terrestris* L. and *T. bimucronatus* Viv. (compare, for example, the description of the Egyptian species in Täckholm 1974:311–313; Boulos 1995:81–82; Boulos 2000:26–30). Intermediate forms between *T. terrestris* and *T. bimucronatus* from Yemen are mentioned by Wood (1997), and include, among others, *T. intermedius* Kralik. Some subfossil specimens from Berenike and Shenshef are broadly winged in the lower part of the fruit, whereas others are unwinged. Both types are described as varieties from *T. bimucronatus*, although the winged variety (var. *bispinulosus* [Kralik] Hosni) has small spines instead of broad wings. Both species are recorded from the Eastern Desert, the Red Sea coastal plain, and the Gebel Elba area. Because of the unclear taxonomic status, the subfossil specimens have been attributed to *T. terrestris* s.l., including *T. terrestris* s.s., *T. bimucronatus*, and their intermediate forms.

In the whole specimen that is depicted, two wings are attached at the ventral side of the fruit. The dorsal side shows a coarsely pitted surface. Occasionally, strongly corroded specimens were found, consisting of the seed chambers only. Two examples of such eroded fruits are also depicted.

Bibliography

Abd El-Ghani, M. M., and A. M. Amer
1990 Studies on Weed Assemblages in Croplands, Egypt I. Broad Bean Fields. *Egyptian Journal of Botany* 33:15–30.

Abd El-Ghani, M. M., and A. A. El-Bakry
1992 Studies on Weed Assemblages in Croplands, Egypt II. Egyptian Clover Fields. *Bulletin of Faculty of Agriculture, University of Cairo* 43:1221–1252.

Ahmed, M. S., G. Honda, and W. Miki
1979 Herb Drugs and Herbalists in the Middle East. *Studia Culturae Islamicae* 8:1–208.

Aldsworth, F. G., and H. Barnard
1996 *Survey of Hitan Rayan*. In Berenike 1995, pp. 411–440.

Aldsworth, F. G., and H. Barnard
1998a *Berenike Survey*. In Berenike 1996, pp. 3–10.

Aldsworth, F. G., and H. Barnard
1998b *Survey of Shenshef*. In Berenike 1996, pp. 427–443.

Aldsworth, F .G., S. E. Sidebotham, and W.Z. Wendrich
1995 *The Town Site: Survey, Plan and Description*. In Berenike 1994, pp. 13–20.

Arora, R. K.
1977 Job's Tears (Coix lacryma-jobi). A Minor Food and Fodder Crop of Northeastern India. *Economic Botany* 31:358–366.

Ayyad, M. A., and S. I. Ghabbour
1986 Hot Deserts of Egypt and the Sudan. In *Ecosystems of the World 12B: Hot Deserts and Arid Shrublands B*, edited by M. Evenari, I. Noy-Meir, and D. W. Goodall, pp. 149–202.

Bagnall. R. S. (editor)
1986 Papyri and Ostraka from Quseir al-Qadim. *Bulletin of the American Society of Papyrologists* 23:1–60 and 27 plates.

Bagnall, R. S. (editor)
1997 *The Kellis Agricultural Account Book.* Oxbow Monograph, Exeter, England.

Bagnall, R. S., C. C. Helms, and A. M. F. W. Verhoogt
1999 *The Ostraka*. In Berenike 1997, pp. 201–205.

Bagnall, R. S., C. C. Helms, and A. M .F. W. Verhoogt
2000 Documents from Berenike. Vol. 1. Greek Ostraka from the 1996–1998 Seasons. *Papyrologica Bruxellensia* 31:1–84.

Baki, B. B., and I. B. Ipor
1992 Paspalum scrobiculatum L. In *Plant Resources of South-East Asia 4: Forages*, edited by L. 't Mannetje and R. M. Jones, pp. 185–187. Pudoc, Wageningen, Netherlands.

Barakat, H. N., and N. Baum
1992 *La végétation antique de Douch (oasis de Kharga)*. Institut Francais D'archéologie Orientale, Cairo.

Barnard, H., I. N. Wolffers, and M. M. Arab
1996 Could the Low Prevalence of Diabetes Mellitus in the Egyptian Deserts Be the Result of Protective Elements in the Bedouin Diet? *The Egyptian Journal of Diabetes* 1:23–30.

Batanouny, K. H., W. Stichler, and H. Ziegler
1988 Photosynthetic Pathways, Distribution, and Ecological Characteristics of Grass Species in Egypt. *Oecologia* 75:539–548.

Bates, D. M., and R. W. Robinson
1995 Cucumbers, Melons and Water-Melons. In *Evolution of Crop Plants,* 2nd edition, edited by J. Smartt and N. W. Simmonds, pp. 89–96. Longman, London.

Baum, N.
1988 Arbres et arbustes de l'Egypte ancienne. La liste de la tombe thébaine d'Ineni (no. 81). *Orientalia Lovaniensia Analecta* 31:1–381.

Beaux, N.
1990 Le cabinet de curiosités de Thoutmosis III. Plantes et animaux du "Jardin botanique" de Karnak. *Orientalia Lovaniensia Analecta* 36:1–349 and 57 plates.

Bebawi, F. F., and L. Neugebohrn
1991 *A Review of Plants of Northern Sudan: With Special Reference to Their Uses*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) Gmbh, Eschborn, Germany.

Becker-Dillingen, J.
1929 *Handbuch des Gesamten Pflanzenbauses einschliesslich der Planzenzüchtung. Band 3: Hülsenfruchterbau und Futterbau*. Verlagbuchhandlung P. Parey, Berlin.

Becker-Dillingen, J.
1929 [1924] *Handbuch des Gesamten Pflanzenbauses einschliesslich der Planzenzüchtung. Band 4: Gemüsebaues*. 2nd edition. Verlagbuchhandlung P. Parey, Berlin.

Bedevian, A. K.
1994 [1935] *Illustrated Polyglottic Dictionary of Plant Names.* Medbouly Library, Cairo.

Bedigian, D.
1998 Early History of Sesame Cultivation in the Near East and Beyond. In *The Origins of Agriculture and Crop Domestication. The Harlan Symposium*, edited by A. B. Damania, J. Valkoun, G. Willcox and C. O. Qualset, pp. 93–101. ICARDA, Aleppo, Syria.

Bedigian, D.
2003 Evolution of Sesame Revisited: Domestication, Diversity and Prospects. *Genetic Resources and Crop Evolution* 50: 779–787.

Bedigian, D.
2004a History and Lore of Sesame in Southwest Asia. *Economic Botany* 58: 329–353.

Bedigian, D.
2004b Slimy Leaves and Oily seeds: Distribution and Use of Wild Relatives of Sesame in Africa. *Economic Botany* 58 (Supplement): S3–S33.

Bedigian, D., and Harlan, J. R.
1986 Evidence for Cultivation of Sesame in the Ancient World. *Economic Botany* 40:137–154.

Berns, M. C., and B. R. Hudson
1986 *The Essential Gourd: Art and History in Northeastern Nigeria*. Museum of Cultural History, Los Angeles.

Billing, J., and P. W. Sherman
1998 Antimicrobial Functions of Spices: Why Some Like It Hot. *The Quarterly Review of Biology* 73:3–49.

Bircher, W. H.
1995 *The Date Palm: A Friend and Companion of Man.* Elias Modern Press, Cairo.

Boardman, S.
1999 The Agricultural Foundation of the Aksumite Empire, Ethiopia. In *The Exploitation of Plant Resources in Ancient Africa*, edited by M. van der Veen, pp. 137–147. Kluwer Academic/Plenum, New York.

Bor, N. L.
1968 *Flora of Iraq: 9. Gramineae.* Robert MacLehose and Company, Glasgow.

