Eurasian Prehistory, 9 (1–2): 29–49.

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

Paolo Biagi[1], Tiziano Fantuzzi[2] and Carlo Franco[3]

[1] *Department of Asian and North African Studies, Ca' Foscari University Venice, Ca' Cappello, San Polo 2035, I-30125 Venezia, Italy; pavelius@unive.it*
[2] *Department of Humanities, Ca' Foscari University Venice, Palazzo Malcanton Marcorà, Dorsoduro 3245, I-30123, Venezia, Italy; tiziano.fantuzzi@gmail.com*
[3] *Department of Asian and North African Studies, Ca' Foscari University Venice, Ca' Cappello, San Polo 2035, I-30125 Venezia, Italy. Italy; utinum@gmail.com*

Abstract

The discovery of shell middens around the Bay of Daun and Lake Siranda (Las Bela, Balochistan) shows that groups of prehistoric gatherers settled along the coasts of Las Bela at least since the last two centuries of the 8th millennium BP. The radiocarbon dating of the Daun sites indicates that the exploitation of the mangrove resources was not continuous, but took place mainly during two distinct periods of the 7th and 5th millennia BP. The presence of Neolithic shell middens along the northern coasts of the Arabian Sea reinforces the impression that this part of the Indian Ocean was first settled during the Middle Holocene when the sea level had stabilized. The radiocarbon dates obtained from marine and mangrove shells from the Tharro and Makli Hills in Lower Sindh, suggest that coastal seafaring began already in this period.

Key words: Arabian Sea, Balochistan, Las Bela, shell middens, radiocarbon chronology, mangrove environment, monsoon cycles.

PREFACE

The first shell middens of the coast of Las Bela (Balochistan, Pakistan) were discovered in January 2000 during a visit paid by one of the authors (P.B.), together with Professor A.R. Khan of the Department of Geography, Karachi University, to Daun, a small bay some 15 km south of Gadani promontory. Given the importance of the finds, surveys aimed at the discovery of more middens were promoted by the Italian Archaeological Mission in 2004 and 2008, along the shores of the same bay, and the high marine terrace that extends south of it (Biagi, 2004; 2011a; Biagi and Franco, 2008).

Little is known of the prehistory of Las Bela (Shaffer, 1986). Most of the surveys have been carried out in the regions of the interior (Stein, 1943; Raikes and Dyson, 1961; Khan, 1964; Raikes, 1967–1968; Fairservis, 1975; Khan, 1979b; De Cardi, 1983; Flam, 1998; Franke-Vogt, 1999), while no attention has ever been paid to this part of the north Arabian Sea coast. From this territory A.R. Khan (1979a:5) reports the presence of prehistoric finds near Kunari Nallah, between Gadani and Phuari headlands, whose Perh limestones are rich in flint nodules exploited since at least the beginning of the Mesolithic (Abbas, 1976:7; Khan, 1979a:12; Naseem *et al.*, 1996–1997:129).

During the surveys carried out in the 1970s, Professor A.R. Khan discovered a few prehistoric sites west of the Hab River mouth (Khan, 1979a: map 1); he also pointed out the importance of the Windar River delta (Khan, 1979b:75) and Khur-

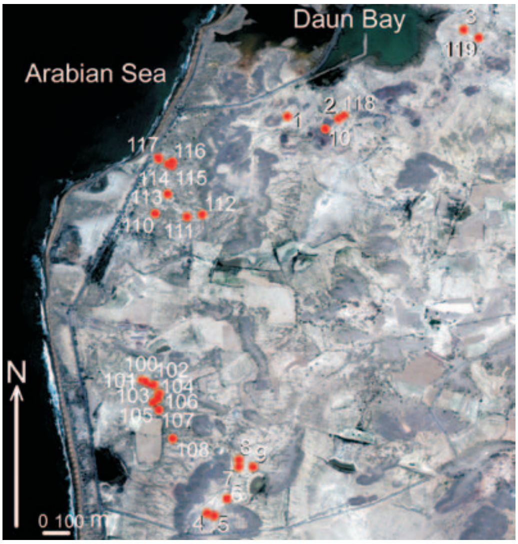

Fig. 1. Daun: distribution map of the shell middens mentioned in the text (from Biagi and Franco, 2008 with modifications)

kera plain, where the Chalcolithic/Bronze Age mound of Kot-Bala (Balakot) is located (Dales, 1974; 1981). Contrary to any expectation prehistoric sites were never discovered during the physical geography reconnaissance of Las Bela coastal zone (Snead, 1969), the only province of Balochistan reached by the summer monsoon rains, rich in water supplies (Pithawalla, 1953:33).

According to the chronicles of the classical authors the coasts of ancient Gedrosia (present-day Makran) were inhabited by fish-eaters in Hellenistic times, and also during the 1st century AD (see for instance Eggermont, 1975:64, referring to Arrian's *Indica*; McCrindle, 1973:195), while the coast of Las Bela was settled by the Oreitai, "*an ethnic group distinguished by strongly primitive traits and culturally similar to the Ichthyophagi*" (Longo, 1987:12). M.U. Hasan (2002:28) reports that fishing hamlets of "*cabins supported by bones of whale*" were still visible along the coast of Makran during the mid-1970s, as they were in the 4th century BC (Hughes-Buller, 1996:36; see also Holdich, 2002:160).

The ethno-archaeological study of Las Bela fishermen (Belcher, 1999; Desse and Desse-Berchet, 2005) has pointed out the importance of fishing in the subsistence of the villagers settled between Gadani promontory and the Hab River mouth (Minchin, 1983:94). The current evidence highly contrasts with the archaeological data, given that traces of prehistoric fishermen settlements along the entire coast of Balochistan are very scarce (Belcher, 2005; Desse *et al.*, 2005), despite the many surveys carried out in the region (Stein, 1931; 1943; Dales, 1982; Besenval and Sanlaville, 1990; Sanlaville *et al.*, 1991; Dales and Lipo, 1992; Besenval and Didier, 2004).

Sonari, a shell midden located at the top of the eastern high terrace of the Hab River close to its flowing into the Arabian Sea, is the only site to have yielded net-sinkers obtained from beach pebbles (Biagi, 2004:fig.6). Quite an opposite situation is known from the Oman Peninsula, where all the Holocene shell middens so far excavated show the importance of fishing in the subsistence strategy of their inhabitants (Uerpmann and Uerpmann, 2003; Cleuziou, 2004; Biagi and Nisbet, 2006; Lézine *et al.*, 2010:12; Charpentier *et al.*, 2012).

GEOGRAPHICAL SETTING

The shell middens of Daun Bay are distributed over a roughly rectangular area between 24°59'18.08"–25°00'27.29" Lat. N. and 66°42' 19.35"–66°43'07.22" Long. E. They lie partly along the sand beach around and south of the bay, some 6m above the maximum level reached by the tide, partly on the top of the Pleistocene marine terrace extending south of a small headland (Snead, 1966:47; 1967; 1969:38; Snead and 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; Biagi and Franco, 2008), although other mangrove and marine species are represented, among which are *Telescopium telescopium* and *Anadara uropygmelana*.

According to their location the sites can be divided in five main groups (Fig. 1):

1) Daun 4, 5, 6, 7, 8 and 9, are located at the top of the marine terrace at an average altitude of some 30 m. (Fig. 2);

2) Daun 100, 101, 102, 103, 104, 105, 106, 107 and 108, north-west of group 1), along the sand beach below the above terrace;

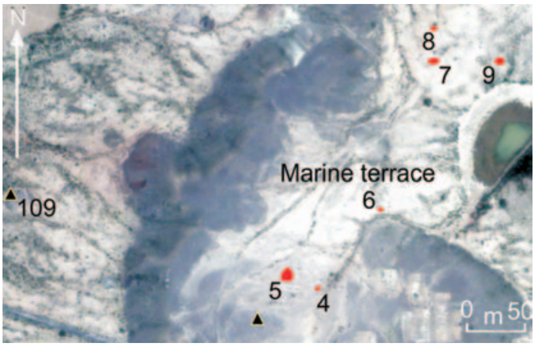

Fig. 2. Daun: distribution map of the shell middens 4–9 on the marine terrace south of the bay. The triangle 109 mark, the point where a quartzite side scarper was found (drawing C. Franco)

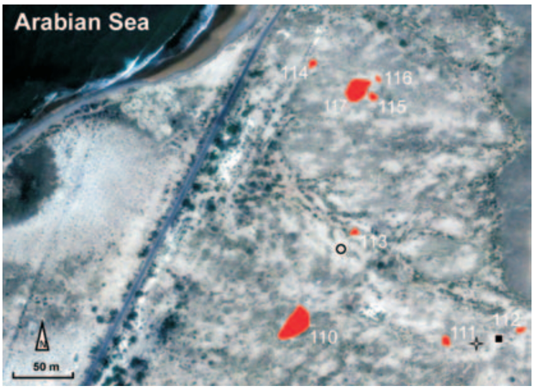

Fig. 3. Daun: distribution map of the shell middens 110–117, along the beach south of the bay: net-sinker (star), quern (circle), core (square) (drawing C. Franco)

3) Daun 110, 111, 112, 113 and, slightly to the north Daun 114, 115, 116 and 117, lie close to the sand shoreline, north-east of the small promontory (Fig. 3);

4) Daun 1, 10, 2 and 118, are located slightly to the north-east, not far from the south-eastern shore of the bay (Fig. 4);

5) Daun 3 and 119, adjacent to each other not far from the eastern shore of the bay (Fig. 5).

