academicJournals

Vol. 5(11), pp. 194-203, December, 2013
DOI 10.5897/JHF2013.0325
ISSN 2006-9782 ©2013 Academic Journals
http://www.academicjournals.org/JHF

Journal of Horticulture and Forestry

Review

Banana domestication on the Arabian Peninsula: A review of their domestication history

Khair Tuwair Said Al-Busaidi

Directorate General of Agriculture and Livestock Research, Ministry of Agriculture and Fisheries, Crop Production Research Centre, Fruit Research Department, P. O. Box 343 Postal Code 615, Samail, Sultanate of Oman.

Accepted 7 October, 2013

Bananas are one of domesticated crops prehistoric in Arabian region. However, domestication history of this crop in this region did not receive attention by researchers. The strategic location of the Arabian Peninsula at the intersection of several main Old World trade routes has made it an incubator for bananas coming from different continents of the world. Tracing the history of bananas in this region and understanding the drivers of their diversity under inhospitable conditions may help maintain and further develop banana cultivation in similar areas of the world, especially where this issue has not been extensively studied. Domesticated banana cultivars presently found in the Arabian Peninsula are not indigenous to the region. The Islands of Southeast Asia and Southern China are the strongest candidate to be the primary sites of banana domestication, the subsequent phases of cultivation and translocation to other parts of the world during the prehistoric era. The Gulf ports, in particular Omani coastal ports and Indian Ocean trade effectively contributed to the exchange of plant genetic resources including bananas between the Arabian Peninsula areas and the Indian subcontinent, Africa and China. There is a relationship between ancient coastal ports and the presence of a variety of banana subgroups in some areas of the Arabian Peninsula such as Oman.

Key words: Maritime routes, ancient ports, linguistic, archaeological, translocation, banana history.

INTRODUCTION

Bananas have a long history of domestication and the role of mankind in their diffusion throughout the tropical and subtropical regions of the world has made them one of the most important fruit crops. Over the centuries, bananas have contributed to the stability of rural communities where they have provided work for farmers and reduced farmer migration to cities in search of alternate livelihoods (De Langhe et al., 2009). Eighty-seven percent of bananas produced globally are consumed locally (Biodiversity International, 2012). Even in many countries of the Arabian Peninsula, bananas play an important role as a food crop, although this arid region has an ecologically unfavourable climate for banana cultivation. Banana production in Arabian countries accounts for 2% of the total world banana production and 1.5% of total area harvested (FAOSTAT, 2010).

Over the past millennia, the banana domestication process has undergone different stages involving exploitation, hybridizations, somatic mutations and cultivation inside the natural habitat (De Langhe et al., 2009).

Subsequent steps involved the dispersal of domesticated varieties outside their natural habitats, to different geographical regions of the world. This led to often unpredicted genetic changes in banana varieties (Buerkert et al., 2009; De Langhe et al., 2009). Given the serious challenges in particular biotic and abiotic stresses facing sustainable banana production, in addition to local

E-mail: abouanfalalbusaidi@yahoo.com. Tel: +968- 99374383, +968- 26893131. Fax: +968 26893097.

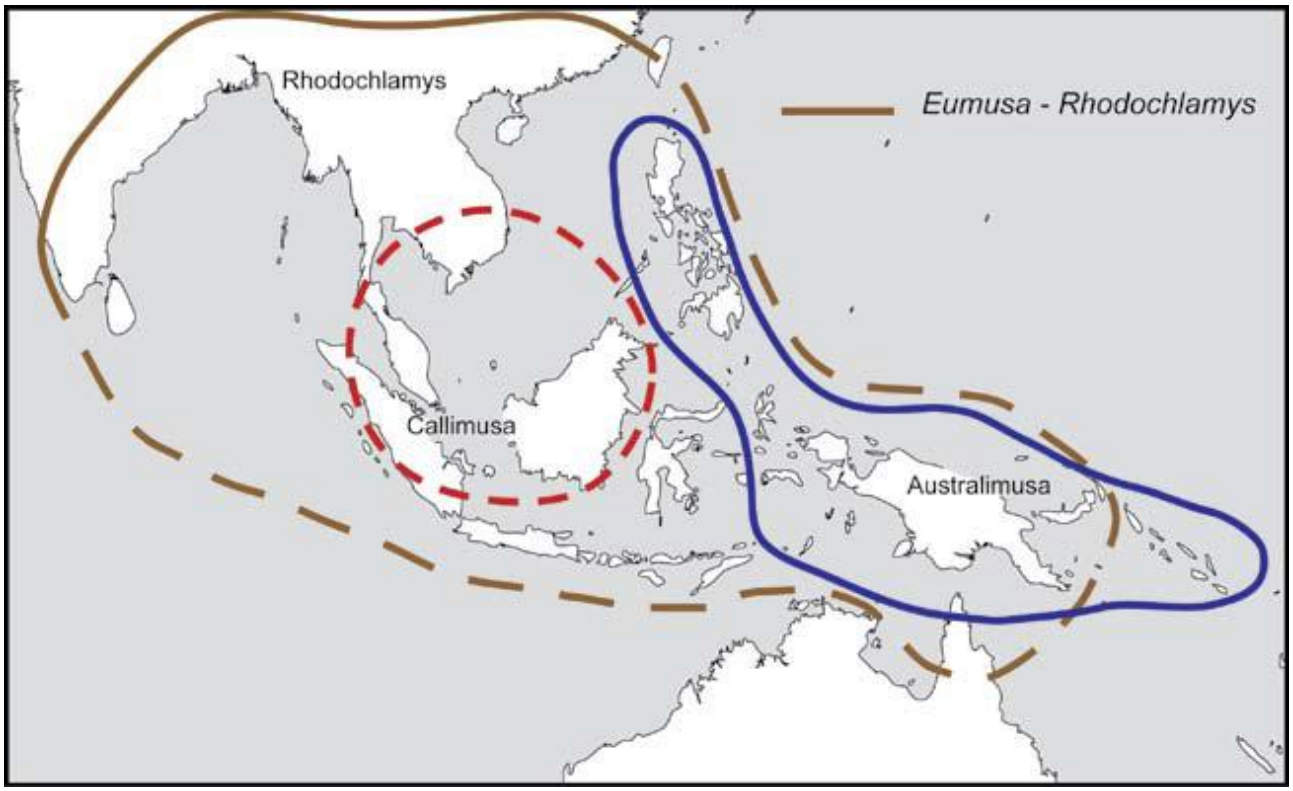

Figure 1. Distribution of *Musa* genus in East Asia (Simmonds, 1962, altered from De Langhe, 2009).

problems such as oasis modernization (Buerkert et al., 2009; Al-Saady et al., 2010), understanding and tracing banana diversity in the Arabian Peninsula is important. The diverse cultivars found in this region of the world include specially adapted varieties, not found anywhere else in the world. This study highlights the history of banana domestication in the Arabian Peninsula areas, particularly introduction and cultivation by reviewing papers that discuss linguistic, genetic and archaeological evidence as well as maritime routes that were perhaps used to introduce bananas to the Arabian Peninsula.