Bottema, S.
1992 Palynological Investigations of the Ibrahim Awad Deposits (Northeastern Nile Delta). Preliminary report. In *The Nile Delta in Transition: 4th–3rd Millennium B.C.*, edited by E. C. N. van den Brink, pp. 123–125.

Boulos, L.
1995 *Flora of Egypt, Checklist*. Al Hadara, Cairo.

Boulos, L.
1999 *Flora of Egypt: 1.* Al Hadara, Cairo.

Boulos, L.
2000 *Flora of Egypt: 2.* Al Hadara, Cairo.

Boulos, L.
2003 *Flora of Egypt:3.* Al Hadara, Cairo.

Braukämper, U.
1992 Peoples and Cultures of the Area. In *The Archaeological Map of the Sudan: VI: The Area of the Red Sea Coast and Northern Ethiopian Frontier*, by F. W. Hinkel, pp. 43–50. Academie Verlag, Berlin.

Breteler, F. J.
1989 Abrus precatorius L. In *Plant Resources of South-East Asia. A Selection*, edited by E. Westphal and P. C. M. Jansen, pp. 27–28. Pudoc, Wageningen, Germany.

Brothwell, D., and P. Brothwell
1969 *Food in Antiquity.* Thames and Hudson, London

Bunbury, E. H.
1959 *A History of Ancient Geography.* 2nd edition. Dover Publications, New York.

Burkill, H. M.
1994 *The Useful Plants of West Tropical Africa: 2: Families E-I.* Royal Botanical Gardens, Kew, England.

Burton-Page, J.
1969 The Problem of *Adansonia digitata* into India. In *The Domestication and Exploitation of Plants and Animals*, edited by P. J. Ucko and G. W. Dimblby, pp. 331–335. G. Duckworth, London.

Butler, A.
2003 The Ethiopian Pea: Seeking the Evidence for Separate Domestication. In *Food, Fuel and Fields. Progress in African Archaeobotany*, edited by K. Neumann, A. Butler, and S. Kahlheber, pp. 37–47. Heinrich Barth Institut, Cologne.

Cappers, R. T. J.
1995 A Palaeoecological Model for the Interpretation of Wild Plant Species. *Vegetation History and Archaeobotany* 4:249–257.

Cappers, R. T. J.
1996 *Archaeobotanical Remains*. In Berenike 1995, pp. 319–336.

Cappers, R. T. J.
1998 *Archaeobotanical Remains*. In Berenike 1996, pp. 289–330.

Cappers, R. T. J.
1999 Trade and Subsistence at the Roman Port of Berenike in the Eastern Desert of Egypt. In *The Exploitation of Plant Resources in Ancient Africa*, edited by M. van der Veen, pp. 185–197. Kluwer Academic/Plenum, New York.

Cappers, R. T. J.
2001 *Archaeobotanical Remains*. In Berenike 1998, pp. 305–310.

Cappers, R. T. J.
2003 Exotic Imports of the Roman Empire: An Exploratory Study of Potential Vegetal Products from Asia. In *Food, Fuel and Fields. Progress in African Archaeobotany*, edited by K. Neumann, A. Butler, and S. Kahlheber, pp. 197–206. Heinrich Barth Institut, Cologne.

Cappers, R. T. J., T. van Thuyne, and L. Sikking
2005 Plant Remains from Predynastic El Abadiya-2 (Naqada Area, Upper Egypt). In *Egypt at Its Origins. Studies in Memory of Barbara Adams. Proceedings of the International Conference "Origin of the State. Predynastic and Early Dynastic Egypt," Krakow, 28th August–1st September 2002*, edited by S. Hendrickx, R.F. Friedman, K.M. Ciałowicz and M. Chłodnicki, pp. 277–293. Peeters, Leuven.

Casson, L.
1989 *The Periplus Maris Erythraei. Text with Introduction, Translation, and Commentary*. Princeton University Press, Oxford.

Cato
n.d. *De Re Rustica*.

Chang, T.
1976 The Origin, Evolution, Cultivation, Dissemination, and Diversification of Asian and African Rices. *Euphytica* 25:425–441.

Chaudhuri, K. N.
1985 *Trade and Civilisation in the Indian Ocean. An Economic History from the Rise of Islam to 1750*. Cambridge University Press, Cambridge.

Clapham, A. J., and P. Rowley-Conwy
2005 New Discoveries at Qasr Ibrim, Lower Nubia. In *Fields of Change. Proceedings of the 4th International Workshop of Archaeobotany*, edited by R. T. J. Cappers, Groningen Archaeological Studies, Groningen, Netherlands, in press.

Clayton, W. D., and A. Renvoize
1986 Genera Graminum. Grasses of the World. *Kew Bulletin Additional Series* 13:1–389.

Collenette, S.
1988 The Sweet Olives of Saudi Arabia. *The Kew Magazine* 5:36–38.

Columella, L. J. M.
1st c. AD *Res Rustica (On Agriculture)* Harvard University Press (The Loeb Classical Library), Cambridge, Massachusetts.

Condit, I. J.
1947 *The Fig*. Chronica Botanica Co., Waltham, Massachusetts.

Cope, T. A., and H. A. Hosni
1991 *A Key to Egyptian Grasses*. Whitstable, Kent, England.

Cosmas Indicopleustes
530 AD *Topographiae Christianae*.

Crawford, D. J.
1979 Food: Tradition and Change in Hellenistic Egypt. *World Archaeology* 11:136–146.

Dalby, A.
1996 *Siren Feasts. A History of Food and Gastronomy in Greece*. Routledge, London.

Dalby, A.
1998 *Cato: On Farming, De agricultura*. Allaleigh House, Devon, England.

Dagan, E. A.
1990 *African Dolls for Play and Magic.* Galerie Amrad African Arts, Montréal.

Darby, W. J., P. Ghalioungui, and L. Grivetti
1977 *Food: The Gift of Osiris*. Vol. 2. Academic Press, London.

