

# Exploiting Mangroves and Rushing Back Home

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## **Exploiting Mangroves and Rushing Back Home** **Fifteen Years of Research Along the Northern Coast of the Arabian Sea, Pakistan**

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**Abstract** The research carried out between 2000 and 2014 along the northern coast of the Arabian Sea in Lower Sindh and Las Bela (Balochistan, Pakistan) has shown that the two regions started to be settled during the last two centuries of the 8th millennium BP. The sites consist of shell middens, shell scatters and fishermen villages, many of which were sampled for conventional and AMS radiocarbon dating from mangrove and marine shells. So far 95 sites have been AMS (GrA-) or conventionally (GrN-) radiocarbon-dated. This paper describes the results obtained from three well-defined macro areas (Lake Siranda, the coastline between Cape Gadani and the Hab River mouth, and the Indus Delta) where the aforementioned research methodology has been applied. The results contribute to the interpretation of the archaeology of the coastal area of Pakistan and the Arabian Sea, the definition of the sea-level variations since the mid-Atlantic period, the presence/absence and exploitation of ancient mangroves, the dynamic of the Indus Delta advance, and the chronology of the early navigation along the northern coast of the Indian Ocean.

**Summary** 1 Preface. – 2 A Radiocarbon Dating Programme. – 3 The Study Regions. – 3.1 Siranda Palaeo-Lagoon (Las Bela, Balochistan). – 3.2 The Coast Between Cape Gadani and the Hab River Mouth (Las Bela, Balochistan). – 3 The Indus Delta (Lower Sindh). – 4 Discussion. – 5 Conclusion.

**Keywords** Pakistan. Arabian Sea coast. Indus delta. Mangroves. Shell middens. Radiocarbon dating. Sea-level changes. Early navigation.

### **1 Preface**

This paper describes and discusses the preliminary results obtained from the surveys carried out along the northern Arabian Sea coast of Lower Sindh and Las Bela (Balochistan) between 2000 and 2014. In this region, from which little archaeological evidence has ever been retrieved (Khan 1979a, Biagi 2011), 14 locations with molluscs were discovered. They show the presence of palaeo-mangroves close to the present coastline and also far inland, from Miāni Hor (Las Bela), in the west, to the Makli Hills (Thatta, Sindh), in the east. With the present 76 radiocarbon dates from *Terebralia palustris* and *Telescopium telescopium*, and 19 more from marine shells (*Purpura panama*, *Meretrix* sp., *Ostreidae*, *Lunella coronata*, *Turbo bruneus*, *Mactridae*), the project still underway furnishes the first detailed data-set for the reconstruction of the early exploitation (second half of the 8th millennium BP) of

mangal resources by semi-nomadic populations. Moreover, it adds new arguments to the interpretation of the evolution of the prograding Indus Delta during the last eight millennia.

The surveyed region spans from the shallow depression of Lake Siranda (Las Bela district, Balochistan), the high coastline between Cape Gadani and the mouth of the Hab River, to the flats of the Indus Delta with some remnants of the pre-deltaic Eocene limestone reliefs, among which are the Makli Hills, south of Thatta, and Aban Shah, in the lower Delta plain (Blanford 1880). Moreover, the research carried out along the limestone mesas that elongate on the western side of the Indus, between Ongar, Meting and Jhimpir, while resulting in the discovery of many archaeological sites from the Lower Palaeolithic to Historical times (Starnini, Biagi 2011), yielded evidence of Bronze Age *T. palustris* shells at Kot Raja Manjera, near Jerruck (Jhirak) (Khan 1979a, 6; 1979c, 71-2; Biagi 2010). This is, at the mo-

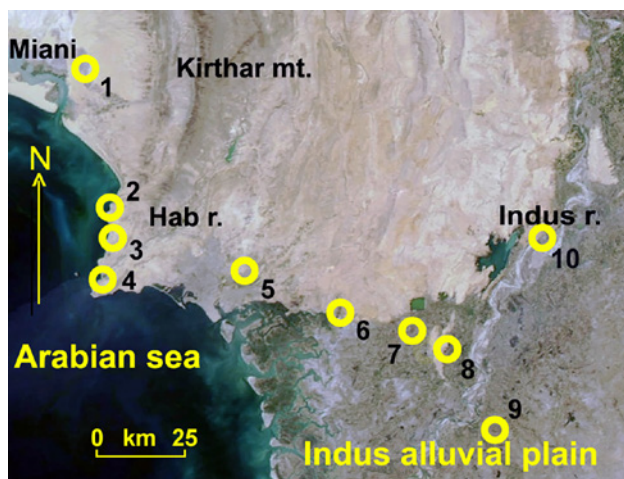
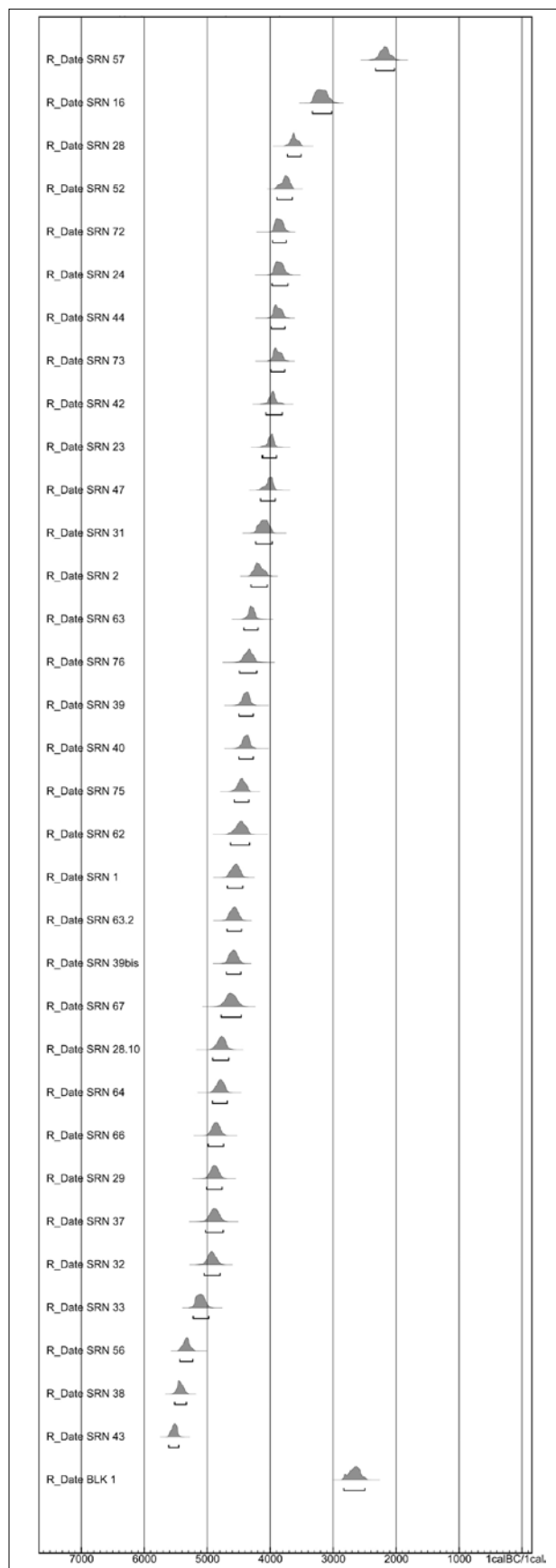