The sites and their assemblages

The Daun shell middens are of different shape and dimension. They yielded assemblages consisting almost exclusively of chipped and coarse stone tools (Table 1). Among the 7th millennium BP

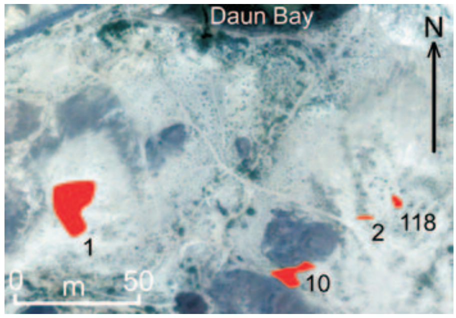

Fig. 4. Daun: location and extension of the shell middens 1, 10, 2 and 118, south of the bay (drawing C. Franco)

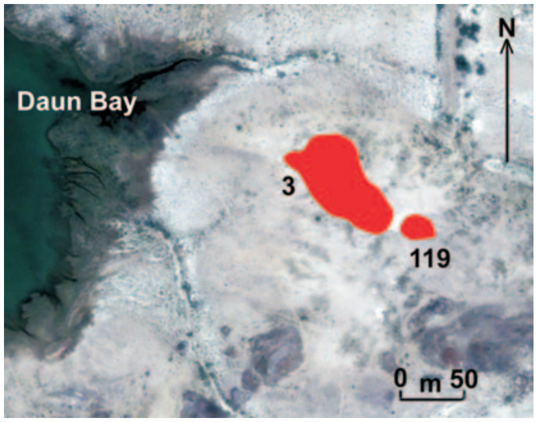

Fig. 5. Daun: location and extension of the shell middens 3 and 119, east of the bay (drawing C. Franco)

sites, Daun 1 is a large midden (Fig. 6) on the surface of which fifty pitted crushing stones with pecked round or oval grooves on one or both surfaces were recorded (Figs 7 and 8). In contrast Daun 10 yielded only one crushing stones and one hammer-stone. The site, well sheltered between volcanic rocky outcrops, consists of scatters of very small fragments of *T. palustris* shells (Fig. 9) on the surface of which many chipped and coarse stone artefacts were collected (Fig. 10).

The chipped stone industries of the 7th millennium BP sites are obtained from flint available from Perh limestone formations that outcrop from Gadani and Phuari headlands, some 15 km north of the bay (Naseem *et al.*, 1996–1997:fig.1). The artefacts have been produced on the spot, as shown by the presence of narrow bladelet cores

Table 1

Daun: main characteristics of the lithic assemblages and other finds

Site number	Lithic materials	Blocks, Pre-cores and Core types	Tool types	Coarse ground tools	Pottery	Cluster
Daun 1	Gadani red flint, chert, limnoquartzite, sandstone	Small blocks; subconical and subcylindrical cores	Trapeze, bladelets, flake(let)s	Crushing stones, hammerstone	Prehistoric	1
Daun 2	None	None	None	None	None	Not dated
Daun 3	Gadani red flint, banded chert	Small block	Flakes, retouched blade	Crushing stone, net-weight	None	4
Daun 4	Gadani red flint	Small block	None	None	Prehistoric	3
Daun 5	None	None	None	Net-weight, tomb, hearths?	Historic?	3
Daun 6	None	None	None	None	None	2
Daun 7	None	None	None	None	Islamic	Not dated
Daun 8	Chert	None	None	Quern	None	3
Daun 9	None	None	None	None	None	Not dated
Daun 10	Gadani red flint, chert, limnoquartzite, sandstone, limestone	Small tested blocks; subcylindrical, prismatic cores	Lunate, side scraper	Crushing stone, hammerstone	None	1
Daun 100	None	None	None	None	None	Not dated
Daun 101	None	None	None	None	None	3
Daun 102	Gadani red flint, chert	None	Flakelets	None	Prehistoric	3
Daun 103	Chert	Micro-core	Truncation on bladelet	None	Prehistoric	3
Daun 104	None	None	None	None	Prehistoric	3
Daun 105	None	None	None	None	None	3
Daun 106	None	None	None	None	None	Not dated
Daun 107	None	None	None	None	None	Not dated
Daun 108	None	None	None	None	None	Not dated
Daun 109	Quartzite	None	Side scraper	None	None	None
Daun 110	Gadani red flint, limnoquartzite, limestone	Small tested block	Flakelets	Crushing stone, hammerstone	None	1
Daun 111	Gadani red flint, chert, limnoquartzite, limestone	Small tested blocks; prismatic core	Flake(let)s	Net-weight	None	1
Daun 112	None	None	None	None	None	3
Daun 113	None	None	None	None	None	3
Daun 114	Gadani red flint	None	Primary flakes	None	None	Not dated
Daun 115	None	None	None	None	None	Not dated
Daun 116	Chert	None	Flakelet	None	None	Not dated
Daun 117	Gadani red flint, chert (striped), quartzite	Prismatic and polyhedric cores	Perforators, flakes	None	None	Not dated
Daun 118	None	None	None	None	None	Not dated
Daun 119	Gadani red flint, chert, limnoquartzite, sandstone, limestone	Tested blocks	Side scraper, blade, flakelets	Crushing stone	None	4

Fig. 6. Daun: shell midden 1 from the north (photograph P. Biagi)

Fig. 7. Daun: group of querns in shell midden 1 (photograph P. Biagi)

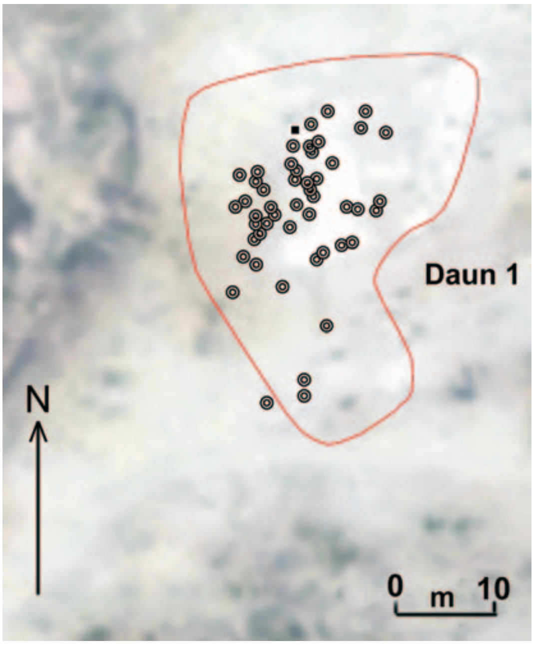

Fig. 8. Daun: shell midden 1: distribution map of crushing stones (circles), and flint core (square) (drawing C. Franco)

with parallel detachments (Fig. 11), most probably obtained by pressure (Inizan, 2012) (Fig. 12: 1, 2), debitage flakes, parallel-sided micro-bladelets (Fig. 12:5–7) and retouched tools (Table 2). Among the latter particularly important are one isosceles trapeze obtained with the microburin technique from Daun 1 (Fig. 12:3), and one lunate, from Daun 10 (Fig. 12:4).

The discovery of geometric microliths raises the problem of the typological variability, function and chronology of these tools. Different classes of isosceles trapezes have been recovered from the Mesolithic sites of the Mulri Hills, east of Karachi (Biagi, 2003–2004), and the Thar Desert dunes of Upper Sindh (Biagi, 2008a:fig.4); while "horned" trapezes, recalling central Asian, Early Neolithic types (Masson, 1996:fig.5; Brunet, 1998; 2012), come from the aceramic Neolithic layers of Mehrgarh (Lechevallier, 2003; Jarrige, 2007–2008; Inizan, 2012). Lunates, which can be subdivided into several classes according to their typology, dimension and retouch, make their appearance in Sindh around the end of the Palaeolithic (Biagi, 2011a) and continued to be in use at least until the Neolithic. Although the

Fig. 9. Daun. shell midden 10 between volcanic outcrops, from the north-west (photograph P. Biagi)

function of the geometric tools from the Daun sites is still undefined, lunates have already been recorded from other 8th and 7th millennium BP shell middens along the Red Sea coast (Bar-Yosef Mayer and Beyin, 2009:114).

The coarse stone tools are represented mainly by crushing stones, which find parallels from many shell middens located along the coast of the Sultanate of Oman, like Saruq and Khor Milkh, for instance, where they are suggested to have been employed for opening *T. palustris* shells (Uerpmann and Uerpmann, 2003:115). Concentrations of crushing stones have been noticed only at Daun 1, where they represent the commonest tools of this important site, suggesting that it acted as a specialised working place for the processing of mangrove shells (Clarke, 2009).

Only a few sites dated to the 5th millennium BP yielded chipped and coarse stone tools (Fig. 13:3, 4), among which is Daun 3 from which comes a retouched blade of exotic chert with use wear traces, from (Biagi, 2004:fig.8).

The evidence for fishing is suggested by one plaquette chipped from limestone from Daun 111 (Fig. 13:1), one isolated net-sinker from a notched

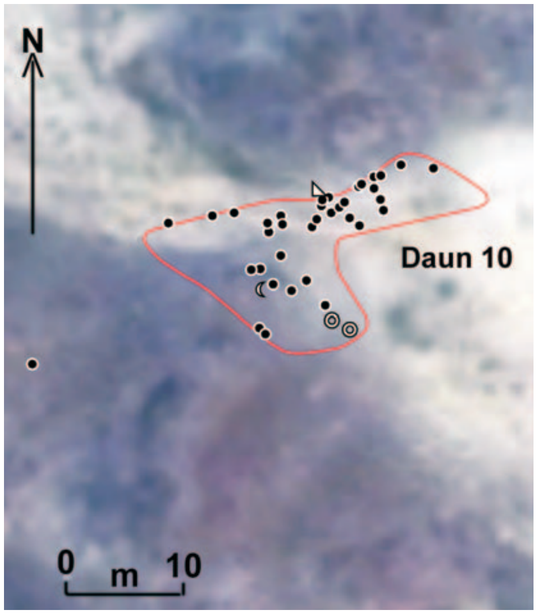

Fig. 10. Daun: shell midden 10: distribution map of chipped stone artefacts (dots), lunate (moon-like symbol), chalcedony fragment (triangle), and coarse ground stones (circles) (drawing C. Franco)

Fig. 11. Daun: shell midden 10. Prismatic microbladelet core on the site's surface (photograph P. Biagi)

