Along the aroma and spice routes

The harbour of Sumhuram, its territory and the trade between the Mediterranean, Arabia and India

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Introduction

Introduction

A. Avanzini

I liked the idea of publishing an easy-to-use volume to coincide with the conclusion of a project funded under PRIN 2007. It would not be restricted to specialists in the field but aim to inform a broader public of some of the more significant results achieved in these two last years of research in Sumhuram.

The scope of this volume is firstly to publish the latest results achieved by the specialists of the various fields and disciplines who have been working in Oman since the mission began and secondly to provide the starting point for future endeavours.

Two final reports and a series of articles have been published in these years; the preliminary reports published in Oman can be consulted on the mission's website (*http://arabiantica.humnet.unipi.it*).

IMTO has been working in the area of Khor Rori and in the port of Sumhuram for 15 years.

I wish to express my heartfelt thanks to His Excellency Abdulaziz al Rowas and to all the team of the Office of the Adviser to His Majesty the Sultan for Cultural Affairs for firstly allowing and then giving their support to the work carried out by the University of Pisa in the Sultanate of Oman.

The main reason I chose to work at Khor Rori was undoubtedly a personal one. The splendid position of the ruins of the ancient city, the ocean on the far horizon, the dark rocks marking the estuary of the wadi touched me deeply from my very first visit and bound me to the region.

From the outset, however, there were obviously, other, very strong scientific reasons for resuming the archaeological and historic investigation of the port of Sumhuram subsequent to the American mission of the 1950s.

I felt sure that trade in the kingdoms of south Arabia was run by the state. From the early first millennium onwards, the kingdoms governed the caravan traffic which was centralized in their respective capital cities.

The sovereigns of Saba, moving northwards, were undoubtedly the first to establish contact with Mesopotamia and with the Near East, as we know from the accounts concerning their mythical queen, and this is the reason that they are the only ancient south Arabian kingdom to be mentioned in the most ancient indirect sources.

The trading capacity of the kingdoms continued to flourish over the centuries as shipping merchandise by sea supplemented overland transportation.

Sea trade and its beginnings had always interested me but I had always had doubts as to how it had developed.

To set sail on the open seas was an enterprise that demanded skills which could not be improvised but called for lengthy training. The centre of ancient south Arabian culture, however, situated as it was at the edge of the desert alongside the northbound trade routes, seemed to have turned its back on the Red Sea and the Indian Ocean.

I deemed the idea that the great development of the overwhelmingly Roman sea trade of the early centuries AD transforming a people of camel-drivers into one of sea-goers, to be completely erroneous, and an ancient south Arabian port had to be excavated to get a more precise historic picture.

The Yemeni-Soviet mission of the 1980s had excavated Kane, the westernmost port on the ocean coast. It had been directed by A. Sedov who then, in 2000, became chief archaeologist of our mission. The sum total of experience thus accumulated paved the way towards achieving landmark results; indeed comparing the two ports, their similarities and their differences, was fundamental towards outlining the history of Sumhuram.

Again, in those years, excavations were being carried out in ports of the Red Sea and the Indian Ocean, and these also contributed towards a better understanding of the sea traffic between the Mediterranean area and India.

The vast distances involved and the technical problems in navigation make the study of maritime transport a highly evocative aspect of ancient history. There was, however, a danger of being trapped within a predominantly Rome-centric scenario that recent excavations have, instead, revealed as being more varied, with new actors involved in managing sea-traffic.

The most suitable period for studying the formation of a network of contacts that the Romans made use of in the early centuries AD is the centuries immediately prior to the birth of Christ, and before the Roman conquest of Egypt.

Sumhuram was established in the third century BC contemporaneously with the foundation of seaports on the Egyptian and Indian coasts.

Maritime traffic therefore developed earlier in south Arabia than was previously thought, and this fact has many highly significant consequences that must now be taken into account by those working in the field; the ports were the scene not only of the arrival of merchandise but of a variety of peoples, new ideas and new artistic trends.

The systematic excavation of a south Arabian city, however, is also important for studying its overall urban structure.

The life of Sumhuram was long - at least 8 centuries - and modifications to the city layout, and the creation of new defence structures must be set into their proper historic setting and explained.

Since its foundation, Sumhuram was a port for trading with far-off destinations, and the study of material imported from the Mediterranean, Egypt, Africa, the Gulf, and India opens a whole new scenario. Indeed, the contribution made by specialists in a diversified series of disciplines - archaeometrics and palynology along with a fresh look at classical sources - has proved to be extremely important. The mission has also made a substantial contribution to the training of young

scholars such as A. Pavan, field director of the mission, who in these years has acquired research skills and capabilities.
As often happens in fieldwork, the presence of younger scholars - Italian and Omani students - is stimulating for their more senior colleagues and is also an unforgettable experience for a young person.
The idea of inviting architects to contribute to the restoration and exploitation of the site gave rise to discussion and proved yet again to be a new experience for all the members of the mission.
In future, the study of both imported and local material will lead to greater knowledge regarding the trade routes, the ports to which Sumhuram was linked and how they changed over time, and will provide a clear picture of the city as a manufacturing centre.
Excavations in a port on the coast of the Indian Ocean in the period from when deep-sea maritime trade began to take shape through when it reached its highest point of development can open continually new horizons for research.

Sumhuram and its territory

Dhofar, the Land of Frankincense

M. Raffaelli, S. Mosti, C. Bellini, M. Mariotti Lippi

The remarkable aspects of the flora and vegetation of Dhofar depend on the concurrent influence of two factors: the monsoon rain and the mountain range extending eastwards parallel to the coast for about 250 km, from the Yemeni border to the gulf of Hasik. From June to September, during the south-western monsoon (*Khareef*), the mountains oppose a natural barrier, stopping fog and rain from penetrating inland. The synergetic effects of monsoon moisture and local orography support a luxuriant vegetation of trees and shrubs on the southern slopes of the mountains (fig. 1), while, on the northern slopes, scarcely or not affected by the monsoon, the soil is covered by isolated trees and shrubs. The northern slopes gradually sink into a dry plateau, followed by a succession of cliffs and gullies dissected by numerous wadis, northwards crossing a vast desert area (fig. 2) with gravel plains combined with rocky hills; here the vegetation is scarce and the rocky hills are quite bare while scattered trees of *Boswellia sacra* (especially at wadi Dowkah), a few bushes and some xerophytic herbs grow in the wadi beds. Towards the Saudi-Arabian border, rocky deserts change into sandy deserts of level land and dunes, with sporadic or no vegetation at all (further information in

Radcliffe-Smith 1980; Miller & Morris 1988).
The main goals of the botanical missions in Dhofar were the study of the flora and vegetation of the region and the reconstruction of the palaeo-environment surrounding the ancient city of Sumhuram (3rd cent. BC-5th cent. AD) in the territory of Khor Rori. The scientific work has been carried out in close collaboration with the archaeological mission from the University of Pisa (IMTO), led by Prof. A. Avanzini, director of the excavations, and thanks to the Office of the Adviser to H.M. the Sultan for Cultural Affairs, which supported many field-activities, particularly those regarding the frankincense tree (*Boswellia sacra*). In the years 2002, 2004 and 2007, MIUR awarded inter-university funding (Pisa, Florence, Venice and Viterbo) for research activity in Dhofar after approval of PRIN Projects.

Floristic and taxonomic research

Between 2000 and 2009, ten expeditions were undertaken in Dhofar, with the aim to increase the floristic knowledge of the region, as well as the plant-collection of the Tropical Herbarium of Florence. The floristic studies, still in progress, provided important taxonomic results, such as the descriptions of five new species: *Desmidorchis tardellii* (fig. 3), *Tichodesma cinereum*, *Polygala moggii*, *Nanorrhinum roseiflorum and Orbea nardii*.
Plants were collected in many places of the region, i.e. Rachyut, Ajdarawt, Al Mughsayl, Mudday, Shisr, Ginan Bin Navatish, Thumrayt, wadi Dowkah, Haluf, Ayun, wadi Andur, Jabal Qara, Raysut, Salalah plain, wadi Adownib, Khor Rori, wadi Darbat, wadi Hinna, Mirbat, Sadh, Jabal Samhan and Hasik. Apart the above mentioned species new to science, the floristic lists from these localities report some species new or rare to Dhofar or Oman, as *Limonium sarcophyllum*, *Pentatropis bentii*, *Schweinfurthia pedicellata*, *Tephrosia subflora* (Hasik area); *Schweinfurthia latifolia*, *Zygophyllum qatarense* (wadi Andur area); *Andrachne aspera* var *glandulosa*, *Zygophyllum coccineum* (wadi Adownib area); *Echolium viride*, *Euphorbia hirta*, *Physalis angulata* (Al Mughsayl area), *Amaranthus hybridus* ssp. *hybridus*, *Teucrium stocksianum* ssp. *stenophyllum* (wadi Dowkah area).
A floristic study of the coastal wadis of Dhofar is currently in preparation, as well as a complete catalogue of the plants collected in Dhofar during the years of the research.

Research on pollen morphology

During the floristic investigations, pollen grains were collected from the many trees, shrubs and woody herbs of the coastal plain and the mountains' monsoon-exposed slopes. In fact, the pollen morphology of the plants growing in this area is poorly known and few works are devoted to this kind of study in Arabian Peninsula.
The most common and typical species were selected. They belong to well represented families, such as Acanthaceae, Capparaceae, Leguminosae, or are particularly common such as *Adenium obesum*, *Commiphora foliacea*, *Jatrofa dhofarica*, *Ziziphus leucodermis*, or are diffused in the woodlands of the Jabal slopes, such as *Anogeissus dhofarica and Blepharispermum hirtum*.
The pollen of *Boswellia sacra*, which grows on the mountain slopes of the coastal area of Dhofar and in the inner semi-desert areas, was also investigated. The grains were observed with light microscope (LM) and with scanning electron microscope (SEM) in the laboratories of the University of Florence (fig. 4).
Pollen morphology is considered one of the characters playing an important role in plant taxonomic studies. This is the case of those pollen grains which display a remarkable variability within the same family (for example Acanthaceae), even if differences are also detectable among the grains belonging to species of the same genus. But the essential theoretical basis for this research is that the knowledge of modern plant's pollen morphology is a necessary prerequisite for the identification of the fossil pollen grains at the lowest possible taxonomic rank, improving the palaeofloristic and palaeovegetational reconstructions. In this perspective, the plants which are currently common or endemic in the area have to be considered.

Sumhuram and its territory

Modern landscape

A particular topic of our research was the study of the flora surrounding the ancient city of

Fig. 1
Monsoon vegetation on the southern mountain slopes behind Salalah.

Fig. 2
Semi-desertic area near wadi Dowkah; rocky pebbly ground with Nannorrhops ritchieana (Palmae).

Fig. 3
Desmidorchis tardellii (Asclepiadaceae), a new endemic species found near Raysut.

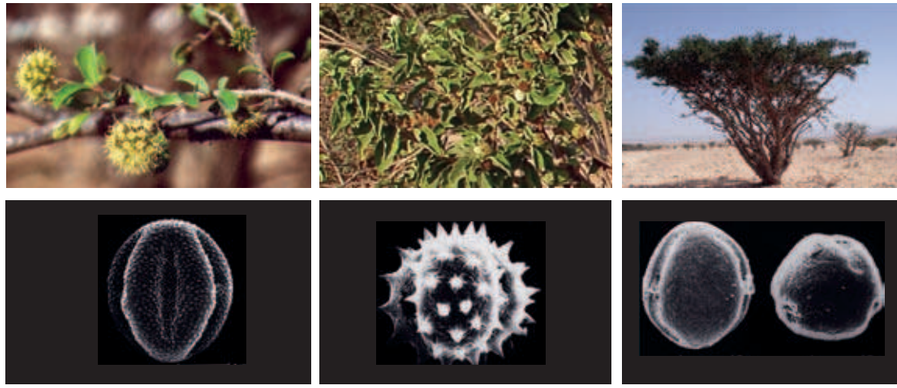


Fig. 4
Pollen morphology of Anoigessus dhofarica (Combretaceae), Blepharispermum hirtum (Compositae) and Boswellia sacra (Burseraceae), the frankincense tree.

Sumhuram, which is located on a rocky hill along the coast. It dominates the final section of wadi Darbat and its estuary (Khor Rori) which is today separated from the Indian Ocean by a sand barrier.

Khor Rori is one of the many creeks (khor) along the coast of the Arabian Sea, lying 40 km east from Salalah; this khor was excavated by the erosive action of the wadi Darbat during rainy climatic phases, the last of which in the Arabian Peninsula dates back to at least 8.000- 4.000 BC. The old colonisers, who arrived around the 3rd century BC, must have realised that this particular khor, on account of its morphology, was an ideal natural port. Indeed, as well as today, its outlet to the Ocean is flanked by two long, rocky flat outcrops, parallel to the coast, that offer protection from storms and the Ocean waves (fig. 5).

Today the archaeological site of Sumhuram, in the territory of Khor Rori, lies in an area heavily exploited by man, in a plain characterized by over-grazing by dromedaries and goats that has been going on for centuries. Especially behind the settlement, as far as the Jabal Qara hills, stretches an almost bare rocky-gravel plain with sparse bushes of *Acacia tortilis*, *Commiphora habessinica* and *Cassia holosericea*, a few herbaceous plants here and there (*Calotropis procera*, *Cometes abyssinica*, *Vernonia arabica*) and some grasses (*Cenchrus pennisetiformis*, *Dactyloctenium aristatum*, *Dichanthium foveolatum*, etc); a slightly thicker vegetation consisting of low *Acacia tortilis*, *Commiphora habessinica*, *Ziziphus leucodermis* and *Cissus quadrangularis* bushes develops along the short, shallow wadis, that cut their way through the bare rocky plain towards the Ocean.

Below the city, to the west a wet saline depression is present, on the edges of which grow hygrophilous plants such as *Cyperus conglomeratus*, *Schoenoplectus litoralis*, *Juncus rigidus*; on the ground flanking the banks of wadi Darbat, large lawns of *Bacopa monnieri* and reed thickets of *Phragmites australis* and *Juncus rigidus* grow, while dense agglomerates of semi-submerged *Myriophyllum* thrive in the water. Today mangrove vegetation has not been found along the final stretch of wadi Darbat.

The two flat outcrops flanking the entrance to the port, are covered with sparse bushes of *Salvadora persica* and *Cadaba farinosa*, and herbaceous plants abound with *Heliotropium fartakense*, *Cleome brachycarpa*, *Suaeda fruticosa*, *Fagonia luntii*, *Commicarpus boissieri*, *Limonium axillare*, *Lindembergia muraria* together with some grasses. Behind Sumhuram, northward beyond the coastal plain, after about 4-5 km, the slopes of Jabal Qara begin to rise, covered with a thick woodland of *Jatropha dhofarica*, *Blepharispermum hirtum*, *Delonix elata*, *Anogeissus dhofarica*, *Commiphora habessinica*, *C. gileadensis* and some plants of *Boscia arabica*; there are also the creeper *Cissus quadrangularis* and the succulent *Adenium obesum* and *Sansevieria ehrenbergii*, on the rocky slopes exposed to the sun. Here opens the wadi Darbat valley where the presence of water (permanent in this stretch of the wadi) allows the formation of *Ziziphus spina-christi* woodlets and various species of *Ficus* (*F. sycomorus* and *F. salicifolia*) that can reach quite large dimensions; the slopes of the wadi Darbat valley enjoy the beneficial influx of the south-west monsoon; during and after the rainy season they are covered with luxuriant *Anogeissus* woods (fig. 6).

Ancient landscape

The palynological studies allowed the reconstruction of the natural landscape surrounding the site. The attention is generally focused on the expansion and contraction of specific types of environments, such as wetlands or forests, and on the presence of cultivated fields or other human activities which impact the territory. In other words, they provide an insight in the past flora and vegetation of the area during a precise span of time.

At Sumhuram, pollen analyses were carried out on stratigraphical sections brought to light during the archaeological excavations (fig. 7). Some of these sections were excavated close to the outside walls of the city, others within the urban context, be it in correspondence of open spaces, such as streets or squares, or inside buildings.

The results revealed that Sumhuram was at first inserted in a landscape characterised by the presence of fresh water habitats which might have had a wide extension, certainty wider than those occurring afterwards. A rich list of aquatic plants, including many Cyperaceae and *Typha* (cattail), was deduced from micro- or macroremains, casts and imprints recovered in the site.