Figure 1. Distribution map of the radiocarbon-dated mangrove sites along the northern Arabian Sea coast of Sindh and Las Bela. 1) Lake Siranda, 2) Ras Gadani and Phuuri, 3) Daun Bay, 4) Sonari, 5) Mulri Hills, 6) Gharo, 7) Tharro Hills, Beri and Shah Husein, 8) Makli Hills and Kalan Kot, 9) Oban Shah, 10) Kot Raja Manjera (drawing by P. Biagi)

Figure 2. Plot of the calibrated dates obtained from mangrove gastropods from the shell middens sampled around Lake Siranda (SRN), and the Chalcolithic/Bronze Age mound of Balakot (BLK-1) (Las Bela, Balochistan) (scatterplot by T. Fantuzzi)

ment, the northernmost point from which mangrove shells have been discovered, some 150 km as the crow flies from the present Indus mouth (fig. 1).

Before the construction of dams and barrages along its course (Pithawalla 1939, Panhwar 1964, Rahman 1988), the Delta shoreline advanced at an average rate of ca. 45 m/year, with maxima of 150 m/year at the mouth of active channels (Giosan et al. 2006). The importance of recognising the complex history of the coastline changes in the millennia in relationship with the prehistoric human presence is easily understood. Several calculations have also been made regarding the rate of rising of the alluvial plain in the Delta area. According to H.T. Lambrick (1986) a rise of 20 to 30 cm a century is quite a realistic figure and the central part of the plain would have increased for ca. 9 m in the last 5,000 years. More recent estimates (Inam et al. 2007) display off-shore sedimentation rates of 50 cm/year at the mouth of the active channel, in the Indus canyon, and huge quantities of sediments, calculated in terms of 250 megatonne per year, were supplied by the river prior to modern damming (Clift, Giosan 2014).



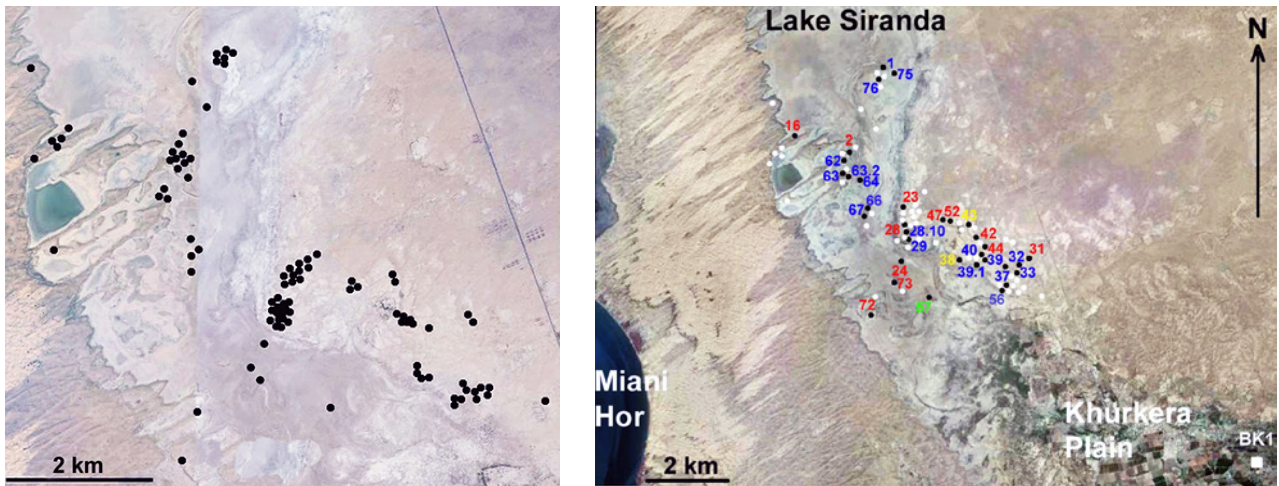


Figure 3a-b. Lake Siranda (Balochistan): Distribution map of the shell middens and shell scatters recorded during the 2010-14 surveys (left), and the radiocarbon dated sites (right). Yellow: 8th millennium BP; blue: 7th millennium BP; red: 6th millennium BP; green: 5th millennium BP; Balakot: BK1 (drawing by R. Nisbet)

## 2 A Radiocarbon Dating Programme

The research was coupled with a wide programme of radiocarbon dating made mainly on mangrove, but also marine shells, whose scope was to define the chronology of the prehistoric and historic exploitation of the coastal forests. Furthermore radiocarbon dates are an excellent way to interpret the changing landscape of the Indus Delta, one of the most active coastlines of the world (Meadows, Meadows 1999).

The description of the aforementioned changes are based on radiocarbon dates mainly obtained from the apex of one single specimen of adult, decoloured, mangrove Gastropod weighing 5 to 10 grams, collected from the centre of each site. *T. palustris* was preferably selected or, in its absence, *T. telescopium*. They all were dated at Groningen University Isotope Laboratory: GrA- in the case of AMS dates from one individual, and more specimens of the same species in the case of ordinary dates (GrN-) processed before 2004.

## 3 The Study Regions

Three main large areas have been considered: 1) the Siranda basin, at present a sabkha-like saline depression, some 15 km long and 4 km wide, whose south-western side lies 5 km from the Sonmiani Lagoon (Miāni Hor) and ca. 15 km from the present sea-shore; 2) the coast between Cape Gadani and the mouth of the Hab River that marks the boundary between Balochistan and

Sindh, with its long low-lying shores and some headlands of solid massive rocks (for instance at Gadani, Phuari, Daun and Sonari); and 3) the Indus Delta, corresponding in our survey to the coast from Karachi to Aban Shah, south of Thatta in longitude, and Gharo-Makli Hills (Thatta) to Kot Raja Manjera (Jerruck) in latitude.

