Holocene peopling and sea-level changes along the northern coast of the Arabian Sea (Pakistan)

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Research Article

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Abstract

Surveys carried out in the provinces of Las Bela and Lower Sindh (Pakistan) have led to the discovery of many sites with knapped stone artefacts associated with mangrove and sea shells. The most important group has been discovered along the ancient shores of Lake Siranda (Balochistan) and on the terraces that rise from the Indus Plain in Lower Sindh. Fifty-five radiocarbon dates from the Siranda Lake sites have shown that the lagoon was settled between the last two centuries of the 8th and the end of the 5th millennium uncal BP. This chronology finds confirmation in Lower Sindh. Since the beginning of the Holocene, the coastal zone has been affected by dramatic events among which are sea-level rise, tectonic activity, and the advance of the Indus Delta. The present landscape began to shape around the end of the Bronze Age, when arid climatic conditions established and the Indus Civilisation declined.

1. Introduction

Since almost two centuries shell middens have played a very important role in the study of prehistory (Worsaae 1849; Gräslund 1987; Andersen 2000) and the coastal peopling during the Holocene sea-level rise (Bailey et al. 2013; Szabó 2017; Biagi 2020; Robson et al. 2022). In the last fifty years, shell midden studies have dramatically improved in some Arabian countries, Oman and the United Arab Emirates in particular (Durante and Tosi 1977; Biagi 1994; Uerpmann, and Uerpmann 2003; Beech 2004; Zazzo et el. 2016; Marcucci et al. 2021). The new results help us to define the ways and modes the coastal peopling of the Arabian Peninsula took place from the beginning of the Holocene to historic periods (Berger et al. 2005, 2013; Béguier and Marcucci 2018). It is well known that "*mangroves constitute a specialized and major component of a coastal ecosystem*" (Kumaran et al. 2005, 418) whose highly dynamic occurrence in a tropical environment is due to the coincidence of several natural factors (Selvam 2003).

Until the 2000s, one of the regions of the Indian Ocean that was still lacking information of the presence of shell middens was the northern coast of the Arabian Sea. Here, concentrations of marine shells had been discovered and radiocarbon dated in a few territories of the Makran, in Pakistani Balochistan (Sanlaville et al. 1991) and Gujarat (Gupta 1972).

During the last twenty-five years, the present author has conducted several surveys along the coasts of Las Bela (Balochistan) and Sindh (Pakistan) (Biagi 2011a). The scope of the surveys was to discover new sites, date them (Biagi 2004; Biagi et al. 2018a), frame them into the wider perspective of the prehistoric peopling of the coastal zone (Biagi 2023), study them in relation to the Holocene sea-level rise, and compare the results with those available from other neighbouring countries facing the Arabian Sea, Oman in particular. It is well known that this coast has been subjected to impressive changes since the end of the Pleistocene (Snead 1993, 366), some of which are closely related to the advance of the Indus Delta (Wilhelmy 1968; Flam 1993; Giosan et al. 2006; Day et al. 2021; Biagi 2023).

According to ancient Greek and Roman chroniclers (Schoff 1974; McCrindle 2000), this part of the Arabian Sea coast was settled by communities of fish eaters (*Ichthyophagoi*) in classical times. They

were described for the first time by the geographers who followed Alexander the Great during his retreat from India to Gedrosia in 325 BC (Hamilton 1972; Romm 2010; Biagi 2017). Apart from the description of their physical aspect, way of life, settlement landscape, habitation structures, and the mangal environment they exploited (Eggermont 1975, 97; Arrian 1983; Hasan 2002), we knew almost nothing of the ancestors of these communities of fishers until the 1970s: where, why, when and how they began to settle along the coasts of Makran, Las Bela and Lower Sindh? We know that the *Ichthyophagoi* of the classical authors lived "*in stifling cabins made of fish bones*" (Hasan 2002, 28) and that fishing is still nowadays the most important economic activity practised along the coast of Las Bela (Siddiqi 1956).