Soon after in the settlement history, a decrease of several types of wild shrubs occurred, for example *Commiphora*, probably due to the human activities

including the cutting and the use of these plants as fuel. This use is also testified by the numerous charcoals found in the urban context which may be related to branches of small size.
During the period of occupation, the occurrence of few pollen grains of *Phoenix* cf. *dactylifera* (date palm) may be considered a signal of its presence in the surroundings. In fact, pollen grains of the date palm are not transported over long distances as demonstrated by modern studies carried out in date palm oases. Large-size pollen grains belonging to Gramineae were also recorded in the sediments. Some of them are attributable to the "*Triticum group*", and may be considered a signal of the presence of *cerealia*, cultivated or processed not very far from the site. In the Arabian Peninsula, the contemporary presence of date palm and *cerealia* pollen in sediments suggests the exploitation of soil for agricultural practices following the so called "oasis farming" model. However, in the case of Sumhuram, the low pollen percentages does not allow to understand whether these grains came from small cultivated fields in the surroundings or from wider oasis farming in the coastal plain, where they currently occur.

Inside the city, particular attention has been focused on a stratigraphical section located nearby the so-called Monumental Building, where brief sequences of laminated sediments were observed and chronologically dated between 204 BC and 130 AD. The palynological investigations on these levels highlighted the repeated occurrence of pollen of exotic plants of Arabic or African provenance. For example, *Juniperus* pollen grains could come from the mountains of Yemen or of central-eastern Africa, while *Alnus* and *Quercus* could have been transported over longer distances. The presence of exotic pollen grains in South Arabia sediments had already been observed in other palynological studies and it is generally related to periods of particular intensity of the monsoon which provokes the transfer of air-diffused particles, included pollen grains, over great distances.
Pollen analyses also pointed out a progressive reduction of fresh water habitats and a possible salinization of the estuary, as shown by the increase of the pollen grains of Cheno-Amaranthaceae. However, this shift to drier conditions was not continuous but interrupted by brief gaps or trend reversals. Finally, a comparison among the ancient and current pollen spectra in wadi Darbat estuary reveals that during the 3rd century BC - 5th century AD the flora of the area was richer and the climate wetter than today.

Research on frankincense tree (Boswellia sacra Flueck.)

The study of incense trees has been one of the main topics of our research. Dhofar has traditionally been one of the main countries producing frankincense. Since ancient times the resin has been object of commerce, with trade routes by sea and land through the Arabian peninsula towards the Mediterranean countries or eastwards to Iran and India. Sumhuram was involved in the incense trade and from here the maritime routes reached Egypt and Rome via the Arabian peninsula coasts and the Red Sea.
In Dhofar the species yielding frankincense is *Boswellia sacra* that also grows in Yemen (Hadramawt) and in northern Somalia. *Boswellia sacra* is a tree up to 7 m tall, commonly branched from the base, rarely with a single trunk. In Dhofar it grows in the northern semi-desertic area behind the coastal mountains, but also on the hills and the mountainous slopes facing the Indian Ocean.
Some of the most important areas where still today considerable populations of *Boswellia sacra* grow were examined: Al Mughsayl, wadi Adownib, wadi Dowkah, Sadh, Hasik. Each site was surveyed to document its environmental characteristics and floristic components. However, the entire region was studied comprehensively, allowing us to report several new localities where frankincense trees still grow today, be it isolated or in small groups (fig. 8); this testifies that distribution was more widespread in the past than in modern times. Increased aridity and excessive exploitation by man (grazing by dromedaries and goats, felling for fire wood) are the main causes behind the marked decline in *Boswellia* populations.

The "frankincense" areas of Dhofar

Wadi Afal and Wadi Mughsayl: Al Mughsayl-Ajdarawt Road, a few km past Al Mughsayl.

Fig. 5
The internal lagoon of Khor Rori, at the entrance to the ancient port, viewed from Sumhuram.

Fig. 6
Permanent water at wadi Darbat: tickets of Ziziphus spina-christi (Rhamnaceae) on the wadi banks; dense woods of the endemic Anogeissus dhofarica (Combretaceae) on the hilly slopes.

Fig. 7
Sumhuram excavations.

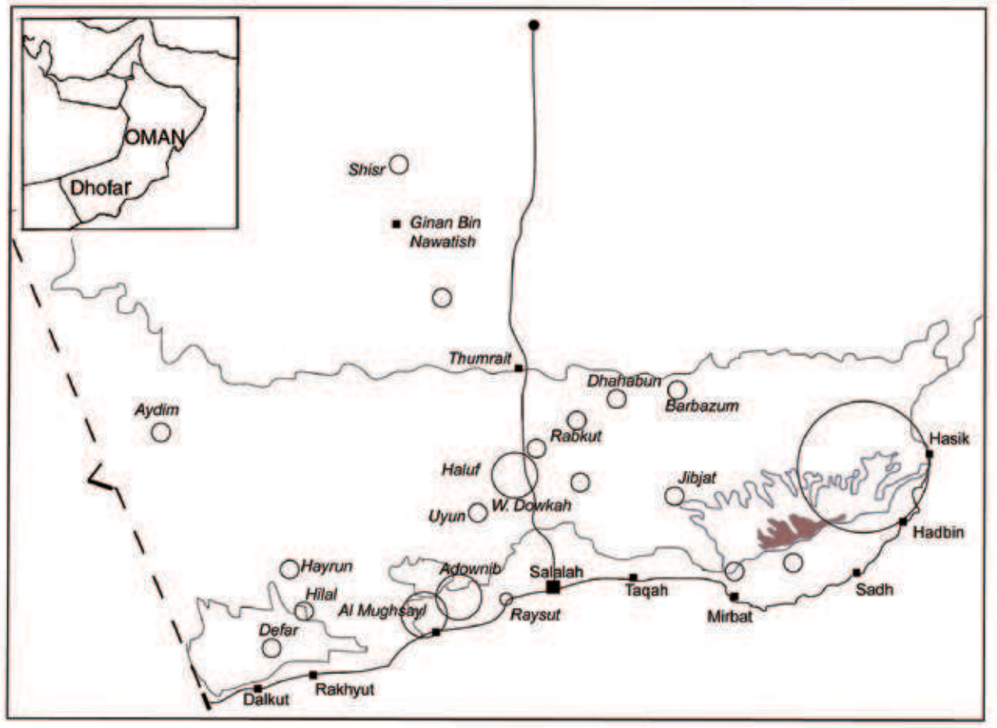


Fig. 8
Distribution of Boswellia sacra in Dhofar: the circles are proportional to the abundance of the frankincense tree in the areas.

Alt. 50-200 m. This area is characterized by deep-set wadis running among arid mountain gorges. *Boswellia sacra* grows on the hilly slopes and in the bottom of the wadis beds. The *Boswellia* trees are numerous and luxuriant in growth. This is probably due to the geographical location of the lateral wadis, protected from the SW monsoon-rain by the coastal mountains, and providing a suitable environment where the frankincense trees can assume notable organographic development.

Wadi Ashawq: Al Mughsayl-Ajdarawt Road, crossroads on the right immediately after Al Mughsayl lagoon, 3-8 km inland from the coast. Alt. 30-50 m. This is an arid valley in the final part of the course of wadi Ashawq. The vegetation is sparse, the soil rocky and pebbly. Frankincense trees grow especially on the banks of the wadis and on the steep hilly slopes.

Wadi Adownib: 30 km west from Salalah, 7-10 km inland from the road Salalah-Al Mughsayl. Alt. 200-220 m. A hilly area characterized by arid rocky depressions among the hills. *Boswellia sacra* scrubland, with plants 1- 4 m high, spaced 3-4 m from one another, covers the hilly slopes and the beds of the numerous wadi tributaries of the great wadi Adownib (fig. 9).

Rocky plateau between Haluf and Uyun: semi-desert area between Salalah and Thumrayt. Crossroads on the left about 47 km along the Salalah-Thumrayt road. Alt. 600-750 m. Rocky semi-desert plateau with ridges and deep wadis. The vegetation is almost absent except for scattered *Boswellia sacra* shrubs (0.5-2.5 m high) on the banks of the wadis sides; many with evident signs of browsing and cutting.

Hayrun-Aydam road: alt. 600-800 m. Semi-desert rocky plateau etched with deep wadis and steep-sloped gorges; the soil is gravelly and the vegetation scarce; scattered and stunted shrubs of *Boswellia sacra* occur on the sides and in the wadi beds.

Sadh coastal plain: coastal plain and low hills in the inland of Sadh, a few km from the Ocean, alt. 18-60 m. The soil is rocky and sandy, the vegetation scarce. Scattered trees of *Boswellia sacra* (1-3 m high), grow in small groups, on the hilly slopes and depressions (fig. 10).

Hasik mountains: the mountains of Hasik, in the eastern Dhofar, are known from ancient times for the collection of frankincense; this is undoubtedly one of the areas where *Boswellia sacra* is most abundant today (fig. 11a). Lacking a road system, except along the coast, the area is rather inaccessible and hard to cross; the mountains can be reached through steep pathways that climb up the slopes or following the principal wadis upstream (wadi Raykhut, wadi Atawnt, wadi Ataran, etc.). The morphology of the territory is steep, with strongly inclined slopes dominated by vertical rock walls and big rock blocks, or cut by deep wadis similar to canyons.

Wadi Dowkah: Salalah-Thumrayt Road, 42 km north from Salalah: rocky and pebbly semi-desert area to the left of the road. Alt: 680-550 m. Wadi Dowkah is a typical rocky and pebbly semi-desert area characterised by small rounded hills intermixed with low depressions excavated by past wadi's flow. The vegetation is scarce, forming local open scrubland where the *Boswellia sacra* trees are predominant (fig. 12a).

Frankincense in the Hasik mountains:
An interview with the elderly of the village

Today, according to the elderly of Hasik, frankincense collection no longer represents an income for their families as in the past; therefore, the story of the elderly of Hasik concerning the way frankincense was once collected and traded is worthy of mention. He told us: *"The gatherers climbed up the mountain on foot, carrying along food supplies for 2-3 days. After this, some of them descended back to the town with the collected resin and replenished the supplies for the others left to continue the collection. Although some of the production areas of frankincense were on the mountain slopes dominating Hasik, most of them were very far away in the mountains. From the nearby localities (approximately 7) frankincense was brought to Hasik and here it was stacked in deposits located in caves along the sea cliff (the deposits were named Halhal; fig. 11b); at the end of the gathering season the resin was transported by sea to Sadh (no street was available). More frankincense was collected in the inland mountain localities (15 in two areas named Isayh and Argath); from here, numerous routes departed and then reunited in one track heading to Sadh where the frankincense was deposited in appropriate storehouses that still exist today (fig. 11c). With favourable monsoon winds (from south-west), frankincense was loaded on the typical ships and brought to the markets in India, a country with which Dhofar held active commercial trading".*

Fig. 9
Frankincense area of wadi Adownib, east from Salalah.

Fig. 10
Frankincense area of Sadh.

Fig. 11: a) Boswellia sacra on the hilly rocky slopes behind Hasik, eastern Dhofar; b) Ancient deposit of frankincense located in a cave along the sea cliff near Hasik; c) Ancient frankincense deposit in a storehouse in Sadh.

Fig. 11
a) Boswellia sacra on the hilly rocky slopes behind Hasik, eastern Dhofar; b) Ancient deposit of frankincense located in a cave along the sea cliff near Hasik; c) Ancient frankincense deposit in a storehouse in Sadh.

The Wadi Dowkah Natural Park

The Omani Government has shown marked interest in the creation of a Natural Park in this area due to the wealth of the *Boswellia* population and its vicinity to Salalah town, only 42 km away along an excellent road. Moreover, the Frankincense Park creation also aims to guarantee future maintenance of this important natural site; a further, but no less remarkable economic goal, is to increase tourism and to promote educational awareness of Dhofar natural environment.

A first step was taken in 2000 when the wadi Dowkah area was listed as one of UNESCO's World Heritage sites in Oman, by virtue of the abundant presence of the frankincense tree. In 2001 the area became a Natural Park. Between 2001 and 2002 the plan of the Park was made; it stretches northward on a 6-7 km² area at an altitude between 680 and 550 m. The Park includes about 1.300 *Boswellia* plants of which at least 100 are of large size -the biggest in Dhofar - (fig. 12b, c) and probably are hundred-year old. Some of the oldest ones are up to 4-5(-6) m high with a 20-35 (-40) m² crown area.

Among the natural heritage of Dhofar, frankincense holds an important place and therefore the interest in preserving and protecting natural *Boswellia sacra* population is high. In 2003-2004, after the initial phase of delimitation of the Park perimeter, the monitoring of *Boswellia* plants and interventions in the safeguard and recovery of the wadi area began.

The first safeguard intervention concerned the oldest and widest *Boswellia* plants; the bases of the trunks were earthed and the big superficial uncovered roots were covered with stones.

Other safeguard interventions aimed to limit the effects of dromedary and goat browsing, blocking the accesses, stopping the tree-cutting for fire-wood and the use of foliage for fodder (fig. 13). Owing to the wide extension of the Park and the resistance of the local shepherds, the banning of browsing inside the Park was and still is one of the hardest challenges to face. In autumn 2004 a marginal area (15 ha) located in the eastern area of the Park (on the side of the Salalah-Thumrayt road) was fenced and secluded to the animals. The fencing allowed the beginning of a monitoring activity of the old *Boswellia* plants present in this area, in absence of the damage caused by animals and shepherds; at the same time, in the fenced area the soil was prepared for the transplant of *Boswellia* cuttings, obtained from the Park plants. In autumn 2004, about 3.000 *Boswellia* cuttings were transplanted in the fenced area with the aim to replenish the natural vegetation of a highly degraded area. In autumn 2005, the seedlings that did not survive the first transplant were substituted with new cuttings. In February 2006, the transplant intervention showed a positive result of over 75-80%: the young seedlings had reached a 20-40 cm height, with new ramifications and abundant new leaves. At the same time the biometrical characteristics of the old *Boswellia* plants present in the fenced area were examined and recorded. The new data, compared with the data collected in March 2004 before the fencing was set up, show that *Boswellia* plants, after the isolation of the area, regained a normal growth habit, with production of 20-50 cm long annual shoots and abundant and well developed leaves on the new and old branches (fig. 14). Following controls in the years 2008 and 2009 confirmed the success of the safeguard measures with the recording of growth rises above expectations and abundant production of new shoots and leaves. It was thus evident that the *Boswellia sacra* population of the Park can be safeguarded with measures intended to prevent animal browsing, leaf use for fodder production and tree cutting for firewood.

Research on "frankincense" resin

The aim of the research was to chemically study the frankincense resin of *Boswellia sacra* in the various localities of Dhofar (Al Mughsayl, wadi Adownib, wadi Dowkah, Sadh, Hasik) where the plant is still abundant, in order to verify the presence of chemical differences. In particular, this study deals with the chemical characterization of the tritepenoid fraction of frankincense resins by means of an analytical procedure based on gas chromatography coupled with mass spectrometry (GC/MS). This study allowed us to chemically characterise the tritepenoid fraction of several samples of frankincense resin from Dhofar, revealing the occurrence of α-boswellic acid, β-boswellic acid, 3-O-acetyl-α-boswellic acid, 3-O-acetyl-β-boswellic acid, 11-keto-α-boswellic acid, 11-keto-β-boswellic acid and 11-keto-3-

Fig. 12
a) Boswellia sacra at Wadi Dowkah Natural Park; b),c) old frankincense trees living in the Park; d) frankincense tree in flower; e) frankincense resin oozing from the bark .

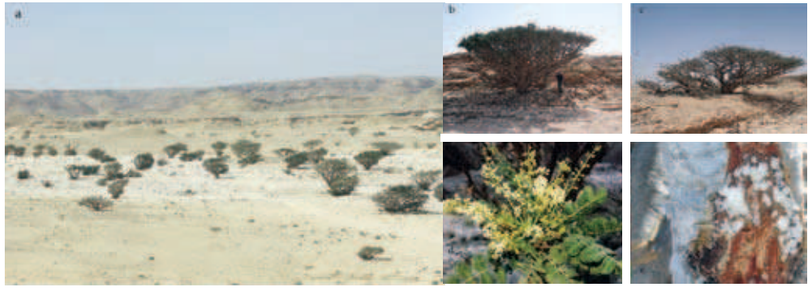


Fig. 13
Causes of damages: root excavated by water flow; plants cut or burned by local shepherds; plants browsed by dromedaries.

Figs. 14
Safeguard interventions at wadi Dowkah: plants of Boswellia in 2004 before fencing the area; the same plants in 2009 after fencing the area. Note the regeneration of branches and leaves.

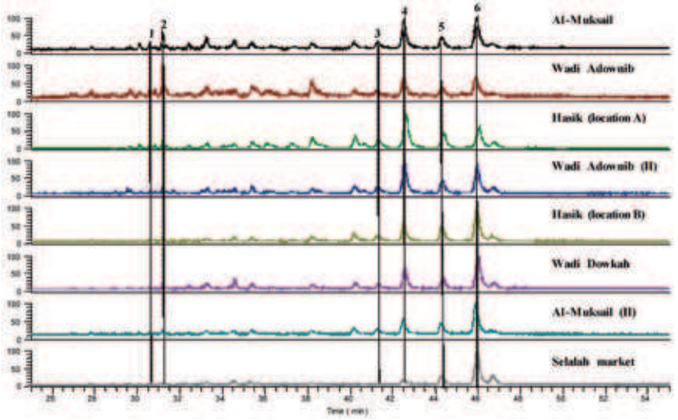
O-acetyl-α-boswellic in all the analysed samples (fig. 15). Moreover, this research pointed out that there are no significant differences in the chemical composition of the triterpenoid fraction of frankincense resin from the various localities of Dhofar and that the quantitative dissimilarities could be addressed to the collection period rather than to the collection localities.