### 3.1 Siranda Palaeo-Lagoon (Las Bela, Balochistan)

At present a detailed sequence in the use of palaeo-mangroves is known from Lake Siranda (Minchin 1907, 9; Hughes-Buller 1908, 96). The early morphological history of the basin is still poorly understood (Biagi, Nisbet, Girot 2013). It is accepted by the authors that it was formerly part of the present Sonmiani Lagoon (Miāni Hor), sharing with it its dominant environmental aspects and that it “functioned as a tidal lagoon in the not-too-distant past” (Snead 1966, 60). According to the aforementioned author, Siranda was formerly connected to Sonmiani Lagoon from which it was later separated by sand dune formations, eventually stabilised by vegetation.

The 33 radiocarbon dates obtained so far from the area show that the first exploitation of mangroves started ca. one century after the radiocarbon result obtained from the Mulri Hills, east of Karachi (MH-15, GrA-63863: 7320±40 BP), and lasted for the entire 7th and 6th millennia BP (fig. 2). The earliest dates, spanning from the last centuries of the 8th and the middle of the 7th millennium BP, come from sites located along the south-eastern

side of the basin. Just after the mid 7th millennium BP the sites spread toward north-east, at the inner sides of the depression. After this period the shell middens seem to disappear from the northern part of the palaeo-lagoon, and are found again at its south-western corner (fig. 3a-b).

Quite rapid shift of sites to its southern margin took place between the end of the 6th and the end of the 5th millennia BP, showing the progressive desiccation of the ancient lagoon, which would have lost its connections with the sea probably by the end of the 4th millennium BP. The more recent shell midden found at Siranda yielded a date of  $4315 \pm 35$  BP (SRN-57, GrA-5733), which is only three centuries more recent than that obtained from Balakot, ca. 10 km to the south-east (BLK-1, GrA-55828:  $4660 \pm 40$  BP). The stratified Chalcolithic/Bronze Age mound of Balakot (fig. 4) started to be settled during the last phases of exploitation of the Siranda palaeo-mangrove, as shown by many *Terebralia palustris* shells retrieved from the Bronze Age occupation layers (Dales 1974, Shaffer 1986). In effect they are very common to the Bronze Age Indus period settlement, where they represent 67% of the total shell assemblage, while their presence reaches only 18% in the Chalcolithic layers.

### 3.2 The Coast Between Cape Gadani and the Hab River Mouth (Las Bela, Balochistan)

South of Sonmiani Lagoon the coast forms a long, low sandy strip, interrupted only by two rocky headlands at Gadani and Phuari (fig. 5). The first belongs to the Bela Ophiolite, a sequence of basaltic pillow-lavas, inter-flow sedimentary rocks (chert, argillite and limestone) mostly of Upper Cretaceous age (Sarwar 1992) emerging as the western part of Mor Range, and the Parh limestone formation (Upper Cretaceous), a unit of the Pab Range.

Ras Gadani is separated from Ras Phuari, some 3.5 km to the south, by a sand strip that runs in a NNE-SSW direction, in the centre of which is a small, seasonal stream called Kunari Dhora, which flows into the Arabian Sea. The Bela Ophiolites outcrop runs along the coast, south of the mouth of the Kunari Dhora as far as Ras Phuari. Two almost identical dates from Gadani (GDN-0,  $4460 \pm 30$  BP: GrN-26369) and Ras Phuari (PHR-11,  $4415 \pm 40$  BP: GrA-55826) prove the existence of mangroves probably at the mouth of the mentioned small streams, around the middle of the 5th millennium BP, a time when

Siranda palaeo-lagoon had already transformed into a saline depression, fed only by monsoon rains and seasonal rivers (Biagi et al. 2013).

Further south, the shell middens of Daun Bay lie partly along the sand beach around and south of the bay, some 4-10 m above the maximum level reached by the tide, partly on the top of the Pleistocene marine terrace (16-20 m) extending south of a small headland (Snead 1966, 47; 1967; 1969, 38; Snead, Frishman 1968, 1673). Their distance from the present shoreline varies from 60 to 700 m. Most sites consist of heaps or scatters of fragmented *Terebralia palustris* gastropods (Biagi 2004), although other mangrove and marine species are represented, among which are *Telescopium telescopium* and *Anadara uropygmelana* (fig. 6).

The radiocarbon results from the Daun sites indicate that the exploitation of the mangrove resources was not 'continuous'. It took place mainly during two distinct periods of the first half of 5th and the 3rd millennium BP respectively (Biagi, Fantuzzi, Franco 2012), thus pointing to the existence of coastal forests at the same time as at Siranda. The first cluster of Daun dates, belonging to the Neolithic, shows a  $\delta^{13}\text{C}$  ratio ranging from -3.44 to -3.97, which is compatible with a mixed marine mangrove ecosystem. A more recent sporadic episode of exploitation, which took place during the Chalcolithic (Daun-6, GrN-28802:  $5370 \pm 35$  BP), shows a dramatic increase to +1.27, possibly an indicator of environmental stress. The samples obtained from the second main cycle of exploitation of Daun Bay, as well as Capes Gadani and Phuari, show once again lower  $\delta^{13}\text{C}$  (-4.49 to -6.10) that are typical of a healthy mangrove ecosystem with mixed marine and freshwater.

At the southern mouth of the Hab River the southernmost extension of Pab Range rises with its Jhill limestone unit, a member of the Miocene Gaj Formation (Blanford 1880). On the top of a saddle 30-40 m high located near the village of Sonari, ca 7 km north-east of Ras Muari (Cape Monze), local prehistoric fishermen living in rectangular stone structures collected mangrove Gastropods in a tidal forest certainly growing along the estuary of the Hab River, at least since the early 4th millennium BP (Biagi, Nisbet 2014) (fig. 7). A similar date was obtained from the Bronze Age Indus Civilisation small settlement of Pir Shah Jurio (PSH,  $4130 \pm 20$  BP: GrN-26370) located on the eastern Hab River terrace surrounded by alluvium, some 6.5 km north-east of its mouth (Fairervis 1993, fig. 9.1). The last





Figure 4. Balakot (Balochistan): the mound from the south-east in January 2012 (photograph by P. Biagi)



Figure 5. Gadani (Balochistan): the sandy coastal strip north of the cape in January 2011 (photograph by P. Biagi)



Figure 6. Daun (Balochistan): the shell midden Daun-10 in the foreground between the rocky outcrops, and the Daun Bay in the background in January 2008 (photograph by P. Biagi)