If we exclude the results yielded by the surveys made around Karachi during the 1970s (Khan 1979), and a few others carried out in Las Bela in the 1960s (Snead 1966; Snead and Frishman 1968), our knowledge of the archaeology of the territory was badly known until the beginning of the 2000s (Boivin et al. 2009; Mutin and Garazhian 2021; Mutin 2022), when new archaeological surveys were promoted (Fig. 1). Their scope was to investigate the coastal strip that extends between Lake Siranda, in the west (Biagi et al. 2018a), and the province of Thatta in Lower Sindh, in the east.

2. Material and Methods

2.1. Las Bela (Balochistan)

The fieldwork was conducted by 2–3 persons, walking ca. 6 hours per day for two 2 weeks each season, recording and mapping all the surface finds by a Garmin-GPS device, photographing all sites and concentrations of artefacts and associated shells on the spot. Shell samples for radiocarbon dating were systematically collected whenever available. One adult *T. palustris* mangrove shell fragment was sampled for dating, though other mangrove (*T. telescopium*) or marine species were also collected in the case of absence of *T. palustris* fragments (Table 1).

The scope of the surveys carried out between 2011 and 2014 along the ancient shores of the Siranda Lake was to check the presence of mangrove shells along the eastern side of the *sabkha* depression which had been reported in the 1960s (Snead 1966, Fig. 15) (Fig. 1, n. 1). The research led to the discovery of 76 sites among which are shell middens and concentrations of knapped stone artefacts often found in association with shells (Biagi and Nisbet 2023). Lake Siranda is located in the southernmost part of the Las Bela Valley, in south-eastern Pakistani Balochistan (Fig. 2). It is oriented in a north-south direction. Its western and southern sides are delimited by mobile sand dunes (Snead 1966, 48) which separate it from the Sonmiāni Lagoon (Miāni Hōr), which is at present surrounded by mangroves, and the Arabian Sea (Naeem et al. 2020).

During the winter and summer monsoon seasons, the depression is fed by sparse rains (Minchin 1907, 18) and the Watto River which flows from the north (Snead 1966, Fig. 13). According to a report written around the beginning of the last century, "*when full ..... is 9 miles long and 2 miles broad*" (Minchin 1907, 9). So far, 45 Siranda sites have been radiocarbon dated at Groningen University Radiocarbon Laboratory

(CIO) mainly by *T. palustris* or *T. telescopium* mangrove shells, 1 *by Anadara rhombea*, 1 by *Scylla serrata* mangrove crab claw, and 6 by fish otoliths (Table 1).

Most of the Siranda shell middens consist of thin deposits of decoloured fragments of *T. telescopium*, *T. palustris* and other shell species. The only exceptions are SRN-28 and SRN-29, which are located along the south-eastern shore of the lake. SRN-28 is a thin, almost circular midden ca 30 m in diameter, which is surrounded by at least 13 heaps of mangrove shells, 2 to 3 m in diameter each (Fig. 3). Most probably it was settled in different periods of the Neolithic: This is confirmed by two radiocarbon dates (SRN-28.10: GrA-62260, 6500 ± 40 uncal BP, and SRN-28: GrA-55819, 5440 ± 40 uncal BP both on *T. palustris*: see Table 1). SRN-29 is an impressive shell mound surrounded by several smaller shell middens and shell heaps scattered over a very wide area (Fig. 4) from which Neolithic knapped artefacts and one copper vessel have been retrieved (SRN-29Sud: GrM-18731, 7130 ± 35 uncal BP, SRN-29: GrA-54299, 6595 ± 35 uncal BP, and SRN-29.1: GrM-18729, 3272 ± 24 uncal BP, all on *T. palustris*: see Table 1). None of the Siranda middens has either been excavated or has shown evidence of habitation structures, graves, human and animal bones, hearths or charcoals. Two Neolithic (SRN-19 and 29), four Chalcolithic and one Bronze Age sites have yielded ceramic potsherds.