De Romanis, F. *See* Romanis de, F.
De Vartavan, C. *See* Vartavan de, C.
De Waard, P. W. F. *See* Waard de, P. W. F.
De Wilde-Duyfjes, B. E. E. *See* Wilde-Duyfjes de, B. E. E.
Dekker, J.
1906 De looistoffen. Botanisch-chemische monographie der tanniden. Deel 1: Bibliographie, botanie, physiologie. *Bulletin van het Koloniaal Museum te Haarlem* 35:1–220.
Demissew, S.
1988 A New Species of Grewia (Tiliaceae) from the Horn of Africa. *Kew Bulletin*, 43:531–533.
Dey, A. C.
1980 *Indian Medicinal Plants Used in Ayurvedic Preparations*. Reprint 1988. Siva Printers, Dehra Dun, India.
Drar, M.
1936 *Enumeration of the Plants Collected at Gebel Elba During Two Expeditions*. Agricultural Museum, Bulletin No. 149, Cairo.
Drar, M.
1954 Plants or Raw Material in the Deserts of Egypt. *Bulletin de L'Institut du desert D'Egypte* 4:70–76.
Duke, J. A.
1981 *Handbook of Legumes of World Economic Importance*. Plenum Press, New York.
Durrani, N.
2004 Luxury Bath. *Current Archaeology* 195:105.
El-Hadidi, M. N.
1980 An Outline of the Planned "Flora of Egypt." *Taeckholmia*, *Additional Series* 1:1–12.
El-Hadidi, M. N., and L. Boulos
1989 *The Street Trees of Egypt*. Revised edition. The American University in Cairo Press, Cairo.
El-Hadidi, M. N., and H. H. El-Fayoumi
1996 Catalogue of the Archaeobotanical Specimens in Cairo University Herbarium. 1. Abu Sha'ar site, Red Sea Coast— Egypt; Season 1990. *Taeckholmia* 16:11–30.
El-Hadidi, M. N., and J. Kosinová
1971 Studies on the Weed Flora of Cultivated Land in Egypt, 1. Preliminary Survey. *Mitteilungen der Botanischen Staatssammlung München* 10:354–367.
Emery-Barbier, A.
1990 L'homme et l'environment en Egypte durant la période prédynastique. In *Man's Role in the Shaping of the Eastern Mediterranean Landscape*, edited by S. Bottema, G. Entjes-Nieborg and W. Van Zeist, pp. 319–326. Balkema, Rotterdam.
Engelhard, J. B., and B. Fenner
1997 *Wer hat die Kokosnuss...? Die Kokospalme—Baum der tausend Möglichkeiten*. Rautenstrauch-Joest-Museum für Völkerkunde, Cologne.
Engler, A.
1912 *Syllabus der Pflanzenfamilien*. Verlag von Gebrüder Borntraeger, Berlin.
Fabricius, B.
1883 *Der Periplus erythräischen Meeres von einem Unbekannten*. Verlag von Veit, Leipzig, Germany.
Forman, L. L.
1974 The Endocarps of *Cocculus* (Menispermaceae). *Kew Bulletin* 29 (3): 477–481.
Franck, I. M., and D. M. Brownstone
1991 *Across Africa and Arabia*. Facts On Line, New York.
Frederiksen, B.
1996 *Caravans and Trade in Afghanistan. The Changing Life of the Nomadic Hazarbuz*. Thames and Hudson, London.
Fuller, D. Q.
2002 Fifty Years of Archaeobotanical Studies in India: Laying a Solid Foundation. In *Indian Archaeology in Retrospect*, Vol. III. *Archaeology and Interactive Disciplines*, edited by S. Settar and R. Korisettar, pp. 247–364. Publications of the Indian Council for Historical Research. Oxford and IBH, New Delhi.
Fuller, D. Q.
2003a African Crops in Prehistoric South Asia: A Critical Review. In *Food, Fuel and Fields. Progress in African Archaeobotany*, edited by K. Neumann, A. Butler, and S. Kahlheber, pp. 239–271. Heinrich Barth Institut, Cologne.
Fuller, D. Q.
2003b Further Evidence on the Prehistory of Sesame. In *Asian Agri-History* 7:127–137.
Fundter, J. M., N. R. de Graaf, and J. W. Hildebrand
1992 Terminalia chebula Retz. In *Plant Resources of South-East Asia 3: Dye and Tannin-Producing Plants*, edited by R. H. M. J. Lemmens and N. Wulijarni-Soetjipto, pp. 122–125. Pudoc, Wageningen, Germany.
Genderen van, H., and L. M. Schoonhoven
1996 *Chemisch-ecologische flora van Nederland en België. Een inleiding over aard en ecologische betekenis van secundaire plantestoffen*. KNNV, Utrecht, Netherlands.
Germer, R.
1985 *Flora des pharaonischen Ägypten*. Verlag Philipp von Zabern, Mainz, Germany.
Germer, R.
1988 *Katalog der Altägyptischen Pflanzenreste der Berliner Museen*. Otto Harrassowitz, Wiesbaden, Germany.
Germer, R.
1989 Die Pflanzenmaterialien aus dem Grab des

Tutanchamun. *Hildesheimer Ägyptologische Beiträge* 28:1–94.

Girgis, W. A.
1971 Plant Indicators in the Egyptian Desert. *The Desert Institute Bulletin, A.R.E.* 21:511–525.

Grant, M.
2000 *Galen on Food and Diet*. Routledge, London.

Grieve, M.
1931 *A Modern Herbal*. Reprint 1994. Tiger Books International, London.

Gunn, C.
1991 Fruits and Seeds of Genera in the Subfamily Caesalpinioideae (Fabaceae). *U.S.D.A. Agricultural Research Service, Technical Bulletin* 1755:1–408.

Gupta, S. M.
1991 [1971] *Plant Myths and Tradition in India*. 2nd edition. Munshiram Manoharlal Publishers, New Delhi.

Haagsma, D.
1997 *The Horticultural Sector in Egypt*. Ministry of Agriculture, Nature Management and Fisheries, Dept. for Trade and Industries, The Hague, Netherlands.

Haar ter, A. A.
1915 *Stroo en kaf als voeder.* Leiter-Nypels, Maastricht, Netherlands.

Hagedorn, D.
1975 Zum Anbauverbot von ἰσάτις, ὀχομένιον und κνῆκος. *Papyrologiek und Epigraphik*: 85–90.

Hancock, J. F.
1992 *Plant Evolution and the Origin of Crop Species*. Prentice Hall, Upper Saddle River, New Jersey.

Harlan, J. R.
1992 *Crops & Man*. 2nd edition. American Society of Agronomy,Inc. and Crop Science Society of America, Inc., Madison, Wisconsin.

Harlan, J. R.
1993 The Tropical African Cereals. In *The Archaeology of Africa. Food, Metals and Towns*, edited by T. Shaw, P. Sinclair, B. Andah, and A. Okpoko, pp. 53–60. Routledge, London.

Harrell, J. A.
1996 *Geology*. In Berenike 1995, pp. 99–126.

Harrell, J. A.
1998 *Geology*. In Berenike 1996, pp. 121–148.

Hayes, J. W.
1996 *The Pottery*. In Berenike 1995, pp. 147–178.

Hayes, W. B.
1957 *Fruit Growing in India*. 3rd revised edition. Vanguard Press, Allahabad, India.

Henrard, J. T.
1932 *A Monograph of the Genus Aristida*: *2* Drukkerij H. Buurman, Leyden, Netherlands.

Hepper, F. N.
1990 *Pharaoh's Flowers. The Botanical Treasures of Tutankhamun*. Kew Gardens, London.

Hepper, F. N.
1992 *Illustrated Encyclopedia of Bible Plants*. Inter Varsity Press, Leicester, England.

Herodotus
n.d. *Histories*. Harvard University Press (The Loeb Classical Library), Cambridge, Massachusetts.

Hillman, G. C.
2001 Archaeology, Percival, and the Problems of Identifying Wheat Remains. In *Wheat Taxonomy: The Legacy of John Percival*, edited by P. D. S. Caligari and P. E. Brandham, pp. 27–36. Special issue no. 3. The Linnean Society of London, London.

Hillman, G. C., S. Mason, D. de Moulins, and M. Nesbitt
1996 Identification of Archaeological Remains of Wheat: The 1992 London Workshop. *Circaea* 12:195–209.

Hjelmqvist, H.
1972 A Find of *Nelumbo nucifera* from Old Cyperus. with Some Notes on the History of the Species. *Botaniska Notiser* 125:383–388.

Hobbs, J. J.
1990 *Bedouin Life in the Egyptian Wilderness*. American University in Cairo Press, Cairo.

Hohmann, B., and F. Deutschmann
1989 *Mikroskopische Untersuchung pflanzlicher Lebensmittel*. Gustav Fischer Verlag, Stuttgart, Germany.

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

Hooker, J. D.
1990 [1879] *Flora of British India*. Vol 2. Reprint. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

Horne, L.
1994 *Village Spaces. Settlement and Dociety in Northeastern Iran*. Smithsonian Institution Press, Washington, District of Columbia.

Hourani, G. F.
1995 [1951] *Arab Seafaring in the Indian Ocean in Ancient and Early Medieval Times*. Princeton University Press, Princeton, New Jersey.

Jabbur, J. S.
1995 *The Bedouins and the Desert. Aspects of Nomadic Life in the Arab East*. State University of New York Press, Albany, New York.

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, M. Reddé, and C. Boutantin, pp. 60–68. Ville de Biesheim, Biesheim, France.