BANANA DOMESTICATION IN THE WORLD

Classification and distribution of banana species

The exact date of banana domestication is still subject to speculation, but recent multidisciplinary evidence indicates that the first domestication stage took place about 4500 years before present (BP) (De Langhe and de Maret, 1999; De Langhe et al., 2009). However, based on the archaeological evidence from New Guinea (Perrier et al., 2011), cultivation of domesticated banana varieties started about 6500 years BP. Human contact and migration played a crucial role in the domestication of banana varieties outside their natural habitat (Mindzie et al., 2001; Vrydaghs et al., 2009; Perrier et al., 2011).

Banana belongs to the family Musaceae which includes three genera; Asian and African *Ensete*, Asian *Musella* and East Asian *Musa* (De Langhe et al., 2009; Perrier et al., 2011). All edible bananas belonged to the genus *Musa* (Perrier et al., 2011). Simmonds (1962) divided the genus of *Musa* into 4 sections (Figure 1): Eumusa which covers all of East Asia, except Eastern Melanesia, Rhodochlamys which is spread along the monsoonal mainland of Southeast Asia, Australimusa which is distributed from south-eastern Indonesia and the southern Philippines to Melanesia, and Callimusa which is presented in Southern Vietnam, Malaysia, Borneo and Sumatra. According to Simmonds and Shepherd (1955), most of the edible diploid and triploid bananas are formed by inter- and intra-specific crosses of *Musa acuminate* (A) and *Musa balbisianana* (B) and are classified into the groups representing both their ploidy and species composition, that is AA, AAA, AAB and ABB. Fuller and Boivin (2009) mentioned that most plantains belonged to the AAB group and most desert bananas to AAA.

Secondary and tertiary distribution followed (Figure 2) and produced seven recognizable geographical areas each with a high density of specific cultivars (De Langhe, 2009):

(1) AA and AAA cultivars in the triangle between Indonesia, the Philippines and Melanesia (red line), with an exceptional density of AA cultivars in and around New

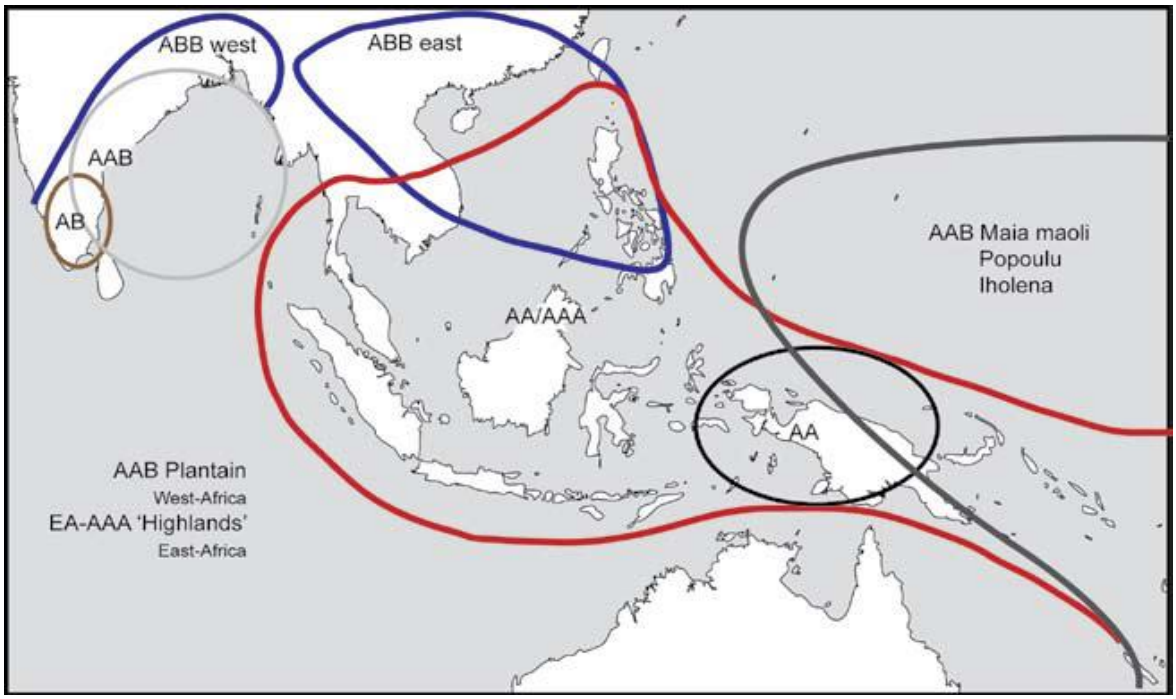

Figure 2. Distribution of the main banana cultivar groups (taken from De Langhe et al., 2009).

Guinea (black oval);
(2) Highland AAA bananas in the Great Lakes region of East Africa (East African Highland Bananas: EA-AAA 'Highlands'; area not shown on map in Figure 2);
(3) AAB plantains in the rainforest zone of Africa (area not shown on map in Figure 2);
(4) AAB Maia Maoli-Popoulu-Iholena cultivars in Oceania (dark grey line);
(5) AB (brown oval) and other AAB (pale grey circles) cultivars in South India;
(6) Eastern ABB cultivars in the Philippines and Vietnam (blue line - closed);
(7) Western ABB cultivars in Northeast and South India (blue line - open).