Research on genetic diversity of the Dhofar's frankincense populations

This study focuses on the genetic diversity of the most widespread population of *Boswellia sacra* in Dhofar (Al-Mughsayl, wadi Adownib, wadi Dowkah, Sadh, Hasik) with the ultimate goal of supplying useful data that may assist the identification and selection of the genetic material to be preserved and propagated for ecological and economic purposes. DNA sequences from the ITS region of the nuclear genome and Inter-Simple Sequence Repeat markers (ISSR) were used to estimate genetic diversity among and within populations of the frankincense tree from Dhofar (fig. 16).

ITS sequences were 511 bp long and showed low (6.4%) variation among geographically different populations. The four selected ISSR primers yielded 93 reproducible bands, of which 91 (97.9%) were polymorphic in the 97 individual profiles obtained. Total genetic diversity (HT) and average heterozygosity within populations (HS) resulted fairly low (0.22 and 0.136, respectively).

Data acquisition from wadi Dowkah showed the lowest level of genetic diversity (HE = 0.107), while the eastern populations from the Hasik area harboured a slightly greater amount of variation. Analysis of Molecular Variance showed that differentiation among populations was relatively high (38.1%), possibly due to the reduced gene flow between the largely isolated stands of *Boswellia* (Nm = 0.39). Genetic distances and AMOVA suggested a clear differentiation between the eastern and western coastal populations, while those from the internal area did not form a consistent group.



n.	*Compound*
1	α-boswellic acid (3-hydroxy-olean-12-en-23-oic acid)
2	β-boswellic acid (3-hydroxy-urs-12-en-23-oic acid)
3	3-*O*-acetyl-α-boswellic acid (3-acetyloxy-olean-12-en-23-oic acid)
4	3-*O*-acetyl-β-boswellic acid (3-acetyloxy-urs-12-en-23-oic acid)
5	11-keto-α-boswellic acid (11-oxo-olean-12-en-23-oic acid)
6	11-keto-β-boswellic acid (11-oxo-urs-12-en-23-oic acid)

Fig. 15
Top: Total ion current chromatograms of the acidic fractions of frankincense resins.- Bottom: Peak assignment: n. = peak number in the chromatograms.

Population	No.	Distribution area	Geographic coordinates	GenBank accessions
Al Mughsayl	1	WC (West coast)	16 52′N 53 42′E	1: FN556595; 2: FN556596
Wadi Adownib	2	WC (West coast)	16 56′N 53 46′E	1: FN556597; 2: FN556598
Wadi Dowkah	3	IB (Internal belt)	17 20′N 54 40′E	1: FN556599; 2: FN556600
Wadi Sanut	4	IB (Internal belt)	17 22′N 54 06′E	1: FN556601
Huluf	5	IB (Internal belt)	17 20′N 53 59′E	–
Hasik	6	EC (East coast)	17 24′N 55 17′E	1: FN556602; 2: FN556603
Sadh	7	EC (East coast)	17 06′N 55 03′E	–

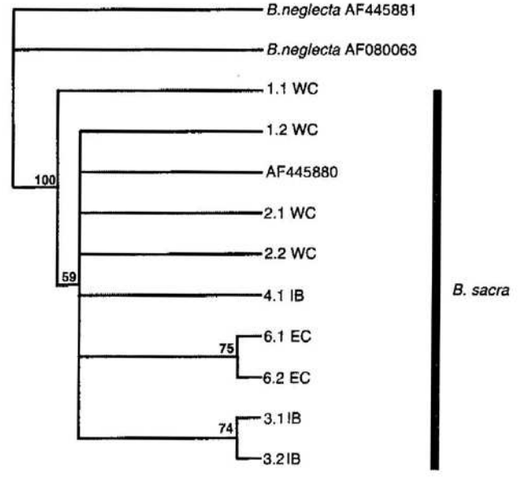


Fig. 16
Top: Examined populations of Boswellia sacra from Dhofar and Geo-Bank accessions for ITS-1-ITS2 DNA sequences. - Bottom: Strict consensus of the 62 trees resulting from parsimony analysis of ITS sequence data of 5 populations of B. sacra (population numbers are as the top-table).

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Sumhuram, the city and its development

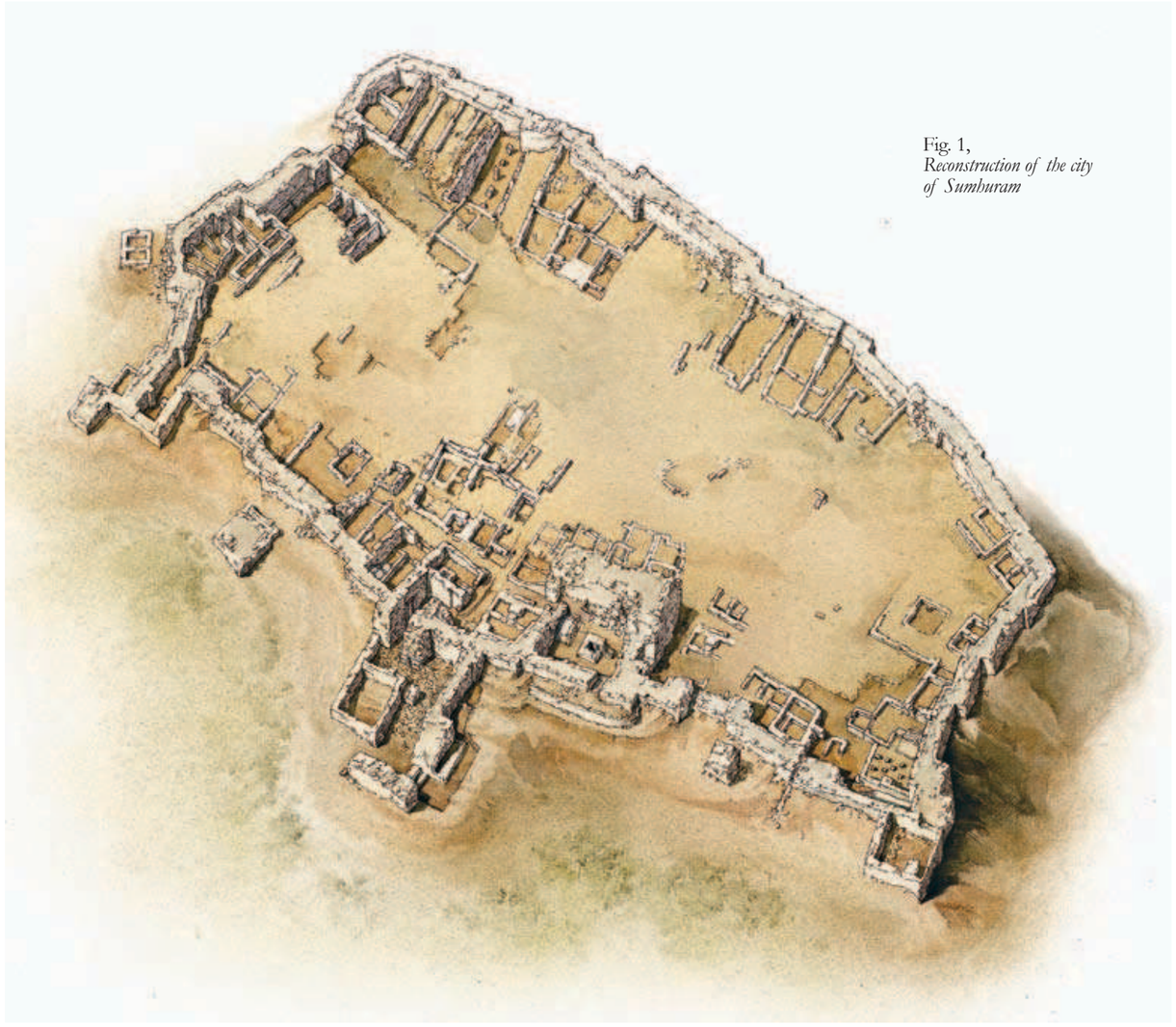


Fig. 1,
Reconstruction of the city of Sumhuram

Sumhuram, a South Arabian port

A. Avanzini, A. Pavan

Sumhuram is a small settlement that did not expand territorially for the whole term of its occupation. It is an excellent example for studying the activities and spatial organization of pre-Islamic south Arabian cities.
Although investigations are not yet concluded and many issues are still open, excavations, particularly those of recent years, have been decisive in defining the urban structure of the city (fig. 1), casting light not only on the layout of the settlement, but also on the domestic architecture, the places of worship, the production activities, and the procurement and conservation of water.

The place

The city was built on the top of a limestone outcrop, the profile of which has until very recently remained almost totally unknown.
The thickness of the sediments that built up during the conclusive phases of the city's occupation and the accumulation of materials due to natural causes or human activity, have long prevented excavations reaching bedrock and the most ancient levels of the city.
The bedrock has not been individuated under the whole city, but recent investigations, together

with some deep soundings, indicate an irregular limestone *plateau* with a general downward slope from east to west with a dip in the westernmost part of the city and in the northernmost one.
There is a foundation filling stratum of some 30-40 cm composed of rock chips mixed with earth and stones between the solid rock and the level of the earliest inhabitation of the city.

The fortification system

The massive system of fortifications put in place in Sumhuram is undoubtedly its most striking feature. It rises, isolated in its monumentality, in a landscape in which the impact of man seems, today, minimal.
The perimeter is marked by a series of offset walls (figs. 2a, b) with a couple of towers set into the north-eastern and north-western corners; a tower guards access to the monumental gate and a couple of isolated towers companions to a wall, itself stand-alone, protects the city (fig. 3). By contrast to the city walls of other south Arabian cities, that of Sumhuram does not appear to have curtains and towers set at regular intervals, but has a zig-zag pattern that follows the natural lie of the land. It is to be stressed that the offsets do not appear to have any defensive scope but be purely aesthetic in nature, contributing to highlight the monumentality of the defensive structure.

The division into quarters

The excavations conducted by the Italian mission have led to establishing the existence of quarters with a specific vocation, namely the warehouse area where merchandise was held in storage, the residential area with private dwellings, and the worship area with the city temple.

The warehouses

The warehouses of Sumhuram consist of a series of long rectangular rooms, seven built towards the north and four towards the south, on both sides of a large rectangular area measuring 8 x 3.20 mt which in recent years has been identified as a marketplace (fig. 4). Towards the east of the marketplace a small doorway in one of the segments of the city wall leads to a steep slope downhill to the port area. In the most ancient period, a wall ran along the western side with a narrow opening 70 cm wide, which made it possible to keep the area under tight control, protecting the merchandise stored within but also safeguarding the security of the commercial transactions. The aperture was subsequently walled up leaving the small gate overlooking the port as the only access point to the storerooms.
The data that has emerged from excavations indicate that from a certain point in time onwards the storerooms were accessed from the roof. Entrance from here or from an upper floor, which seems to have been characteristic of the second phase of storeroom usage, would appear to have been quite normal in Sumhuram, as can be seen in the imposing towers set towards the north which seem to be completely shut off to the outside and thus accessible only from above.
The way the storehouses were built in Sumhuram is identical to that of other sites in south Arabia such as Kane. The chambers were plastered with a thick coat of mortar which probably helped to improve the conditions of conservation of the merchandise stored within (frankincense or other produce).
Although only the long chambers located by the south-eastern corner have been referred to as storehouses, some of the structures set alongside the southern end seem to have had the same function.
Furthermore, there is what could be an opening in the city wall in the vicinity of these chambers. Unfortunately, the intense erosion that has taken place in this part of the city, where the bedrock is at the surface in a number of places, makes it impossible to remove all doubt in pinpointing the southerly line followed by the city wall. Although, there is an attractive theory according to which there may have been an open space from which the packages of incense could have been made to slide downhill to the port.
Albright put forward the interesting hypothesis, but it's hard to prove archaeologically, that the city mint stood in premises by the storehouses. The discovery on the site of bronze waste, addition to certain materials interpreted

as blanks ready for striking and as a high concentration of coins with Sumhuram written on them, could indeed be confirmation of coin manufacture on site.

The residential quarter

The main residential quarter of the city of Sumhuram has been identified in the northern part of the city, to the east of the building protecting the well, where several buildings which may be interpreted as private dwellings were investigated (fig. 5). However, buildings of domestic use have also been identified near the temple of Sin (fig. 6).
The domestic architecture consists of squared sandstone or limestone ashlars - a choice probably based on the wealth of the owner - for dwellings which, by and large, make use of the city wall as a load-bearing wall.
The houses look very crowded although lower-floor windows could indicate small open courtyards between buildings.
Evidence of a second floor is seen in the remains of stairways (fig. 7), often strengthened by a structure in mud-bricks.
It must not be ruled out that certain upper floors were built in mud-bricks instead of stones; indeed this may have been the case of the building protecting the well, where the remains of mud-bricks can still be seen in the uppermost parts of the structure. Similarly, other bricks have been identified, albeit in the form of the collapse to the south of the southern wall which, therefore, makes an upper structure in mud-bricks highly plausible.
Moreover, regularly placed holes to house wooden beams which can be seen in various parts of the city, is further proof of a second floor.
Traces of activities tied to food preparation mainly consist in open hearths dug into the flooring and sometimes bordered by small and medium-sized stones. Remains of food leftovers (animal and sea-shells) have been found in dumps or in pits in the ground in various places in the settlement.
It would appear that no particular area was set aside for areas dedicated to manufacturing.
Kilns of various types have been found in different areas of the city, in open or closed spaces, such as the "tannur" with circular base with a neck of amphora used to regulate the airflow (fig. 8) or the simple structure partly dug into the ground with its perimeter marked by medium-size stones, used for blacksmithing (see Chiarantini, Benvenuti in this volume).
An interesting complex that gave rise to debate was discovered in recent years just behind the structure protecting the well. These are a series of chambers, completely plastered, that contain several basins set in the corners, or set in the centre of small rooms. The way these chambers have been laid out with the basins suggests that their function involved the use of water or the working of grain. Another hypothesis is that they may have been some kind of public bath or hammam, used by the inhabitants of Sumhuram (fig. 9).

The city's layout consists in roads, main and secondary, and more or less wide open spaces.
During the long history of the settlement many changes have been done: certain roads and streets got closed off by buildings or got occupied by dwellings or again converted into open spaces.
One big road leads from the city's main temple to the building protecting the well. The circular plinths by the side of the road suggest that it may have been a colonnaded avenue with a street running parallel to it alongside the city wall, in the city's earliest phase of inhabitation (fig. 10).

The religious area

Despite the smallness of the city, no fewer than three buildings of a religious nature have been found: the great temple of the moon god Sin (fig. 11), one small sanctuary and the *extra muros* temple.
The main temple of the city is a complex structure that underwent several alterations in the course of the city life. The structure of the temple in Sumhuram was based on a hypostyle chamber divided by two rows of pillars with a podium on the axis of the entrance and five additional chambers having different functions.
In particular one room has been identified thanks to the remains of food leftovers as the temple kitchen.
An additional building used for religious purposes

Fig. 2a, b
Offset walls in the north-eastern side of the city.

Fig. 3
The path of the entrance.

Fig. 4
The market place in the south-eastern corner of the city.

Fig. 5
View of the residential area.

Fig. 6
Private dwellings near the temple of Sin.

Fig. 7
Staircase in a private house.

Fig. 8
Furnace with amphora neck.

Fig. 9
Rooms linked with production activities.

was excavated in 2008-2010. Rebuilt several times, its original structure was not, however, subjected to any radical alterations (fig. 12). Altar, benches set by the internal perimeter and plastered basins in the corners of the main chamber were constant all through the temple's history. The most interesting aspect of this small sanctuary is the quantity and quality of the discoveries unearthed inside it. Several architectural elements such as lintels, decorated blocks and pillars were discovered along with highly prestigious religious artefacts especially incense burners (figs. 13a,b,c). There is a striking serpent motif that appears in the decoration of small pillars set beside the altar (fig. 14), on architectural elements and also in the form of statuettes. The snake is not common in the Hadrami iconography and it could be linked to some kind of local custom or symbolism. The serpent and its cult are well known in the north of the Omani peninsula and it would be of great significance as example of encounter between local and Hadrami culture.

An *extra-muros* temple was erected along the bank of the wadi and probably destroyed during a flood. It consists in a large chamber, an antechamber and two smaller service rooms. It has not been possible to establish the deity to whom it is dedicated.