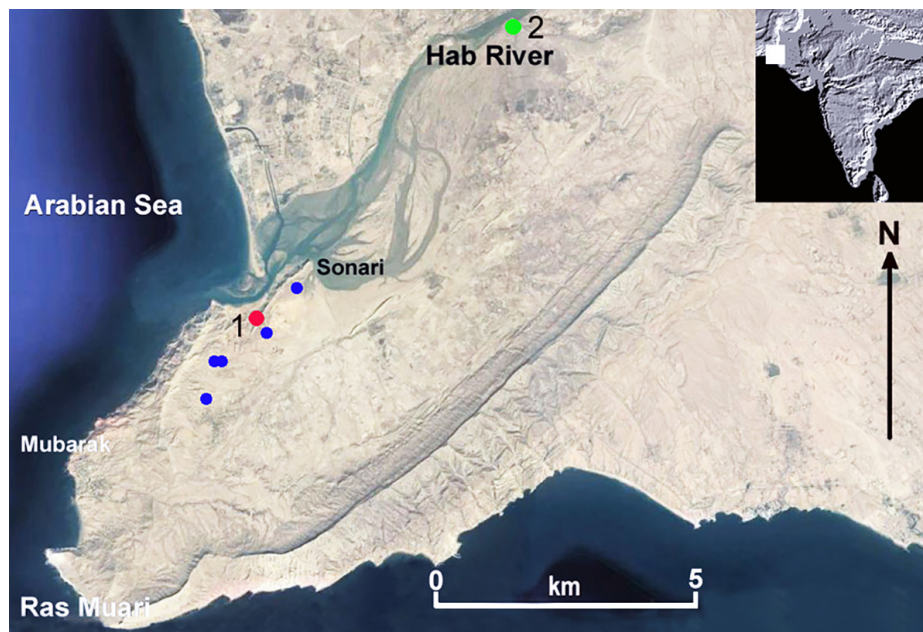


Figure 7. Hab River Mouth (Sindh): Location of the Bronze Age fishermen site of Sonari (1) and of the Indus site of Pir Shah Jurio (2) and other radio-carbon-dated shell scatters in the Ras Muari region (after Biagi, Nisbet 2014)



two results from Sonari (SNR-3, GrA-62249: 2190±30 BP and SNR-2, GrA-59834: 670±50 BP) are so far the only historical dates available for the Pakistani palaeo-mangroves.

### 3.3 The Indus Delta (Lower Sindh)

The date from the Mulri Hills, at the eastern outskirts of Karachi (MH-15, GrA-63863: 7320±40 BP), is the oldest radiocarbon result available to date showing the presence of mangroves along the seaside of present-day Pakistan. The Mulri Hills are literally covered with Late (Upper) Palaeolithic and Mesolithic sites, whose location is unique to the entire study region. The hills are rich in freshwater that springs out of roughly east-west oriented faults, from which originate small streams that flow southward straight into the Malir River and soon after the Ghizri Creek west of Rehri, and Kadiro Creek (Khan 1979b, Biagi 2003-2004). Given the inland position of the hills ca. 70 m high (Zaidi et al. 1999), it is probable that the *T. palustris* shells were collected from mangroves that flourished along the coast ca. 8 km to the south, where they still survive (Manora Island and surrounding areas) or along the mouth of the Malir River at Ghizri Creek and further south, or east at Kadiro Creek (Snedaker 1984, Kazi 1999). However, according to A.R. Khan the whole coastal area around Karachi has been subjected to at least three phases of uplift during the Holocene, with the formation of a series of raised beaches and marine terraces (at 6-7 m, 9-12 m and over 15 m respectively) (Khan 1979a, 19-21). How effective these tectonic processes were in causing changes to the coastal mangroves is still to be understood, as they resulted in the seaward advance of the shoreline.

Moving eastward, the first AMS-dated occurrence of *T. telescopium* is known from Gharo (Gar-1: 6320±60: GrA-59844). Located on a limestone terrace, at an altitude of ca. 30 m, the site is 4-5 km from the ruins of the 8th century AD Gharo Creek outpost of Bhambor (Majumdar 1934, 19; Cousens 1998, 64), at present along the shore of an active channel of the Indus River and close to the actual mangrove.

A consistent number of radiocarbon dates has been obtained west and south of Thatta, one of the ancient capitals of Sindh. The shell middens are located some 30 km from the present western coastline, and more than 80 km from the mouth of the main Indus channel, in the south. Almost all the samples come from the top or, less fre-

quently, the side of isolated tracts of calcareous and sandstone hillocks, rising from the alluvial plain between 10 and 30 m, at an elevation of 15-40 m above the sea level. These features were undoubtedly surrounded by the sea before the advance of the Delta, forming an archipelago which could be easily reached from the coast even in historical times. Arrian's account on Nearchos journey mentions some "isles" when the fleet reached the sea. The more evident of these elevations are the Makli Hills, running north-south with the ruins of an impressive fortress known as Kalan Kot, close to which the earliest date for the area has been obtained (KKT-2, GrN-32464: 6320±45 BP).

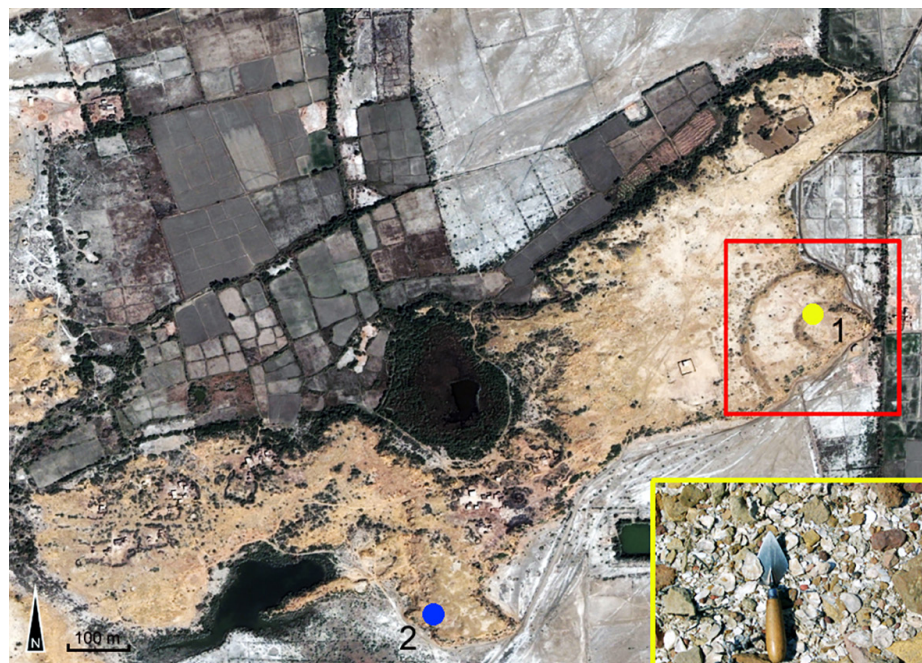
The results yielded by nine sites show the presence and exploitation of mangroves since the mid 8th to end of the 6th millennium BP. There are, however, interesting exceptions from Shah Hussein (JSH-2, GrA-45181: 4245±40 BP and JSH-10, GrA-62255: 2715±30 BP), an isolated rocky cliff ca. 13 km west-southwest from Thatta (fig. 7), from which we have evidence of several mangrove shell scatters as well as chipped stone artefacts. The latter date shows that a mangrove environment lasted locally probably as late as the Hellenistic period, along one or more creeks connecting the site to the seaside over a period of four millennia.