Linguistic and cultural evidence indicates that West Africa was the earliest centre for growing AAB plantains, while specimen of the AAA group were the first grown in East Africa (De Langhe and Maret, 1999; De Langhe et.al., 2009; Blench, 2003). The great diversity of cultivars in these areas and Iron Age phytoliths of banana found in Cameroon support this evidence (Mbida et al., 2000).

Origin and migration routes of banana species from natural habitat to other continents

Recent DNA and fingerprinting analyses of more than 400 wild and cultivated accessions, in addition to samples taken from Cameroon and Nigeria to better represent the diversity found in Africa, revealed that the islands of Southeast Asia and Western Melanesia likely are the main centre for the hybridization between different *M. acuminata* subspecies which generated edible diploids cultivar subgroups (AA cultivars; Perrier et al., 2011). Banana domestication passed through two stages: first the translocation from wild to edible diploids by hybridization of *M. acuminata* during the Holocene in New Guinea (Simmonds, 1962; Perrier et al., 2011) and subsequently the development of edible triploids (AAA) from edible diploids (AA) via spontaneous triploidizations (Perrier et al., 2011). Most domesticated bananas are triploid, including the widely distributed commercial Cavendish group (Perrier et al., 2011). Lastly, Perrier et al. (2011) used genetic, linguistic and archaeological data to determine the locations of banana groups. They suggested three contact areas of *M. acuminata* subspecies where the development of domesticated diploids took place: the Northern contact area with *malaccensis, microcarpa* and *errans* in South East Asia, Borneo and the Philippines; the eastern contact area with *errans* and *banksii* between the Philippines and New Guinea; and the Southern contact area with *banksii*, *zebrina* and *microcarpa* located between New Guinea and Java. It seems clear that the islands of Southeast Asia are the origin for all bananas and subsequently the different groups migrated to different areas of the world (Perrier et al., 2011). Based on this, Perrier et al. (2011) suggested two independent introduction events for triploid subgroups to Africa:

(i) AAA Mutika Lujugira and associated AAcv moved from the region between New Guinea and Java (Southern contact area) to East Africa;
(ii) AAB African Plantains moved from the Philippines and New Guinea (Eastern contact area) to Africa.

These hypotheses were also supported by Blench (2009) who mentioned that based on the botanical and linguistic evidence West African plantains (AAB) arrived from Southeast Asia earlier than 3000 BP. Similarly, Fuller and Madella (2009) hypothesized that the major diffusion of banana cultivars occurred in the later Iron Age, 2000 years BC. This is based on textual sources and historical linguistics from South Asia and China.

Geography of the Arabian Peninsula and early agriculture

The Arabian Peninsula is natural point of contact between the continent of Africa from the West and the Levant and Europe from the north and the continent of Asia from the east (Boivin and Fuller, 2009). In most of the Arabian Peninsula, the desert climate is considered the most important agro-ecological factor to determine landuse. The Arabian Peninsula is located between two main rainfall patterns: the winter rains of the Mediterranean region and summer monsoon rains (Boivin and Fuller, 2009). Digging wells and extracting water from aquifers supported agriculture in lowland oases and coastal regions which have insufficient rainfall (Edens, 1993; Blau, 1999). The later development of the *aflaj* system (Magee, 2005) leads to increased use of oases for agriculture and allowed the cultivation of different crops. Agricultural and accompanying maritime activities in the Arabian Peninsula have been triggered to a large extent by changes in climatic conditions over the Holocene period.

The early and middle Holocene (9000 to 2500 before Christian, BC) periods were characterized by relatively high rainfall intercepted by pronounced dry periods, in particular between 4000 to 4500 years BC (Boivin and Fuller, 2009). During this period, settlements were established in the desert areas such as the Eastern Sahara or Arabian Desert from northern Egypt to Eritrea in the south and parts of Sudan and Ethiopia, which were in habitated by Egyptian/Sudan groups (Hassan, 1997; Fuller, 1998).The Thar desert or Great Indian Desert (arid region in the north-western part of the Indian subcontinent) was settled by Mesolithic groups from India / Pakistan (Fuller, 2006). Similarly, the An Nafud or Al-Nefud settlement (located in the Northern part of the Arabian Peninsula) was established and with vegetables and fruits were grown (Boivin and Fuller, 2009).

In the mid-Holocene (6000 to 5900 BC), the conditions were wetter than at present and this was also the case for An-Nafud in the north of the Arabian Peninsula (Lézine et al., 1998). Potts (2008) mentioned that in the seventh millennium BC, Arabia was more attractive to the people than the Levant and Mesopotamia and this might have contributed to their migration to Arabia and the associated transfer of cultivated plant species from the Levant to Arabia. Evidence from northern Oman, the United Arab Emirates and the An-Nafud region indicates a period of aridity around 3800 BC called the 'Dark Millennium' during which even well established settlements collapsed (Uerpmann, 2003). Additionally, evidence from the Awafi palaeolake in the United Arab Emirates indicates that during the period from 3900 BC and 3200 BC, two arid periods led to a general decline of vegetation and its disappearance in Eastern Arabia (Parker et al., 2004, 2006).

Introduction of crops to the Arabian Peninsula in the Bronze age

The fertile periods in the early and middle Holocene experienced by the Arabian Peninsula and the establishment of agricultural settlements such as An-Nafud encouraged the entry of various agricultural crops including banana. Hammer et al. (2009) reported that about 21.3% of plant species in the Arabian Peninsula came from South and Southeast Asia, 20.6 % from the Near East and East Mediterranean and 15.4% from South America. This data supports the view of Boivin and Fuller (2009) who considered that most of the plants and animals in the Arabian Peninsula region are not native to this region. Despite the limited archaeological evidence of agriculture in the Arabian Peninsula the presence of agricultural equipment (Potts, 1994), of ancient (3200 BC) irrigation systems in the highlands of Yemen (Harrower, 2008) and the great areas of wheat and barley cultivation in some areas of the Arabian and Persian Gulf region indicate that agriculture has been practiced in this region for a long time. Taking into accounts the geographical distribution of banana genotypes (Figure 2), it seems that the Arab/Swahili and Malagasy-Malay (after 600 AD) trade played a vital role in the early dispersal of banana across the Indian Ocean and Red Sea to the Arab world. Similar banana varieties are found in Oman and Egypt (Castillo and Fuller, 2012). This trade route dispersal theory is supported by the discovery of remains of banana peels from the Arab trading period in Quesir al-Qadim located on the coast of the Red Sea (Van Der Veen, 2011).