Jain, S. K.
1968 *Medicinal Plants*. 6th Edition 1996. National Book Trust, New Delhi.

Jain, S. K., and D. K. Banerjee
1974 Preliminary Observations on the Ethnobotany of the Genus Coix. *Economic Botany* 28:38–42.

Jansen, P. C. M.
1981 *Spices, Condiments and Medicinal Plants in Ethiopia, Their Taxonomy and Agricultural Significance*. Pudoc, Wageningen, Germany.

Johnson, D. J.
1987 *Nabataean Trade: Intensification and Culture Change*. PhD dissertation, University of Utah, Salt Lake City. U.M.I. Dissertation Information Service, Ann Arbor, Michigan.

Kajale, M. D.
1977 Ancient Grains from Excavations at Nevasa, Maharashtra. *Geophytology* 7:98–106.

Kajale, M. D.
1991 Current Status of Indian Palaeoethnobotany: Introduced and Indigenous Food Plants with a Discussion of the Historical and Evolutionary Development of Indian Agriculture and Agricultural Systems in General. In *New Light on Early Farming. Recent Developments in Palaeobotany*, edited by J. M. Renfrew, pp. 155–189. Edinburgh University Press, Edinburgh.

Kajale, M.D.
1994 Archaeobotanical Investigations on a Multicultural Site at Adam, Maharasthra, with Special Reference to the Development of Tropical Agriculture in Parts of India. In *Tropical Archaeobotany. Applications and New Developments*, edited by J. G. Hather, pp. 34–50. Routledge, London.

Kajale, M. D.
1996 Neolithic Plant Economy in Parts of Lower Deccan and South India. In *Abstracts: The Sections of the XIII Int. Congress on Prehistoric and Protohistoric Sciences, Forli (Italia), 8–14 Sept. 1996*, edited by O. Bar-Yosef, L. Cavalli-Sforza, R. J. March, and M. Piperno, pp. 67–70. Forli, Italy.

Kamal, H.
1975 *Encyclopædia of Islamic Medicine with a Greco-Roman Background*. General Egyptian Book Organization, Cairo.

Karttunen, K.
1997 India and the Hellenistic World. In *Studia Orientalia*, edited by the Finnish Oriental Society 83: 1–439.

Kay, D .E.
1979 *Food Legumes*. Tropical Products Institute, London.

Kearny, J., and J. Smartt
1995 The Grasspea. In *Evolution of Crop Plants*, edited by J. Smartt and N. W. Simmonds, pp. 266–270. Longman, London.

Keimer, L.
1967 [1924] *Die Gartenpflanzen im alten Ägypten*. Band I. Georg Olms Verlagsbuchhandlung, Hildesheim, Germany.

Keimer, L.
1984 *Die Gartenpflanzen im alten Ägypten*. Band ll. Herausgegeben von R. Germer. Verlag Philipp von Zabern, Mainz, Germany.

Kemp, P. R.
1989 Seed Banks and Vegetation Processes in Deserts. In *Ecology of Soil Seed Banks*, edited by M. A. Leck, V. T. Parker, and R. L. Simpson, pp. 257–281. Academic Press, London.

Kent, M., and P. Coker
1992 *Vegetation Description and Analysis. A Practical Approach*. CRC Press, Boca Raton, Florida.

Kislev, M. E.
1988 Pinus pinea in Agriculture, Culture and Cult. In *Der prähistorische Mensch und seine Umwelt. Festschrift für U. Körber-Grohne zum 65. Geburtstag*. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg, Band 31, edited by H. Küster, pp. 73–97. Kommissionsverlag-Konrad Theiss Verlag, Stuttgart, Germany.

Klichowska, M.
1983 Neolithic Traces of Tropical Cereals and Other Cereal Grasses from the Excavations in Sudan. *Sprawozdania Archeologiezne* 34:83–86.

Konen, H.
1999 Reis im Imperium Romanum. Bemerkungen zu seinum Anbau und seiner Stellung als Bedarfs- und Handelsartikel in der Römischen Kaiserzeit. *Münsterche Beiträge zur antiken Handelsgeschichte* 18:23–47.

Knörzer, K. H.
1970 *Römerzeitliche Pflanzenfunde aus Neuss*. Gebr. Mann, Berlin.

Körber-Grohne, U.
1996 *Pflaumen, Kirschpflaumen, Schlehen. Heutige Pflanzen und ihre Geschichte seit der Frühzeit*. Theiss, Stuttgart, Germany.

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.

Kroll, H.
1999 Literature on Archaeological Remains of Cultivated Plants (1997/1998). *Vegetation History and Archaeobotany* 8:129–163

Kroll, H.
2000 Literature on Archaeological Remains of Cultivated Plants (1998/1999). *Vegetation History and Archaeobotany* 9:31–68

Kroll, H.
2001 Literature on Archaeological Remains of Cultivated Plants (1999/2000). *Vegetation History and Archaeobotany* 10:33–60

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

Kučan, D.
1995a Zur Ernährung und dem Gebrauch von Pflanzen im Heraion von Samos im 7. Jahrhundert v. Chr. *Jahrbuch des Deutschen Archäologischen Institutut*, Band 110:1–64.

Kučan, D.
1995b Ein Beitrag zur Geschichte der Kulturpflanzen in Bosnien mit neuen Funden aus der früheisenzeitlichen Wallburg Klisura Kadiëa Brdo bei Sokolac. *Probleme der Küstenforschungen* 23:153–173.

Küster, H.
1995 *Postglaziale Vegetationsgeschichte Südbayerns Geobotanische Studien zur Prähistorischen Landschaftskunde*. Akademie Verlag GmbH, Berlin.

Langer, R. H. M., and G. D. Hill
1982 *Agricultural Plants*. Cambridge University Press, Cambridge, New York.

Leisten, T.
1993 Die Gärten der islamischen Welt. In *Die Gärten des Islam*, edited by H. Forkl, J. Kalter, T. Leisten, and M. Pavaloi, pp. 60–76. Staib & Mayer, Stuttgart, Germany.

Lemmens, R. H. M. J., and P. C. Wessel-Riemens
1992 Indigofera. In *Plant Resources of South-East Asia 3: Dye and Tannin-Producing Plants*, edited by R. H. M. J. Lemmens and N. Wulijarni-Soetjipto, pp. 81–83. Pudoc, Wageningen, Germany.

Lemmens, R. H. M. J., N. Wulijarni-Soetjipto, R. P. van der Zwan, and M. Parren
1992 Introduction. In *Plant Resources of South-East Asia 3: Dye and Tannin-Producing Plants*, edited by R H. M. J. Lemmens and N. Wulijarni-Soetjipto, pp. 15-34. Pudoc, Wageningen, Germany.

Lentini, A. and G. Scala
2003 Rigging from Ships in San Rossore, Pisa: Identification of Textile Fibres, Weave Materials. Characterisation of Leather Tanning Technology. *Restoration and Conservation* 20: 10–22.

Letschert, J. P. W.
1993 Beta Section Beta: Biogeographical Patterns of Variation and Taxonomy. *Wageningen Agricultural University Papers* 93 (1): 1–155.

Lucas, A., and J. R. Harris
1962 *Ancient Egyptian Materials and Industries*. Reprint 1989. Histories and Mysteries of Man, London.

Macarthur, J.
1993 Misleading Names. In *Spicing Up the Palate. Studies in Flavourings. Ancient and Modern. Proceedings of the Oxford Symposium on Food and Cookery 1992*, edited by H. Walker, pp. 173–177. Prospects Books, Blackawton, England.

McCrindle, J. W.
1979 Ancient India as Described in Classical Literature. Oriental Books Reprint Corporation (reprinted from Westminster 1901), New Delhi.