The well

Mention has often been made of how the city is structured and its imposing defensive system. Its powerful walls, its location, its structured access complex and its watch towers guaranteed the city protection from enemy attack whether by sea or by land. Survival in case of attack, however, required a series of facilities including water that was guaranteed from a rectangular well 25.6 metres deep (fig. 15).

The excavation of the internal part of the building surrounding the well, brought to light two major phases of usage of the well. The second phase, successive to the raising of the structure can, in turn, be divided into a series of sub-phases which left their mark in the many floor levels that emerge in stratigraphy.

The first phase of the well's usage (fig. 15a) must have been contemporary to the foundation of the city and, at that time, the structure was not yet in masonry. It was not until the vast rebuilding in the course of the 1st cent. AD, that the well was lined completely and its rim raised by 3 metres. The care taken in lining, consisting of regular limestone ashlars, may have been deemed necessary because of sacs of clay, sand or other incoherent materials in the lower part. The holes in the masonry some 50 cm deep noted by Albright, were probably bored to enhance the catchment of water from natural cavities or smaller aquifers.

Contemporarily to raising the well, walls, used to support the structure, were build on the bare rock (fig. 15b). In this second period a probable wooden superstructure was built onto the well with a pulley and rope for pulling up the bucket. Traces of the rope rubbing into the stone can still be seen.

The well was connected to a drain channel by means of a basin which may have been used for decantation. The drain channel was lined with limestone and passed through the western wall of the building surrounding the well, to go outside the city by means of an aperture dug through the city wall. The three external basins, interconnected and set at different heights, have been brought to light (fig. 16). Other much simpler channels have been discovered in various areas of the city showing how capillary was the supply and disposal of water. A segment has been discovered in the residential area dug into the upper part of the "foundation filling", which then continues below floor level in the area of the gate.

The territory

We have already noted how the city's development took place substantially within the city walls. Investigations on site, however, have produced some interesting results; there are traces of occupation contemporary to the settlement as well as prior to it (settlements dating to the Bronze Age on the eastern promontory) and successive (Islamic settlements on both the promontories closing the harbour, a mosque alongside the lagoon, an Islamic necropolis to the north-west of the settlement). Here, we shall only briefly deal with the structures contemporary to Sumhuram.

In addition to the *extra muros* temple already mentioned, built west of the settlement along the

Fig. 10
The road connecting the temple with the building protecting the well.

lagoon, archaeological investigations have been focussed on the area north of the settlement where four caves, some 300 metres from the city, were investigated. These have been interpreted as cave-crypts.

Of the four cavities only one has been excavated (fig. 17), revealing an interesting structure. The entrance is up six steps between two walls. A kind of lock, made of dressed stones with a recess on one side, sealed the entrance to the cave. Human bones (some of them burnt) have been discovered inside the cave together with several pottery shards and some small finds.

Outside the cave, scanty remains of a room that was connected with the burial complex have been identified. Unfortunately in addition to having been looted in antiquity, the cave was lived in by Bedouins in medieval and modern times.

To the east of the city there are three simple structures, connected with farming the land around the city. Geological surveys in the same area have revealed the remains of dams and walls delimiting cultivated fields.

Fig. 11
Detail of the temple of Sin.

Fig. 12
The first phase of the urban shrine.

Figs. 13a-b-c
Incense burners from the small shrine.

Fig. 14
Altar with small pillars decorated with snakes (last occupational phase).

Fig. 15
The well.

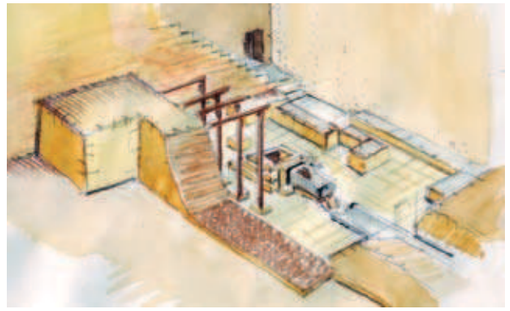


Fig. 15a
Hypothetical reconstruction of the first phase of the well's usage.

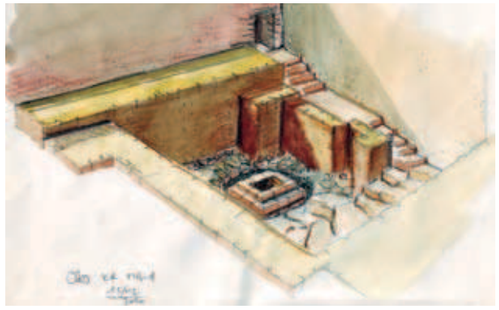


Fig. 15b
Hypothetical reconstruction of the second phase of the well's usage.

Fig. 16
The basins outside the city wall.

Fig. 17
The entrance to the main cave.

Past and present at Sumhuram: from the ruins to the archaeological park

A. Avanzini

From 2000 Khor Rori has been added to the Unesco's Word Cultural and Heritage list as "Land of Frankincense" site.
The importance of this reward encouraged the Office of the Adviser to H.M. the Sultan for Cultural Affairs and IMTO in creating instruments and facilities to disseminate the knowledge of the history of the city and to improve the fruition of the site for the visitors.
The creation of an archaeological park comprising the city of Sumhuram and the ruins placed on the territory was the first step of a big project which now includes the installation of panels illustrating the archaeological remains and resting areas for the visitors.
Spaces for didactical activities addressed to the school children are in course of organization.
In July 2010 a new "Sumhuram Gallery" (fig. 1) presenting an exhibition of objects from the excavations and panels with information about the settlement and, generally, about Dhofar, has been inaugurated. Its realization which joins the "Museum of Frankincense land" of Salalah (fig. 2), wants to be a further instrument for the comprehension of the site

and its territory, explaining different aspects of the life in Sumhuram during the antiquity.
The work at Sumhuram has been huge: beyond the archaeological activity, IMTO, from 2005, started with an important operation of restoration and consolidation of the masonry structures with the double aim to give back to the site its original monumentality and to create the proper condition of safety for the visitors (figs. 3a,b).
Now the city is equipped with panels describing, with the help of reconstructions, the different areas of the city. Fixed and temporary paths have been created on the site; the temporary ones change at the end of every season, following the progress of the excavations.
In this way the visitor could have the idea of the "work in progress" of the activities on the field.
Moreover, to improve the knowledge of the site, IMTO prepared a guide, published by the Office of the Adviser to H.M. the Sultan for Cultural Affairs, able to provide correct information about the site and the pre-Islamic culture of southern Arabia (fig. 4).

Thus, the approach followed by IMTO, had the aim to develop the knowledge of the site and the richness of the culture of southern Arabia not only among the scientific community but also on a general level to the public at large.
For this reason IMTO used also instruments as the web, with the creation of a portal dedicated to the pre-Islamic Arabian studies (*http://arabiantica.humnet.unipi.it/*). Here it's possible to find a rich section dedicated to Sumhuram where is also possible to download the reports with the results of each campaign.
The sharing of data and information is, moreover, considered very important by IMTO: a data base collecting all the information from the excavations can be consulted freely, asking for a password (*http://imtodb.humnet.unipi.it/*).

Fig. 1
The new Sumhuram Gallery recently inaugurated on the site.

Fig. 2
The Museum of Frankincense Land in Salalah.

Figs. 3a-b
The north-western corner of the city before and after restorations.

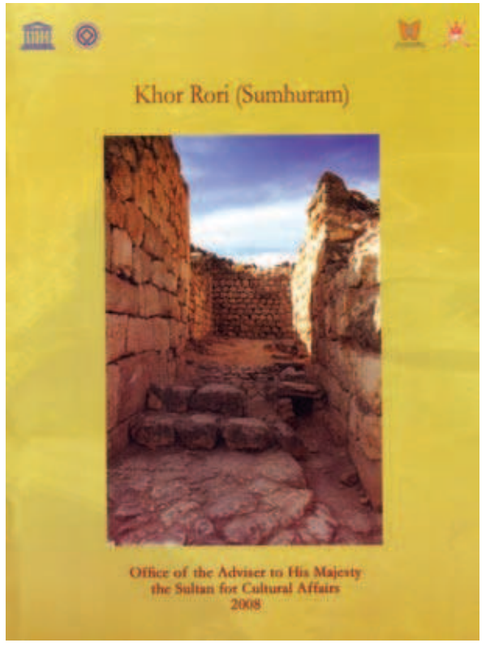


Fig. 4
The guide of Sumhuram.

Sumhuram and the production activities

Sumhuram as centre of production: the metal working

L. Chiarantini, M. Benvenuti

During recent archaeological excavations at Sumhuram (Dhofar region, Oman) by the Italian Mission to Oman (IMTO), significant amounts of bronze and iron artefacts have been recovered (Lombardi et al. 2008). They include tools for everyday use - mainly in iron - such as nails, chisels, hooks, needles, razors, various blades and weights. Besides, many bronze objects for cosmetics (mirrors, small sticks for applying kohl, hairpins), personal ornaments (bracelets, necklaces, pendants, rings, earrings, etc.) have also been found, as well as splendid ornamental and ritual items in bronze (basins, incense burners, small plaques with inscription or illustration, etc.). More than 1200 coins have been found at the site as well. In addition to these metallic artefacts, whose occurrence obviously does not attest *per se* to local metal production, archaeological excavations carried out in the period 1997-2010 unearthed in different parts of the old town of Sumhuram other finds, including pieces of slag, crucibles and one probable metallurgical furnace, which can be related to metallurgical activity *in situ*.

In the framework of the research project with

IMTO, researchers from the Department of Earth Sciences of Florence developed during the last three years a reconnaissance study of ancient metal production at Sumhuram, just starting from the above recalled "wastes" of metallurgical activity.
The main results of our research indicate that both iron and *copper/bronze* were worked, at least to some extent, at Sumhuram. The debated question of the existence of a *mint* at Sumhuram has also been tackled.

Iron working

In the antiquity, except for the Chinese area since the 5th cent. BC, iron production basically included two main process steps: the *bloomery* process (i.e., a *smelting* process carried out in low-shaft furnaces by which iron ores were reduced to raw iron metal: the *bloom*) and the *smithing* process, during which the final iron objects were produced by hot-working (heating, *quenching*, and hammering) the *bloom*, which underwent deep changes of both physical and chemical properties (Leroy & Merluzzo 2004). Each different step of the metallurgical process may produce different kinds of slag which, at least in principle, should differ as to their mineralogical, chemical, textural and physical features (Serneels et al. 2004). Most of the slags found at Sumhuram are *plano-convex* in shape (fig. 1), with diameters and thicknesses typically comprised between 7-13 cm and 3.5-6 cm respectively. Their bottom surfaces commonly include fragments of charcoal and soil. On the basis of chemical and mineralogical analyses, two main groups of iron slag may be distinguished (fig. 2a-b). The first group ("fayalite-rich slags") is mainly constituted by phases of the *olivine* group (fayalite and Ca-rich fayalite) associated with abundant iron oxides (*wüstite*), hydroxides (*goethite*) and sulphides (*pyrrothite*) (fig. 2c). In the second group ("rusty slags"), silicates are almost absent and the dominant phases are iron oxides (*magnetite*, *wüstite*) and hydroxides together with plagues of metallic iron (fig. 2d) and, more rarely, copper.
Both macro- and microscopic features of plano-convex slags indicate that they formed by accumulation of fused material (metallic particles, slag inclusion, fluxes, furnace lining fragments, charcoal…) in the lower part of a *smithing hearth* (Serneels & Perret 2003). Although it is difficult to distinguish different kinds of *smithing* slag (for example, if they are related to purification of raw iron ingots rather than to shaping and/or forging of iron tools), we can tentatively attribute "fayalite-rich slags" to hot forging of the iron piece, i.e. (quoting Serneels & Perret 2003) "hot oxidation of the metal with a small input of silica from various sources (lining, ashes, dust and eventually flux)". On the other hand, the "rusty" samples could represent the weathered (oxidized) products of once metallic iron-rich materials produced by loss of metallic particles during hammering of a poorly compacted metal. The occasional presence of copper droplets may indicate occasional working of polymetallic iron and copper objects (Serneels 1993).
Only very scanty evidence of metallurgical furnaces have been so far identified at Sumhuram. During our survey in November 2006, in area B, building BB1, on the ground floor of room A73 we could observe an elongated fireplace dug into the floor (0.75 m long, 0.44 m wide and 0.26 m deep) delimited by stone blocks, some of which slagged on the inner side (fig. 3). This structure was completely filled with light grey ashes mixed with few burnt bones, marine shells and pieces of charcoal; abundant hammerscale (fig. 4) was scattered around it. All these finds seem to indicate that the area was occupied by a *smithing* workshop with furnaces partially excavated into the soil and made up with stone blocks. The comparatively small size of plano-convex slags is consistent with the observed dimensions of the furnace.
In summary, there is evidence that *smithing* of iron was practiced at Sumhuram. No fragments of iron ores nor *smelting* slags (derived from the bloomery process) have been found associated with metallurgical wastes. This fact seems to suggest that the Sumhuram inhabitants imported raw metallic iron for local production from elsewhere through commercial exchanges.

Fig. 1
Top and cross section of some iron slags with typical plano-convex shape.

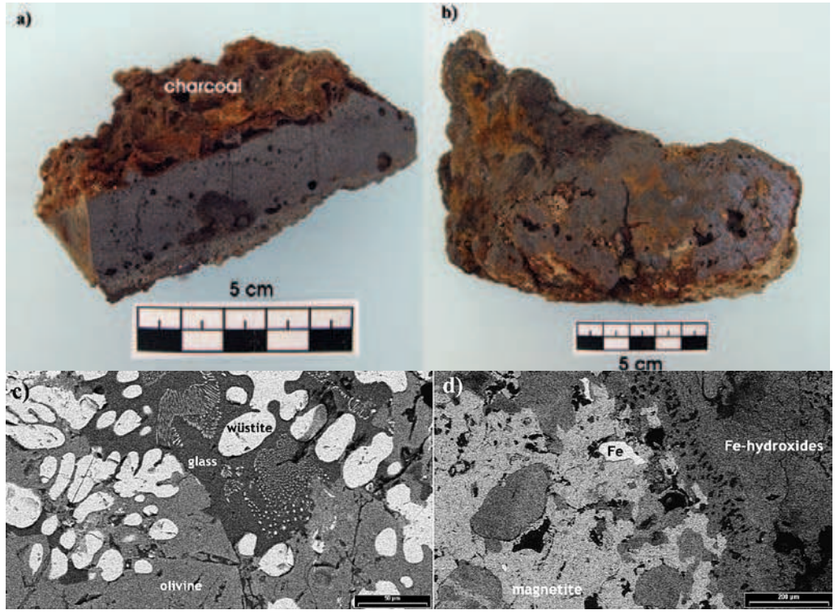


Fig. 2
Cross sections of "silicate slag" (a) and "rusty slag" (b). (c)-(d): Typical microtextural features (backscattered electron images) of smithing slag: c) "silicate slag" with large olivine crystals (light grey), glass (dark grey) and wüstite dendrites (white); d) "rusty slag" with abundant magnetite (light grey), iron hydroxides (dark grey) and metallic iron droplets (white).

Fig. 3
The smithing hearth found in Sumhuran, area B.

Fig. 4
Hammerscales (strongly magnetic) collected in proximity to the smithing hearth in fig. 3.

Copper/bronze working

The copper/bronze production chain is quite complex, including multiple phases such as *smelting* (reduction of the ores to metals), *refining* of metals, *alloying* (mixing of copper, tin and other metals to produce the final alloy) and *working* (casting the alloy into moulds and hot/cold *hammering* of the objects) (Tylecote 1987).
Despite the abundance of "bronze" artefacts found during excavations at Sumhuram, the only direct evidence of bronze-working *in situ* are a number of clay crucibles for bronze-copper melting and casting found at this site. Almost all crucibles are either hemispherical or triangular-shaped small- volume vessels, about 2-3 cm across and 2,5 to 4,5 cm deep (fig. 5 a-b). Thickness may vary between 3 and 7 mm. They could have held about 4 to 10 cm^3 of melted metal and were reasonably employed for the production of small objects like personal ornaments, small artefacts and, possibly, coins (*see below*) (Chiarantini et al. 2007; La Porta 2006).
Many crucibles are strongly vitrified on both inner and outer sides, possibly indicating reuse for multiple cycles of melting/casting (fig. 6). Their preservation state is commonly very poor. Composition of bronze alloys entrapped in the vitrified inner surface range from Cu-Sn to Cu-Sn-Pb. A small plague of slag still adhering to the inner surface of one small fragment, possibly belonging to a larger vessel, contains droplets of metallic copper, Cu-Sn alloy and tin oxide (SnO_2) crystals dispersed in a matrix of glass with scarce olivine (fig. 7). This type of slag are generally ascribed to the processes of bronze alloying and/or bronze recycling (Northover & Rehren 1992).
A few crucibles, on the other hand, are quite well preserved: the lower degree of vitrification allows some evaluation to be made about the mineralogical and textural features of their ceramic body. They are made of abundant *mullite* and *quartz* which would impart highly desirable refractory properties of great strength. Since clay outcrops are not found in the vicinity of the Sumhuram area, (Platel et al. 1992a/b), production of these vessels either took place elsewhere or required import

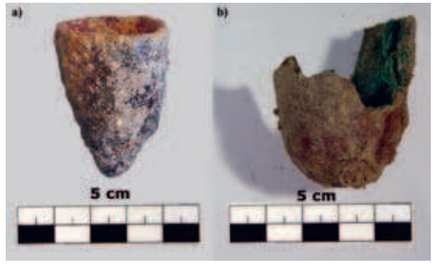


Fig. 5
Crucibles varying in shape from triangular (a) to hemispherical (b): the latter vessel (b) is strongly vitrified and contained abundant metal residues.