In general, data indicate that the early third millennium saw the introduction of different crops including banana from Africa, South and Southeast Asia to the Arabian region (Boivin and Fuller, 2009). This has been confirmed by intensive presence of bread wheat in the Persian Gulf and the presence of the same variety in Asia particularly in the Indus region (Fuller, 2003, 2006). This indicates the starting of crop migration from South Asia to the

Arabian Peninsula. Also, in Yemen, Egypt and Nubia emmer wheat was dominant until the first millennium BC (Fuller, 2004), suggesting genetic exchange between the Arabian Peninsula and North Africa.

According to Robinson (1996), banana is mentioned in the Holy Koran as the 'tree of paradise' and the name of the genus (*Musa*) is derived from the Arabic word Mouz. Ancient Egyptian drawings already show bananas and it is believed also that the Assyrian civilization, which extended its authority to the Nile, introduced bananas to the Middle East (Attif and Muhammad, 2000). In 327 BC, the first accurate description of bananas appeared in Greek books after the invasion of India by Alexander the Great; however, it is believed that Arabs introduced bananas from India to the Middle East and North Africa (Attif and Muhammad, 2000). Kinder and Hilgemann (1974) mention that the arrival of Muslims in India, where a great variety of bananas exists, may have contributed to the introducing of bananas to the Arabian Peninsula.

Despite the long and ancient history of banana cultivation in the Arabian Peninsula, the archaeological and historical evidence is still limited. The exact origin, entry date and routes of banana introduction to this region remain a source of speculation. Since edible bananas reproduce vegetatively and not by seeds, their spread is particularly difficult to track (Vrydaghs et al., 2009). Potts (1994) mentioned that banana arrived in south-eastern Arabia by the 9th Century. Historical and cultivation evidence suggests that the origin of the banana planted in Dhofar and Yemen described in Medieval times (Varisco, 1994) was New Guinea/Indonesia (Kennedy, 2008) and the Valley of the Indus (Fuller and Madella 2001). Archaeobotanical evidence from Oman (Muweilah, Mleiha, Hili Bat, Ras al-Hamra, Ras al-Jinz), United Arab Emirates (Dalma, Umm an-Nar, Tell, Abraq, Muweilah, Mleiha, and Rumeilah and Yemen (Sabir, Hajar Bin Humeid, Hajar al-Tamrah, Haja al-Rayhani, Baraqish, Raybun and Khawlan sites: al-Raqlah, Jubabat al-Juruf, Wadi Yanaiim, Dhamar sites: Hayt al-Suad, al-Massanah) indicates that plants were domesticated in Arabian Peninsula between 1500-5000 BC, (Boivin and Fuller, 2009) and bananas could therefore have been introduced even earlier than in the 9th century BC.

Banana genetic diversity on the Arabian Peninsula

Despite of drought periods experienced by the Arabian Peninsula in successive millennia, bananas have not vanished. This was previously noted in the report of a survey by De Langhe (2002) in some Arabian countries. He pointed out the existence of large banana genetic diversity in this region. The bananas found in the Middle East (Jordan, Egypt and Oman), belong to the subgroups AA, AAA, AAB, AB and ABB (De Langhe, 2002). The crop may have undergone some modification over time, which made it more adapted to the arid regional conditions. Genetic mutations and human practices such as cultivation of banana under the shade of date palm in the Interior Governorate of Oman to provide humid microclimate could be one of the factors which have contributed to the survival of this crop in this region. As mentioned previously, Southeast Asia is the main source of banana; however the bananas present on the Arabian Peninsula today did not necessarily come directly from Southeast Asia, but may have travelled through Africa or India, before reaching the habitats on the Arabian Peninsula. However, this dispersal theory remains controversial. Buerkert et al. (2009) hypothesize that the AAA cultivar (cv. 'Umq Bir') recently discovered in the Upper Tiwi Valley of Oman reached there via East Africa, most likely Zanzibar, Madagascar or the Comoros islands where many AA and AAA cultivars are available.

De Langhe and Maret (1999) and Kennedy (2008) believe that *Musa sapientum,* which was planted in Dhofar and Yemen in antiquity, was introduced through Guinea/Indonesia, while others believe it came through the Indus Valley (Fuller and Madella, 2001). More than 31 accessions of banana were planted in 1997/1998 at the Salalah Agriculture Research Station of Dhofar Governorate, Oman. The origins of these accessions are the Comoros Islands, Zanzibar and India (De Langhe, 2002). Recently, nine hybrid cultivars (FHIA) were introduced by INIBAP and evaluated under southern (Dhofar Governorate) and northern Omani (North Al-Batinah Governorate, Sohar) conditions with respect to yield and tolerance to biotic and abiotic stresses, especially Sigatoka and Panama disease as well as salt and heat stress. When banana varieties are transferred from one area to another, their names sometimes remain the same and in this case it is easy to trace them (De Langhe, 2002). However, sometimes the names are changed immediately after arrival to a new place or after different generations which makes it more difficult to trace and identify them linguistically (Perrier et al., 2011). For example, in Yemen banana are called ‘Al-Mawaz Al-Hindi’ which means Indian Banana. In Egypt banana is also called ‘Hindi’. In Oman, the ‘Somali’ banana variety may have been introduced from Somalia by individuals while the ‘Malindi’ variety might have entered Oman from the town of Malindi located northeast of Mombasa, on the Indian Ocean. Similarly, the ‘Zanzibar’ variety likely is from the Island of Zanzibar (Tanzania). The ‘Fardh’ variety belongs to the Mysore group possibly having been introduced from near the town of Mysore in India, the plantain ‘Kenya’ from Kenya and ‘Abubaker Pilipino’ from the Philippines.