McLaren, F .S.
1995 Plums from Douara Cave, Syria: The Chemical Analysis of Charred Stone Fruits. In *Res Archaeobotanicae. Proceedings of the 9th Symposium in Kiel 1992*, edited by H. Kroll and R. Pasternak, pp. 195–216. Oetker-Voges-Verlag, Kiel, Germany.

Maesen van der, L. J. G.
1972 Cicer, a Monograph of the Genus, with a Special Reference to the Chickpea (Cicer arietinum L.), Its Ecology and Cultivation. *Mededelingen Landbouwhogeschool Wageningen* 10:1–342.

Maesen van der, L. J. G.
1979 Genetic Resources of Grain Legumes in the Middle East. In *Food Legume Improvement and Development*, edited by G. C. Hawtin and G. J. Chancellor, pp. 140–146. IDRC, Ottawa, Canada.

Maier, U.
1996 Morphological Studies of Free-Threshing Wheat Ears from a Neolithic Site in Southwest Germany, and the History of the Naked Wheats. *Vegetation History and Archaeobotany* 5:39–55.

Mallebrein, C. (editor)
1993 *Die anderen Götter. Volks-und Stammesbronzen aus Indien*. Braus, Cologne.

Mandaville, J. P.
1990 *Flora of Eastern Saudi Arabia*. Kegan Paul International, London.

Manniche, L.
1989 *An Ancient Egyptian Herbal*. University of Texas Press, Austin.

Marnival, P.
1993 Etude carpologique d'offrandes alimentaires végétales dans les sépultures gallo-romaines: réflexions préliminaires. In *Monde des morts, monde des vivants en Gaule rurale. Actes du Colloque Archea/Ager (Orléans, 7–9 février 1992)*, edited by A. Ferdière, pp. 45–65.

Maydell von, H.-J.
1990 [1986] *Trees and Shrubs of the Sahel. Their Characteristics and Uses*. Verlag Josef Margraf, Weikersheim, Germany.

Mazzarino, S.
1997 On the Name of the Hipalus (Hippalus) Wind in Pliny. In *Crossings. Early Mediterranean Contacts with India*, edited by F. de Romains and A. Tchernia, pp. 72–79. Manohar, New Delhi.

Meiggs, R.
1998 *Trees and Timber in the Ancient Mediterranean World*. Oxford University Press, New York.

Meijer, F., and O. van Nijf
1992 *Trade, Transport and Society in the Ancient World*. Routledge, London.

Meijers, H. J. M.
1998 *Finds' Conservation*. In Berenike 1996, pp. 403–413.

Menninger, E. A.
1977 *Edible Fruits of the World*. Horticultural Books Inc., StuartFlorida.

Menon, K. P. V., and K. M. Pandalai
1958 *The Coconut Palm. A Monograph*. Times of India Press, Bombay.

Miller, J. I.
1998 *The Spice Trade of the Roman Empire*. Reprint. At the Clarendon Press, Oxford, England.

Miller, A. G., and T. A. Cope
1996 *Flora of the Arabian Peninsula and Socotra*. Vol. 1. Edinburgh University Press, Edinburgh.

Moeller, J.
1905 *Mikroskopie der Nahrungs- und Genussmittel aus dem Pflanzenreich*. Verlag von Julius Springer, Berlin.

Murray, M. A.
1999 Wine Production and Consumption in Pharaonic Egypt. In *The Exploitation of Plant Resources in Ancient Africa*, edited by M. van der Veen, pp. 149–169. Kluwer Academic/Plenum, New York.

Murray, M. A.
2000 Fruits, Vegetables, Pulses and Condiments. In *Ancient Egyptian Materials and Technology*, edited by P. T. Nicholson and I. Shaw, pp. 609–655. Cambridge University Press, Cambridge.

Nash, M. J.
1985 *Crop Conservation and Storage in Cool Temperate Climates*. Pergamon Press, Oxford, England.

Nassib, A. M., A. Rammah, and A. H. A. Hussein
1990 The Role of Legumes in the Farming Systems of Egypt. *Developments in Plant and Soil Sciences* 8:51–61.

National Academy of Sciences
1979 *Tropical Legumes: Resources for the Future*. National Academy of Sciences, Washington, District of Columbia.

Neef, R.
1989 Planten. In *Een verhaal voor het oprapen. Opgravingen te Deir Alla in de Jordaanvallei*, edited by G. van der Kooij and M. M. Ibrahim, pp. 30–37. Rijksmuseum van Oudheden, Leyden, Netherlands.

Neef, R., and S. Bottema
1991 Mest als bron voor verkoold plantaardig materiaal uit opgravingen in het Nabije Oosten. Waarnemingen en experimenten. *Paleo-Aktueel* 2:72–76.

Neer van, W., and A. Lentacker
1996 *The Faunal Remains*. In Berenike 1995, pp. 337–355.

Neer van, W., and A. Ervynck
1998 *The Faunal Remains*. In Berenike 1996, pp. 349–388.

Neer van, W., and A. Ervynck
1999a *The Faunal Remains*. In Berenike 1997, pp. 325–348.

Neer van, W., and A. Ervynck
1999b *The Faunal Remains from Shenshef and Kalalat*. In Berenike 1997, pp. 431–444.

Oedekoven, K. H.
1970 United Arab Republic. In *Afforestation in Arid Zones*, edited by R. N. Kaul, pp. 86–97. W. Junk N.V., The Hague, Netherlands.

Ohler, J. G.
1989 Cocos nucifera L. In *Plant Resources of South-East Asia: A Selection*, edited by E. Westphal and P. C. M. Jansen, pp. 90–95. Pudoc, Wageningen, Germany.

Orta da, G.
1987 *Colloquies on the Simple and Drugs of India*. Reprint. Mehra Offset Press, Delhi, India.

Osborne, D. J.
1968 Notes on Medicinal and Other Uses of Plants in Egypt. *Economic Botany* 22:165–177.

Palladius
n.d. *Gentibus Indiae et Bragmanibus*.

Peacock, D.
1993 The Site of Myos Hormos: A View from Space. In *Journal of Roman Archaeology* 6:226–232.

Petrucci-Bavaud, M., and S. Jacomet
1997 Zur Interpretation von Nahrungsbeigaben in römerzeitlichen Brandgräbern. *Ethnographisch-Archäologische Zeitschrift* 38:567–593.

Philostratus
1960 [1912] *The Life of Apollonius of Tyana*. With an English translation by F. C. Conybeare. Harvard University Press, London.

Pliny
n.d. *Natural History*. Harvard University Press (The Loeb Classical Library), Cambridge, Massachusetts.

Plu, A.
1985 Bois et graines. In *La momie de Ramsès II*, edited by L. Balout and C. Roubet, pp. 166–174. Éditions Recherche sur les Civilisations, Paris.

Prestel, P.
2004 Die Lebenselixiere der Pharaonen. In *Heilwissen versunkener Kulturen. Im Bann der grünen Götter*, edited by G. Graichen, pp. 22–81. Econ Verlag, München (Munich).

Purseglove, J. W.
1968 *Tropical Crops. Dicotyledons 2*. Longmans, Green, London.

Rahman, M. S.
1999 Purpose of Food Preservation and Processing. In *Handbook of Food Preservation*, edited by M. S. Rahman, pp. 1–10. Marcel Dekker, New York.

Raimondi, J.
1923 *Le Désert Oriental Egyptien*. Mémoires de la Société Royale de Géographie D'Egypte. Institut Français d'Archéologie Orientale, Cairo.

Rawlison, G.
1881 *History of Ancient Egypt*. 2 volumes. J. B. Alden, New York.