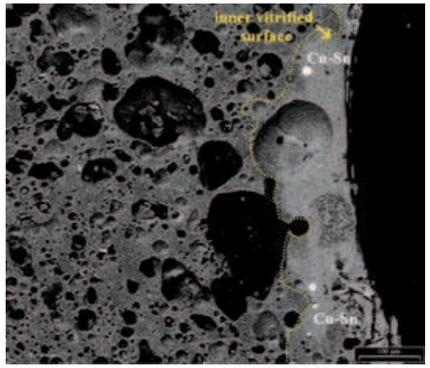


Fig. 6
Typical microtextural features of a crucible wall (backscattered electron images): to the right the less porous, vitrified inner side of crucible wall (light grey) with some Cu-Sn droplets (white).

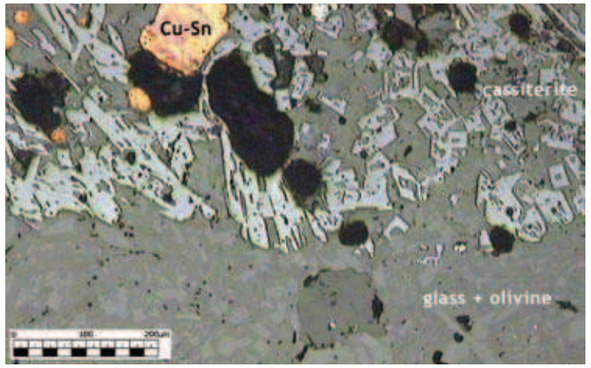


Fig. 7
Microphotograph of the slag adhering to a ceramic fragment. Abundant skeletal cassiterite crystals (light grey) and Cu-Sn droplets (yellow) dispersed in the silicate groundmass mainly constituted by olivine crystals (dark grey).

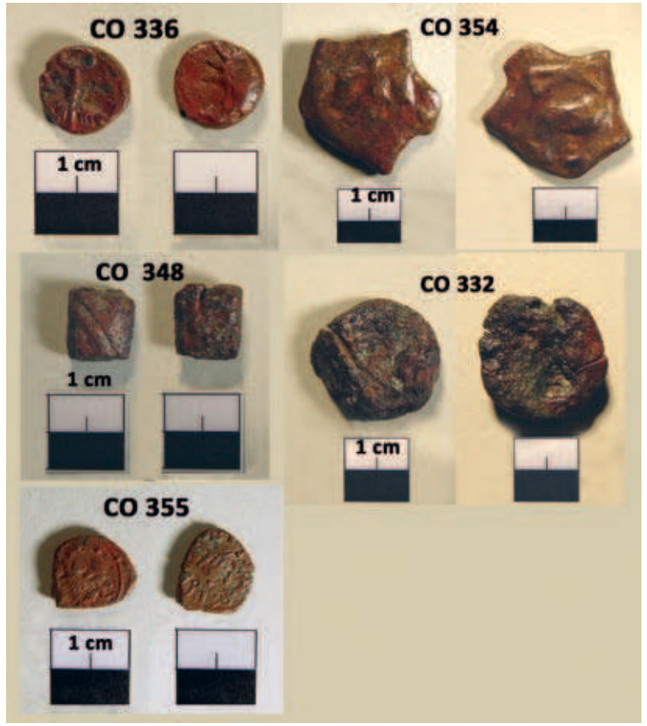
of raw materials from outside. As already seen for iron, we have only evidence of the last metallurgical step of the bronze production chain, i.e., alloying and casting of Cu-Sn(Pb) alloys. We did not find any slag related to the *smelting* process of pure metals, nor fragments of smelted ores. It may thus be argued that raw metals (as ingots?) were imported from elsewhere and remelted, alloyed and cast *in situ* to produce mostly small objects and/or even coins (?). Recycling of broken bronze tools may also have been practiced.

Coins and coinage (?) at Sumhuram

The recovery of about 1300 coin-blanks during the first excavations at Sumhuram in the 50's of past century (Albright 1982) led this author to suggest that a mint existed there in pre-Islamic times. Unfortunately descriptions and/or analyses of these blanks have never been published. The "mint hypothesis" gained further support from the more recent discovery of some 600 coins during excavations at Sumhuram by IMTO (Avanzini, Sedov 2005; Sedov 2002; Sedov 2008).

Detailed numismatic classifications of ancient Hadramawt coinage (Sedov, Aydarus 1995) and, more in general, of south Arabia pre-Islamic coins (Sedov 2005), are mainly based on a "stylistic" study of specimens from the Museum collections. In order to include in the numismatic database also chemical and textural characteristics of different coins, in 2008 it was started a cooperative project between the Florence research team and Prof. A.V. Sedov (The State Museum of Oriental Art, Moscow), aimed to get information on production techniques and type(s) of alloys used for coins found at Sumhuram, as well as to shed some light (if possible) on the old vexed question of the mint. Therefore we selected for minero-chemical analyses 19 coins coming from Sumhuram excavations and belonging to different chronological and stylistic series of the Hadramawt and Himyarite kingdoms (fig. 8); in addition, 10 coins from the same stylistic series coming from Kane (Yemen) were chosen for comparison. Results of this study, still largely unpublished (Tasselli 2006; Bertini 2008; Cilio 2008) and partly in progress, will be the focus of a dedicated paper (Chiarantini et al., in prep.). We provide hereafter only some partial, preliminary results. Analytical data evidenced significant changes in both composition and production techniques of Hadramawt coins over time. Most coin series are composed of a *lead-tin bronze* of rather variable lead content. The earliest coins are small in size, struck and well manufactured, while later series are proportionally greater, heavier and richer in lead. They show a generally lower manufacturing quality, and may be both cast and (cold/hot) struck. Himyarite coins are generally smaller than Hadrami ones, and show (at least those from the so-called "Bucranium series") good manufacturing technique and homogeneous composition (high-tin bronze). Of particular interest are the results of microtextural and compositional analyses of "Type 3" (radiated head/winged caduceus) coins of the Hadramawt kingdom (Co 336 in fig. 8). These coins display, on the obverse, the Hadrami monogram representing the name *S²qr* (the name of the royal residence in Shabwa) on the reverse side a different monogram which should be deciphered as "Sumhuram" (Robin in Sedov 2005), name interpretable as the mint-name or as the name of the king who struck the coins. Following this interpretation, the "Type 3" coinage series could be a provincial coinage minted not in the Hadramawt kingdom capital (Shabwa) but in Sumhuram. "Type 3" coins show peculiar compositions, different from all other investigated coins, since they are made of a copper matrix containing significant amounts of nickel (generally >1wt%), cobalt and iron with dispersed Cu-Fe sulphides (fig. 9). This feature possibly indicates that a different type of copper ore was used for these coins: if this is true, one cannot exclude that coinage was made in a different mint, i.e. at Sumhuram! Up to now, however, there is not any direct (i.e., archaeological) evidence of this. In addition, at the moment we have not found any metal residue within crucibles with a chemical composition compatible with "Type 3" Hadrami coins. The question is open still!

Fig. 8
Selection of analyzed coins. Hadramawt coins: Co 336 ("Type 3", radiated head/ winged caduceus); Co 354 ("Type 4", head/ eagle); Co 332 ("Type 5.3", radiated head/ bull); Co 348 ("Type 10", S^2qr/ bull). Himyarite coin: Co 355 (two heads).



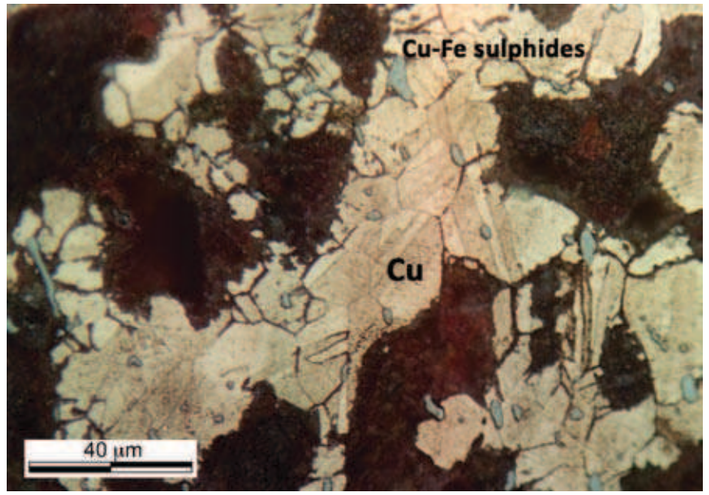
Concluding remarks

Metallurgical activities performed in Sumhuram were mostly devoted to secondary metal-working.

For both iron and copper/bronze production, no traces of *smelting* activities (slags, fragments of smelted ores, etc.) have been detected thus far. Metal import could have been favoured by the extensive trade exchanges which connected the Sumhuram port-town with other parts of the south-Arabian region, northern Oman, the Red Sea and India long before getting in touch with Rome. The amount of iron *smithing* slag discovered in the site testify a significant activity of iron-working (shaping and *forging*) mostly for the production of tools for local needs. As to local bronze-working activity, the analyses of crucibles indicate that bronze alloys varying in composition from Cu-Sn to Cu-Sn-Pb were *melted* and cast for the production of small ornaments and every day objects. The reported occurrence of a large number of coin blanks, together with the peculiar Ni (±Co,Fe)-rich composition of "Type 3" copper coins, bearing the Sumhuram monogram, could support the hypothesis of the existence of a mint in Sumhuram, although no metal residue in excavated crucibles matches this chemical signature. New information could hopefully come from the study of metal provenance through the integration of chemical, textural and isotopic data.

As a final comment, it must be emphasized that archaeological excavations up to now have been carried out only within the perimeter delimited by town walls: the surroundings of the town of Sumhuram are, as yet, substantially unexplored. Since the metallurgical process of whatever type is typically very poisonous, and tended to be carried out in peripheral areas, outside the inhabited quarters, it is thus possible that future excavations in the surrounding territory could tell a partly different story about metal production activities at Sumhuram.

Fig. 9
"Type 3" coin (micro-photograph, reflected light): Cu-Fe sulphide inclusions (light blue) dispersed within recrys-tallized and twinned grains of copper (light and dark yellow).



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Local raw materials used by craftsmen and in the development of the city of Sumhuram

P. Pallecchi, A. Pavan

Geological setting

The ancient port of Sumhuram is located within the region of Dhofar (southern Oman) and it is set into the costal plane at the edge of the large plateau of Jabal Samhan, mainly composed of outcrops of calcareous rocks belonging at the Umm Er Radhuma Formation (UER), of Paleogene-Early Eocen age.
This formation is made of compact limestone of sea origin, white or pale-pink fossil-like material, dolomitic limestone, biocalcareous rocks formed of fossil fragments cemented by a calcareous background, chalks and layers of siliceous rocks (Reuter et *alii* 2008).
Along the coastal plain, the area of Khor Rori has revealed the presence of recent sedimentary debris whose origin is mainly calcareous, but containing even quite high contents of siliceous components (fig. 1).
These deposits and alluvial sediments have been transported there by water streams coming down from the plateau and were deposited in the estuary areas or in lagoons which were not directly communicating with the sea (fig. 2).

The analysis of samples of these materials show the presence of several sorts of sediments.
There are deposits from estuaries, which are composed of dark layers of clay elements with a high component of organic materials together with sand, and lagoon sediments, composed of thin dark layers of clay minerals with high plasticity.
In these sediments the sandy component does not exceed 58% of the total weight and their granulometry is lower than 1200 microns.
Mineral and petrographic analysis of the debris show the presence of clay materials together with a high carbonatic component, with scarce granular elements of quartz, feldspar, fossil remains, chalk, halite. There are also numerous aggregates of iron oxide.
Red clay materials, mixed with conglomerates, are present also in the area of Khor Rori (figs. 3 and 3a), while clay materials are found into the alluvial deposits of gravel, northern from Sumhuram and Taqah.
At the outlet of the wadis in the coastal plane some thick deposits of travertine have also formed, one of the most important being just north-east from Sumhuram (fig. 4).
Important chalk deposits are present in the plateau just off Thumrayt.
To find rocks different from the carbonatic ones, it's necessary to go towards Mirbat (30 km from Sumhuram), where it's possible to find large outcrops of the Paleozoic basement, comprising granitic rocks and gneiss, together with metal mineralization.
Volcanic rocks are present in quite far areas, towards the northern mountains of Oman or in Hadramawt (Yemen).
Judging from these geolitologic characteristics it's evident that around the town of Sumhuram it was possible to find many raw materials to be used as building materials or in the daily life objects.
The presence of the carbonatic component both in the plateau rocks and in the sediments along the coast (marly clays with a limestone skeleton) allows the distinction between the objects produced with local materials and those imported, and it also allows a careful study of the technical choices and the selection of raw materials available around the town.

Building materials

The city has been built in drystone masonry, with walls made of regular size stone blocks arranged in horizontal rows (fig. 5). A filling of disorganized mixture (broken stones of medium and small size, sand and earth) was placed between the two faces of the walls.
The earth put within is a sandy incoherent calcareous lime, made red by iron oxides, and containing small quantities of quartz, feldspar and clay materials.
The macroscopic observation of the calcareous blocks has allowed to recognise four main different litotypes which have been analyzed through mineralogical and petrographic analysis, x-rays diffractometer and the optical polarization microscope.
The main part of the stones used as building material is a compact dolomitic limestone of white or pink colour, of chemical or biochemical origin, containing some rare fossil fragments.
The diffractometer investigation has showed the presence of calcite and dolomite.
Also a calcareous sandstone (calcarenite) has been often used. It's less compact than the previous one, composed of a debris part of carbonatic origin (calcite, fossilised remains of algae, echinoderm and briozoae).
This rock is typically highly porous with a consequent worsening of the physical characteristics compared to the dolomitic limestone.
The third litotype consists of carbonate rocks vacuolar, due to the presence of vegetation elements at the moment of the rock formation, and the fourth is made of an intricate scheme of fossil vegetal elements, linked to a carbon deposit of chemical origin in a vegetation-rich natural environment.
This last litotype shows a white colour together with a high porosity and a low cohesion level which have limited its use.
A very small number of walls have been obtained using mud-bricks, pale in colour, with low cohesion and high porosity.
The empty minimal cavities have walls with concretionary aspect.
The analysis with the polarising microsope

within a section of a sample of mud-brick shows a main carbonatic composition, while the aggregate is still made of carbonatic elements with a small quantity of quartz, feldspar, white micas and pyroxene traces.
The carbonatic component of the aggregate is due to the presence of calcite, micritic limestone, carbonatic rocks and a fibrose-radial structure of likely chemical origin (travertine or alabaster) and, for its main part, of microfossil calcareous fragments and rests of shells.
The granulometry of these components is around 3 mm. The quartz and feldspar have a low degree of rounding and a granulometry between 0,05 and 0,1 mm. The results of the mineralogical exam through x-ray diffractometer agrees with what was observed at the diffraction microscope, showing calcite as the main mineralogical component, and quartz, feldspar, halite and phillosillicates as secondary components.
The walls of the city were covered with several layers of plaster during the building process.
The analysis carried out on some samples show that the covering of the walls of Sumhuram was obtained by using clay earth over which a plaster and a chalk-based layer was spread, together with a compound made again of fragments of chalk crystals and earth parts, calcite fragments and calcareous rocks.
In some cases, over the covering, there was also a finishing made mainly of lime.
The observations made on the building materials reveal a clear link between the stones employed in the city and the stones found in the immediate areas surrounding the site.
The choice of the materials was linked by the availability of the raw materials but it was also influenced by the physical characteristics of them: for this reason there was a main use of the micritic limestone instead of calcarenite, more porous and so less durable, and of travertine.
The use of mud-bricks was limited to partition walls. They were made out from calcareous mud of low plasticity, which acquired mechanical resistance during the drying process, due to the precipitation of the calcium carbonate. The composition of these bricks is different from the earth commonly used as building material, made of a composite material of chunky aggregate held together by a clay-based binding.
The calcareous clays are frequent sediments in the estuaries along the coasts of Dhofar, so the reason of the choice of these materials for the building of mud- bricks is to be found in their availability *in situ*. This is also confirmed by the results of the palynologic analysis which have evidenced the presence of pollen granules from plants growing near and along the coastal fresh water basins (Mariotti et *alii* 2008).