The role of the Arabian Peninsula in inter-regional and inter-continental exchange of crops

There has been a lot of discussion about the role of the Arabian Peninsula’s maritime ports in the transmission of plant materials, including banana, to different regions of

the world. This role is supported through ancients tombs discovered in Bahrain and Kuwait, dating back to the second millennium BC and through Geniza records, pointing to an early contact of Arabs with South Asia (Nizami, 1994). The long presence of Arabs in India is reflected by the use of the word *Hindi* as the suffix to Arabic terms such as Mauz Hindi, Ud Hindi and Tamar Hindi (Nizami, 1994). Watson (1983) suggests that medieval Arab trade played a vital role in introducing banana to East Africa and Madagascar. This was confirmed by Sauer (1952) and Cleuziou and Tosi (1989) who believed that the Arabian Peninsula served as an intermediate region for the transmission of plant and animal materials from Asia and Africa throughout antiquity. Oman was the Gulf country to produce frankincense and copper and both trading goods likely played a major role in the inter-regional plant species exchange within in Arabian Peninsula as well outside Arabia (Hammer et al., 2009).

The ancient trade between Gujarat and Arabia was particularly important during the second millennium BC and is considered to have triggered crop exchanges between Africa and South Asia (Boivin and Fuller, 2009). The availability of African crops in Gujarat and Baluchistan during second millennium BC provides evidence that maritime contact between Gujarat and Oman and Dilmon extended to Yemen and Africa (Boivin and Fuller, 2009). The discovery of African crop species at 33 archaeological sites in South Asia, dating back to the Middle Bronze Age (2000 BC) and Iron Age (300 BC) indicates that the exchange of crops between the two continents went both ways (Fuller, 2003; Cooke et al., 2005). However, Boivin et al. (2009) believed that African crops did not transfer to the Arabian Peninsula in the Bronze Age due to the absence of agricultural communities during that time, unlike at the coastal region of Gujarat. However, Vansina (1990) believed that the introduction of AAB banana to the Upper Nile Great Lakes region of Africa occurred not from the coast but through North West Africa (Atiff and Mohamed, 2000).

THE ROLE OF MARITIME ROUTES IN TRANSFERRING PLANTS TO ARABIA

The Indian Ocean

The transfer and exchange of plants outside their natural habitats was not limited only to the land roads, but maritime routes played an essential role in the transmission process. However, the role of maritime routes in the transport of crop plants to new areas is still subject to much speculation. Blench (2003) suggested three maritime routes to transfer plants species between Africa and India. The first route was between Northwest India and Egypt, across Iran, the second was a shipping route (The 'Sabaean Lane') that linked Oman, Egypt, India and Africa, across the Sea Red and the Indian Ocean, and the third route run between the West Indian coast and East Africa across the open sea. The Arabian Peninsula has played an important role in maritime trade since the Bronze Age and therefore also in the exchange and dispersal of plant genetic resources across the Indian Ocean (Fuller et al., 2011). Furthermore, archaeological discoveries in the Arabian region support this hypothesis: Chinese coins found at Al-Qualify in eastern Saudi Arabia give evidence of the role of Arabian Gulf ports in ancient trade with the Far East (Cribb and Potts, 1996). Moreover, Fuller and Boivin (2009) viewed that the north-western Indian Ocean was one of the earliest long-distance maritime routes in the world. It allowed the significant exchange of livestock (e.g. cattle) and crops like bananas and taro (*Colocasia esculenta*) as early as 2000 BC. Also, the latter authors stated that the first biological exchange was in the Bronze Age / Chalcolithic (3000–1200 BC) along the circumference of the Arabia Peninsula and northern Indian Ocean where domesticated species were transferred between the Savannahs of India and northeast Africa and Yemen. Fuller and Boivin (2009) supported their view by claiming that at the end of the 3rd and 2nd millennium BC, there was a crop transfer between eastern Africa and South Asia through the Indian Ocean and along the southern coast of Arabia. This shows that the coastal ports contributed greatly to the exchange of plant resources between continents. The maritime ports between the Indian subcontinent (Figure 3) and Oman established in the middle of the 3rd millennium BC fostered the cultural and commercial relations and also contributed to the exchange of plant materials (Al Jarow, 2011; Al-Wagad, 2011). This is supported by archaeological discoveries in the port of Samahram in the Dhofar Governorate were Indian statues, pieces of pottery and coins dating from the 1st millennium BC (Albright, 1982) were unearthed as were Indian potteries in the port of Sohar (Al Jarrow, 2011) (Figure 3).

An intensive maritime trade between Gujarat and Arabia in the 2nd millennium BC is considered to be the starting point of plant species exchange between Asia and Africa. The evidence for this is the availability of African crops in Baluchistan during that period. This indicates that maritime trade between Gujarat and Oman was strong and extended to the west of the Arabian Peninsula towards Yemen and Africa (Fuller and Boivin, 2009). Blench (2003) mentioned that in the early medieval period, plants were introduced into West Africa by Arabs. Boivin and Fuller (2009) mentioned that the Indian Ocean was controlled by Arabic traders and hence these might be responsible for introducing and exchanging crops between eastern Africa Southeast Asian and India across Indian Ocean and along the southern coast of Arabia in the 2nd millennium BC. Also, Sauer (1952) and McMaster (1962) mentioned that the eastern coasts of the Arabian Peninsula contributed to the transfer of Southeast Asian bananas to Africa.

Figure 3. Ancient Indian ports with trade links to ports in the southern Arabian Peninsula (altered form Al Jarow, 2011).

Over centuries Omani coastal were a route of transit trade between the countries of the Far East (India, China and the East Indies) and the Arabian Peninsula countries as well as Iraq, the Mediterranean Sea countries and East Africa. Muftah (2011) also suggested that commercial ships in their trip between the coastal Omani ports and India to and on to China might have used three different maritime routes (Figure 3). The first route starts in Basra in Iraq, heads towards the Eastern coast of the Gulf, stops in Ciraf (Bu Shar) in Southern Iran, then reaches Sohar and Muscat to cross the Indian Ocean to Coolum Meli south of Almalbar on the Indian coast. The second route stretches from Muscat to Polien on the Indian coast, then continues to Serindep (Sri Lanka) and Kelah port and finally reaches Khanfo in China. The third route begins in the Omani ports of Dhofar and Merbat, goes to Kalikot or Coolum Meli and then directly to China (Figure 4).