Some 13 km west of Thatta and 3 south-west of Gujo, another limestone terrace is well known in the archaeological literature as a fortified Amri Culture site, from the surface of which thousands of chipped stone tools have been retrieved since decades (Majumdar 1934, Piggott 1950). The site, known as Tharro Hills, is located at the south-eastern edge of the terrace. It is surrounded by two parallel, semi-circular stone walls. During the intensive survey carried out in January 2008 (Biagi, Franco 2008), many specialised areas were recorded, 41 of which yielded characteristic Amri chipped stone tools among which are bladelets with semi-abrupt retouch, truncations and typical elongated scalene triangles. Two radiocarbon dates were obtained from samples of *Ostreidae* (THR-1, GrN-27053: 5240±40 BP) and *T. palustris* (THR-3, GrA-47084: 5555±35 BP) respectively recovered from a well-defined spot of shells located along the southern edge of the inner wall, confirming one again the Chalcolithic attribution of the site (fig. 8).

South-east of the Tharro Hills another Chalcolithic site was discovered at the top of a small limestone terrace rising from the Indus alluvium, locally called Beri (Biagi 2010, 9). A *Terebralia*



Figure 8. Tharro Hills (Sindh): Limestone terrace on which the fortified Chalcolithic site is located (right), and the two points from which Chalcolithic (1) and Neolithic (2) radiocarbon dates have been obtained from marine and mangrove shells (after Biagi 2017)



*palustris* shell sample was collected from the surface of this site, later radiocarbon-dated to  $5960 \pm 50$  BP (Beri-1: GrN-32166)

The only dated site on the left bank of Indus is an isolated rocky hill known as Aban Shah. The site lies some 70 km north of the present Arabian Sea shore. The date (ABS-1, GrA-47082:  $3790 \pm 35$  BP) provides evidence of a local mangrove still growing after the end of the Bronze Age. It shows that 1) the progress of the coastline has been relatively slow (20 km/3,500 years) in comparison with other points of the Delta; 2) the presence of mangroves surrounding the site during the early 4th millennium BP would exclude it as the island “out in the sea” of the 4th century BC reported by Arrian, erroneously considered by H.T. Lambrick (1986, 113) the islet on which Alexander landed, before sailing back to Patala (see Eggermont 1975, map 2).

In this chronological frame, the most intriguing date obtained from our survey in the Delta area comes from an inland site located on a flat-topped limestone mesa (45-47 m asl) of the Khirthar formation, called Kot Raja Manjera. The site is famous for its Buddhist stupa and other archaeological remains attributed to the 5th century AD. The terrace is roughly east-west oriented, along the south-western bank of an ancient meander of the Indus, which at present flows some 5 km to the east. Kot Raja Manjera is a fortified Amri Culture Chalcolithic settlement (fig. 9a-b). From its

surface also a few Bronze Age potsherds were collected as well as many chipped stone tools among which are small drills for bead manufacture (Khan 1979c, 72). A few marine shells were recovered as well as one *T. palustris* specimen, which was AMS-dated to  $4635 \pm 35$  BP (KRM-13, GrA-47083). Close to the terrace the river forms a semicircular bend that in prehistoric times lapped the limestone formation on which the village of Lakho Pir is located (Biagi 2010, fig. 14).

According to the above results we have to admit that 1,000-1,500 years after the exploitation of the mangroves in Thatta region the same was still happening around a site ca. 60 km northward. In fact Kot Raja Manjera yielded the northernmost finding of a mangrove shell within the entire Indus Delta region.

#### 4 Discussion

At the end of the 8th millennium BP there is evidence of mangroves at or near the mouth of a few rivers in the Sonmiani and Karachi areas, which were exploited by the earliest Holocene inhabitants of the northern coast of the Arabian Sea. These data can be compared with those obtained from the earliest shell middens of the coasts of Oman (Berger et al. 2013, Zazzo et al. 2016), and more generally the entire coastline of the Arabian Peninsula, from which we have a reasonable set