Local pottery

Beside the imported pottery, in Sumhuram seems to be attested also the production of a local pottery, manufactured with materials found nearby the settlement.
Two different kind of wares are connected with this local manufacture: one linked to the Dhofari tradition and the second which recalls shapes of the Hadrami tradition, but realized with fabrics exploiting local clays, collected in the lagoons.
The local raw material is always made of a high percentage of calcareous component, which gives a clear colour to the ceramics. When the calcareous component is prevalent, and, together with this element, there also are a large number of silicate and iron oxide, possibly due to the accumulation of residual materials linked to the process of dissolution of limestone (deposits of debris along the feet of the mountain area), ceramics have a pinkish to reddish colour.
The Dhofari group is characterized by materials, manufacture and decorations which show a long history and which reveal *echoes* in the traditional pottery produced till today in the region.
It's a pottery with reddish/buff fabrics which usually employs, as temper, crushed shells or calcareous microfossils, with up to 2-3 mm in diameter, together with silicates sub-angular quartz, feldspar, micas (fig.7), never wheel made, with particular decorations, made after

burnishing the vessels with shells or pebbles of small dimensions, used also in the present-day tradition.
The exterior is treated rubbing the surface when it's still wet, while the interior was shaped and finished off with a clam shell, as happens also today in local manufacture.
The ancient Dhofary pottery consists of rounded bottom vessels with incised decorations placed at the base of the neck, showing rosettes, chevrons, slashes, triangular pendants or their combination. Dot-circle motif is common, as well, from many pottery Dhofari sites.
These decorations were made with sharpen tools and or with a rouletting technique, the same used till now in the modern Dhofari handicraft tradition.
Information about the firing process could be understood from the traditional pottery produced in the handicraft centres (see box).
Beside the Dhofari ware, we suppose that a second kind of local pottery has been produced in the settlement or nearby.
A large amount of jars, made with a coarse and porous fabric, has been discovered in the site. Their fabric is usually pale yellow in colour, largely made of fragments of calcareous rocks together with a few included sub-angular quartz and frequents fossil remains (fig. 8). It presents also a large amount of vegetal temper, their shape consist in a globular body with short neck and high-ring base.
More interesting, the analysis of the ware reveal an identical composition noticed in the mud-bricks, confirming that bricks and pots have been manufactured using the same kind of materials.
The firing process was probably done in pits dug nearby the settlement of in open- air fires which did not leave traces.

Stone vessels

In the course of the excavations carried out in Sumhuram there have been found numerous fragments of stone vessels. These have been taken from some large blocks of massive soft stone, of white colour, green or blue-green, and from very soft stones of grey colour with green veins, greasy to the touch, flaking easily into lamellar scale-shaped fragments, with a mother-of-pearl finish. Rarely there have been findings of whole objects, while we have numerous ones in fragments, caused by the breaking of these rocks which have a particularly low mechanical resistance.
Apart from the fragmentary conditions, the stone surfaces are in a good state and we can still observe some traces of the working process, particularly evident with the craft objects made with green stone (fig. 9). Some of these manufacts contain white encrustations of a concretionary aspect, and they are a few millimetres thick, due to their components.
At this point in research, it's possible to divide the stone vessels found in Sumhuram into three main groups on the basis of the clorite-rich rocks, talcum-rich rocks and calcareous rocks.
The petrographic investigation, carried out on six thin sections observed at the polarization microscope, together with the diffraction analysis, have allowed to identify the petrographic characteristics of the three groups. The stone vessels made of chlorite rock typically show the presence of this mineral (> of the 90%).
The fragments are slightly pleochroic with a spherulic structure.
Together with chlorite there are also quantities of opaque minerals, calcite, muscovite and talcum (fig. 10). The stone vessels containing talcum were produced out of elongated lamellar crystals of the same mineral. Together with talcum there were small quantities of plagioclase, serpentine and muscovite (fig. 11).
Among the stone vessels made of carbonatic rocks where are to be found a few examples made of white biocalcarenite.
The use of chlorite -rich and talcum-rich rocks is well known in the Arabian peninsula (David 2002, Magee et *alii* 2005), also considering the large presence of these rocks in south-eastern Arabia. The use of this material for cooking vessels is not unintentional, and it can be linked to reasons like its low hardness, allowing an easy carving of the stone on the wheel, and low heat transmission, which is useful for keeping the contents warm and for

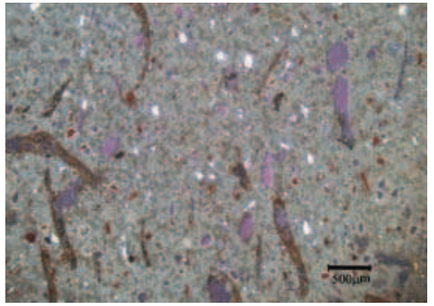
Fig. 1
Geological map of the area of Khor Rori, scala 1:1000000 (ministery of Petroleum and Minerals, Sultanate of Oman 1993). Simplifted legend: brown areas: massive limestone and dolomitic limestone; yellow areas biocalcarenitic and micritic limestone; white areas: alluvional deposits).

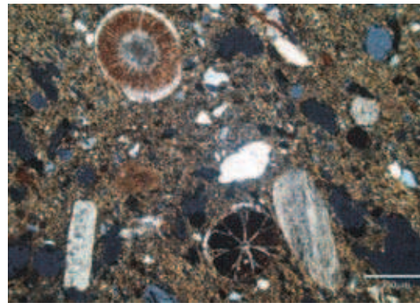
Fig. 2
Clay deposits near Mirbat.

Fig. 3
Red clay deposits in the territory of Khor Rori.

Fig. 6
Blocks in calcarenite at the entrance of the main temple of Sumhuram.

Figs. 7, 8
Microphotograph of the thin section of the local pottery by polarized microscope.





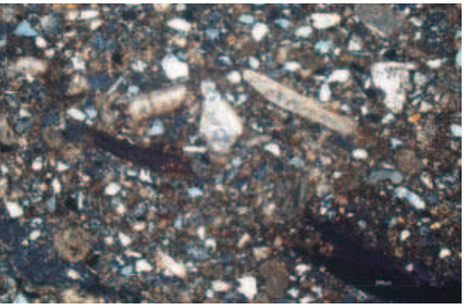


Fig. 3a
Microphotograph of the thin section of a sample of red clay by polarized microscope.

Fig. 4
Deposits of travertine 10 km north from Sumhuram.

Fig. 5
Example of a wall in Sumhuram, made from stone blocks of regular size, arranged in horizontal rows.

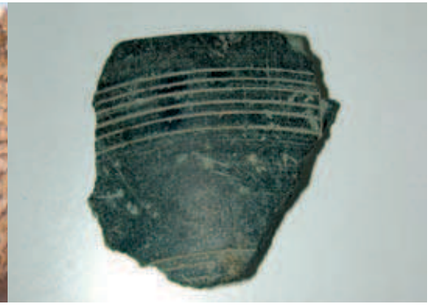


Fig. 9
Fragment of stone vessel in chlorite.

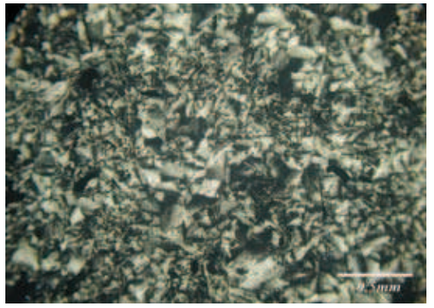


Fig. 10
Microphotograph of the thin section of the stone vessel in chlorite by polarized microscope.

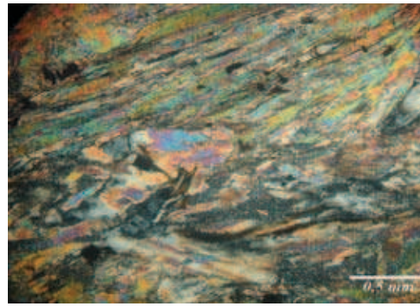


Fig. 11
Microphotograph of the thin section of the stone vessel in talc by polarized microscope.

cooking on direct fire.
About the origin of the vessels made out of chlorite-rich rocks, the studies available identify the area of extraction in the north-eastern mountains of Oman where ophiolitic rocks (Semail Ophiolite) can be found, including soft stone due to the alteration of ultrabasic rock, where there is a presence of chlorite and minor quantities of serpentine and talcum.
This statement derives from the comparison of the petrographic characteristics of the vessels analyzed with those of the single rocks belonging to the ophiolitic complex in north-eastern Oman, available in many scientific studies. This comparison has showed a very close similarity between the stones used for the making of soft stone vessels found in Sumhuram and the rocks found in the Semail Ophiolite, in the al-Hajjar Mountain. This area includes many sorts of soft rocks and thus it's considered the main source for the soft stone used in the creation of shaped engraved crafts since the Iron Age (Magee et *alii* 2005).
The group of stone vessels obtained starting from talcum-rich rocks are, instead, linked to the outcrop of these stones present in Yemen, still used today for similar handicraft products.
The stone vessels made out of carbonatic rocks, on the other hand, are of local production. The small number of local calcareous stone vessels found in Sumhuram are considered to be linked to the great difficulty in working this sort of rock compared to soft stones and to a worst resistance to fire.

Conclusions

The research made on the raw materials used for building activities show that these have been almost entirely taken from around the site. This shows little interest in the use of decorative elements in more precious stones which could be taken somewhere else and then transported by the ships to Sumhuram.
The use of local stones for building up the town shows, however, a great knowledge of the raw materials available around the settlement and a different use of the stones related to their destination. The excellent knowledge of the local raw materials is also confirmed by the use of local stones to imitate imported crafts, as shown by a calcarenite tray in the same shape of the stone vessels made out of talc-schist coming from Yemen. The same considerations can be made for the chalk-based raw materials used in the wall coverings, and of the layer of lime-based finishing. The use of lime clearly shows the knowledge of the Sumhuram artisans of this product, even if, in the wall coverings, they preferred chalk which had been used for a long time: it was easier and more reliable.
The raw material used in the plastering was taken from the local area: chalk mines were all around Thumrayt, a few kilometers away from the site, or going eastward, around Hasik. The limestone to obtain the lime was found directly around Sumhuram, like the earth added to the binder and the carbonatic component of the aggregate.
About the raw materials used in ceramics, the Khor Rhori area doesn't offer very good materials. The clay found all along the coastal strip is typically made of a high calcareous components. Thus the plasticity of the materials is scarce and it had to be improved by adding vegetal remains. The use of a raw material which scarce plasticity and with low cohesion turned into porous vessels, with thick walls and low mechanical resistance.

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Pottery tradition in Dhofar

The Woman Societies of Taqah and Mirbat are modern centres where traditional pottery is still produced. These associations, funded by the Omani government, enable the women of the villages to have a free place for producing and firing pottery vessels and, above all, incense burners, to be sold in the local markets.
Thanks to the observation of the manufacturing processes and the interviews with women working there, different aspects of the production of ancient Dhofari ware have been clarified.

Materials and pottery making

The clay used for the pottery produced both in Taqah and Mirbat is taken from the mountains and, particularly, from the area comprised between Madinat al-Haq and Tawi Attair (fig. 1).
According to the women, it's not necessary to add to the clay any temper material and the clay is simply sieved in order to purify it as much as possible. According to the tradition, small rotary querns, the same used for cereals, could be use also to grind the clay, but neither in Taqah nor in Mirbat this practise is still in use.

The clay shows the presence of tiny inclusions, whitish in colour, recognized as limestone fragments but, according to the place of provenience, in some cases, the temper could be made by white shells.
The first step consists of softening the material. Water is added to the clay and longer kneaded to have a soft and homogeneous mixture.
To model a globular vessel, a clay disk is created, flattened with a roll and delimited with a knife. Thus the disk is pressed against a cloth covering an old clay pot (fig. 2) and finally shaped by pressing and refined scraping with a curved shell. After the modelling of the vessel's base, strips of clay are added in order to complete the shape of the vessel with a kind of simplified coiling technique (fig. 3).
The different thickness is reduced manually with the fingers and the surface smoothed with a wet pebble or a shell in a very quickly way.
Different is the case of the burners modelled in Mirbat. Here the clay is simply beaten in blocks of uniform thickness, cut and joined together according the desired shape when the clay is still we (fig. 4). The object, still wet, is simply refined with the blade of a knife (fig. 5).

Decoration and firing

The decoration is made, after the burnishing of the vessel, with incisions performed with a sharpen tool (aluminium stick, steel hairpin) or rouletting metal wires, twisted around a ring (fig. 6).
Firing now takes place in an electric oven where the vessels, piled up, are cooked one or a couple of days in a week.
Until few years ago, the firing took place in open fires, fuelled with the combustible material easily available (palm fronds, coconut husks, pieces of wood) in pits dug into the hearts (fig. 7). The vessels were piled up into the pit, directly on the bed of charcoals, and left for about 30 minutes, covered by other combustible material.
The produced shapes are above all incense burners, liked to the tourists, but globular vessels, originally made to store water and milk (fig. 8), are manufactured as well with coffee cups and bread stamps.

Fig. 1
Jebel Taqah, one of the favourite sources for the clay.

Fig. 2
Shaping a globular vessel, the modelling of the lower part.

Fig. 3
Shaping a globular vessel, the modelling of the upper part.

Fig. 4
Shaping an incense burner, the creation of the object.

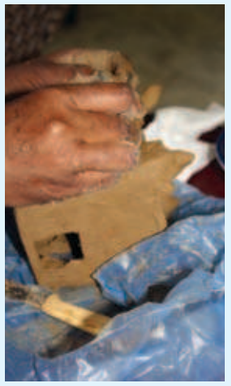


Fig. 5
Shaping an incense burner, the decoration technique.

Fig. 6
Typical Dhofari decoration, made by pointed tools and rouletting metal wires.

Fig. 7
Open air firing sometimes used in Dhofar.

Fig. 8
Modern pots produced in Taqah.

Sumhuram and the international trade

Sumhuram as international centre: the imported pottery

A. Pavan

There are a number of reasons why the study of the South Arabian perspective on the international trade that developed along the coast of the Indian Ocean, has been long considered of marginal interest and hence underestimated.

To objective factors, as well as the socio-political situation, must be added a skewing of the history of studies in favour of a "Roman" perspective which tended to focus the interest of scholars not only on a specific geographic area - the Mediterranean - but also on a certain period in history, after the Roman conquest of Egypt. This outlook, however, has undergone change in recent years following a general re-thinking of how history, economics and trade evolved between the Mediterranean and India.

New investigations have been conducted in crucial sites such as Berenike, acquired data reviewed in the light of new discoveries - such is the case of Arikamedu - and the opening up of the South Arabian "frontier", enormously enriched the quantity and quality of knowledge, painting a much more detailed and diversified picture. The case of Sumhuram is a perfect example of this.

Believed by the Americans to be the twin port of Kane, it was supposed to be built in the 1st

cent. AD, when trade between the Mediterranean and India had reached its zenith (Albright 1982). Furthermore, its vicinity to the Nejd, the pre-desert area in which the highest quality of frankincense is grown, made Sumhuram a perfect new foundation for the kingdom of the Hadramawt, to exploit the profitable trade in spices and aromas which was being plied along the shores of the Indian Ocean.

Excavations in recent years, however, have overturned this perspective.

The city's foundation is to be backdated by at least four centuries earlier than the heyday of Roman trade, in the 3rd century BC.

This was also a time of great political and economic upheavals, with a scenario in part comparable to that of the 1st century AD, which has only recently been set within the context of its real importance.

This was the period in India during which the shift from the so-called *Megalithic Culture* to the *Early Historical* period was sanctioned; the era was marked by far-reaching social, economic and cultural changes which developed and became more pronounced under the Mauryan dynasty and the imperial expansionist policies of King Asoka.

Indeed, Asoka claimed to control almost the whole of India, Pakistan and Afghanistan, as far as Sri Lanka, where he introduced Buddhism of which he had become a follower.

The sources make no mention of the part played by the sites on the Arabian coasts in such a far-off era although indirect data refer to their involvement in the embryonic phase of the trade between Egypt and India.

The *Periplus* of the *Erythraean Sea* reminds us that Eudaimon Arabia, the present-day Aden, was a hub of international trade and in paragraph 26 the author narrates that in times before his own, Eudaimon Arabia was a port of call for Egyptian ships who moored here to trade with Indians who still dared not venture any further north than Bab al-Mandab.

This is echoed in Strabo (*Geografia*, II, 5, 12) who tells that under the Ptolemies not even a fleet comprising twenty vessels dared to pass the pillars of Hercules of Bab al-Mandab, whereas in his time no fewer than a hundred and twenty set sail.

The author may certainly have exaggerated the number of ships that set sail in his time, the 1st cent. AD, just as he may have underplayed the number that left in the 3rd cent. BC but his point is that trade, albeit on a small scale, had taken place since the Ptolemaic era.