Archaeological discoveries at Ras al-Jinz and Ras al-Had in the Sharqia North Governorate of Oman, dating back to the third millennium BC, yielded remains of boats and Indian rings from the Bronze Age to the 5th millennium BC (Jūtīlir et al., 1983). This provides evidence for ancient relations between Oman and the civilizations of Mesopotamia, Sindh and Africa. Michael (1994) mentioned commercial maritime routes to India from the Strait of Harmuz, through Ras al-Had in northern Oman directly to the Eastern Indian coast. This sea route linking Oman and India may have greatly contributed to the direct existence of banana diversity in Dhofar and coastal cities such as Sohar and Tiwi (Figure 5). This hypothesis is supported by Muftah (2011) who mentioned that India, China and Southeast Asian Islands were the main sources of commodities to the coastal Omani ports and then to other regions of Arabian Peninsula. He also added that bananas and coconuts (*Cocos nucifera*) were the most important fruit crops imported from India to Oman in Medieval times.

The Red Sea trade: Incense routes

Most scholars agree that the 'Land of Punt', a mining region in southern Egypt played an essential role in the maritime trade in the Red Sea during the 3rd millennium. Electrum, slaves, and particularly frankincense (*Boswellia sacra*) and myrrh (*Commiphora myrrha*) were traded from Punt via the Red Sea (Boivin and Fuller, 2009). The Arabian frankincense species is native to Dhofar in Oman and Hadhramout in Yemen, while other species of frankincense are native to northern and western Ethiopia and Eritrea (*B. papyrifera*), some areas of Sudan and West Africa (Boivin and Fuller, 2009), Somalia (Hepper, 1969) and the Island of Socotra (Boivin and Fuller, 2009). The genus of Myrrh tree (*Commiphora*) is native to southern and eastern Ethiopia, Somalia, Yemen, southwest Saudi Arabia and the coastal plains of Oman (Boivin and Fuller, 2009). All of these countries also cultivate banana and it is therefore likely that there was an intensive exchange of banana germplasm between these countries. Archaeological evidence from Barbar, Umm-an-Nar, Tall Abraq, Hili, Wadi Suq, Ras al-Hamra,

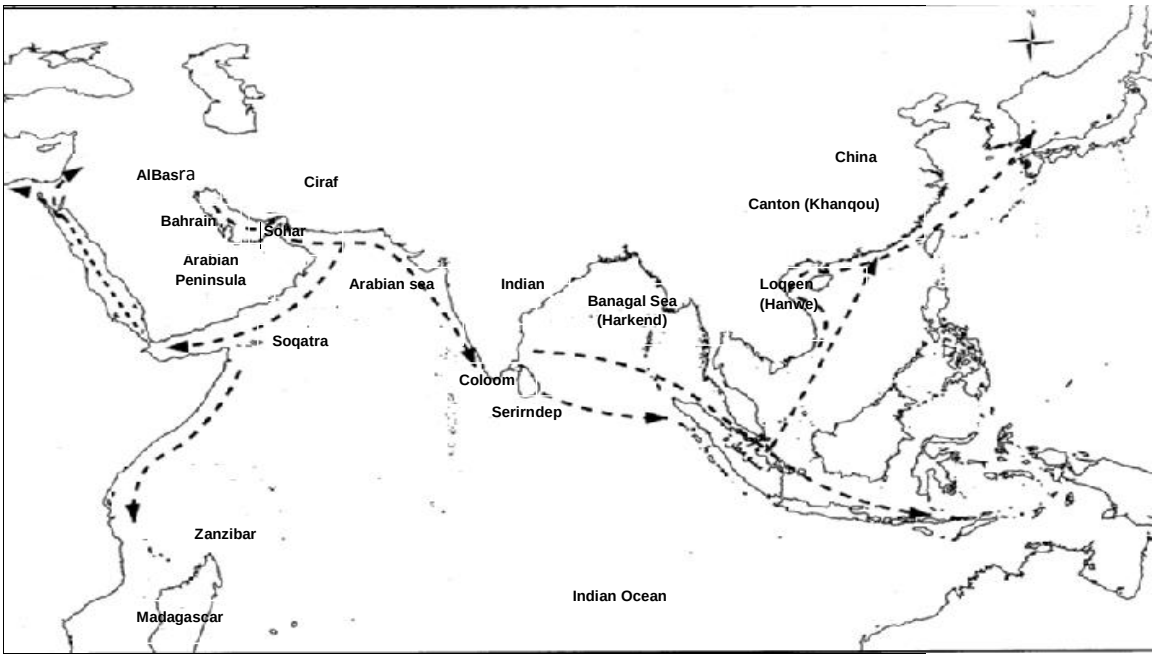

Figure 4. Trade routes and sea ports between the Arabian Peninsula, India and China (altered from Al-Wagad, 2011; Muftah, 2011).

Figure 5. Regional distribution of banana cultivars groups in Oman (De Langhe, 2002; Al-Saady, 2010).

Ras al-Hadd, Ras al-Jinz, and as-Suwayh confirm the prosperity of the Red Sea trade during the 3rd millennium (Boivin and Fuller, 2009). It can therefore be hypothesized that trade of frankincense and myrrh via the Red Sea contributed to the exchange of plant genetic sources such as bananas between Africa, India and the Arabian Peninsula.

CONCLUSIONS

While the debate on the origins of banana domestication is on-going, evidence presented in this chapter suggests that the islands of Southeast Asia and Southern China are the primary sites of banana domestication followed by subsequent phases of pre-historic cultivation and translocation to other parts of the world. Owing to the desert climate conditions in many areas of the Arabian Peninsula and based on linguistic, genetic, archaeological and maritime route data, it can be concluded that domesticated banana cultivars presently found in this area are not indigenous to the region. Humankind maintained these varieties over the ages, despite unfavourable climatic conditions. Whether domesticated banana varieties were introduced directly from their natural habitat or arrived via Africa or India cannot be clearly determined at this stage. The ancient commercial relations between the Arabian Peninsula, East Africa and India may have played a key role in introducing banana to the Arabian Peninsula. The Gulf ports, in particular those of Oman, seem to have effectively contributed to the exchange of plant genetic resources including bananas between the Arabian Peninsula and the Indian subcontinent, Africa and China. Oman's strategic location and its wealth of frankincense and copper were factors that made it an important transit centre for the exchange of plant genetic resources, including different banana subgroups. Further studies are needed to verify the truth of banana domestication on the Arabian Peninsula.