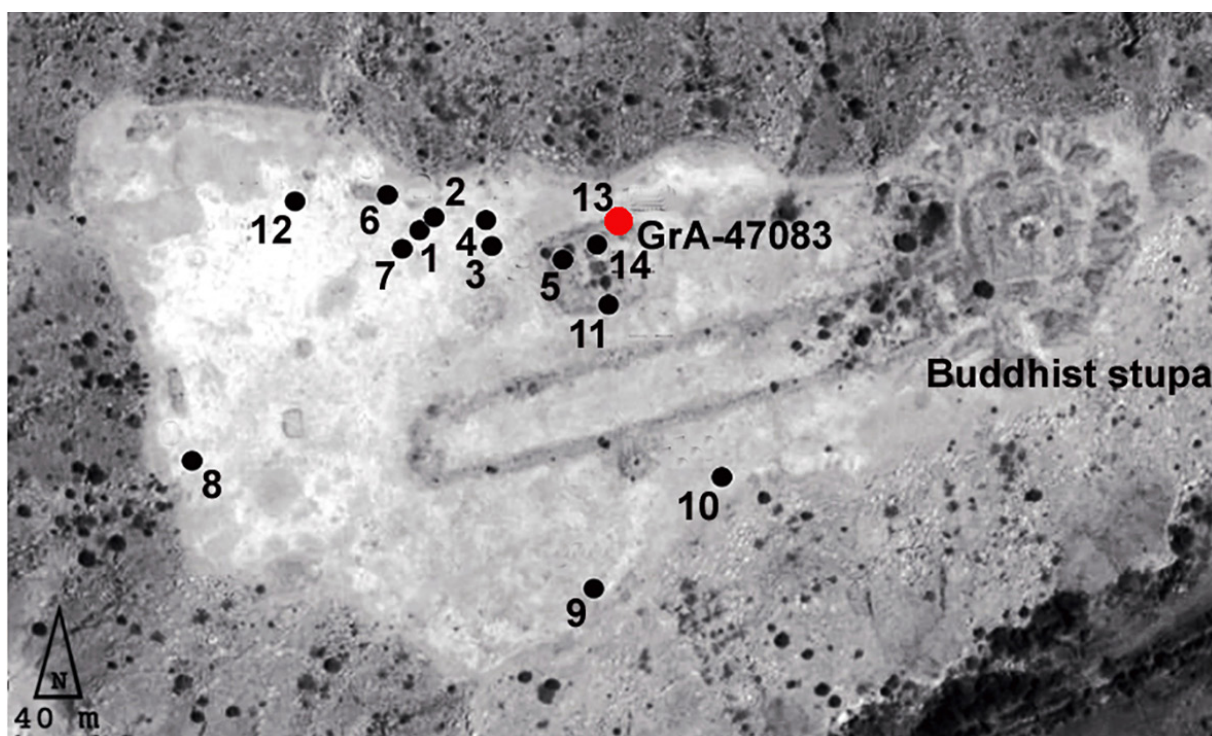


Figure 9a-b. Kot Raja Manjira (Sindh): Location of the site close to an ancient Indus River bend (below), and location of the Chalcolithic chipped stone scatters and the radiocarbon date from mangrove shell (above) (drawing by P. Biagi)

of dates confirming that the territory began to be settled roughly during this period (Boivin, Fuller 2009). According to the available radiocarbon results from mangrove shells, between the 7th and 6th millennia BP the coast of the Indus Delta was located along an arc running from Manora-Ghizri Creek, in the west, to Thatta-Makli Hills, in the east. It seems, therefore, that the western sector of the Delta, from Karachi to Bhambor-Gharo developed at that time, and later seaward accretion occurred in a minor extension (see Tremenhoe 1867). In contrast, the central part of the Delta, south of Thatta, has been subjected to a much larger advance even in historic times, though it is not possible, on the basis of our data, to define the precise dynamics in the course and position of the palaeo-channels (Wilhelmy 1968).

With regard to the last two millennia, since the 18th century AD many authors have tried to reconstruct the road followed by Nearchos fleet in its journey back to Babylon, in relationship with the location of the ancient seashore, generally exploiting as a source the itineraries handed down by Greek and Roman historians (Eggermont 1975; Biagi 2017). According to H.R. Haig (1894) the head of the Delta would be situated at the latitude of Thatta in Hellenistic times, which well agrees with the radiocarbon data. A similar opinion is shared by T.H. Lambrick (1986, 113), yet suggesting that the western coast of the Delta was not far from the Makli Hills and Pir Patho (Thatta) in Alexander's times. This hypothesis is not consistent with both the radiocarbon dates, and the reconstruction by P.H.L. Eggermont, though his interpretation of Aban Shah hillock as "the island in the sea" (Eggermont 1975, map 2) is not confirmed by our *T. palustris* date (OBS-1, GrA-47082: 3790±35 BP). In contrast it points to the presence of mangroves in the area at least one thousand years before Alexander's retreat from India.

According to D.A. Holmes, deltaic morphologies are found as inland as to 55 km north-east of Hyderabad in historical times, "suggesting a very high rate of alluvial aggradation and delta advancement" (Holmes 1968, 369). Similarly the reconstruction proposed by L. Flam that is mostly based on aerial photography and the distribution of archaeological sites in the Delta, suggests that the 6th-5th millennium BP coast was probably located somewhere between Hyderabad and Thatta (Flam 1999), an hypothesis that would better fit with our dates, and could also explain such an early date as that from KRM-13 (GrA-47083: 4635±35 BP).

## 5 Conclusion

The results obtained from the 2000-2014 surveys carried out along the coast of Lower Sindh and Las Bela in Balochistan have remarked the great potential of the area for the study of the prehistory of the two regions. The discovery of an impressive number of sites, and their radiocarbon dating, has shown that the earliest settlements of the coastal strip are to be referred to the last centuries of the 8th millennium BP. Moreover, the data retrieved from our research indicate that:

1. The Early Neolithic settlements are not exclusively restricted to the regions of the interior of Pakistani Balochistan as suggested by most authors (see f.i. Fairervis 1956, Jarrige 2004). According to both the new radiocarbon results, and the analysis of the lithic assemblages recovered from the Siranda shell middens, among which are geometric microliths obtained from Gadani dark red flint, Neolithic sites, though somewhat ephemeral, undoubtedly existed along the ancient coastline of the northern Arabian Sea. Our results show that the sites are attributable to a period that immediately follows the earliest occupation of Mehrgarh in the Kachi Plain (see Petrie et al. 2010, table 2.1);
2. The movements along the northern coast of the Arabian Sea began at least around the beginning of the 7th millennium BP. A scatter of oyster shells discovered along the southern edge of the Tharro Hills yielded a date of 6910±60 BP (THR-2, GrN-32119), which can be compared with some of the most ancient results from Lake Siranda (SRN-38, GrA-54303: 7095±35 BP and SRN-56, GrA-57702: 6980±35 BP). This fact would suggest that navigation along the northern coast of the Arabian Sea had already started at least in this period;
3. The Indus Delta 'islands' were undoubtedly exploited since the Late Neolithic and Chalcolithic periods as shown by the presence of Amri Culture sites, like the Tharro Hills. The same do not seem to have been settled during the Bronze Age Mature Indus Civilization period. This fact is rather problematic, since we know that during the mid 3rd millennium BC, Indus sailors and traders systematically moved across the Ocean even to reach the coasts of the Arabian Peninsula where Indus outposts





Figure 10a-c. Present-day mangroves in Baba Island, Karachi Gulf (a), Manora, Karachi (b) and Miāni Hor (Las Bela, Balochistan) (c) (photographs by P. Biagi and R. Nisbet)



are known since a few decades (Méry 1996, Ratnagar 2004);