The situation was even more dynamic along the shores of the Red Sea. Indeed Ptolemy Philadelphus who lived between 309 and 246 BC was the first Hellenistic sovereign of Egypt to promote trade with south Arabia and sub-Sahara Africa, as well as, apparently, encouraging relations with India.

Evidence of this interest is to be found in the new foundations alongside the Red Sea; not only Berenike, built in honour of the mother of Ptolemy II Philadelphus, but also the satellite city of Arsinoe, built in honour of his bride.

Ptolemies' interest in trading coincides with their military interests, and the new ports were the ideal places for reaching and exploiting the areas where the elephants that the Egyptian militias made use of, were captured, and for getting the gold used to pay mercenary soldiers. Unfortunately, the Ptolemaic levels of Berenike have been partially excavated, as well as Eudaimon Arabia is sealed underneath modern-day Aden; thus the site of Sumhuram became of fundamental importance as a link between the Red Sea and India.

The data emerged from the stratigraphic excavations, the study of materials and a fresh reading of the events surrounding the kingdom of the Hadramawt, has in fact led to an overall rethink of the city's history and its dating. Sumhuram was in fact founded in the 3rd cent. BC and immediately became a stage of outmost importance in the traffic along the Indian Ocean coastline.

Seaports, points of exchange by definition, all typically have a great variety and quantity of imported material. Sumhuram is no exception. India, Iran, Mesopotamia, the Hadramawt motherland, and then to the north, Egypt, Cyprus, the Greek islands and Italy are identified as the areas where the pottery discovered on site came from (fig. 1).

Sumhuram and India

The indications are that the city had a special relationship with the Indian subcontinent from the very beginning. Indeed it is no coincidence that the one of the most significant discoveries on site - unearthed by the American excavations in 1953 - was a bronze statuette of a so-called Salabhanjika (fig. 2), differently interpreted as a divinity or as a young woman who makes trees bud with a touch of her foot (Goetz 1963). This is a unique piece, not only for Arabia, but also for all the other countries that enjoyed relations with India, where it is extremely rare for Indian objects to be discovered.

Despite being less spectacular, discoveries made in recent years have enabled the relationship between Sumhuram and India to be clarified, pointing to a continuity in relations from the 3rd century BC for the whole long period when the city was lived in.

The most interesting datum to emerge in more recent studies is the presence of Indian pottery dating indisputably to the centuries BC. The discovery of fragments of true Rouletted Ware (fig. 3), a variant of Fine Gray pottery, is to be considered exceptional, as being the only evidence of this kind to be found in all the Arabian peninsula. These are actually fragments of plates or shallow bowls that have a characteristic beaked rim and a typical decoration on the base that gives the name to the type (rouletting).

Rouletted ware became very widespread in India's eastern coastline while being almost totally absent on the western coast where it was discovered quite recently only near Pattanam, along the Malabar coast. It later appeared in Arabia, but only in the site of Sumhuram, and on the Red Sea in Berenike and Myos Hormos.

The discovery of Rouletted Ware, which went out of production in the 1st century BC (Schenk 2006), in strata that can be dated to when the city was first inhabited, not only confirms the 'early' dating of Sumhuram, but also how it very soon became involved in the international trade between Arabia and India.

Rouletted ware therefore enables us to establish that there was a link among the three ports of Arikamedu, Sumhuram and Berenike; it is not, however, the only evidence of this.

Yet again, of all the sites in Arabia that have been excavated, Sumhuram is the only one where fragments of the hand-made "paddle impressed ware" ceramic have been discovered (fig. 4).

These vessels were large in size, made to be used for storing or cooking purpose, and were decorated by means of a procedure of percussion, grooving paddles on the outside.

Similarly to Rouletted Ware, this, too, is a guide fossil of great interest.

The technique, although still in use today, is limited to southern India and, in particular, to the area of Arikamedu which, therefore, may be considered the centre where these vessels were manufactured and shipped from.

This ware is not attested in western India, in the Gulf or in Kane, but it is mentioned in sizeable amounts in Berenike which, again, confirms the links that connected this site with Sumhuram and Arikamedu.

While Sumhuram was therefore part of the network that stretched from the Red Sea to India in the 1st cent. BC, a different scenario began to unfold from the 1st cent. AD onwards.

Indeed it was in this period that the Indian forms and wares grew up and became predominant those from northern India. The vessels are thicker, red in colour and the variety of shapes broadens with a predominance of containers for transport and storage.

There is also an increase in utilitarian vessels against fewer pieces of tableware; several samples of carinated pots, lids (fig. 5), oil lamps have been discovered in all the sites overlooking the Indian Ocean.

At this juncture, the new commercial trajectories seem to be more oriented towards India's north-western coast evidence of which, in Sumhuram, is seen not only in the pottery but also by the coins unearthed. The coin of King Kaniskha I and one of Abhiraka, Satrap of Barygaza, are the only Indian coins discovered in whole Arabian peninsula.

This combination of evidences outlines a scenario in which Sumhuram plays an important part. Backdating its foundation also affects the importance of the site and obliges us to rethink the reasons for its importance. Such an early involvement does not seem to have been due to the trade of frankincense as to its favourable geographic position, in the centre of the southern

coast of the Arabian Peninsula. The position was ideal for ships to take advantage of the winds that would carry them to India and the Gulf.
There is an interesting point of discussion regarding whether or not there was an Indian community on the site. The idea had already been put forward indirectly by Goetz who was led by the discovery of the bronze statuette to hypothesize that an Indian merchant may have had a private chapel. The great quantity of imported utilitarian vessels discovered here seems to be another evidence of a resident community in Sumhuram.
On the base of the pottery material discovered in the site of Berenike, which mirrors that of Sumhuram, it has been hypothesized that there was a community of Indians there, too. Further evidence of a colony in Egypt is provided by the remains of rice discovered on the site which, according to Cappers (Cappers 2006), was eaten by the Indian merchants who resided there.

Sumhuram and the Gulf

In its list of ports and merchandise, the *Periplus of the Erythraean Sea* makes no mention of the Gulf region. It describes the sites of Apologos and Omana which have not yet been unequivocally identified, but the brevity of the quotation would seem to signify that these stages were of scanty importance in the complex network of traffic it describes.
A plausible reason for this lacuna may be that the *Periplus*, the only piece of evidence of this trade to reach us, is in fact only one of the sources describing international trade in the 1st cent AD.
However it's probable that other routes existed, also if they have not been recorded. Indeed trade must have taken place along several segmented routes that involved every country along the shoreline of the Indian Ocean. The reason that the *Periplus* does not mention the cities of the Gulf (the sites of Mleiha and ed-Dur are not mentioned despite being of a certain importance at the time) could in fact be that they were not on the routes taken by our mariner, certainly not because they didn't exist. Furthermore, the term Gulf stands for a vast diversified area that includes the coast of Iran, northern Oman, what are now the United Arab Emirates, but also the Saudi site of Gerrha, in addition to Bahrein and southern Iraq with the marshlands of Shatt al-Arab.
The relations that Sumhuram had with the sites of the Gulf can be seen in the prestigious ceramic tableware, large storage vessels and also coins and artefacts.
The first important point is the large number of pieces of glazed pottery discovered on site. According to M. Mouton (Mouton 2009) it is numerically the biggest corpus of all those discovered in the whole of south-west Arabia. Produced in southern Iraq and south-east Iran, the glazed pottery discovered in Sumhuram can be divided into two main groups: that of a golden colour with a slightly dusty look that can be dated to the centuries BC of which there is less, and that of a green-bluish hue which can be dated to the early centuries AD which is the more numerous of the two (fig. 6).
In addition to tablewares, there are also storage vessels from eastern Arabia attested on-site, such as the vessels belonging to the group of "Black and Gray" pottery (fig. 7). These pots were hard to transport because of their large size (the rim measures between 40 and 100 cm) and of excellent quality (thick, non-porous fabric, very well-fired) which is particularly suited to storing food. Despite the "Black and Gray" origin not being univocally accepted, it does seem most likely that it comes from the area which is now the United Arab Emirates.
Iranian pottery has also been discovered in Sumhuram. Fragments of Orange Fine Painted Ware, the production centres of which are attested in southern Iran, have been discovered in contexts dated to the 2nd century AD (fig. 8).
The brown-coloured jars with sandy fabric, sometimes internally coated with bitumen, were widespread in the whole Persian Gulf area from the 1st century AD onwards. Probably originating in eastern Arabia, these too, seem to have been channelled through Mleiha and ed-Dur on their way to Oman.
These two sites are also part of the history of the coins with a seated Zeus holding a horse and the head of Heracles wearing the pelt of a Nemean

lion, struck in eastern Arabia and discovered in the site of Sumhuram in contexts datable to the early centuries AD (fig. 9). Furthermore, an interesting complete spout in the form of a horse protome is evidence of links with the Gulf region (fig. 10). Its variety of discovery contexts enables us to reconstruct the function of the object which was connected with carinated bronze bowls belonging to wine sets commonly in use in eastern Arabia. These kind of spouts, with stylistic variants, have been found in ed-Dur, Mleiha, Samad ash-Shan, Sama'il, Qasr-i Abu Nasr and Jebel Kenzan, suggesting the same area of origin.

From its foundation, therefore, Sumhuram would appear to have had relations with the Gulf as it had with India. These relations, however, must have been of lesser importance in the centuries BC at least consisting in sporadic trade which might even have been overland. Some relationship framework, however, was already in place as early as at least the 1st century BC (and possibly earlier) but it only came to fullness after the birth of Christ when the Gulf opened up to more consistent and regular trade with the areas of India and South Arabia.

Sumhuram and the Mediterranean

Objects from the Mediterranean area - specifically amphorae and terra sigillata (fig. 11-12) - have been, from the beginning, more recognizable.

The assemblage of amphorae unearthed in Sumhuram is a complex and varied collection of material from a time-span that stretches from the 3rd/2nd centuries BC up to the 5th century AD.

The largest group, numerically, is that of Dressel 2-4 of Italic production, recognizable both for its shape and the fabric which is bright red in fracture, rich in a great variety of volcanic inclusions (the pyroxenes typical of the Campanian region).There is also a good number from the Aegean - mostly Dressel 2-5 - recognizable for their orange-pink colour and the fine fabric.

Likewise, vessels manufactured in Crete are attested in addition to some rare examples of Cypriot vessels. It is therefore true that the greatest number of fragments date from the first three centuries AD however it is also a fact that the oldest strata of the city included some vessels from Kos and Rhodes earlier than 1st century AD. This is the most significant information to emerge from the typological and petrographic studies of the amphorae of Sumhuram that confirms and supports the new dating of the site and its early involvement in international trade. The same types have been found in Arikamedu (Will 1996, 2004) which lends strength to the link we outlined earlier between Sumhuram and India.

Current studies undertaken by Roberta Tomber confirm the presence of wine amphorae from Mareotis (the wetland near Alexandria) with their typical dark brown fabric, poor in inclusions, and with the surface flaking easily.

Furthermore rare attestations of amphorae produced in the ancient site of Ayla (modern-day Aqaba) with a typical strongly ribbed body have also been discovered in Sumhuram as in Berenike, Adulis and Kane. Recently dated to the 4th century AD by discoveries made in Berenike, and not to the 7th as initially believed, they indicate Sumhuram's involvement in trade up to the 4th century when the city began to decline until its final abandonment in the 5th century AD.

There is a lack of manufactured goods of African origin which is interesting considering how widespread they were in Roman times and the relative vicinity of the two coastlines. Between the 2nd and the 5th cent. AD, for example, a large quantity of material imported from the area of Tripolitania and Aksum has been discovered in Kane, which, by contrast, is totally lacking in Sumhuram.

As regards terra sigillata, fragments of Italic Terra Sigillata, Eastern Sigillata A, Eastern Sigillata B have been discovered along with very few fragments of fine Cypriot and fine Hellenistic ceramics (R. Tomber, unpubl. Report).

Preliminary analyses point to a prevalence of Italic manufactured pieces, including one fragment with a stamp, which have been attested, albeit somewhat few in number, in the sites of Kane, Shabwa and Timna.

A prevalence of Italic terra sigillata has also been noted in the sites of Berenike and Myos Hormos, indicating that they may have had trade relations with Sumhuram.

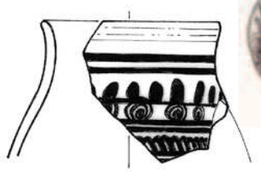
By contrast with the scarcity of fragments of Eastern Sigillata A there are, instead, a fair number of Eastern Sigillata B ones which are attested more in the Aegean area and in Egypt than in the

Fig. 1
Map with the main centres involved in the Indian Ocean trade.

Fig. 2
Indian bronze statuette found in Sumhuram during American excavations.

Fig. 3
Fragment of Rouletted Ware.

Fig. 4
Rim and part of wall of a paddle-impressed jar



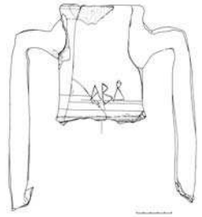


Fig. 5
Fragment of lid with Tamil-Brahmi inscription.

Fig. 6
Glazed jug probably from Mesopotamia

Fig. 7
Rim and decorated wall of "Black and Gray" pottery.

Fig. 8
Drawing of a Orange Fine painted ware small jar.

Fig. 9
Bronze coin from the Gulf depicting the head of Heracles.

Fig. 10
Bronze spout in form of horse protome.

Fig. 11
Drawing of an amphora with Greek inscription.

Fig. 12
Fragment of Terra Sigillata.

Italic area. Their dissemination in southern Arabia, therefore must have been through Egyptian ports along the same route as the Italic Terra Sigillata.
A recent article on the fine ceramic discovered in ed-Dur (Rutten 2007) surmised that Sumhuram played a major role in the spread of fine tablewares towards ed-Dur and the Persian Gulf.

Sumhuram and the Hadramawt

Although not strictly within the ambit of international relations, a brief mention must be made of the relations between the city and the Hadramawt.
As a colony founded by the easternmost kingdom of south Arabia, Sumhuram's relation with its motherland was assuredly complex.
The first point regards the name of the city itself which is, indeed, a royal name; the attribution of a king's name to a settlement is in itself extraordinary.
We also know that state officials must have kept a tight rein on the city; the city inscriptions refer to them with the epithets "servant of the king of Hadramawt", "governor of the king in the land of Sakalan" or "chief of the Hadramawt military detachment in the Sakalan land".
We also know that the city survived the collapse of the kingdom which proved the settlement had acquired its autonomy; it is likely that, similarly to Kane, Sumhuram gravitated into the Himyaritic sphere of influence and that it was in the Himyar empire's best interests, to hold sway over the outlying port of Sumhuram, so far east along the coastline and thus better placed for trading with the Gulf and India.
Backdating the foundation of Sumhuram to the 3rd century BC has important repercussions in the history of the kingdoms of south Arabia. The decision by the Hadramawt to establish an outpost so far east seems to indicate antagonism among them, stemming from the conquest of territories as well as moves to gain the upper hand in trading no longer exclusively overland but also by sea.
All these moves and countermoves must have taken place much earlier than thought until recently, indeed from the 3rd century BC.
This is a colony so, obviously, there is a lot of material on site coming Hadramawt and the other south Arabian kingdoms.

Noteworthy are the storage jars in porous clay, greenish in colour and set on high ring bases, big basins with South Arabian graffiti (fig. 13), the steatite-temper cooking pots, the so-called "Bayhan bowls", but also stone vessels and Hadramawt coins along with some Himyaritic ones from the city's final period.
It was of special interest to discover that amphorae may have been produced in Yemen. Petrographic analysis on a number of pieces discovered in Sumhuram revealed that there were amphorae used for transportation that copied the shape of the amphorae produced in Roman times but of a fabric that is undoubtedly Yemeni in origin (Pavan, Pallecchi 2009).

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Sumhuram in the classical sources

C. Tavolieri D'Andrea

In the ancient Greek and Roman worlds all the territories controlled by the south Arabian kingdoms were known as *Arabia Felix*, a toponym due to their renowned production of fine goods. The most valuable, frankincense, traveled all the way to Greece and Rome both for religious ceremonies and everyday life purposes.
The site of Sumhuram, located within the territory of Khor Rori in the Dhofar region, was identified in the second half of the 19th century with the ruins of Moscha *limén*, mentioned in the *Periplus Maris Erythraei*, the famous traders' guide of the mid-1st century AD.
It also matched the description of the city of Abussapolis, mentioned by the famous 2nd century AD Greek geographer Claudius Tolomeus.
In the *Periplus* and in Tolomeus's map, Moscha is listed together with Okelis, Eudaimon Arabia (Aden) and Kane, as one of the most important ports of call in ancient Arabia.
Yet, archaeological expeditions only started around the mid-1900s: the discoveries of the first team of archaeologists working on the site, let them to shift the period of occupation of the ancient city from the 1st to the 3rd-4th centuries AD: hence, they considered it an outcome of the Roman

activity along the trade route between Rome and the Indian Ocean.