Ray, H. P.
1994 *The Winds of Change. Buddhism and the Maritime Links of Early South Asia*. Oxford University Press, Delhi, India.

Rickman, G.
1971 *Roman Granaries and Store Buildings*. University Press, Cambridge, England.

Rickman, G.
1996 *The Corn Supply of Ancient Rome*. Clarendon Press, London.

Ridley, H. N.
1983 *Spices*. Reprint: International Book Distributors, Dehra Dun, India.

Ridley, H. N.
1990 *The Dispersal of Plants Throughout the World*. Reprint. Otto Koeltz Science, Koenigstein, Germany.

Roelfsema, H. R.
1916 *De kokos-cultuur*. H. D. Tjeenk Willink & Zoon, Haarlem, Netherlands.

Romanis de, F.
1997 Rome and the Nótia 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. Manohar, New Delhi.

Rowley-Conwy, P., W. Deakin, and C. H. Shaw
1999 Ancient DNA from Sorghum. The Evidence from Qasr Ibrim, Egyptian Nubia. In *The Exploitation of Plant Resources in Ancient Africa*, M. van der Veen, pp. 55–61. Kluwer Academic/Plenum, New York.

Rutten, A. M. G.
1997 *Ondergang in bedwelming. Drugs en giften in het West-Romeinse Rijk*. Erasmus, Rotterdam, Netherlands.

Samuel, D.
1995 Umbellifer Fruits (Trachyspermum copticum [L.] Link.) from the Workmen's Village. In *Amarna Reports* VI, edited by B. J. Kemp, pp. 372-383. The Egyptian Exploration Society, London.

Sanden van der, W.
1997 *Through Nature to Eternity. The Bog Bodies of Northwest Europe*. Batavian Lion International, Amsterdam.

Sandy, D. B.
1989 The Production and Use of Vegetable Oils in Ptolemaic Egypt. *Bulletin of the American Society of Papyrologists*. Suppl. no. 6:1–136.

Schaik, Van-van Banning, A. J. J.
1992 Phyllanthus emblica L. In *Plant Resources of South-East Asia* 3*: Dye and Tannin-Producing Plants*, edited by R. H. M. J. Lemmens and N. Wulijarni-Soetjipto, pp. 106–108. Pudoc, Wageningen, Germany.

Schienerl, P. W.
1992 *Dämonenfurcht und böser Blick: Studien zum Amulettwesen*. Analo Verlag, Aachen, Germany.
Schoff, W. H.
1995 *The Periplus of the Erythraean Sea. Travel and Trade in the Indian Ocean by a Merchant of the First Century*. Reprint. Munshiram Manoharlal, New Delhi.
Schuiling, M., and H. C. Harries
1992 The Coconut Palm in East Africa. *The Palm Enthusiast* 9:22–35.
Schuster, W. H.
1992 *Ölpflanzen in Europa*. DLG-Verlag, Frankfurt, Germany.
Schwartz, O.
1939 Flora des tropischen Arabien. *Mitteilungen aus dem Institut für allgemeine Botanik in Hamburg* 10:1–393.
Schweinfurth, G.
1865a Reise an der Küste des Rothen Meeres von Kosser bis Suakin. *Zeitschrift für Allgemeine Erdkunde* 18:131–150, 283–313, and 321–384.
Schweinfurth, G.
1865b Dr. G. Schweinfurth's Ausflüge um Kosser. *Verhandlungen der Kaiserlich-Königliche zoologisch-botanische Gesellschaft* 15:267–280.
Schweinfurth, G.
1865c Flora des Soturba an der nubischen Küste. *Verhandlungen der Kaiserlich-Königlichen zoologisch-botanische Gesellschaft* 15:537–560.
Schweinfurth, G.
1865d Vier Briefe des dr. Schweinfurth. *Zeitschrift für Allgemeine Erdkunde* 18:305–314.
Schweinfurth, G.
1894–99 Sammlung arabisch-aethiopischer Pflanzen. Ergebnisse von Reisen in den Jahren 1881, 88, 89, 91, und 92. *Bulletin de l'Herbier Boissier* 2 app. II:1–340.
Schwinden, L.
1983 Handel mit Pfeffer und anderen Gewürzen im römischen Trier. *Kurtrierischen Jahrbuch* 23:20–26.
Seegeler, C. J. P.
1983 Oil Plants in Ethiopia, their Taxonomy and Agricultural Significance. *Belmontia* 16:1–368.
Sidebotham, S. E.
1991 Ports of the Red Sea and the Arabia-India Trade. In *Rome and India. The Ancient Sea Trade*, edited by V. Begley and R. D. de Puma, pp. 12–38. The University of Wisconsin Press, Madison.
Sidebotham, S. E.
1995a *Historical Sources*. In Berenike 1994, pp. 5–11.
Sidebotham, S. E.
1995b *Survey of the Hinterland*. In Berenike 1994, pp. 85–101.
Sidebotham, S. E.
1996 *The Excavations*. In Berenike 1995, pp. 7–97.
Sidebotham, S. E.
1998 *The Coins*. In Berenike 1996, pp. 181–192.
Sidebotham, S. E.
1999 *The Excavations*. In Berenike 1997, pp. 3–94.
Sidebotham, S. E.
2000 *Survey of the Hinterland*. In Berenike 1998, pp. 355–377.
Sidebotham, S. E., and W. Z. Wendrich
1995 *Interpretative Summary and Conclusion*. In Berenike 1994, pp. 103–106.
Sidebotham, S. E., and W. Z. Wendrich
1998 Berenike: Archaeological Fieldwork at a Ptolemaic-Roman Port on the Red Sea Coast of Egypt: 1994–1998. *Sahara* 10:85–96.
Sidebotham, S. E., W. Z. Wendrich, and A. M. Hense
1996 *Statuary and Cult Objects*. In Berenike 1995, pp. 229–243.
Sidebotham, S. E., and R. E. Zitterkopf
1996 *Survey of the Hinterland*. In Berenike 1995, pp. 357–409.
Sidebotham, S. E., and W. Z. Wendrich (editors)
1994 *Preliminary Report of the Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert*. CNWS, 1995, Leiden, Netherlands.
Sidebotham, S. E., and W. Z. Wendrich (editors)
1995 *Preliminary Report of the Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert*. CNWS, 1996, Leiden, Netherlands.
Sidebotham, S. E., and W. Z. Wendrich (editors)
1996 *Preliminary Report of the Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert*. CNWS, 1998, Leiden, Netherlands.
Sidebotham, S. E., and W. Z. Wendrich (editors)
1997 *Report of the1997 Excavations at Berenike and the Survey of the Eastern Desert, including excavations at Shenshef*. CNWS, 1999, Leiden, Netherlands.
Sidebotham, S. E., and W. Z. Wendrich (editors)
1998 *Report of the1998 Excavations at Berenike and the Survey of the Eastern Desert, including excavations at Wadi Kalalat*. CNWS, 2000, Leiden, Netherlands.
Smid, E. J., and L. G. M. Gorris
1999 Natural Antimicrobials for Food Preservation. In *Handbook of Food Preservation*, edited by M. S. Rahman, pp. 285–308. Marcel Dekker, New York.

Smith, W.
1998 Fuel for Thought: Archaeobotanical Evidence for the Use of Alternatives to Wood Fuel in Late Antique North Africa. *Journal of Mediterranean Archaeology* 11:191–205.

Smith, W.
2003 *Archaeobotanical Investigations of Agriculture at Late Antique Kom el-Nana (Tell el-Amarna)*. Burlington Press, London.

Soderstrom, T. R.
1969 Impressions of Cereals and Other Plants in the Pottery of Hajar Bin Humeid, App. II. In *Hajar Bin Humeid: Investigations at a Pre-Islamic Site in South Arabia*, edited by G. W. van Beek, pp. 399–407. Johns Hopkins, Baltimore, Maryland.