The percentage and state of fragmentation of the mangrove shells varies site by site, although *T. telescopium* is always prevailing (Haque and Choudhury 2015; Raw et al. 2017). Other common species are *Anadara rhombea* and *Thais*. Three characteristic net weights, obtained from bilaterally notched beach pebbles, have been recorded from the Neolithic shell middens SRN-62, 64 and 73. They suggest that the Siranda Neolithic communities practised some type of small scale fishing.

The radiocarbon results and the techno-typological characteristics of the knapped stone artefacts suggest that the oldest shell middens were settled during the Neolithic, between the last two centuries of the 8th and the entire 7th millennium uncal BP (Fig. 2). The lithic assemblages of this period are represented by microlithic bladelet artefacts obtained almost exclusively from dark reddish-brown Ras Gadani chert, whose sources outcrop ca. 50 km south of the lake (Sarwar 1992; Naseem et al. 1996–1997). The tools consist of prismatic and subconical microlithic cores with one prepared platform from which parallel-sided microbladelets have been detached, microlithic isosceles trapezes, micro-drills, retouched and unretouched microbladelets (Biagi and Nisbet 2023).

The 6th millennium uncal BP Chalcolithic sites have yielded knapped stone artefacts made from Gadani and other varieties of black and whitish chert. Although the location of these sources is currently unknown, we can exclude that they exploited any of the well-known Sindhi sources (Biagi et al. 2018a). At present we know that limestone formations and conglomerate deposits containing knappable cherts do exist in Balochistan (Aubry et al. 1988), although the provenance of our Chalcolithic artefacts cannot be established with certainty.

Most of the Chalcolithic bladelets were detached by pressure to obtain blanks with straight, parallel sides and trapezoidal or triangular cross-section. The tools are represented by semi-abrupt retouched bladelets and truncation and one lunate (Biagi and Nisbet 2023). These artefacts can be compared with those of

the Amri phase that flourished in Sindh during this period (Casal 1964; Biagi 2005), and the Chalcolithic layers of Mehrgarh in Balochistan (Lechevallier 2003; Biagi 2022).

Along the Las Bela coast, other groups of shell middens have been discovered and radiocarbon dated at Ras Gadani and Ras Phuari (Biagi et al. 2013b) (Fig. 1, n. 2), and along the small Bay of Daun (Biagi 2011a; Biagi et al. 2013a) (Fig. 1, n. 3). The available data suggest that this part of the northern coast of the Arabian Sea (Hughes 1877, 136) was unpopulated until the last centuries of the 8th millennium uncal BP, as has been suggested for the entire coast of the Arabian Peninsula (Preston and Parker 2013).

Moving farther south, the Bronze Age site of Sonari is the only fishers-gatherers settlement known along the northern coast of the Arabian Sea. The site is located in a well-sheltered saddle that opens at the top of the limestone terrace facing the Hub River mouth at Ras Muari (or Cape Monze, Sindh) (Fig. 1, n. 4). It consists of a few small, rectangular stone structures oriented in an east-west and north-south direction whose floor is covered with hundreds of fragments of *Meretrix* bivalves. The presence of several net sinkers made from beach pebbles, marine and mangrove shells, shows that fishing and shells gathering were the most important subsistence activities practised by the inhabitants of the site, which has been radiocarbon dated to the 5th millennium uncal BP by mangrove and marine shells (Biagi et al. 2021b).

2.2. Lower Sindh and the Indus Delta

Lower Sindh is one of the provinces of Pakistan whose careful investigation can lead to great improvements in our knowledge of the archaeology of the Indian Subcontinent. The complexity of the Sindhi landscape has been stressed by several authors (Haigh 1894; Pithawalla 1936; Lambrick 1964, Khan 1979; Flam 1993). A seminal volume on the geology of the region has been written by W.T. Blanford (1880) who reported the presence of "*rocky outcrops*" raising from the Indus alluvium all of which have shown traces of prehistoric settling (Biagi 2023).