Their conclusion was based on two types of evidence:

- the city's peculiar geographical environment, which favoured the growth of an extremely precious variety of frankincense - *Boswellia sacra* Flueck;
- the remains of ancient parts of the city where coins, imported ceramics, and artefacts have been found in large quantities.

These discoveries were also supported by quotations in classical authors, and by the indications found in the monumental city gate inscriptions, where Eleazos, king of Hadramawt, is mentioned (fig. 1) as well as the arrival of settlers from Shabwa, capital of the reign (fig. 2), is narrated.

The excavations conducted by IMTO have recently modified this interpretation, significantly anticipating the foundation of Sumhuram to the 3rd cent. BC.

The city was therefore collocated in a completely different scenario, in a time characterized by flourishing trades between Egypt, India and part of the African coast.

Archaeological campaigns have revealed a structure that was not so vast, but characterized by distinct urban traits, such as residential areas, restricted areas dedicated to strictly government-regulated trade, workshops and a templar area.

Remarkable evidence of intense maritime trade activities has been found. This has encouraged further studies on the importance of mercantile transactions in the pre-Roman era, thus guaranteeing a broader sight of this phenomenon, one that includes the Indian and southern Arabian perspectives.

Following such investigations a different date was established for the final abandonment of the urban area: the 5th century AD.

Even indirect sources such as the *Periplus Maris Erythraei* indicate the existence of a commerce that was centralized and that characterized the south Arabian world, where the "gift" of valuable objects meant for the king, such as precious metal artworks, statues (fig. 3), and horses was actually a clear sign of the government's strict control over trades.

The Greek source reports the same kind of control over the frankincense trade, which was only allowed in harbors of the Hadramawt: in the port of Khor Rori a god protects the precious substance from greedy sailors.

The unknown author of the *Periplus* goes to great lengths when describing the routes from Egypt to India, along the coasts of the Red Sea: he provides us with details on distances that are comparable with those calculated by geographers of the time, and with particular information on each port, its commerce, and the customs of its inhabitants.

The *Erythraeus* sea was for the Greeks, and therefore for the author of the *Periplus*, the sea between the Indian Ocean, the Red Sea, and the Persian Gulf.

In the *Periplus Maris Erythraei*, Moscha *limén* is not described as a port of trade (emporion), but only as a "hormos apodedeigmenos tou Sachalitou libanou pros embolen", a "well known harbor to load the Sachalite frankincense".

Both 'Hellenic' and Arabian ships called at Moscha *limén*, but on different circumstances and for different purposes.

'Hellenic' ships moored at Moscha only sailing back from the Indian ports of Barygaza (nowadays Broach) and of Limyrike (nowadays Kerala): on those occasions, they gave Indian items - cotton, grain and oil - in return for frankincense.

More frequently, Arabian ships came to Moscha *limén* from Kane. Certainly, when they sailed back to Kane, those ships carried the Sachalite frankincense to be sold to merchants from Roman Egypt.

Excavations have shown that Sumhuram inhabitants imported also unrefined metals from elsewhere and this evidence can be taken as a further proof of the oversea connections of this port, and, ultimately, compared with the information provided by the author of the *Periplus Maris Erythraei*.

Along with decorated silverware brought for king Eleazos, unrefined metals - *chalkos* (copper) and *kassiteros* (tin) - were among the goods imported to Barygaza and Limyrike from Egypt.

One particular document from Egypt, a receipt for 22 plaques of tin dated 18 BC, provides evidence of the trade of unrefined metals in the Egyptian harbor of Myos Hormos, after the Roman conquest.

Therefore, it is reasonable to imagine a connection

Fig. 1
The inscription Khor Rori 2 (KR2), mentioning the foundation of the city.

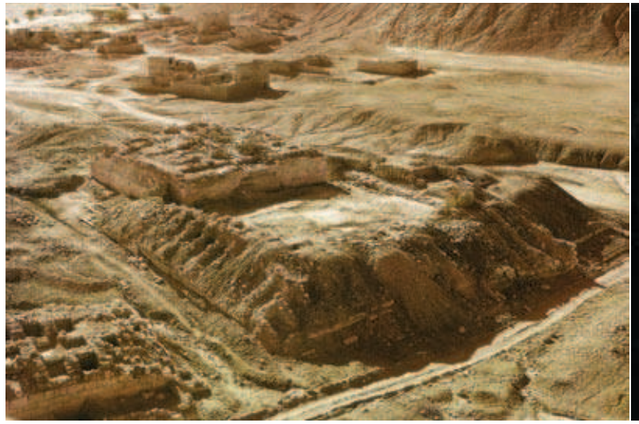

Fig. 2
The Royal Palace of Shabwa.

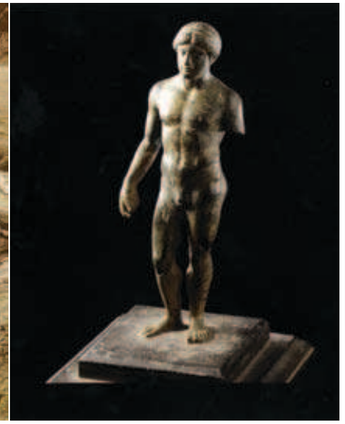

Fig. 3
Imported statuette of a young man from Shabwa.

Fig. 4
Bronze animal statuette mentioning the word ḏhb.

Fig. 5
South Arabian silver coins.

between the use of bronze in southern Arabian coastal sites and western India during the 1st century AD, and the extensive imports in those regions of copper and tin from Egypt.
In southern Arabia copper and tin were not only needed for coinage, but also for tools or votive objects - statuettes of men or animals in a metal called *ḏhb* (fig. 4).
For a long time this word was believed to refer to gold (as 'gold' is the meaning of the word in many West Semitic languages); yet, *ḏhb* in South Arabian exclusively referred to bronze.
Consequently, we argue that bronze trade flourished at the ports of Hadramawt, Kana and Moscha *limén*: they probably manufactured bronze coins and imported copper and tin. Unrefined metals came from Egypt, reached Kane and then Moscha: it is significant that the *Periplus* mentions precious metal artworks, along with horses and mules, as main imports only in the ports of the westernmost regions of Southern Arabia, e.g. Muza, whereas only unrefined copper and tin were imported in the ports of Hadramawt. This can explains why coins were exclusively minted in bronze there, while silver was normally used in South-western Arabia (fig. 5), hence making it clear that the whole of South Arabia had a vast production of bronze locally differentiated according to each specific regional demand.

Commercial Activity at Moscha limén

F. de Romanis

The exact range and nature of commercial activities taking place at Moscha *limén* (Sumhuram in the ancient south Arabic inscriptions, located in the modern territory of Khor Rori) is still somewhat unclear. On the basis of contradictory information in the Greek sources regarding its location, a modern scholar has concluded that Moscha *limén* "was a port solely for the use of the king's shippers, and the only foreigners ever found in it were Indian seamen who had been forced to winter there" (Casson 1989). Although the Greek toponym by itself suggests that the Hellenized merchants considered Moscha a harbor (*limén*) rather than an *emporion*, and although there are reasons to think that relatively few, if any, "Greek ships" (as the *Periplus* labels the vessels from Roman Egypt) called at the port of Moscha, this judgment must be softened, to some extent. A closer consideration will reveal that the function of Sumhuram in the trade of Indian Ocean was more complex than usually acknowledged.
Consider the following passages by the author of the *Periplus Maris Erytharaei*: "To Moscha *limén* are usually directed some ships from Kane (Hisn al-Ghurab) and those which pass-by from Limyrike

(modern Kerala) or Barygaza (modern Broach), <or> winter there because of the season being late" (PME 33; notice that the text requires a slight and necessary emendation).

This sentence actually categorizes up to three distinct types of business in which Sumhuram was involved. The first one is the transfer to Kane of the frankincense collected in the Dhofar region: around the month of September, ships from Kane used to sail to Moscha in order to bring back to the main *emporion* of the Hadramawt the best quality of frankincense, which the Latin authors call *carfiathum*, collected from mid-June to mid-September and exported from October onward. Apparently the "Greek ships" from Egypt didn't like to venture beyond Kane to get the frankincense: departing from Egypt too early would have meant navigating the seas beyond Bab el-Mandeb during a particularly hazardous time of the year. Consequently, the frankincense from Dhofar had to be first conveyed to Kane in order to be exported to Egypt. The ships which were sent to Moscha for this purpose very likely belonged to the Hadramawt king Eleazos, who controlled most of the trade of his realm and was understandably willing to maximize the export to Egypt of the highly prized *carfiathum* frankincense collected throughout his realm (fig. 1).

The second type of business at Moscha occurred during the months of January and February, when the vessels coming back from India en route to Egypt used to call first at the *emporia* along the gulf of Aden. At these *emporia*, ships sailing from Barygaza or Limyrike offloaded Indian cotton cloth, grain and (sesamine?) oil in return for frankincense. This is what has been recently defined 'triangular commerce' (Gupta 2007): a "Greek ship" sailed to India to get Indian items, which will be exchanged in Arabia (and in Somaliland) for frankincense and other aromatics (fig. 2).

A third opportunity for business arises in the cases of merchants who were unable to return safely from India to Egypt with their cargo. Ships travelling to India faced a number of obstacles which hampered their commercial enterprise. One such setback would be the temporary shortage of typical items (pepper, *malabathron*, ivory, silk, pearls etc.) at the Indian port of call. If the merchants of a ship could not acquire their return cargo in due time (keeping in mind that they had to reach Egypt before the end of the winter monsoon), these merchants would be forced to compensate for potentially considerable losses. This could be accomplished by postponing their return journey for a year and continuing in the interim to trade in the Indian Ocean.

In such circumstances, Moscha could offer interesting chances of business. We are told by the author of the *Periplus* that ships could "winter" at Moscha because of the "season being late". The author must be referring to those ships who docked at Moscha between the end of the winter and the onset of the summer monsoon. The *Periplus* does not describe any other port around the Gulf of Aden in the same way (that is, as hosting merchant vessels between the winter and summer monsoons). It then becomes necessary to understand this seemingly distinctive feature of the port of Moscha, and we shall see that it is in all likelihood related to the peculiar nature of the frankincense harvest in the Dhofar region.

If ships wintered in Moscha and in no other harbor of the area of the Gulf of Aden, the reason is that in those months (March to June) larger quantities of frankincense were available at Moscha. This frankincense, one should note, was not the remnants of the previous season's harvest. Pliny the Elder mentions two kinds of frankincense: *carfiathum*, considered the best frankincense, and the less valuable *dathiathum*. While the *carfiathum* was collected in fall, the *dathiathum* was harvested during spring. The *Periplus* reference to ships at Moscha between winter and summer monsoons strongly suggest, therefore, that their presence is a consequence of the large *dathiatum* harvest in Dhofar. Apparently, the *dathiatum* harvest provided a commercial option for those merchants who were forced to winter in Moscha because they had been unable to depart in due time from India to reach Egypt. With the onset of the summer monsoon, they sailed back to India to sell their *dathiatum* and try their luck again.

It is very unlikely, however, that the spring business of Moscha relied solely on those unfortunate India traders. The *dathiatum* of Dhofar must have had other buyers whose

Fig. 1
Trade at Moscha: links with Kane.

Fig. 2
Trade at Moscha: links with western India.

Fig. 3
Trade at Moscha: links with lower Mesopotamia and gulf of Oman.

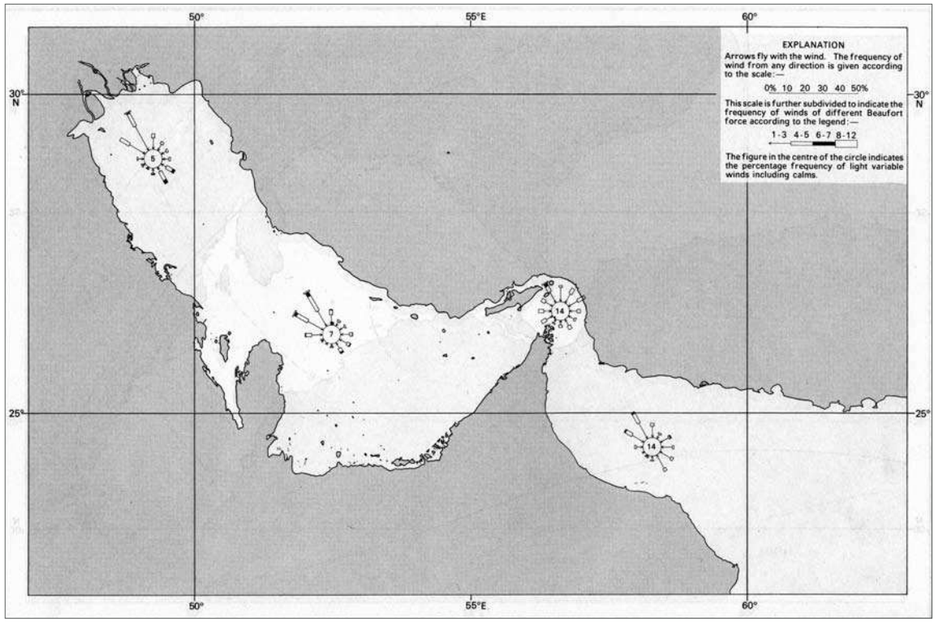

Fig. 4
Wind frequency distribution in January (Persian Gulf Pilot 1982).

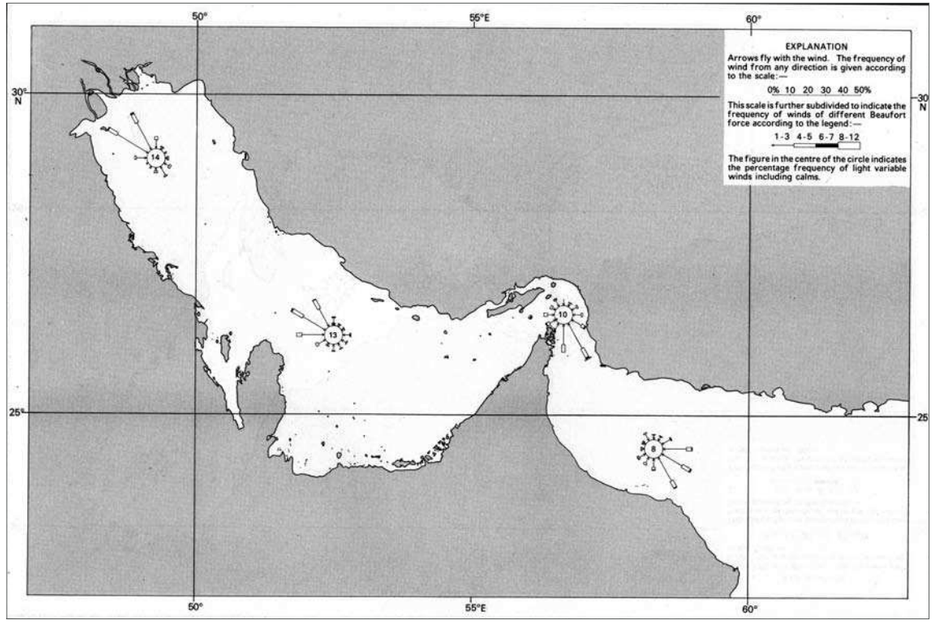

Fig. 5
Wind frequency distribution in July (Persian Gulf Pilot 1982).

activity is not properly portrayed by the literary sources. The author of the *Periplus*, we must remember, is an Egyptian expert on Indian Ocean trade, advising traders and investors based in Egypt. His description of Indian Ocean trade will not emphasize other active sea routes without direct connection back to Egypt. Nevertheless, he does refer to a sea route linking Kane and more generally Arabia with the Iranian side of the gulf of Oman and lower Mesopotamia. From the *emporia* of these areas a range of items were exported to Arabia: pearls, purple, local cloth, wine, considerable quantities of dates and gold (PME 36) (fig. 3). From Arabia the key export was frankincense. Although the *Periplus* doesn't specify in which season these ships navigated this route, a glance at the wind frequency distribution for the region suggest that it is at least probable that they sailed from across the gulf of Oman or from Lower Mesopotamia late in winter and sailed back at the beginning of summer (fig. 4, 5). As a consequence, it is likely that the frankincense they imported was *dathiathum*.

In conclusion, one cannot argue with the fact that Moscha's easternmost location certainly hampered its commercial potentialities in trade with Egypt. The kings of Hadramawt were obliged to organize a sort of state transshipment to Kane in order to re-export Dhofar autumn frankincense (*carfiathum*) in Roman Egypt. When the "Greek ships" passed-by sailing back from India, in January/February, they could stop in Moscha and still find remnants of *carfiathum*. On the other hand, Dhofar production of spring frankincense (*dathiathum*) attracted ships from Lower Mesopotamia and Iran and gave a second chance to unlucky India traders from Roman Egypt.

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