Table 2

Daun: main characteristics of the sites and radiocarbon dates

Site number	Coordinates	Measures m.	Extension mq.	Lab. Number	Sample	^{14}C date BP	δ^{13}C (‰)	Cluster	Geo Groups	Cultural Attribution	Reference
Daun 1	25°00'14.34" N, 66°42'39.82" E	121.00	837.00	GrN-26368	*T. palustris*	6380±40	-3.08	1	4	Neolithic	Biagi, 2004: 16
Daun 2	25°00'14.00" N, 66°42'47.00" E	25.30	23.80	Undated	None	None	None	Undated	2	Undefined	
Daun 3	25°00'26.55" N, 66°43'04.67" E	250.00	3560.00	GrN-27954	*T. palustris*	4100±30	-4.49	4	5	Final Indus	Biagi, 2004: 16
Daun 4	24°59'18.07" N, 66°42'29.46" E	14.00	13.60	GrN-28800	Ostreidae	4800±35	-5.30	3	1	Mature Indus	
Daun 5	24°59'18.46" N, 66°42'28.53" E	37.40	104.00	GrN-28801	*T. palustris*	4900±35	-5.44	3	1		
Daun 6	24°59'20,49" N, 66°42'31,38" E	13.20	13.30	GrN-28802	*T. palustris*	5370±35	+1.27	2	1	Amri/Nal	
Daun 7	24°59'25.00" N, 66°42'33.00" E	25.20	46.50	Undated	None	None	None	Undated	1	Undefined	
Daun 8	24°59'25,99" N, 66°42'33,00" E	15.70	19.60	GrN-28803	Mactridae	4540±35	-5.16	3	1	Mature Indus	Biagi, 2004: 16
Daun 9	24°59'25.00" N, 66°42'35.00" E	23.70	44.60	Undated	None	None	None	Undated	1	Undefined	
Daun 10	25°00'12.61" N, 66°42'45.14" E	83.10	254.00	GrN-31489	*T. palustris*	6305±45	-3.97	1	4	Neolithic	Biagi, 2011: Fig. 1
Daun 100	24°59'37.19" N, 66°42'19.35" E	16.60	18.00	Undated	None	None	None	Undated	2	Undefined	
Daun 101	24°59'37.03" N, 66°42'19.86" E	15.70	11.70	GrN-31490	*T. palustris*	4470±30	-5.49	3	2	Mature Indus	Biagi, 2011: Fig. 1
Daun 102	24°59'36.54" N, 66°42'21.03" E	54.70	140.00	GrN-32117	*T. palustris*	4590±35	-5.96	3	2		
Daun 103	24°59'35.37" N, 66°42'21.77" E	27.80	50.60	GrN-31491	*T. palustris*	4435±40	-5.37	3	2		
Daun 104	24°59'35.01" N, 66°42'21.63" E	17.80	16.70	GrN-32118	*T. palustris*	4470±35	-610	3	2		
Daun 105	24°59'34.64" N, 66°42'21.60" E	15.00	15.60	GrN-31643	*T. telescopium*	4470±40	-5.09	3	2		
Daun 106	24°59'34.10" N, 66°42'20.96" E	24.30	30.90	Undated	None	None	None	Undated	2	Undefined	
Daun 107	24°59'33.04" N, 66°42'21.72" E	6.95	3.10	Undated	None	None	None	Undated	2		
Daun 108	24°59'28.97" N, 66°42'23.69" E	12.40	12.20	Undated	None	None	None	Undated	2		
Daun 109	24°59'20.84" N, 66°42'20.52" E	N	N	Undated	None	None	None	Quartzite scraper	N		
Daun 110	25°00'00.66" N, 66°42'21.20" E	87.30	469.00	GrN-31492	*T. palustris*	6690±40	-3.44	1	3	Neolithic	Biagi, 2011: Fig. 1
Daun 111	25°00'00.17" N, 66°42'25.67" E	26.10	49.00	GrN-31493	*T. palustris*	6590±45	-3.57	1	3		
Daun 112	25°00'00.52" N, 66°42'27.87" E	20.80	27.60	GrN-32462	*T. palustris*	4625±30	-4.95	3	3	Mature Indus	
Daun 113	25°00'03.42" N, 66°42'22.96" E	21.40	30.20	GrN-32463	*T. palustris*	4455±30	-5.44	3	3		

Table 2 continued

Site number	Coordinates	Mea-sures m.	Exten-sion mq.	Lab. Number	Sample	^{14}C date BP	δ^{13}C (‰)	Cluster	Geo Groups	Cultural Attribu-tion	Reference
Daun 114	25°00’08.37” N, 66°42’21.72” E	22.00	35.00	Undated	None	None	None	Undated	3	Unde-fined	
Daun 115	25°00’07.40” N, 66°42’23.49” E	23.20	39.90	Undated	None	None	None	Undated	3		
Daun 116	25°00’07.92” N, 66°42’23.66” E	16.30	16.10	Undated	None	None	None	Undated	3		
Daun 117	25°00’07.62” N, 66°42’23.05” E	66.30	307.00	Undated	None	None	None	Undated	3		
Daun 118	25°00’14.40” N, 66°42’47.78” E	26.30	45.40	Undated	None	None	None	Undated	4		
Daun 119	25°00’25.44” N, 66°43’06.72” E	74.80	418.00	GrN-31644	*T. palustris*	4165±25	-4.05	4	5	Final Indus	Biagi, 2011: Fig. 1

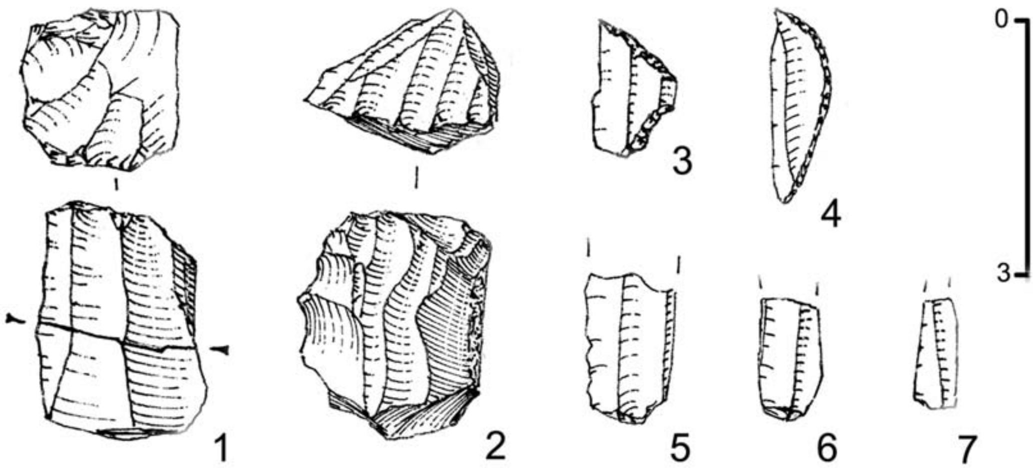

Fig. 12. Daun: chipped stone assemblage. Prismatic bladelet cores (1 and 2), isosceles trapeze (3), lunate (4), narrow microbladelets (5–7). Numbers 1, 3, 6 and 7 from Daun 1; 2, 4 and 5 from Daun 10. 3 and 5 are from Gadani red flint (scale in cm) (drawings P. Biagi, inking G. Almerigogna)

beach pebble, collected some 20 m east of Daun 111 (Fig. 13:2), and two larger net-weights from Daun 3 and 5.

Very small potsherds, mainly prehistoric, were collected from a few sites (see Table 2).

THE RADIOCARBON RESULTS

According to the radiocarbon results, four shell middens developed during the 7th millennium BP. Daun 110 is the oldest site (GrN- 31492: 6690±40 BP), followed by Daun 111, some 100 m to the east (GrN-31493: 6590±45 BP), while Daun 1 and Daun 10, roughly 600 m to the north-west, are slightly more recent (GrN-26368: 6380±40 BP and GrN-31489: 6305±45 BP respectively) (cluster 1). The cluster of Neolithic dates is followed by a gap of some one thousand years, corresponding to the Chalcolithic, during which only Daun 6 was settled (GrN-28802: 5370±35 BP) (cluster 2).

The radiocarbon dates from Daun 5 and Daun 4 (GrN-28801: 4900±35 BP and GrN-28800:

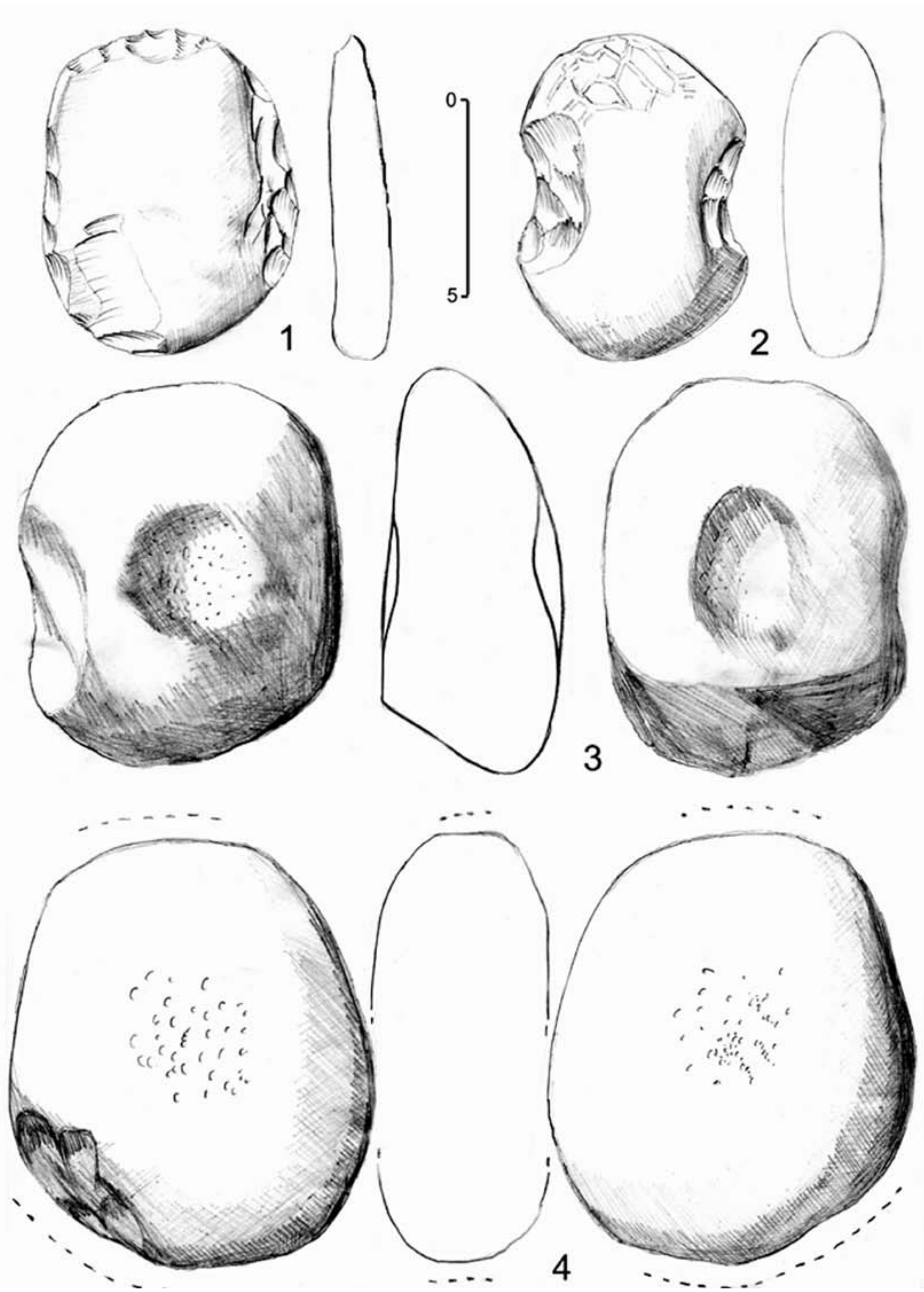

Fig. 13. Daun: coarse stone tools. Retouched limestone plaquette from Daun 111 (1), limestone net-sinker from east of Daun 111 (2), crushing sandstone from Daun 10 (3) and limestone hammerstone from Daun 119 (4) (scale in cm) (drawings E. Starnini)