ACKNOWLEDGEMENT

The authors invaluable appreciation also goes to Pro. Dr. Buerkert and Dr. Alexandra Zum Felde, Kassel University for their scientific advice and English correction of this investigation.

REFERENCES

Al Jarow AS (2011).Trade relationships between ports of Oman and ports of the Indian subcontinent (In light of Greek and Romanian resources and archaeological evidence). International Symposium: Oman and India. Prospects and civilization. The Omani Studies Centre and the Office for External Cooperation at Sultan Qaboos University, Muscat, Oman.

Al-Saady NA, Al-Lawati AH, Al-Subhi AM, Khan AI (2010). Evaluation of Genetic diversity in Omani banana cultivars (*Musa* cvs.) using AFLP markers. J. Plant Sci. 5(4):402-413.

Albright FP (1982). The American Archaeological Expedition in Dhofar, Oman. American Foundation for the Study of Man (AFSM). Foundation of the Study of Man, Vol. 6. Washington D.C., USA.

Al-Wagad MMAH (2011). Shipping routes between Oman and India in light of Arabic geographical resources. International Symposium: Oman and India. Prospects and Civilization. The Omani Studies Centre and the Office for External Cooperation at Sultan Qaboos University, Muscat, Oman.

Attif MI, Mohammed NHKH (2000). Banana. Its plantation, management and production. 1st edition, Alexandria, Egypt. 460 p.

Biodiversity International (2012). Sustainable production. http:// bananas.biodiversityinternational.org/.

Blau S (1999). Of water and oil: Exploitation of natural resources and social change in eastern Arabia. In: Gosden, C. and Hather, J. (Eds.). The prehistory of food: Appetites for change 83-98. Routledge, London, England.

Blench R (2003). The movement of cultivated plants between Africa and India in prehistory. In: Neumann, K., Butler, A. and *Kahlheber, S.* (Eds): Food, Fuel and Fields. Progress in African Archaebotany. Africa Praehistorica 15. Köln (Heinrich–Barth–Institute). pp. 273-292.

Blench R (2009). Banana and plantations in Africa: Re-interpreting the linguistic evidence. Ethnobot. Res. Appl. 7:363-380.

Boivin N, Fuller DQ (2009). Shell middens, ships and seeds: Exploring coastal subsistence, maritime trade and the dispersal of domesticates in and around the ancient Arabian Peninsula. J. World Prehistory 22:113-180.

Boivin N, Blench R, Fuller DQ (2009). Archaeological, linguistic and historical sources on ancient seafaring: A multidisplinary approach to the study of early maritime contact and exchange in the Arabian Peninsula, In: Petraglia, M and Rose, J, (Eds.). The evolution of human populations in Arabia. Paleo-environments, prehistory and genetics. 18:251-278.

Buerkert A, De Langhe E, Al Khanjari S (2009). Ecology and morphological traits of an ancient *Musa* accuminata cultivar from a mountain oasis of Oman. Genetic Resour. Crop Evol. 56:609-614.

Castillo C, Fuller D (2012). Bananas: the spread of a tropical forest fruit as an agricultural staple. In: The Oxford Handbook of the Archaeology of Diet (in press).

Cleuziou S, Tosi M (1989). The southeastern frontier of the ancient Near East. In K. Frifelt and P. Serenson (Eds.), South Asian Archaeology Curzon Press: London. pp. 15-48.

Cooke M, Fuller DQ, Rajan K (2005). Early historic agriculture in southern Tamil Nadu: Archaeobotanical research at Mangudi, Kodumanal and Perur. In: U. Franke-Vogt and J. Weisshaar (Eds.), South Asian Archaeology 2003: Proceedings of the European Association for South Asian Archaeology Conference, Bonn, Germany, 7th–11th July 2003. Linden Soft, Aachen, Germany. pp. 329-334.

Cribb J, Potts D (1996). Chinese coin finds from Arabia and the Arabian Gulf. Arabian Archaeol. Epigraphy 7:108-118.

De Langhe E, De Maret P (1999). Tracking the banana: its significance in early agriculture. In C. Gosden and J. Hather (Eds). The Prehistory of Food .Appetites for Change. Rutledge, London, England. pp. 377-398.

De Langhe E (2002). Banana Diversity in the Middle East (Jordan, Egypt and Oman). International Network for the Improvement of Banana and Plantain (INIBAP), Montpellier, France, 56 p.

De Langhe E, Vrydaghs L, De Maret P, Perrier X, Denham T (2009). Why bananas matter: An introduction to the history of banana domestication. Ethnobot. Res. Appl. 7:165-177.

Edens C (1993). Indus-Arabian interaction during the Bronze Age: A review of evidence. In G. L. Possehl (Ed.), Harappan civilization: A recent perspective (2nd ed). New Delhi, Oxford and IBH.

FAOSTAT (2010). Food and Agriculture Organization of the United Nations. Statistics Division, http://faostat.fao.org (data accessed on 17.02.2012).

Fuller DQ (1998). Palaeoecology of the Wadi Muqaddam: A preliminary report on the significance of the plant and animal remains. Sudan Nubia 2:52-60.