Professor A.R. Khan surveyed part of the territory in the 1970s. He was the first to report the discovery of marine shells "*60 miles inland and at a high of more than 1,100 feet*" (Khan 1979, 18). Many concentrations of knapped stone artefacts, mangrove and marine shells have been discovered and radiocarbon dated in the region during the last two decades (Biagi et al. 2018a, 2021c).

Investigations have been extended to the confluence of the Mol and the Khadeji Rivers, ca. 30 km north of the present coastline (Fig. 1, n. 12), where concentrations of knapped stone artefacts have been found in association with a few marine and mangrove shells (Biagi et al. 2021a). One fragment of a large marine bivalve from the Khadeji Valley site KDJ-1 has been radiocarbon dated to 8275 ± 45 uncal BP (GrA-63862) (Biagi 2019–2020). The result shows that groups of Holocene hunter-gatherers were active in the territory during the second half of the 9th millennium uncal BP, that they exploited the Arabian Sea coastal environment, and moved towards the interior following the terraces of the most important watercourses, the Malir River, in our case (Khan 1979, 18).

T. telescopium Chalcolithic shell middens have been discovered in the Makli Hills and Shah Hussain, south of Thatta (Biagi et al. 2018b; Biagi 2023) (Fig. 1, nn. 9 and 10). However, the only settlement of this

period with evidence of intensive exploitation of marine resources is Tharro Hill near Gujo (Majumdar 1934, 20) (Fig. 1, n. 8). The site has been attributed to the Chalcolithic Amri phase (Shaffer 1992) due to the recovery of characteristic painted potsherds with geometric motifs, typical knapped stone artefacts, and two radiocarbon dates obtained from marine and mangrove shells (Biagi 2022). A small concentration of Oyster shells discovered along the southern edge of the Tharro terrace has been radiocarbon dated to 6910 ± 60 uncal BP (GrN-32119). Neolithic mangrove shell fragments have been collected and dated from the Mulri Hills (Fig. 1, n. 5), in the eastern suburbs of Karachi, Rehri (Fig. 1, n. 6), a village facing the Gharo Creek, and the limestone terraces around the village of Gharo (Biagi et al. 2021c) (Fig. 1, n. 7).

Sindh is punctuated by many shallow salt basins, called "*dhandhs*", which show "*evidence of the former sea communicating the interior..... After a huge inundation of the area, they lose their aloofness from one another and are joined together for the time being. Later on, when the flood waters subside, they regain their individuality and aridity and grow in salinity*" (Pithawalla 1936, 310–311). Their archaeological importance has been implemented by the discovery of concentrations of microlithic knapped stone artefacts along the western banks of the Kheenjar Lake (Fig. 1, n. 14) near Jhimpir (Biagi 2011b), and west of the Haleji Lake (Fig. 1, n. 13).

In December 2022, surveys were conducted along and around two low hills located ca 1000–1500 m west of the Haleji freshwater reservoir (Khan et al. 2012). Before the 1930s, Haleji was a *dhandh*, a "*fine sheet of water, also fed by hill torrents, but its size is chiefly regulated by the amount of rainfall*" (Hughes 1876, 291). The surveys led to the discovery of many concentrations of knapped stone artefacts often associated with Oyster shells and, in one case, *T. telescopium* fragments. So far only three Haleji sites have been radiocarbon dated (Fig. 5). The results show that the concentrations with microlithic stone tools and Oyster shells (Fig. 6) discovered on the top of the terrace were settled during the last centuries of the 8th millennium (HLJ-41: GrM-32748, 7215 ± 27 and HLJ-67: GrM-32749, 7237 ± 26 uncal BP), while that with *T. telescopium* mangrove shell fragments discovered at the north-easternmost foot of the same terrace, belongs to the last centuries of the 7th millennium (HLJ-22: GrM-32746, 6254 ± 24 uncal BP) (Fig. 7).