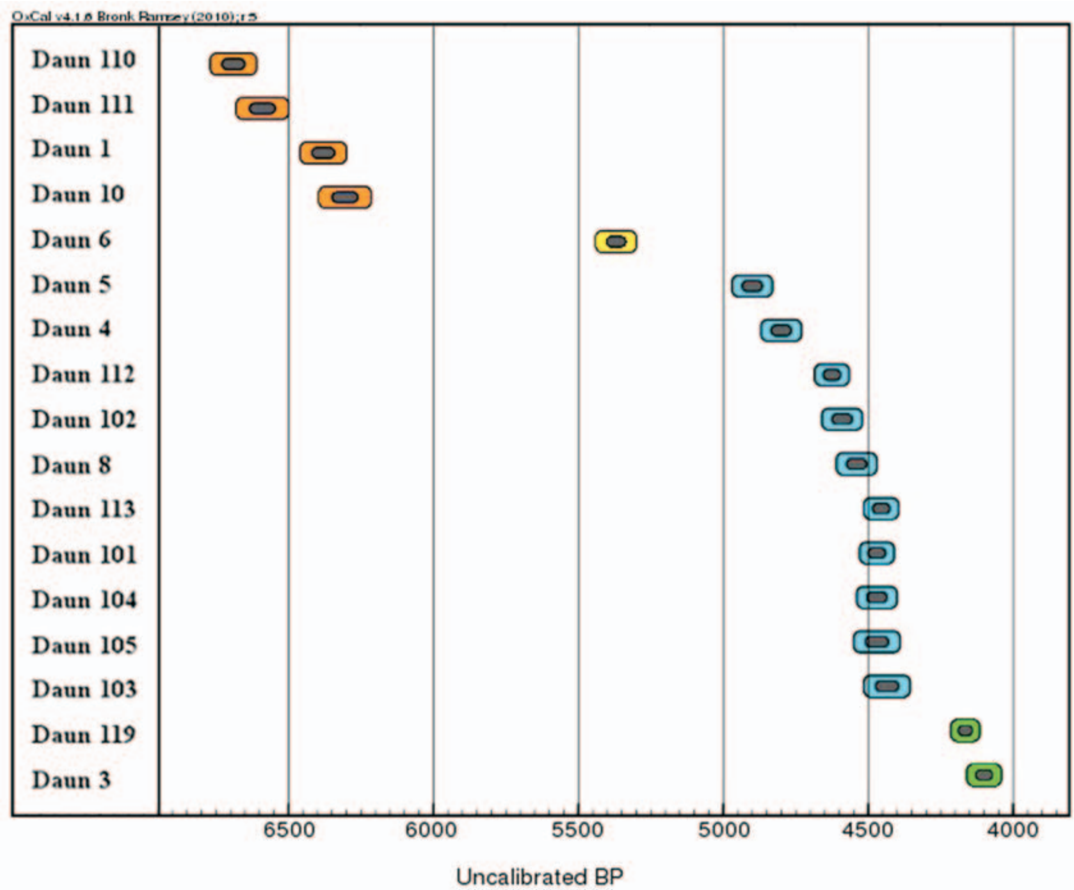

Fig. 14. Daun: scatterplot of the uncalibrated BP dates. The colours indicate the four clusters into which they have been subdivided: 7th millennium (brown), 6th millennium (yellow), mid 5th millennium (blue) and late 5th millennium BP (green) (drawing T. Fantuzzi)

4800±35 BP, respectively) are followed by eight other dates (Daun 112, 102, 8, 113, 101, 104, 105 and 103) all around the middle of the same millennium (cluster 3). Daun 119 and Daun 3 form another small cluster (4) slightly more recent than cluster 3 (GrN-31644: 4165±25 BP and GrN-27945: 4100±30 BP, respectively) (Fig. 14).

Variations in the δ^{13}C values

The δ^{13}C values of the samples show quite a distinctive pattern. Cluster 1 yielded values ranging from –3.44 to –3.97, characteristic of a mangrove environment. Daun 6, with a much higher value (+1.27), should indicate its non-mangrove provenance (cluster 2). The following exploitation episodes (cluster 3) show some depletion in the δ^{13}C values, represented by another "low" peak ranging from –4.95 to –6.10 followed by a slight enrichment at Daun 119 (–4.05) and Daun 3 (–4.49) (cluster 4).

The curve of the above δ^{13}C values is believed to show a well defined climatic and biochemical events. Given that "*carbon isotope ratios of shell carbonates have been considered a good indicator of the isotopic composition of inorganic carbon in seawater*" (Lin *et al.*, 1991: 339), various local and regional alteration processes, among which are changes in precipitation, hydrological regimes and coastline variations, are to be considered. Thus a preliminary interpretation of the events that took place around the bay can be put forward, given that most results (except for Daun 4, 8 and 105) have been obtained from *T. palustris* gastropods that are considered to be reliable climatic indicators:

1) As reported above the four dates of cluster 1 show low δ^{13}C values (average –3.515). If we compare them with the δ^{13}C values from other mangrove swamps (Lin *et al.*, 1991), they suggest that mangroves were already present at Daun around the early-mid 7th millennium BP, when the sea level line was probably slightly higher than that of the present (Lambeck, 1996:55);

2) The higher δ^{13}C value of Daun 6, and the absence of any further 6th millennium archaeological evidence, might suggest that mangroves retreated during the Chalcolithic;

3) The 5th millennium BP assays show a general depletion in δ^{13}C values, which is consistent with a typical mangrove environment. The fact that low values match with the majority of sites shows that mangroves had re-established around Daun Bay in this period, and were exploited by Mature Indus communities. Mid 5th millennium BP dates from marine shells associated with potsherds are reported from Pasni (Makran) by Sanlaville *et al.* (1991:13), suggesting the presence of other Bronze Age sites in the region;

4) The dates from Daun 119 and 3 show that the mangrove swamps retreated again during the late 5th millennium BP. They probably mark an arid episode, recorded also from the northern and eastern Arabian Sea (Sarkar *et al.*, 2000; Staubwasser *et al.*, 2003), and the Thar Desert lakes (Saifuddin and Iqbaluddin, 2000; Kajale *et al.*, 2004:90), corresponding to the decline of the Indus civilization (Madella and Fuller, 2006:1298). Sanlaville *et al.* (1991:13) report similar dates from Pasni in Makran, obtained from marine shells. The absence of other late 5th millennium results suggests that, during this period, mangroves were confined to the eastern part of the bay, where the current morphology favours a prolonged persistence of wetter environments. The fact that the δ^{13}C values of cluster 4 are higher than the average preceding ones might point to another clue in this regard;

Although the above interpretation is disputable due to possible alteration effects in the tested samples, a few more problems are considered to be relevant. They are:

1) The 6th millennium BP peak is represented by only one date. If compared with those of the arid episodes recorded from the Arabian Sea and lake-cores (Von Rad *et al.*, 1999; Ajithprasad, 2004; Staubwasser and Weiss, 2006), we can argue that mangrove swamps effectively retreated during this period;

2) The variability of the δ^{13}C values of the above samples might depend on both specific/individual differences, and local/regional climatic effects among which the most important are:

(a) Dimension, individual age and feeding habits of the samples (Pape *et al.* 2008);

(b) Monsoon cycle-tied climatic variations (Shankar *et al.*, 2002; Loschnigg *et al.*, 2003; Wright *et al.*, 2008), that may significantly alter the δ^{13}C values (Bouillon *et al.*, 2004);

(c) Riverine/precipitation regime (Jain and Tandon, 2003), shoreline (Lambeck, 1996) and specific hydrological changes (Raikes, 1967; Meadows and Meadows, 1999) eventually causing undetectable hard-water effects (Badgley *et al.*, 1972; Banse, 1984);

(d) Environmental conditions, among which are mangrove swamp extensions, influencing, for instance, both organic litter decomposition and light intensity (Snedaker, 1984; Ahmed, 1999);

3) Fourteen of the above seventeen δ^{13}C values are from *T. palustris* gastropods. The results were then compared with typical mangrove and non-mangrove values from different species recovered from other mangrove environments around the world, especially Florida (Lin *et al.*, 1991). This might mask possible inter-specific local and/or regional differences. Regional and seasonal variability might even complicate the problem, as they are difficult to recognize on the basis of the available data.

Calibration problems

The problems related with the calibration of the radiocarbon dates of the prehistoric shell middens of the north-western Arabian Sea have been long debated with contrasting results (Uerpmann, 1990; Biagi, 1994; Uerpmann and Uerpmann, 2003; Saliège *et al.*, 2005). As already pointed out for the Oman sites, the absence of data from the northern coast of the Arabian Sea makes the choice of the appropriate calibration curve of the Daun sites rather problematic for two main reasons:

1) As the δ^{13}C values show, most samples

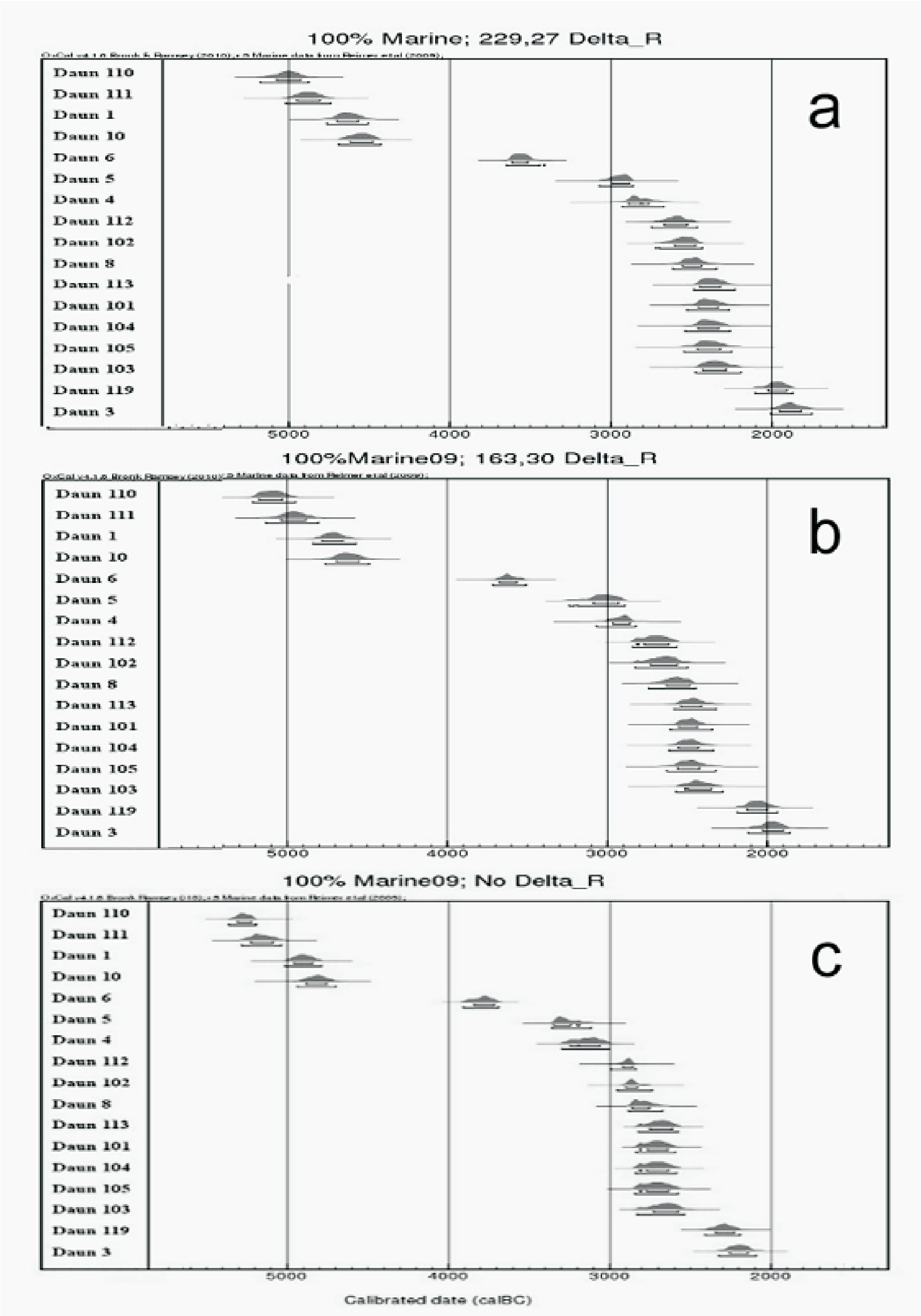

Fig. 15. Daun: chronological distribution of the calibrated BC results according to the three models described in the text (a-c) (drawing T. Fantuzzi)

come from mangrove environments. This cannot exclude possible alteration effects among which are hard-water, freshwater, and organic litter decomposition, as well as other specific/individual difference as, for example, age and feeding habits of the individuals tested (Pape *et al.*, 2008).

2) There is no specific datum such as deep-water upwelling and/or oceanic reservoir effect that may have influenced the Daun sites calibration. The nearest data come from a core 300 km north of port Okha, with a regional mean of 229±27 ^{14}C yrs (Reimer and Reimer, 2001) and from Port Okha itself, with a value of 163±30 ^{14}C yrs (Dutta *et al.*, 2001). They were chosen to construct two of the interpretative models presented in this paper, although fixed and constant values always need to be treated with caution given that both local and decadal (or even inter-year) variations, that have proven to be relevant in modern samples (Dutta *et al.*, 2001), may be unrecognised to some extent.

Following the above considerations, we have preferred to present both the "raw" uncalibrated results (Table 2; Fig. 14), and three different calibration models: 1) the sequence after calibration against the 229±27 reservoir value from the regional mean published by Reimer and Reimer (2001), 2) the 163±30 reservoir effect from Port Okha (Dutta *et al.*, 2001), and 3) the Marine 09 Calibration Curve, without reservoir effect (Fig. 15).

The general distribution of the calibrated dates looks unvaried as expected, although mainly in the diagrams of Fig. 15 a) and b) the shell exploitation peak matches well with the Mature Indus civilization period.

DISCUSSION

The Daun radiocarbon dates suggest that mangrove environments were present around the bay just before the mid 7th millennium BP, and were exploited by the Neolithic inhabitants for shellfish consumption. Their exploitation ceased during the 6th millennium BP, the only exception being that of Daun 6, whose high δ^{13}C value shows a non-mangrove origin. This result allows us to hypothesize that mangrove swamps retreated or disappeared (?) from the area during the Chalcolithic Amri/Nal cultures, reinforcing the impression of a Mid Holocene dry episode already known from other parts of Eurasia (Anderson *et al.*, 2007:8), among which are the Indus-Sarasvati region (Brooks, 2006:38), and the Thar Desert lakes of Rajastan (Deotare *et al.*, 2004:20).

Mangrove swamps spread again during the 5th millennium BP, when a peak in *T. palustris* exploitation is marked by a cluster of dates with depleted δ^{13}C values, typical for mangrove environments. Mangrove swamps retreated again, perhaps during another dry episode, in the late 5^{h} millennium BP, when only two shell middens were settled east of the lagoon, not far from the present-day shoreline.

The suggested cycles of mangrove exhaustion and rejuvenation seem to match well with the monsoon cycles, which show a general weakening around 6000–5500 BP (Morrill *et al.*, 2003). Arid periods have been recorded from a few Rajasthan and Gujarat lake cores, in particular Nal Sarovar, where dryer episodes occurred during the early 7th and the 6th millennia BP, and general arid conditions before the end of the 5th millennium BP (Ajithprasad, 2004). Furthermore global-scaled arid/cooling episodes alternated between 5200 and 4200 BP, and possibly also 6000 BP (Staubwasser and Weiss, 2006). They are intriguing for the different episodes of mangrove exhaustion and rejuvenation at Daun.

The climatic and morphological changes of Las Bela coastal zone can be compared to those that took place along the coast of Oman during the Middle Holocene (Lézine, 2009), where variations in the littoral Arabian Sea environments have been recorded along formerly ancient lagoons rich in mangroves, at present dissected basins, which had been seasonally settled during most favourable periods by different human groups (Charpentier *et al.*, 2000; 2012; Lézine *et al.*, 2002; Martin, 2002, Cleuziou, 2004:134).

As for other parts of the world the systematic radiocarbon dating of mangrove shell samples around the Bay of Daun has shown that, also in this region, shell middens are not exclusively a stone age phenomenon (Andersen, 2007). Shell gathering took place in different periods according to the availability of the mangrove resources, with two distinct picks of exploitation during the Neolithic and the Bronze Age, as part of different cycles of prehistoric subsistence.

CONCLUSION

According to the radiocarbon results, human groups began to settle along the coasts of Daun Bay during the first half of the 7th millennium BP (Fig. 14). Similar dates come from other sites distributed along the shores of the Arabian Peninsula and the Gulf (Biagi, 2008b; Boivin and Fuller, 2009:fig.5; Uerpmann and Uerpmann, 2003:table 2.1), which were settled during the middle Holocene, when the sea-level stabilised along a line some 0.5–3m higher than that of the present (see for instance Gupta, 1972; Sanlaville, 1992; Bernier *et al.*, 1995; Lambeck, 1996).

The research under-way along the coasts of Las Bela and Lower Sindh led to the discovery of a few 8th millennium, and several 7th millennium BP shell middens along the shores of Lake Siranda (Balochistan) (Biagi *et al.*, in press a; in press b), the Tharro and Makli Hills (Lower Sindh) (Biagi, 2010; 2011b). These discoveries raise important questions regarding the mid-Holocene peopling of this part of the Arabian Sea, although we have to consider that "*the distribution of shell mounds is probably a poor indicator of the distribution of coastal population*" (Bailey and Milner, 2002:6), and that people moved across the Gulf (Cleuziou, 2004:136; Carter, 2008) and the Arabian Sea, exploited different environments, and developed specific activities according to the different locations they inhabited, as they still do nowadays (Potts, 1990: 57; Costa, 1991; Lancaster and Lancaster, 1992; Nadjmabadi, 1992).

The most important questions to be answered regard 1) the problems related with the earliest seafaring along the northern shores of the Arabian Sea (Biagi, in press), 2) the changes that took place in the coastal environment during the Holocene, and the Middle Atlantic period in particular (Kennett and Kennett, 2006:76; Bailey *et al.*, 2007:133), and 3) the relationships between coastal shell middens and Neolithic settlements of the interior (Khan, 1979b).

1) A small scatter of Ostreidae along the southern edge of the Tharro Hills (Gujo, Lower Sindh), radiocarbon-dated to 6910±60 BP (THR2: GrN-32119), shows that the "islet" was reached by boat around the beginning of the 7th millennium BP (Biagi, 2010:fig.16). The Makli Hills were settled a few centuries later, as shown by a scatter of *T. palustris* shells (KKT2: GrN- 32464: 6320±45 BP) (Biagi, 2013);

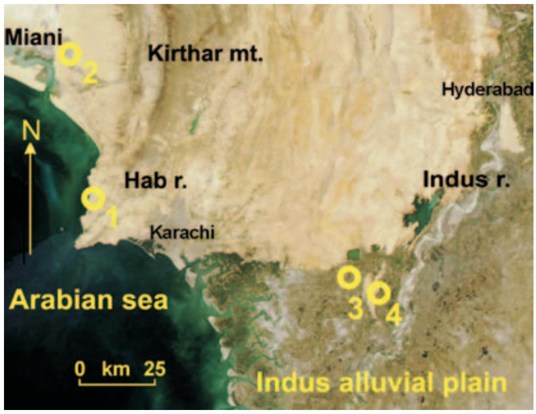

Fig. 16. Distribution map of the radiocarbon-dated 8th and 7th millennium BP shell middens of Las Bela and Lower Sindh: 1) Daun, 2) Lake Siranda, 3) Tharro Hills, 4) Makli Hills (drawing P. Biagi)

2) The above dates show that the Tharro and Makli Hills, at present surrounded by the alluvial plain of the Indus delta (Blandford, 1880:24), were "islands" in the 7th millennium BP. The new dates obtained from shell middens discovered along the shores of Lake Siranda, two of which yielded 8th millennium, and five 7th millennium BP results (van der Plicht pers. comm. 2012; Biagi *et al.*, in press b), help us follow the environmental changes that effected this basin that, according to R.E. Snead (1966:60), was connected to the Sonmiani lagoon "*in the not-too-distant past*";