Solomon, J.
1995 The Apician Sauce—Ius Apicianum. In *Food in Antiquity*, edited by J. Wilkinns, D. Harvey and M. Dobson, pp. 115–131. University of Exeter Press, Exeter, England.

Springuel, I.
1997 Vegetation, Land Use and Conservation in the South Eastern Desert of Egypt. In *Reviews in Ecology: Desert Conservation and Development. A Festschrift for Prof. M. Kassa on the Occasion of His 75th Birthday*, edited by H. N. Barakat and A. K. Hegazy, pp. 177–206. Metropole, Cairo.

Stika, H.-P., and K.-S. Frank
1989 Die Kirschpflaume: Systematik, Morphologie, Verbreitung, Verwendung, Genetik und archäologische Funde. In *Der prähistorische Mensch und seine Umwelt. Festschrift für U. Körber-Grohne zum 65. Geburtstag.* Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg, Band 31, edited by H. Küster, pp. 65–71. Kommissionsverlag-Konrad Theiss Verlag, Stuttgart, Germany.

Strabo
n.d. *Geography*. Harvard University Press (The Loeb Classical Library), Cambridge, Massachusetts.

Täckholm, V.
1961 Botanical Identifications of the Plants Found at the Monastery of Phoebammon. In *Le Monastère de Phoebammon dans la Thébaïde*. Tombe lll, edited by C. Bachatly, pp. 1–38. La Société d'Archéologie Copte, Cairo.

Täckholm, V.
1974 *Students' Flora of Egypt*. Cairo University, Cairo.

Täckholm, V., and M. Drar
1950 *Flora of Egypt*. Vol 2. Fouad I University Press, Cairo.

Täckholm, V., G. Täckholm, and M. Drar
1941 *Flora of Egypt*. Vol 1. Fouad I University Press, Cairo.

Tannahill, R.
1973 *Food in History*. 2nd edition, 1988. Clays, London.

Ter Haar, A. A. *See* Haar ter, A.A.

Theophrastus
n.d. *Concerning Odours*. Harvard University Press (The Loeb Classical Library), Cambridge, Massachusetts.

Theophrastus
n.d. *Enquiry into Plants*. Harvard University Press (The Loeb Classical Library), Cambridge, Massachusetts.

Thorne, S.
1986 *The History of Food Preservation*. Totowa, Paterson, New Jersey.

Thulin, M., and P. Claeson
1991 The Botanical Origin of Scented Myrrh (Bissabol or Habak Hadi). *Economic Botany* 45:487–494.

Tomber, R. S.
1999 *The Pottery*. In Berenike 1997, pp. 123–159.

Tosi, M., and G. Gerster
1983 Shahr-i-Sokhta: 5000 Jahre städtische Kultur in der Seistan-Wüste. *Bild der Wissenschaft* 10:46–50, 54, 58–59, 62.

Townsend, C. C., and E. Guest
1980 *Flora of Iraq*. Vol. 4: Cornaceae to Resedaceae. Robert MacLehose, Glasgow .

Townsend, C. C., and E. Guest
1985 *Flora of Iraq*, Vol. 8: Monocotyledones Excluding Gramineae. The Whitefriars Press, Tonbridge, England.

Tucker, A. O.
1986 Frankincense and Myrrh. *Economic Botany* 40:425–433.

Untracht, O.
1997 *Traditional Jewelry of India*. Harry N. Abrams, New York.

Usmanghani, K., G. Honda, and W. Miki
1986 Herb Drugs and Herbalists in Pakistan. *Studia Culturae Islamicae* 28:1–281.

Van der Maesen, L. G. J. *See* Maesen van der, L. G. J.

Van der Sanden, W. *See* Sanden van der, W.

Van der Veen. *See* Veen van der, M.

Van Genderen, H. *See* Genderen van, H.

Van Neer, W. *See* Neer van, W.

Van Winter, J. M. *See* Winter van, J. M.

Van Zeist, W. *See* Zeist Van, W.

Vartavan de, C., and V. A. Amorós
1997 *Codex of Ancient Egyptian Plant Remains*. Triade Exploration, London.

Veen van der, M.
1996 The Plant Remains from Mons Claudianus, a Roman Quarry Settlement in the Eastern Desert, Egypt. An interim report. *Vegetation History and Archaeobotany* 5:137–141.

Veen van der, M.
2003 Trade and Diet at Roman and Medieval Quseir al-Qadim, Egypt. A preliminary report. In *Food, Fuel and Fields. Progress in African Archaeobotany*, edited by K. Neumann, A. Butler, and S. Kahlheber, pp. 207–212. Heinrich Barth Institut, Cologne.

Veen van der, M.
2004 The Merchants' Diet: Food Remains from Roman and Medieval Quseir al-Qadim. In *Trade and Travel in the Red Sea Region. Proceedings of Red Sea Project*, edited by P. Lunde and A. Porter, pp. 123-130. BAR International Series 1269. British Archaeological Reports, Oxford.

Veen van der, M., and S. Hamilton-Dyer
1998 A Life of Luxury in the Desert? The Food and Fodder Supply to Mons Claudianus. *Journal of Roman Archaeology* 11:101–116.

Vehling, J. D.
1977 *Apicius Cookery and Dining in Imperial Rome*. Reprint. Dover, New York.

Vermeeren, C.
1998 *Wood and Charcoal*. In Berenike 1996, pp. 331–348.

Vermeeren, C.
1999a *Wood and Charcoal*. In Berenike 1997, pp. 307–324.

Vermeeren, C.
1999b *Wood and Charcoal* from Shenshef. In Berenike 1997, pp. 427–429.

Vermeeren, C.
2000 *Wood and Charcoal*. In Berenike 1998, pp. 311–342.

Von Maydell, H.-J. *See* Maydell von, H.-J.

Waard de, P. W. F.
1989 Piper nigrum L. In *Plant Resources of South-East Asia. A Selection*, edited by E. Westphal and P. C. M. Jansen, pp. 225–230. Pudoc, Wageningen, Germany.

Waisel, Y., and S. Ovadia
1971 Biological Flora of Israel 3: Suaeda monoica Forssk. ex J. F. Gmel. *Israel Journal of Botany* 21:42–52.

Waller, J. M., and J. E. M. Mordue
1983 *CMI Descriptions of Pathogenic Fungi and Bacteria. Ustilago hordei*. Commonwealth Agricultural Bureaux, *Cambridge News* (Aberystwyth), no. 749, Cambridge, England.

Walter, H.
1983 *Vegetation of the Earth and Ecological Systems of the Geo-biosphere*. 2nd edition. 1st reprint. Springer Verlag, Berlin.

Walter, H.
1986 The Namib Desert. In *Ecosystems of the World 12b: Hot Deserts and Arid Shrublands*, edited by M. Evenari and I. Noy-Meir, pp. 245–282. Elsevier, Amsterdam.

Warfa, A. M.
1990 Taxonomy and Distribution of Cordia sinensis and C. nevillii (Boraginaceae), a Widespread Species Pair in Africa and Asia. *Nordic Journal of Botany* 9:649–656.

Warmington, E. H.
1995 *The Commerce Between the Roman Empire and India*. Reprint. Munshiran Manoharlal, New Delhi.

Wasylikowa, K.
1998 Flora of the 8,000 Year—Old-Archaeological Site E-75-6 at Nabta Playa, Western Desert, Southern Egypt. *Acta Palaeobotanica* 37:99–205.

Weir, S.
1990 *The Bedouin*. British Museum Publications, London.

Weiss, E. A.
1971 *Castor, Sesame & Safflower*. Leonard Hill, London.