4. The series of dates obtained from shells provide excellent arguments for a preliminary reconstruction of the Holocene history of the mangroves along the coasts of Las Bela, and the variation of the profile of the Indus Delta in the same period. In this region mangroves followed the millennial built-up of the land at least since the 6th millennium BP. Unfortunately at present no dates are available for the earliest formation of the Delta, probably pre-Holocenic, whose apex several authors would set dozens km north to Hyderabad. The advance of the Delta coast during the last millennium could by no means hinder the use of the river for sailing northward. Though the number of 5,000 boats moving from the ancient port of Debal (al-Daybul, most probably Bhambor: Pathan 1978, 417) at the time of Sultan Feroz Shah Tughluq invasion of Sindh (1365-1367 AD) (Panhwar 1983, 32) might have been exaggerated by the ancient geographers. According H.G. Raverty, near Thatta the river was so large that from a side of the river "the land around could not be distinguished" and therefore "a great part of the delta south of [Thatta] has been formed since these events happened" (Raverty 1895, 126);
5. The new radiocarbon dates show that a number of mangroves were still flourishing in the mid-Holocene (fig. 10a-c). For still unknown reasons they were no longer exploited after the 5th millennium BP (Lake Siranda) or much later, around the end of 3rd millennium BP at Sonari, or even in historical times (again at Sonari). At the present state of the research it is impossible to define whether this fact can be related to their disappearance because of eco-climatic changes, as it should be in the case of Lake Siranda, or different cultural reasons. The data achieved from fieldwork show that all the palaeo-mangroves so far recorded in Las Bela (Siranda, Gadani, Phuari and Daun), as well as those still flourishing one or two centuries ago at the Hab River mouth (SNR-2, GrA-59834:  $670 \pm 50$  BP) at present have totally disappeared.

## References

- Berger, J.F. et al. (2013). "The Dynamics of Mangrove Ecosystems, Changes in Sea Level and the Strategies of Neolithic Settlements Along the Coast of Oman (6000-3000 cal. BC)". *Journal of Archaeological Science*, 40, 3087-104.
- Biagi, P. (2003-2004). "The Mesolithic Settlement of Sindh: a Preliminary Assessment". *Praehistoria*, 4-5, 195-220.
- Biagi, P. (2004). "New Radiocarbon Dates for the Prehistory of the Arabian Sea Coasts of Lower Sindh and Las Bela in Balochistan". *Rivista di Archeologia*, 28, 5-16.
- Biagi, P. (2010). "Archaeological Surveys in Lower Sindh: Preliminary Results of the 2009 Season". *Journal of Asian Civilizations*, 33(1), 1-42.
- Biagi, P. (2011). "Changing the Prehistory of Sindh and Las Bela Coast: Twenty-Five Years of Italian Contribution" [online]. *World Archaeology*, 43(4), 523-37. DOI 10.1080/00438243.2011.624695.
- Biagi, P. (2013). "The Shell Middens of Las Bela Coast and the Indus Delta (Arabian Sea, Pakistan)" [online]. *Arabian Archaeology and Epigraphy*, 24, 9-14. DOI 10.1111/aae.12013.
- Biagi, P. (2017). "Uneasy Riders: with Alexander and Nearchos from Pattala to Rhambakia". Antonetti, C.; Biagi, P. (eds.), *With Alexander in India and Central Asia: Moving East and Back to West*. Oxford, 255-78.
- Biagi, P.; Fantuzzi, T.; Franco, C. (2012). "The Shell Middens of the Bay of Daun: Environmental Changes and Human Impact Along the Coast of Las Bela (Balochistan, Pakistan) Between the 8th and the 5th Millennium BP". *Eurasian Prehistory*, 9(1-2), 29-49.
- Biagi, P.; Franco, C. (2008). "Ricerche Archeologiche in Balochistan e nel Sindh Meridionale (Pakistan)". Gelichi, S. (a cura di), *Missioni archeologiche e progetti di ricerca e scavo dell'Università Ca' Foscari-Venezia, VI Giornata di Studio*. Roma, 9-18.
- Biagi, P.; Nisbet, R. (2014). "Sonari: a Bronze Age Fisher-Gatherer Settlement at the Hab River Mouth (Sindh, Pakistan)" [online]. *Antiquity Project Gallery* 341, September. URL <http://antiquity.ac.uk/projgall/biagi341> (2017-10-09).
- Biagi, P.; Nisbet, R.; Girod, A. (2013). "The Archaeological Sites of Gadani and Phuari Headlands (Las Bela, Balochistan, Pakistan)". *Journal of Indian Ocean Archaeology*, 9, 75-86.
- Blanford, W.T. (1880). "The Geology of Western Sind". *Memoirs of the Geological Survey of India*, 17, 1-211.