3) The 7th millennium Daun shell middens show that mangrove (and marine) resources were seasonally exploited by communities of shellfish gatherers moving seasonally between the coast and other landscapes, whose base settlements were located most probably slightly inland (Lézine *et al.*, 2002:229), although so far there is no evidence for Early Neolithic sites in this part of Las Bela and Lower Sindh (Khan, 1979a; 1979b; Shaffer, 1986; Possehl, 1999; Gangal *et al.*, 2010). This fact is most probably due to the absence of any accurate surveys aimed at the recovery of settlements of this period (Khan, 1979c:58). The unknown chronology of the Early Neolithic sites of Balochistan (Fairservis, 1956), and the uncertain radiocarbon seriation of Neolithic Mehrgarh (Jarrige *et al.*, 1995:555; 2007–2008), have been

recently criticised (Petrie *et al.*, 2010). Nevertheless the absolute dates obtained from the bottom of the pollen column sampled from this latter site shows that Neolithic Mehrgarh started to be settled at the beginning of the 8th millennium BP as shown by a conventional date of 7928±126 uncal BP (R-2290: Costantini, 2007–2008:171). The inhabitants of Mehrgarh undoubtedly entertained relationships with the northern coasts of the Arabian Sea since the beginning of the Neolithic, as indicated by the great quantity of marine shell ornaments in the aceramic Neolithic graves goods (Ray, 2003:33; Jarrige, 2004:48). In this respect it is important to point out that the new radiocarbon results from Lake Siranda show that the shores of this ancient lagoon were already settled during the last two centuries of the 8th millennium BP (Fig. 16), remarking the complexity of the oceanic and terrestrial movements that shaped the geomorphology of the region since the beginning of the Holocene (Bailey and Parkington, 1988).

At Daun, the almost absence of 6th millennium shell middens contrasts with the high number of 5th millennium BP stations, suggesting that climatic and environmental changes affected the peopling of this part of the coast of Las Bela during the above periods. These data point out the importance of the freshwater resources and monsoon precipitations for the communities that temporarily settled in the area to exploit the rich mangrove environments available along the shores of the bay (Ewel *et al.*, 1998) during periods of increasing productivity of the oceanic coastal microenvironments (Erlandson and Fitzpatrick, 2006).

Acknowledgments

Research at Las Bela has been made possible thanks to the financial support of the Italian Ministry of Foreign Affairs (MAE, Rome), EURAL Gnutti (Rovato, Brescia), and Ca' Foscari University archaeology funds.

The authors are very grateful to Professor A.H. Bouk (Department of Computer Science, Balochistan University, Quetta), for his company, help and support during the 2008 fieldwork season. Special thanks are due to Professor A.R. Khan (Department of Geography, Karachi University) without whose advise the Daun sites would have never been discovered, and Dr. M. Spataro (British Museum, UK) who took part in the 2000 and 2004 exploratory visits, and Professor P.J. Reimer (Queen's University, Belfast) for the useful discussions on isotopic fractionation.

REFERENCES

ABBAS S.G. 1976. Use of Landsat imagery in the study of ophiolites of Lasbela and Khuzdar districts of Baluchistan, Pakistan. In: R.W. Fary Jr. (ed.) *Cento Workshop on Applications of Remote Sensing Data and Methods*. NASA Center for AeroSpace Information, Islamabad, 1–7.

AHMED M. 1999. Animal and Plant Communities in the Present and Former Indus Delta. In: A. Meadows, P.A. Meadows (eds.) *The Indus River Biodiversity ? Resources ? Humankind*. Linnean Society of London. Oxford University Press, Karachi, 12–30.

AJITHPRASAD P. 2004. Holocene Adaptations of the Mesolithic and Chalcolithic Settlements in North Gujarat, Western India. In: Y. Yasuda, S. Vasant (eds.) *Monsoon and Civilization*. Lustre Press, Singapore, 115–132.

ANDERSEN S.H. 2007. Shell middens *("Køkkenmøddinger")* in Danish Prehistory as a reflection of the marine environment. In: N. Milner, O.E. Craig, G.N. Bailey (eds.) *Shell Middens in Atlantic Europe*. Oxbow Books, Oxford, 31–45.

ANDERSON D.G., MAASCH K.A., SANDWEISS D.H., MAYEWSKI P.A. 2007. Climatic and culture change: exploring Holocene transitions. In: D.G. Anderson, K.A. Maasch, D.H. Sandweiss (eds.) *Climate Change and Cultural Dynamics: A Global Perspective On Mid-Holocene Transitions*. Academic Press, Amsterdam-Boston, 1–20.

BADGLEY F.I., PAULSON C.A., MIYAKE M. 1972. *Profiles of Wind, Temperature and Humidity over the Arabian Sea*. International Indian Ocean Expedition Meteorological Monograph Number 6. East-West Center Press, Honolulu.

BAILEY G., FLEMMING N.C., KING G.C.P., LAMBECK K., MOMBER G., MORAN L.J., AL-SHAREK A., VITA-FINZI C. 2007. Landscape and Human Evolution: The Red Sea Basin and the Farasan Islands. *Journal of Island and Coastal Archaeology* 2 (2), 127–160.

BAILEY G., MILNER N. 2002. Coastal hunter-gatherers and social evolution: marginal or central?. *Before farming. The Archaeology of Old World Hunter-Gatherers* 3/4(1), 1–15.

BAILEY G., PARKINGTON J. 1988. The archaeology of prehistoric coastlines: an introduction. In: G. Bailey, J. Parkington (eds.) *The archaeology of prehistoric coastlines*. New Directions in Archaeology. Cambridge University Press, Cambridge, 1–10.

BANSE K. 1984. Overview of the Hydrography and Associated Biological Phenomena in the Arabian Sea, off Pakistan. In: B.U. Haq, J.D. Milliman (eds.) *Marine Geology and Oceanography of Arabian Sea* *and Coastal Pakistan*. Van Nostrand Reinhold Company, New York-Cincinnati-Stroudsburg-Toronto-London-Melbourne, 271–303.

BAR-YOSEF MAYER D.E., BEYIN E. 2009. Late Stone Age Shell Middens on the Red SeaCoast of Eritrea. *Journal of Island and Coastal Archaeology* 4, 108–124.

BELCHER W.R. 1999. The Ethnoarchaeology of Fishing in a Baluch Village. In: H.P. Ray (ed.) *Archaeology of Seafaring. The Indian Ocean in the Ancient Period*. Indian Council of Historical Research Monograph Series 1. Pragati Publications, Delhi, 22–50.

BELCHER W.R. 2005. Marine Exploitation in the Third Millennium BC – the eastern coast of Pakistan. *Paléorient* 31(1), 79–85.

BERNIER P., DALONGEVILLE R., DEPUIS B., DE MEDWECKI V. 1995. Holocene shoreline variation in the Persian Gulf: Example of the Umm al-Qowayn Lagoon (UAE). *Quaternary International* 29/30, 95–103.

BESENVAL R., DIDIER A. 2004. Peuplement protohistorique du Kech-Makran au 3^{e} millénaire av. J.C.: l'assemblage céramique de la période IIIc sur le site de Miri Qalat. *Paléorient* 30(2), 159–178.

BESENVAL R., SANLAVILLE P. 1990. Cartography of Ancient Settlements in Central Southern Pakistani Makran: New Data. *Mesopotamia* XXV, 79–146.

BIAGI P. 1994. A radiocarbon chronology for the aceramic shell-middens of coastal Oman. *Arabian Archaeology and Epigraphy* 5, 17–31.

BIAGI P. 2003–2004. The Mesolithic Settlement of Sindh (Pakistan): 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. 2008a. New Discoveries of Mesolithic Sites in the Thar Desert (Upper Sindh, Pakistan). In: E. Olijdam, R.H. Spoor (eds.) *Intercultural Relations between South and Southwest Asia. Studies in Commemoration of E.C.L. During Caspers (1934–1996)*. BAR International Series 1826, Oxford, 78–85.

BIAGI P. 2008b. The shell-middens of the Arabian Sea and the Gulf: Maritime connections in the seventh millennium BP? In: A.R. Al-Ansary, K.I. Al-Muaikel, M. Alsharek (eds*.) The City in the Arab World In Light of Archaeological Discoveries: Evolution and Development*. Abdul Rahman Al-Sudaity Foundation, Riyadh, 7–16.

BIAGI P. 2010. Archaeological surveys in Lower Sindh: Preliminary results of the 2009 season *Journal of Asian Civilizations* 33(1), 1–42.

BIAGI P. 2011a. Late (Upper) Palaeolithic Sites at Jhimpir in Lower Sindh (Pakistan). In: H. Taşkiran, M. Kartal, K. Özcelik, M.B. Kösem, G. Kartal (eds.) *Işin Yalçinkaya'ya Armagan*. Ankara University, Ankara, 67–84.

BIAGI P. 2011b. Changing the prehistory of Sindh and Las Bela coast: twenty-five years of Italian contribution. *World Archaeology* 43(4), 523–537.

BIAGI P. 2013 (in press). The shell middens of Las Bela coast and the Indus delta (Arabian Sea, Pakistan). *Arabian Archaeology and Epigraphy* 24.

BIAGI P., FRANCO C. 2008. Ricerche Archeologiche in Balochistan e nel Sindh Meridionale (Pakistan). In: S. Gelichi (ed.) *Missioni archeologiche e progetti di ricerca e scavo dell'Università Ca' Foscari – Venezia*, *VI Giornata di Studio*. G. Bretschneider, Rome, 9–18.

BIAGI P., GIROD A., NISBET R. (in press a). Prehistoric shell middens, seascapes and landscapes at Lake Siranda (Las Bela, Balochistan): A review. In: A. Tripathi (ed.) *Recent Researches in Archaeology, Art, History and Culture of Northeast India (Professor J.B. Bhattacharjee Felicitation Volume)*. Department of History, Assam University.

BIAGI P., GIROD A., NISBET R. (in press b). The shell middens of Lake Siranda (Las Bela, Balochistan). *Antiquity Gallery*.

BIAGI P., NISBET R. 2006. The prehistoric fisher-gatherers of the western coast of the Arabian Sea: a case of seasonal sedentarisation? *World Archaeology* 38(2), 220–238.

BLANDFORD W.T. 1880. *The Geology of Western Sind*. Memoirs of the Geological Survey of India XVII, Calcutta, 1–120.

BOIVIN N., FULLER D. 2009. Shell Middens, Ships and Seeds: Exploring Coastal Subsistence, Maritime Trade and Dispersal of Domesticates in and around the Ancient Arabian Peninsula. *Journal of World Prehistory* 22, 113–180.