Wendrich, W. Z.
1999 Fringes Are Anchored in Warp and Weft: The Relations Between Berenike, Shenshef and the Nile Valley. In *Life on the Fringe. Living in the Southern Egyptian Deserts During the Roman and Early Byzantine Periods*, edited by O. E. Kaper, pp. 243–251. CNWS, Leyden, Netherlands.

Westphal, E.
1974 Pulses in Ethiopia, Their Taxonomy and Agricultural Significance. *Agricultural Research Reports* 815:1–276.

Wetterstrom, W.
n.d. *Plant Remains from Quseir al-Qadim: The 1982 Campaign*. Preprint.

Wetterstrom, W.
1982 Plant Remains. In *Quseir Al-Qadim 1980. American Research Center in Egypt Reports*, edited by D. S. Whitcomb and J. H. Johnson, pp. 355–377.

Wetterstrom, W.
1984 The Plant Remains. In *Archaeological Investigations at el-Hibeh 1980: Preliminary Report*, edited by R. J. Wenke, pp. 50–79. Undena, Malibu, California.

Whitcomb, D. S., and J. H. Johnson
1982 *Quseir al-Qadim 1980 Preliminary Report (American Research Center in Egypt Reports*, Vol. 7). Undena, Malibu, California.

Wiersema, J. H., and B. León
2000 *World Economic Plants: A Standard Reference*. CRC Press, London.
Wilde-Duyfjes de, B. E. E.
1976 A Revision of the Genus Allium L. (Liliaceae) in Africa. *Mededelingen Landbouwhogeschool Wageningen* 76:1–239.
Winter van, J. M.
1987 The Role of Preserved Food in a Number of Medieval Households in the Netherlands. In *Food Conservation*, edited by A. Riddervold and A. Ropeid, pp. 56–72. Prospect Books, London.
Woenig, F.
1971 *Die Pflanzen im alten Aegypten*. Reprint. Philo Press, Amsterdam.
Woldring, H.
2000 On the Origin of Plums: A Study of Sloe, Damson, Cherry Plum, Domestic Plums and Their Intermediate Forms. *Palaeohistoria* 39/40:535–562.
Wood, J. R. I.
1998 *A Handbook of the Yemen Flora*. Royal Botanical Gardens, Kew, England.
Wrigley, G.
1995 Date Palm, *Phoenix dactylifera*. In *Evolution of Crop Plants*, 2nd edition, edited by J. Smartt and N. W. Simmonds, pp. 399–403. Longman, London.
Yajima, H.
1976 The Arab Dhow Trade in the Indian Ocean. *Studia Culturae Islamicae* 3:1–58
Zahran, M. A.
1965 Distribution of the Mangrove Vegetation in U.A.R. (Egypt). *Bulletin de l'Institute du desert d'Egypte* 15:7–12.
Zahran, M. A., and A. J. Willis
1992 *The Vegetation of Egypt*. Chapman & Hall, London.
Zeist, W. van, and J. Vynckier
1984 Palaeobotanical Investigations of Tell ed-Der. In *Tell ed-Der IV, Progress Reports*, 2nd series, edited by L. de Meyer, pp. 119–143. Peeters, Louvain, Belgium.
Zeven, A. C., and J. M. J. de Wet
1982 *Dictionary of Cultivated Plants and Their Regions of Diversity*. Pudoc, Wageningen, Germany.
Zohary, D.
1996 The Mode of Domestication of the Founder Crops of Southwest Asian Agriculture. In *The Origins and Spread of Agriculture and Pastoralism in Eurasia*, edited by D. R. Harris, pp. 142–158. UCL Press, London.
Zohary, D., and M. Hopf
2000 *Domest*ication of Plants in the Old World. 3rd edition. University Press, Oxford.
Zohary, M.
1972 Geobotanical Foundations of the Middle East. Vol. 2. Gustav Fischer Verlag, Stuttgart, Germany.
Zohary, M.
1991 [1966] Flora Palaestina: Part 1. The Israel Academy of Sciences and Humanities, Jerusalem.

Index to Scientific Names of Bacteria, Fungi and Plants

General Index

Karachi
Karam Elba
Karanis (Kôm Aushim)
Kellis
Kerala
Kharga
Khartoum
Khesm Umm Kabu
Kolhapur
Kom Aushim
Kom el-Nana
Koptos
Kottanarikê (= Cottonara)
Lahej
Leukos Limên
Levant
Libyan Desert
Limyrikê (see also: Malabar coast)
Loyang
Luxor
Ma'adi
Madeira
Madhya Pradesh
Malabar coast (see also: Limyrikê)
Malaô (= Berbera)
Marsa Alam
Mons Claudianus
Mons Porphyrites
Mons Smaragdus
Mukha
Mundu (= Heis)
Narhan
Nelkynda
Nevasa
Nubia
Nugrus
Oberaden
Ocelis
Omana
Opone
Ostia
Palmyra
Paris
Persian Gulf
Peshawar
Petra
Philae
Philotera
Pompeii
Port Said
Portus Uterque (= Portus Traiani; Portus Claudii)
Ptolemais Thêrôn
Punjab
Punt
Puteoli (= Pozzuoli)
Qariya Mustafa 'Amr Gama
Qasr Ibrim
Qena
Qift (see also: Koptos)
Quseir al-Qadim (= Myos Hormos)
Rajputana
Ras Abu Soma
Ras Banas
Ras hadarba (Cape Elba)
Red Sea
Rhapta
Rhodes
River Pambiyar
River Danube
River Euphrates
River Ganges
River Indus
River Kisilikun
River Nile
River Pambiyar
River Rhine
River Tigres
River Yellow
Rome
Safaga
Sahara
Saqqara
Samos
Sangankallu
Senna
Sharh-i-Sokhta
Shelateen
Shenshef
Sikait
Sinai
Siwa
Skythia
Socotra
Straubing
Suakin
Surat
Susis
Syrastrênê (= Kathiawar Peninsula)
Taprobane (= Sri Lanka)
Taradih (= Bihar)
Tebtynis
Tell el-Fara'in
Tell Ibrahim Awad
Thebes
Thomna (= Asaylan)
Tunis
Turin
Tylos (= Bahrain)
Tyndis (= Ponnani)
Ur
Uttar
Wadi Aizhab
Wadi Allaqi
Wadi Ambagi
Wadi al-Rayan
Wadi el-Matuli
Wadi Gadireh
Wadi Gimal
Wadi Ibib
Wadi Mandit
Wadi Shenshef
Wadi Umm Athl
Wadi Umm el-Mandit
Xanten

During the Graeco-Roman period, Berenike served as a gateway to the outside world together with Myos Hormos. Commodities were imported from Africa south of the Sahara, Arabia, and India into the Greek and Roman Empire, the importance of both harbors evidenced by several contemporary sources. Between 1994 and 2002, eight excavation seasons were conducted at Berenike by the University of Delaware and Leiden University, the Netherlands. This book presents the results of the archaeobotanical research of the Roman deposits. It is shown that the study of a transit port such as Berenike, located at the southeastern fringe of the Roman Empire, is highly effective in producing new information on the import of all kinds of luxury items. In addition to the huge quantities of black pepper, plant remains of more than 60 cultivated plant species could be evidenced, several of them for the first time in an archaeobotanical context. For each plant species detailed information on its (possible) origin, its use, its preservation qualities, and the Egyptian subfossil record is provided. The interpretation of the cultivated plants, including the possibilities of cultivation in Berenike proper, is supported by ethnoarchaebotanical research that has been conducted over the years. The reconstruction of the former environment is based on the many wild plant species that were found in Berenike and the study of the present desert vegetation.

COTSEN INSTITUTE OF
ARCHAEOLOGY AT UCLA

ISBN: 1-931745-26-9