3. Discussion

More than 150 radiocarbon dates have been obtained from artefacts and shells concentrations discovered along the coasts of Las Bela and Lower Sindh. The results have contributed to the study of the Holocene coastal changes, chronology and location of the ancient mangrove ecosystems and their related archaeological sites, period during which the present arid conditions established and the Bronze Age Indus Civilization began to fractionate and decline (Staubwasser et al. 2003; Ivory and Lézine 2009; Giosan et al. 2012). This happened roughly around 4000 uncal BP when the number of mangrove ecosystems started to decrease and their distribution reached more or less that of the present (Kumaran et al. 2005, 429). Furthermore, the discovery of Neolithic sites has contributed to the definition of a period of which almost nothing was known until the 2000s (Possehl 2002, 32; Kenoyer 2015, 18), the earliest

sea movements along the northern coast of the Arabian Sea, and the first peopling of its related islands (Biagi 2023).

The new Haleji radiocarbon results suggest that during the last centuries of the 8th millennium uncal BP important changes took place along the coast of Lower Sindh. This happened during a humid phase with increased monsoon precipitations (Sirocko et al. 1993), sediment transport (Li and Clift 2023) and the consequent advance of the Indus Delta (Syvitski et al. 2014). During the same period, we assist to a flourishing of mangrove ecosystems and, most probably, their first systematic exploitation by prehistoric communities.

The distribution of the shell middens discovered along the eastern shore of Lake Siranda (Fig. 2) can be compared with that of the Ja'alan coast in Oman. The Neolithic shell middens discovered in this region are distributed slightly in the interior of the present coastline, close to ancient mangrove swamps which flourished during a period of humidity and freshwater supply undoubtedly higher than that of the present (Berger et al. 2013, Fig. 13).

The radiocarbon dating of shell sites has been crucial also for the definition of the exploitation of the coastal zone during the Chalcolithic Amri phase, a period of which too little is known. It is becoming clear that the coastal zone of Sindh and its neighbouring islands, Tharro Hill for example (Majumdar 1934), played a very important role in the strategic and economic system of this period. In contrast, the available evidence shows the almost absence of Bronze Age sites all along the coastal area. This fact is even more evident regarding the Early Bronze Age Kot Diji phase, whose distribution is important for the interpretation of the origin and spread of the Mature Indus Civilisation. What are the relationships between the three aspects reported above? This is far from being clear and our knowledge has not improved very much during the last decades (Biagi and Starnini 2021).

In conclusion, we have to stress the contribution that surveys and systematic radiocarbon dating of the coastal sites have given to the prehistory of Las Bela and Lower Sindh compared to what we knew just two decades ago regarding the periods preceding the Mature Indus phase (Possehl 2002, Table 2.2).

Our present view is based on data which favour robust hypotheses on settlement chronology and location variability through the ages, in relation to the distribution and exploitation of mangrove ecosystems, and establishment of the present coastline, throughout millennia that saw the development of impressive environmental changes, early sea movements and island settling, decreasing number of mangal ecosystems and the continuous advance of the Indus Delta.

Declarations

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Tables

Table 1 is available in the Supplementary Files section.