Fuller DQ (2003). African crops in prehistoric South Asia: A critical

review. In: Neumann, K., Butler, A. and Kahlheber, S. (Eds.). Food, Fuel and Fields. Progress in African Archaeobotany. Heinrich-Barth Institut, Cologne, Germany. pp. 239-271.
Fuller DQ (2004). Early Kushite agriculture: Archaeobotanical evidence from Kawa. Sudan Nubia 8:70-74.
Fuller D Q (2006). Agricultural origins and frontiers in South Asia: A working synthesis. J. World Prehistory 20:1-86.
Fuller DQ, Madella M (2009). Banana cultivation in South Asia and East Asia: A review of the evidence from archaeology and Linguistics. Ethnobot. Res. Appl. 7:333-351.
Fuller DQ, Madella M (2001). Issues in Harappan archaeobotany: Retrospect and prospect. In: Settar, S. and Korisettar, R. (Eds.). Indian archaeology in Retrospect, Vol. II. Protohistory. Manohar, New Delhi, India. pp. 317-390.
Fuller DQ, Boivin N (2009). Crops, cattle and commensals across the Indian Ocean: Current and potential archaeobiological evidence. Etudes Ocean Indian 43:13-46.
Fuller DQ, Boivin N, Hoogervorst T, Allaby R (2011). Across the Indian Ocean: the prehistoric movement of plants and animals. Antiquity 85(328):544-558.
Hammer K, Gebauer J, Al Khanjari S, Buerkert A (2009). Oman at the cross-roads of inter-regional exchange of cultivated plants. Genet. Resour. Crop Evol. 56(4):547-560.
Harrower M (2008). Hydrology, ideology, and the origins of irrigation in ancient southwest Arabia. Current Anthropology 49(3): 497-510.
Hassan FA (1997). Holocene palaeoclimates of Africa. Afr. Archaeological Rev. 14(4): 213-230.
Hepper FN (1969). Arabian and African frankincense. J. Egypt. Archaeol. 55:66-72.
Jūtīlir JR, Firth N, Huston SS (1983). Preliminary research in ancient mining in the Sultanate of Oman. Our heritage. Ministry of Heritage and Culture, Oman 41 p.
Kennedy J (2008). Pacific bananas: Complex origins, multiple dispersals? Asian Perspect. 47(1):75-94.
Kinder H, Hilgemann W (1974). Atlas of World History Vol. 1. From the Beginning to the Eve of the French Revolution. Penguin, Harmondsworth, England. 299 p.
Lézine AM, Saliége JF, Robert C, Wertz F, Inizian ML (1998). Holocene lakes from Ramlat as-Sab'atayn (Yemen) illustrate the impact of monsoon activity in southern Arabia. Quat. Res. 50:290-299.
Magee P (2005). The chronology and environmental background of Iron Age settlement in Southeastern Iran and the question of the origin of the Qanat irrigation system. Iranica Antiqua 40:217-231.
Mbida CM, Van Neer W, Doutrelepont H, Vrydaghs L (2000). Evidence for banana cultivation and animal husbandry during the first millennium BC in the forest of southern Cameroon. J. Archaeol. Sci. 27:151-162.
McMaster DN (1962). Speculations on the coming of the banana to Uganda, J. Trop. Geogr. 16:57-69.
Michael R (1994). The Archaeology of the Arabian Gulf (500-323 BC). 1st ed. Microwave Technology Series (Gebundene Ausgabe), Routledge, ISBN 0415032687, New York, NY, USA. 388 p.
Mindzie MC, Doutrelepont H, Vrydaghs L, Swennen RL, Swennen RJ, Beeckman H, De langhe E, Maret P (2001). First archaeological evidence of banana cultivations in central Africa during the third millennium before present. Veget. Hist. Archaeobot. 10:1-6.
Muftah AMAF (2011). Ports of the coast of Oman and their role in the prosperity of trade between Oman and India in the Islamic era (200-800 AH). International Symposium: Oman and India. Prospects and Civilization. The Omani Studies Center and the Office for External Cooperation at Sultan Qaboos University, Muscat, Oman.
Nizami KA (1994). Early Arab contact with South Asia. J. Islamic Stud. 5(1):52-69.
Parker AG, Eckersly L, Smith, MM, Goudie AS, Stokes S, Ward S, White K, Hodson MJ (2004). Holocene vegetation dynamics in the northeastern Rub' al-Khali desert, Arabian Peninsula: A phytolith, pollen and carbon isotope study. J. Quat. Sci. 19(7):665-676.
Parker AG, Goudie AS, Stokes S, White K, Hodson MJ, Manning M, Kennet D (2006). A record of Holocene climate change from lake geochemical analyses in south-eastern Arabia. Quat. Res. 66(3):465-476.
Perrier X, De Langhe E, Donohue M, Lentfer C, Vrydaghs L, Bakry F, Careel F, Hippolyte I, Horry JP, Jenny C, Lebot, V, Risterucci AM, Tomekpe K, Doutrelepont H, Ball T, Manwaring J, Maret P, Denham T (2011). Multidisplinary perspectives on banana (*Musa spp*) domestication. PNAS 108(28):11311-11318.
Potts DT (2008). Arabian Peninsula. In: D. Pearsall (Ed.). Encyclopedia of archaeology. pp 827-834. Elsevier, New York, NY, USA.
Potts DT (1994). Contributions to the agrarian history of Eastern Arabia II: The cultivars. Arabian Archaeol. Epigraphy 5:236-275.
Robinson JC (1996). Bananas and Plantain. Cambridge University Press, Cambridge, UK, 238 p.
Sauer JD (1952). Agricultural Origins and Dispersals. American Geographical Society, New York, NY, USA.
Simmonds NW (1962). The Evolution of the Bananas. Tropical Science Series. Longmans, London, England.
Simmonds NW, Shepherd K (1955). The taxonomy and origins of the cultivated bananas. J. Linnaean Soc. (Botany) 55:302-312.
Uerpmann M (2003). The dark millennium: Remarks on the final atone age in the Emirates and Oman. In: Potts, D.T., Naboodah, H. and Hellyer, P. (Eds.), Archaeology of the United Arab Emirates. Proceedings of the First International Conference on the Archaeology of the UAE. Trident, London, England. pp. 74-81.
Vrydaghs L, Ball T, Volkaert H, Houwe IVD, Manwaring J, De Langhe E (2009). Differentiating the Volcaniform Phytoliths of Bananas: *Musa acuminata*. Ethnobot. Res. Appl. 7:165-177.
Van der Veen M (2011). Consumption, Trade and Innovation: Exploring the Botanical Remains from the Roman and Islamic Ports at Quseir Al-Qadim, Egypt. Africa Magna Verlag, Frankfurt, Germany 303 p.
Vansina J (1990). Paths in the Rainforest: Towards a History of Political Tradition in Equatorial Africa. University of Wisconsin Press, Madison, WI, 438 p.
Varisco DM (1994). Medieval agriculture and islamic science. The Almanac of a Yemeni Sultan. University of Washington Press. USA. 349 p.
Watson AM (1983). Agricultural innovation in the Early Islamic world. Cambridge Cambridge University Press, Cambridge, England, pp 272.