BOUILLON S., KOEDAM N., BAEYENS W., SATYANARAYANA B., DEHAIRS F. 2004. Selectivity of subtidal benthic invertebrate communities for local microalgal production in an estuarine mangrove ecosystem during the post-monsoon period. *Journal of Sea Research* 51, 133–144.

BROOKS N. 2006. Cultural responses to aridity in the Middle Holocene and increased social complexity. *Quaternary International* 151, 29–49.

BRUNET F. 1998. La Néolithisation en Asie Centrale: un état de la question. *Paléorient* 24(2), 27–48.

BRUNET F. 2012. The technique of Pressure Knapping in Central Asia: Innovation or Diffusion? In: P.M. Desrosiers (ed.) *The Emergence of Pressure Blade Making from Origin to Modern Experimentation*. Springer, New York-Dordrecht-Heidelberg-London, 307–328.

CARTER R. 2008. Excavations and Ubaid-Period Boat Remains at H3, As-Sabiyah (Kuwait). In: E. Olijdam, R.H. Spoor (eds.) *Intercultural Relations between South and Southwest Asia. Studies in commemoration of E.C.L. During Caspers (1034–1996)*. BAR International Series 1826, Oxford, 92–102.

CHARPENTIER V., ANGELUCCI D.E., MÉRY S., SALIÈGE J.F. 2000. Autour de la Mangrove Morte de Suwayh. L'habitat VIe-Ve millénaire de Suwayh SWY-11, Sultanat d'Oman. *Proceedings of the Seminar for Arabian Studies* 30, 69–85.

CHARPENTIER V., BERGER J.-F., CRASSARD R., LACAZE M., DAVTIAN G. 2012. Prehistory and palaeo-geography of the coastal fringes of the Wahiba Sands nd Bar al-Hikman, Sultanate of Oman. *Proceedings of the Seminar for Arabian Studies* 42, 57–78.

CLARKE A. 2009. Craft Specialisation in the Mesolithic of Northern Britain: the evidence from the coarse stone tools. In: N. Finlay, S. McCartan, N. Milner, C. Wickham-Jones (eds.) *From Bann Flakes to Bushmills papers in honour of Professor Peter Woodman.* Prehistoric Society Research Paper No. 1. Oxbow Books, Oxford, 12–21.

CLEUZIOU S. 2004. Pourquoi si tard? Nous avons pris un autre chemin. L'Arabie des chasseurs-cuilleurs de l'Holocène au début de l'Age du Bronze. In: J. Guilaine (ed.) *Aux marges de grands foyers du Néolithique. Périphéries débitrices ou créatrices?*. Errance, Paris, 123–148.

COSTA P.M. 1991. *Musandam Architecture and Material Culture of a Little Known Region of Oman*. IMMEL Publishing, London.

COSTANTINI L. 2007–2008. The First Farmers in Western Pakistan: The Evidence of the Neolithic Agro-pastoral Settlement of Mehrgarh. *Prâgdhârâ* 18, 167–178.

DALES G.F. 1974. Excavations at Balakot, Pakistan, 1973. *Journal of Field Archaeology* 1, 3–22.

DALES G.F. 1981. Reflections on five years of Excavations at Balakot. In: A.H. Dani (ed.) *Indus Civilisaion New Perspectives*. Quaid-I-Azam University, Islamabad, 25–32.

DALES G.F. 1982. Adaptation and Exploration at Harappan Coastal Settlements. In: S. Pastner, L. Flam (eds.) *Anthropology in Pakistan: Recent Socio-Cultural and Archaeological Perspectives*. Indus Publications, Karachi, 154–165.

DALES G.F., LIPO C.P. 1992. *Explorations on the Makran Coast, Pakistan. A Search for Paradise*. Contributions of the Archaeological Research Facility University of California at Berkeley 50. Berkeley.

DE CARDI B. 1983. *Archaeological Surveys in Baluchistan, 1948 and 1957*. Institute of Archaeology Occasional Publication No. 8. London.

DEOTARE B.C., KAJALE M.D., RAJAGURU S.N., BASAVAIAH N. 2004. Late Quaternary geomorphology, palynology and magnetic susceptibility of Playas in western margins of the Indian Thar Desert. *Journal of the Indian Geophysical Union* 8(1), 15–25.

DESSE J., DESSE-BERSET N. 2005. Les Ichthyophages du Makran (Bélouchistan, Pakistan). *Paléorient* 31(1), 86–96.

DESSE J., DESSE-BERSET N., SALIÈGE J-F. 2005. Datation de la bioapatite de restes osseux d'origine marine: Application à des sites du Makran (Pakistan). *Paléorient* 31(1), 70–73.

DUTTA K., BHUSHAN R., SOMAYAJULU B.L.K. 2001. ΔR Correction Values for the Northern Indian Ocean. *Radiocarbon* 43(2A), 483–488.

EGGERMONT P.H.L. 1975. *Alexander's Campaigns in Sind and Baluchistan and the Siege of the Brahmin Town of Harmatelia*. Orientalia Lovaniensia Analecta 3. Leuven University Press, Leuven.

ERLANDSON J.M., FITZPATRICK S.M. 2006. Oceans, Islands and Coasts: Current Perspectives on the Role of the Sea in Human Prehistory. *Journal of Island and Coastal Archaeology* 1, 5–32.

EWELL K.C., TWILLEY, R.R., EONG ONG, J. 1998. Different kind of mangrove forests provide different goods and services. *Global Ecology and Biogeography Letters* 7, 83–94.

FAIRSERVIS W.A. JR. 1956. *Excavations in the Quetta Valley, West Pakistan*. Archaeological Papers of the American Museum of Natural History 45(2), 199–402.

FAIRSERVIS W.A. JR. 1975. *The Roots of Ancient India.* The University of Chicago Press, Chicago and London (2nd edition).

FIELD H. 1959. *An Anthropological Reconnaissance in West Pakistan, 1955. With Appendixes on the Archaeology and Natural History of Baluchistan and Bahawalpur*. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University, LII. Cambridge, Massachusetts.

FLAM L. 1998. The Other Side of the Mountains Explorations in the Kirthar Mountains Regionn of Western Sindh, Pakistan. In: C.S. Phillips, D.T. Potts, S. Searight (eds.) *Abiel II New Research in the Arabian Peninsula. Arabia and its Neighbours Essays on prehistorical and historical developments*. Brepols, Brussels, 315–326.

FRANKE-VOGT U. 1999. *A Survey of Archaeological Sites in Sind Kohistan and the Greater Hab Valley. Report on a Survey carried out between January 6th and 18th and March 4th to 11th, 1999, for LASMO Oil Pakistan Lmt*. Institute of Near Eastern Archaeology, Berlin.

GANGAL K., VAHIA M.N., ADHIKARI R. 2010.

Spatio-temporal analysis of the Indus urbanization. *Current Science* 28(6), 846–852.

GOULD R.A. 1980. *Living Archaeology*. New Studies in Archaeology. Cambridge University Press, Cambridge.

GUPTA S.K. 1972. Chronology of the Raised Beaches and Inland Coast Reefs of the Saurashtra Coast. *Journal of Geology* 80, 357–361

HASAN M.U. 2002. *Baluchistan A Retrospect*. Royal Book Company, Karachi.

HOLDICH T. 2002. *The Gates of India being an historical narrative*. Asian Educational Service, New Delhi-Madras (1st reprint).

HUGHES-BULLER R. 1996. *Baluchistán District Gazettere Series. Vol VII. Makrán. Text and Appendices*. Indus Publications, Karachi (1st reprint).

INIZAN M.-L. 2012. Pressure Débitage in the Old World: Forerunners, Researchers, Geolopitics – Handing on the Baton. In: P.M. Desrosiers (ed.) *The Emergence of Pressure Blade Making from Origin to Modern Experimentation*. Springer, New York-Dordrecht-Heidelberg-London, 11–42.

KAJALE M.D., DEOTARE B.C., RAJAGURU S.H.. 2004. Palaeomonsoons and Palaeoclimatic Background to the Prehistoric Cultures of the Western and Central Thar Desert, Rajastan, Northwestern India. In: Y. Yasuda, S. Vasant (eds.) *Monsoon and Civilization*. Lustre Press, Singapore, 83–98.

KENNETT D.J., KENNETT P.K. 2006. Early State Formation in Southern Mesopotamia: Sea Levels, Shorelines, and Climatic Change. *Journal of Island and Coastal Archaeology* 1, 67–99.

KHAN F.A. 1964. Las Bela and S.W. Sind Expedition: 1959-60. *Pakistan Archaeology* I, 32–34.

KHAN A.R. 1979a. Ancient Settlements in Karachi Region. In: A.R. Khan (ed.) *Studies in Geomorphology and Prehistory of Sind. Grassroots Special Issue* III(2). University of Sind, Jamshoro, 1–24.

KHAN A.R. 1979b. New Archaeological Sites in Las Bela – A Neolithic Settlement Discovered. In: A.R. Khan (ed.) *Studies in Geomorphology and Prehistory of Sind. Grassroots Special Issue* III(2). University of Sind, Jamshoro, 62–79.

KHAN A.R. 1979c. River Piracy and Diversion in Karachi Basin. In: A.R. Khan (ed.) *Studies in Geomorphology and Prehistory of Sind. Grassroots Special Issue* III(2). University of Sind, Jamshoro, 47–61.

JAIN M., TANDON S.K. 2003. Fluvial response to Late Quaternary climate changes, western India. *Quaternary Science Review* 22, 2223–2235.

JARRIGE, C., JARRIGE J.-F., MEADOW R.H., QUINVRON G. (eds.) 1995. *Mehrgarh Field Reports 1974–1985 – From Neolithic Times to the Indus Civilization*. Department of Culture and Tourism, Government of Sindh, Karachi.

JARRIGE J.-F. 2004. Le Néolithique des frontières indo-iraniennes: Mehrgarh. In: J. Guilaine (ed.) *Aux marges de grands foyers du Néolithique. Périphéries débitrices ou créatrices?*. Errance, Paris, 29– 60.

JARRIGE J.-F. 2007–2008. Mehrgarh Neolithic. *Prâgdhârâ* 18, 135–154.

LAMBECK K. 1996. Shoreline reconstructions of the Persian Gulf since the last glacial maximum. *Earth and Planetary Science Letters* 142, 43–57.