Figures

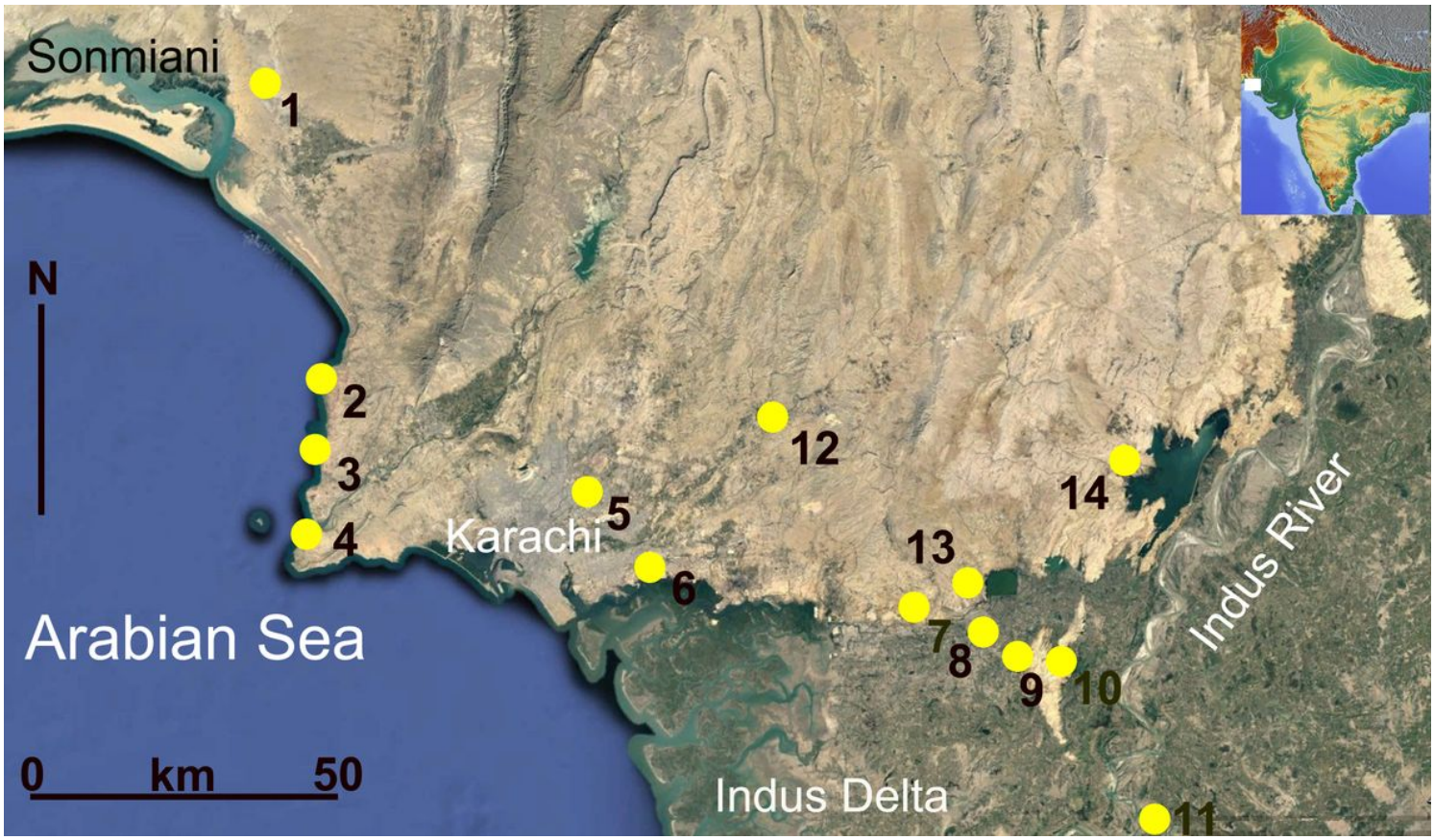

Figure 1

Distribution map of the sites mentioned in the text: Lake Siranda (n. 1), Ras Gadani and Ras Phuari (n. 2), Bay of Daun (n. 3), Sonari (n. 4), Mulri Hills (n. 5), Rehri (n. 6), Gharo (n. 7), Tharro Hill (n. 8), Shah Hussain (n. 9), Makli Hills (n. 10), Aban Shah (n. 11), Mol and Khadeji (n. 12), Haleji (n. 13), Jhimpir (n. 14) (drawing by P. Biagi).