- Boivin, N.; Fuller, D. (2009). "Shell Middens, Ships and Seeds: Exploring Coastal Subsistence, Maritime Trade and the Dispersal of Domesticates in and around the Ancient Arabian Peninsula" [online]. *Journal of World Prehistory*, 22(2), 113-80. URL <https://link.springer.com/article/10.1007%2Fs10963-009-9018-2>.
- Clift, P.D.; Giosan, L. (2014). "Sediment Fluxes and Buffering in the Post-Glacial Indus Basin". *Basin Research*, 26, 369-86.
- Cousens, H. (1998). *The Antiquities of Sind, with Historical Outline*. 3rd ed. Karachi.
- Dales, G.F. (1974). "Excavations at Balakot, Pakistan". *Journal of Field Archaeology*, 1(1-2), 3-22.
- Eggermont, P.H.L. (1975). *Alexander's Campaigns in Sind and Baluchistan and the Siege of the Brahmin Town of Harmatelia*. Leuven. Orientalia Lovaniensia Analecta 3.
- Fairservis, W.A. Jr. (1956). *Excavations in the Quetta Valley, West Pakistan*. Anthropological Papers of the American Museum of Natural History, 45(2). New York.
- Fairservis, W.A. Jr. (1993). "Allahdino: an Excavation of a Small Harappan Site". Possehl, G.L. (ed.), *Harappan Civilization. Second Revised Edition*. New Delhi; Bombay; Calcutta, 107-12.
- Flam, L. (1999). "The Prehistoric Indus River System and the Indus Civilization in Sindh". *Man and Environment*, 24(2), 35-69.
- Giosan, L. et al. (2006). "Recent Morphodynamics of the Indus Delta Shore and Shelf". *Continental Shelf Research*, 26, 1668-84.
- Haigh, M.R. (1894). *The Indus Delta Country, a Memory Chiefly on its Ancient Geography and History*. London.
- Holmes, D.A. (1968). "The Recent History of the Indus". *The Geographical Journal*, 134(3), 367-82.
- Hughes-Buller, R. (1908). *Imperial Gazetteer of India. Provincial Series. Baluchistan*. Calcutta.
- Inam, A. et al. (2007). "The Geographic, Geological and Oceanographic Setting of the Indus River". Gupta, A. (ed.), *Large Rivers: Geomorphology and Management*. London, 333-46.
- Jarrige, J.-F. (2004). "Le Néolithique des frontières indo-iraniennes: Mehrgarh". Guillemin, J. (éd.), *Aux marges des grands foyers du Néolithique. Périphéries débitrices ou créatrices?*. Paris, 29-60.
- Kazi, A.H. (1999). "The Indus River: Water, Power Resources and Environment". Meadows, A.; Meadows, P. (eds.), *The Indus River. Biodiversity, Resources, Humankind*. Karachi, 141-50.
- Khan, A.R. (1979a). "Ancient Settlements in Karachi Region", in *"Studies in Geomorphology and Prehistory of Sind"* ed. by A. Khuhro, special issue, *Grassroots*, 3(2), 1-24.
- Khan, A.R. (1979b). "Geomorphology of the Mango Pir Spur", in *"Studies in Geomorphology and Prehistory of Sind"* ed. by A. Khuhro, special issue, *Grassroots*, 3(2), 35-46.
- Khan, A.R. (1979c). "New Archaeological Sites in Las Bela. A Neolithic Settlement Discovered", in *"Studies in Geomorphology and Prehistory of Sind"* ed. by A. Khuhro, special issue, *Grassroots*, 3(2), 62-78.
- Lambrick, H.T. (1986). *Sind. A General Introduction*. 3rd edition. Hyderabad; Jamshoro. History of Sind Series 1.
- Majumdar, N.C. (1934). *Explorations in Sind. Being a report of the exploratory survey carried out during the years 1927-28, 1929-30 and 1930-31*. 1st reprint. Karachi. Memoirs of the Archaeological Survey of India 48.
- Meadows, P.S.; Meadows, A. (1999). "The Environmental Impact of the River Indus on the Coastal and Offshore Zones of the Arabian Sea and North-West Indian Ocean". Meadows, A.; Meadows, P. (eds.), *The Indus River. Biodiversity, Resources, Humankind*. Karachi, 151-71.
- Méry, S. (1996). "Ceramics and Patterns of Exchange across the Arabian Sea and the Persian Gulf in the Early Bronze Age". *Colloquium XXXII. Trade as a Subsistence Strategy. Post Pleistocene Adaptations in Arabia and Early Maritime Trade in the Indian Ocean = XII International Congress of Prehistoric and Proto-historic Sciences (Forlì)*, 157-79.
- Minchin, C.F. (1907). *Las Bela. Text and Appendices*. Karachi.
- Panhwar, M.H. (1964). *Ground Water in Hyderabad & Khairpur Divisions*. Hyderabad.
- Panhwar, M.H. (1983). *Chronological Dictionary of Sind*. Jamshoro.
- Pathan, M.H. (1978). *Sind Arab Period*. Hyderabad. History of Sind Series 3.
- Petrie, C. et al. (2010). "The Investigations of Early Villages in the Hills and on the Plains of Western South Asia". Petrie, C.A. (ed.), *Sheri Khan Tarakai and Early Village Life in the Borderlands of North-Western Pakistan*. Oxford, 1-28.
- Piggott, S. (1950). *Prehistoric India to 1000 B.C.* Harmondsworth.
- Pithawalla, M.B. (1939). "Settlements in the Lower Indus Basin (Sind). Part I. Showing the Influences of Political, Climatic, Geomorphological, Tectonic and Hydrographical Changes in the Region". *Journal of the Madras Geographical Association*, 13(4), 323-57.

- Rahman, M. (1988). *Agriculture in Pakistan*. Budapest. Geography of World Agriculture 13.
- Ratnagar, S. (2004). *Trading Encounters. From the Euphrates to the Indus in the Bronze Age*. New Delhi.
- Raverty, H.G. (1895). *The Mihran of Sind and its Tributaries: a Geographical and Historical Study*. Calcutta.
- Reimer, P.J. et al. (2013). "IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0-50,000 Years Cal BP". *Radiocarbon*, 55(4), 1869-87.
- Sarwar, G. (1992). "Tectonic Setting of the Bela Ophiolites, Southern Pakistan". *Tectonophysics*, 207(3-4), 359-81.
- Shaffer, J. (1986). "The Archaeology of Baluchistan: a Review". *Newsletter of Baluchistan Studies*, 3, 63-111.
- Snead, R.E. (1966). *Physical Geography Reconnaissance: Las Bela Coastal Plain, West Pakistan*. Baton Rouge. Louisiana State University Studies Coastal Studies Series 13.
- Snead, R.E. (1967). "Recent Morphological Changes along the Coast of West Pakistan". *Annals of the Association of American Geographers*, 57(3), 550-65.
- Snead, R.E. (1969). *Physical Geography Reconnaissance: West Pakistan Coastal Zone*. Albuquerque. University of New Mexico Publications in Geography 1.
- Snead, R.E.; Frishman, S.A. (1968). "Origin of Sands on the East Side of Las Bela Valley, West Pakistan". *Geological Society of America Bulletin*, 79, 1671-7.
- Snedaker, S.C. (1984). "Mangroves: a Summary of Knowledge with Emphasis on Pakistan". Hag, B.U.; Milliman, J.D. (eds.), *Marine Geology and Oceanography of the Arabian Sea and Coastal Pakistan*. New York, 254-62.
- Starnini, E.; Biagi, P. (2011). "The Archaeological Record of the Indus (Harappan) Lithic Production: the Excavation of RH862 Flint Mine and Flint Knapping Workshops on the Rohri Hills (Upper Sindh, Pakistan)". *Journal of Asian Civilizations*, 34(2), 1-61.
- Tremenheere, C.W. (1867). "On the Lower Portion of the River Indus". *Journal of the Royal Geographical Society of London*, 37, 68-91.
- Wilhelmy, H. (1968). "Indus Delta and Rann of Kutch". *Erdkunde*, 23(3), 177-91.
- Zaidi, S.M.S. et al. (1999). "The Landform Inventory and Genesis in the Mulri Hills Area, Karachi East". *Journal Geographic*, 2(1), 39-48.
- Zazzo, A. et al. (2016). "A Revised Radiocarbon Chronology of the Aceramic Shell Midden of Ra's Al-Hamra 6 (Muscat, Sultanate of Oman): Implication For Occupational Sequence, Marine Reservoir Age, and Human Mobility" [online]. *Radiocarbon*, 58(2), 383-95. DOI 10.1017/RDC.2016.3.