LANCASTER W., LANCASTER F. 1992. Tribe, Community and the Conncept of Access to Resources: Territorial Behaviour in South-East Ja'alan. In: M.J. Casimir, A. Rao (eds.) *Mobility and Territoriality. Social and Spacial Boundaries among Foragers, Fishers, Pastoralists and peripatetics*. Berg, New York, Oxford, 343–363.

LECHEVALLIER M. 2003. *L'industrie lithique de Mehrgarh fouilles 1974–1985*. Éditions Recherche sur les Civilisations, Paris.

LÉZINE A.-M. 2009. Timing of vegetation changes at the end of the Holocene Humid Period in desert areas at the northern edge of the Atlantic and Indian monsoon systems. *Geoscience* 341, 740–749.

LÉZINE A.-M., SALIÈGE J.-F., MATHIEU R., TAGLIATELA T.L., MÉRY S., CHARPENTIER V., CLEUZIOU S. 2002. Mangroves of Oman during the Late Holocene: climatic implications and impact of human settlements. *Vegetetional History and Archaeobotany* 11, 221–232.

LÉZINE A.-M., ROBERT C., CLEUZIOU S., INIZAN M.-L., BRAEMER F., SALIÈGE J.-F., SYLVESTRE F., TIERCELIN J.-J., CRASSARD R., MÉRY S., CHARPENTIER V., STEIMER-HERBET T. 2010. Climate change and human occupation in the Southern Arabian lowlands during the last deglaciation and the Holocene. *Global and Planetary Change* 72(4), 412–428.

LIN G., BANKS T., STERNBERG L. 1991. Variation in δ^{13} C values for the seagrass *Thalassia Testudinum* and its relation to mangrove carbon. *Aquatic Botany* 40, 333–341.

LONGO O. 1987. A Trip Among the Fish Eaters. *Newsletter of Baluchistan Studies* 4, 11–18.

LOSCHNIGG J., MEELH G.A., WEBSTER P.J., ARBLASTER J.M., COMPO G.P. 2003. The Asian Monsoon, the Tropospheric Biennial Oscillation, and the Indian Ocean Zonal Mode in the NCAR CSM. *Journal of Climate* 16(11), 1617–1642.

MADELLA M., FULLER D.Q. 2006. Palaeoecology and the Harappan Civilisation in South Asia: a reconsideration. *Quaternary Science Review* 25, 1283–1301.

MARTIN C. 2002.The shell material from Suway I (Oman, Neolithic). In: Bar-Yosef Mayer E. (ed.)

Archaeomalacology Molluscs in former environments of human behaviour. Proceedings of the 9th ICAZ Conference. Oxbow Books, Oxford, 166–173.

MASSON V.M. 1996. The Cultural Zones and \Variations of the Late Chipped Stone Industries in Central Asia. In: S.K. Kozłowski, H.G.K. Gebel (eds.) *Neolithic Chipped Stone Industries of the Fertile Crescents, and Their Contemporaries in Adjacent Regions*. Studies in Early Near Eastern Production, Subsistence, and Environment 3. Ex Oriente, Berlin, 91–103.

MCCRINDLE J.W. 1973. *The Commerce and Navigation of the Erythrćan Sea; being a Translation of the Periplus Maris Erythrći by an Anonymous Writer and partly from Arrian's Account of the Voyage of Nearkhos*. Philo Press, Amsterdam (1st reprint).

MEADOWS P.A., MEADOWS A. 1999. The Environmental Impact of the River Indus on the Coastal and Offshore Zones of the Arabian Sea and the NorthwestIndian Ocean. In: A. Meadows, P.A. Meadows (eds.) *The Indus River Biodiversity ? Resources ? Humankind*. Linnean Society of London. Oxford University Press, Karachi, 151–171.

MINCHIN C.F. 1983. *Las Bela. Text and Appendices*. Indus Publications, Karachi (1st reprint).

MORRILL C., OVERPECK J.T., COLE J.E. 2003. A synthesis of abrupt changes in the last Asian summer monsoon since the last deglaciation. *The Holocene* 13(4), 465–476.

NADJMABADI S. 1992. 'The Sea Belongs to God, the Land Belongs to us': Resource Management in a Multi-resource Community in the Persian Gulf. In: M.J. Casimir, A. Rao (eds.) *Mobility and Territoriality. Social and Spacial Boundaries among Foragers, Fishers, Pastoralists and peripatetics*. Berg, New York, Oxford, 329–342.

NASEEM S., SHEIKH S.A., QADEERUDDIN M. 1996–1997. Geochemistry and Tectonic Setting of Gadani-Phuari Segment of Bela Ophiolithes, Balochistan, Pakistan. *Journal of Karachi University, Earth Sciences* 9, 127–144.

PAPE E., MUTHUMBI A., KAMANU C.P., VANREUSEL A. 2008. Size-dependent distribution and feeding habits of *Terebralia Palustris* in mangrove habitats of Gazi Bay, Kenya. E*stuarine, Coastal and Shelf Science* 76, 797–808.

PETRIE C.A., KHAN F., KNOX R., THOMAS K., MORRIS J. 2010. The investigation of early villages in the hills and on the plains of western South Asia. In: C.A. Petrie (ed.) *Sheri Khan Tarakai and early village life in the borderlands of north-west Pakistan*. Oxbow Books, Oxford and Oakville, 7–28.

PITHAWALLA M.B. 1953. *The Problem of Baluchistan*. Ministry of Economic Affairs. Government of Pakistan Press, Karachi.

POSSEHL G.L. 1999. Prehistoric Population and Settlement in Sindh. In: A. Meadows, P.A. Meadows (eds.) *The Indus River Biodiversity – Resources – Humankind*. Linnean Society of London. Oxford University Press, Karachi, 393–408.

POTTS D.T. 1990. *The Arabian Gulf in Antiquity. Volume I From Prehistory to the Fall of the Achaemenid Period*. Clarendon Press, Oxford.

RAIKES R.L. 1967. *Water, Weather and Prehistory*. Humanities Press, New Jersey.

RAIKES R.L. 1967–1968. Archaeological explorations in southern Jhalawan, and Las Bela (Pakistan). *Origini* 2, 103–171.

RAIKES R.L., DYSON R.H. 1961. The Prehistoric Climate of Baluchistan and the Indus Valley. *American Anthropologist* 63, 265–281.

RAY H.P. 2003. *The Archaeology of Seafaring in Ancient South Asia*. Cambridge University Press, Cambridge.

REIMER P.J., REIMER R.W. 2001. A Marine reservoir correction database and on-line interface. *Radiocarbon* 43(2A), 461–463.

SAIFUDDIN, IQBALUDDIN. 2000. Quaternary signatures of paleo-humidity in arid zone, Rajastan, India. *Journal of Arid Environment* 45, 151–158.

SALIÈGE J.-F., LÉZINE A.-M., CLEUZIOU S. 2005. Estimation de l'effet réservoir ^{14}C marin en mer d'Arabie. *Paléorient* 31(1), 64–69.

SANLAVILLE, P. 1992. Changements climatiques dans la Péninsule Arabique durant le Pléistocène supérieur et l'Holocène. *Paléorient* 18(1), 5–26.

SANLAVILLE P., BESENVAL R., EVIN J., PRIEUR A. 1991. Évolution de la region littorale du Makran Pakistanais à l'Holocène. *Paléorient* 17(1), 3–18.

SARKAR A., RAMESH R., SOMAYAJULU B.L.K., AGNIHOTRI R., JULL A.J.T., BURR G.S. 2000. High resolution Holocene monsoon record from the eastern Arabian Sea. *Earth and Planetary Science Letters* 177, 209–218.

SHAFFER J.G. 1986. The Archaeology of Baluchistan: A Review. *Newsletter of Baluchistan Studies* 3, 48–62.

SHANKAR D., VINAYACHANDRAN P.N., UNNIKRISHNAN A.S. 2002. The monsoon currents in the north Indian Ocean. *Progress in Oceanography* 52, 63–120.

SNEAD R.E. 1966. *Physical Geography Reconnaissance: Las Bela Coastal Plain, West Pakistan*. Louisiana State University Studies 13. Louisiana State University Press, Baton Rouge.

SNEAD R.E. 1967. Recent Morphological Changes along the Coast of West Pakistan. *Annals of the Association of American Geographers* 57(3), 550– 565.

SNEAD R.E. 1969. *Physical Geography Reconnaissance: West Pakistan Coastal Zone*. University of New Mexico Publications in Geography 1. Department of Geography, University of New Mexico, Albuquerque.

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, 1671–1677.

SNEDAKER S.C. 1984. Mangroves: A Summary of Knowledge with Emphasis on Pakistan. In: B.U. Haq, J.D. Milliman (eds.) *Marine Geology and Oceanography of Arabian Sea and Coastal Pakistan*. Van Nostrand Reinhold Company, New York-Cincinnati-Stroudsburg-Toronto-London- Melbourne, 255–262.

STAUBWASSER M., SIROCKO F., GOOTES P.M., SEGL M. 2003. Climate change at the 4.2 ka BP termination of the Indus valley civilization and the Holocene south Asian monsoon variability. *Geophysical Research Letters* 30(8), 1425–1428. doi:10.1029/GLO16822.

STAUBWASSER M., WEISS H. 2006. Holocene climatic and cultural evolution in late prehistoric-early historic West Asia. *Quaternary Research* 66(3), 372–387.

STEIN A. 1931. *An Archaeological Tour to Gedrosia*. Cosmo, Delhi.

STEIN A. 1943. On Alexander's Route into Gedrosia: An Archaeological Tour in Las Bela. *The Geographical Journal* CII(5-6), 193–227.

UERPMANN H.-P. 1990. Radiocarbon dating of shell middens in the Sultanate of Oman. In: W.G. Mook and H.T. Waterbolk (eds.) *Proceedings of the second international symposium 14C and Archaeology, Groningen 1987, PACT* 29, Council of Europe, Groningen, 335–347.

UERPMANN H.-P., UERPMANN M. 2003. *Stone Age Sites and their Natural Environment. The Capital Area of Northern Oman. Part III*. Beihefte zum Tübinger Atlas des Vorderen Orients. Reihe A (Naturwissenschatfen) Nr. 31/3. Dr. Ludwig Reichert, Wiesbaden.

VON RAD U., SCHAFF M., MICKELS K.H., SCHULZ H., BERGER W.H., SIROCKO F. 1999. A 5000-yr record of old climate change in varved sediments from the oxygen minimum zone off Pakistan, northeastern Arabian Sea. *Quaternary Research* 51, 39–53.

WRIGHT R., BRYSON R.A., SCHULDENREIN J. 2008. Water supply and history: Harappa and the Beas regional survey. *Antiquity* 82, 37–48.