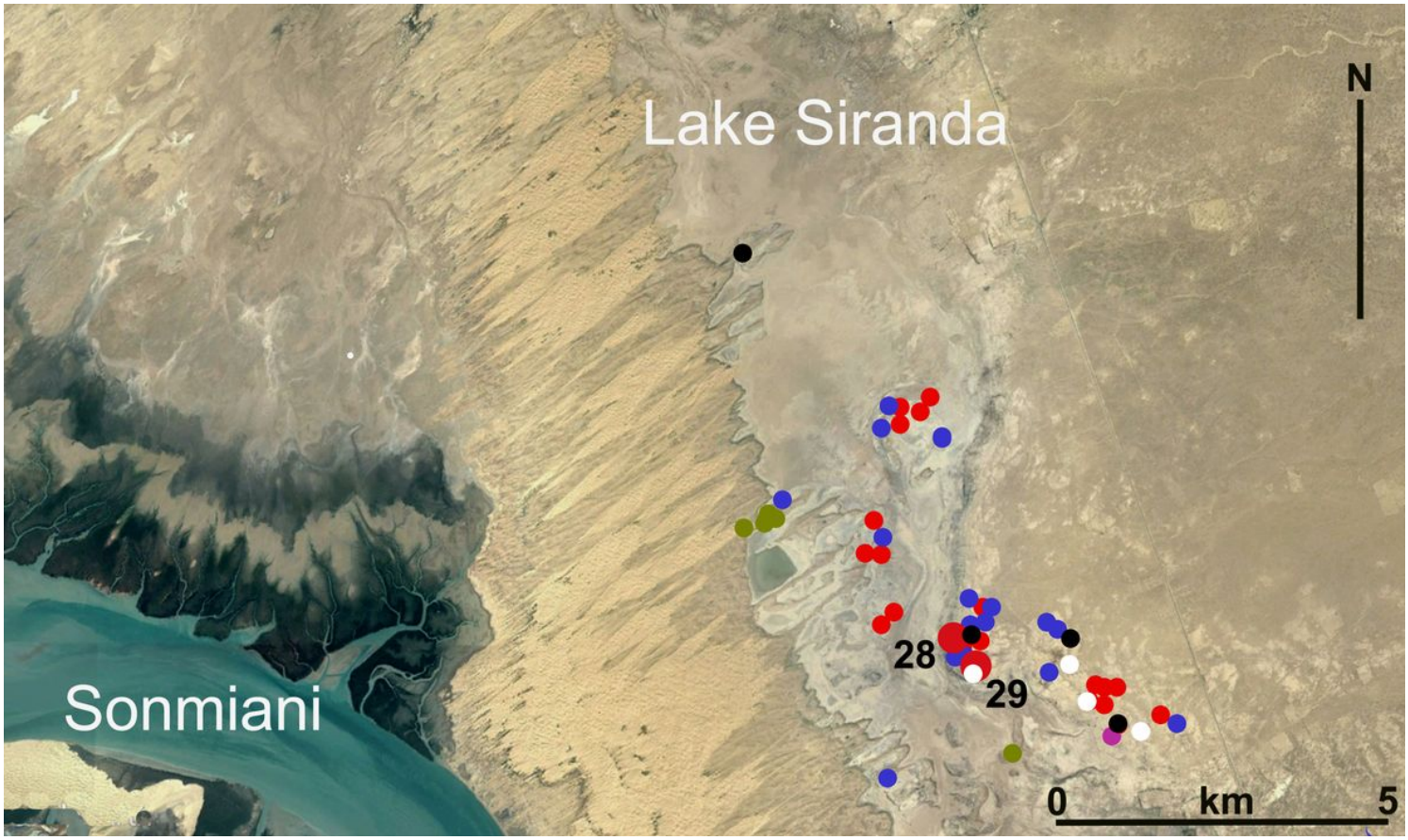

Figure 2

Siranda Lake: Distribution map of the radiocarbon dated sites: 9th millennium BP (violet dot), 8th millennium BP (white dots), 7th millennium BP (red dots), 6th millennium BP (blue dotes), 5th millennium BP (green dots), historic dates (black dots) (drawing by P. Biagi).

Figure 3

Siranda Lake: General view of Site SRN-28 taken from SRN-29 (top), *T. telescopium* fragments on the site's surface (bottom) (photographs by P. Biagi, 2013).

Figure 4

Siranda Lake: General view of Site SRN-29 (top), *T. telescopium* and *T. palustris* fragments on the site's surface (bottom) (photographs by P. Biagi, 2013).

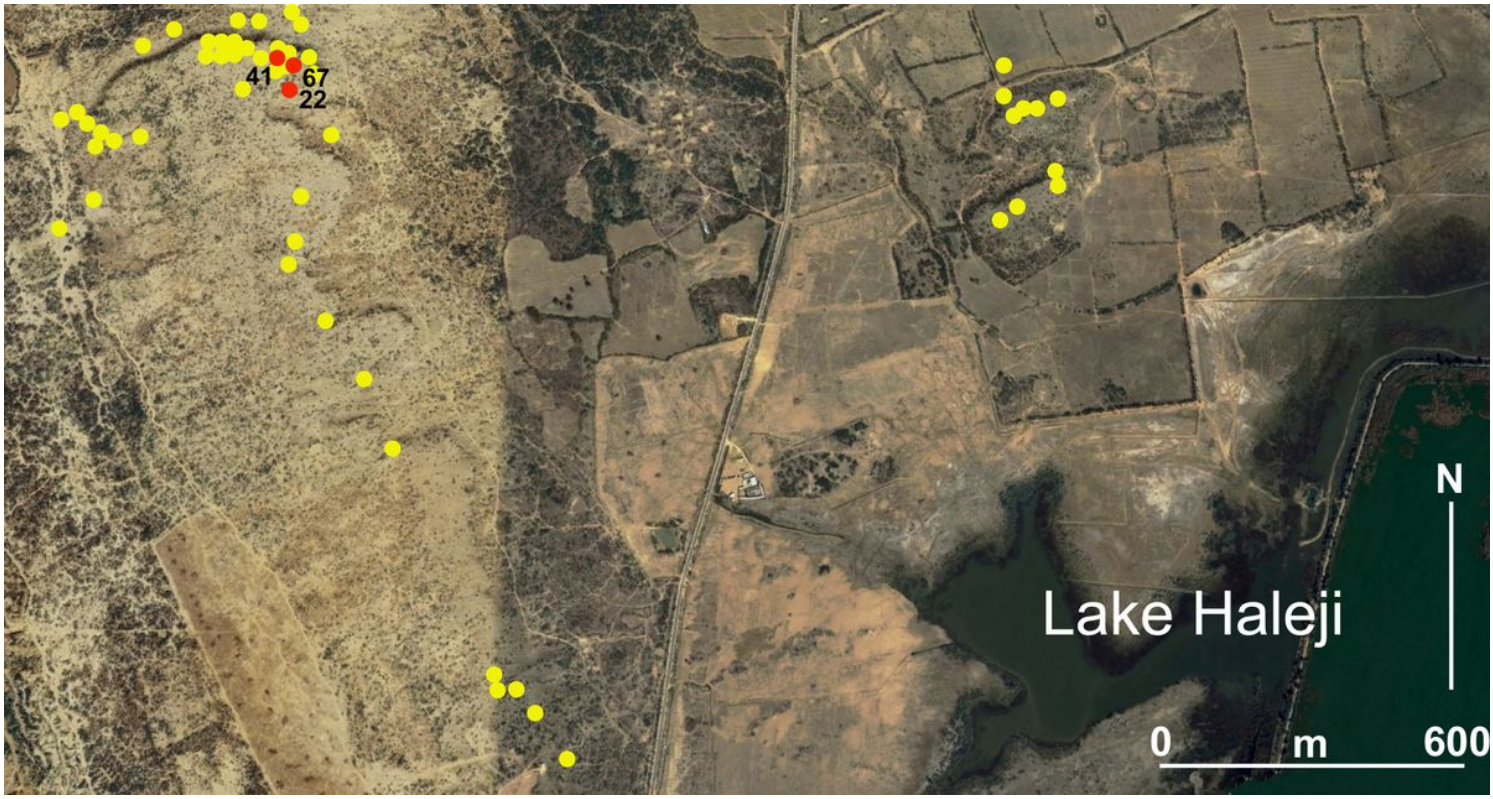

Figure 5

Haleji: distribution map of the concentrations of knapped stone artefacts and shells discovered in December 2022 on the terraces west of the Haleji Lake (yellow dots) and radiocarbon dated sites (red dots) (drawing by P. Biagi).

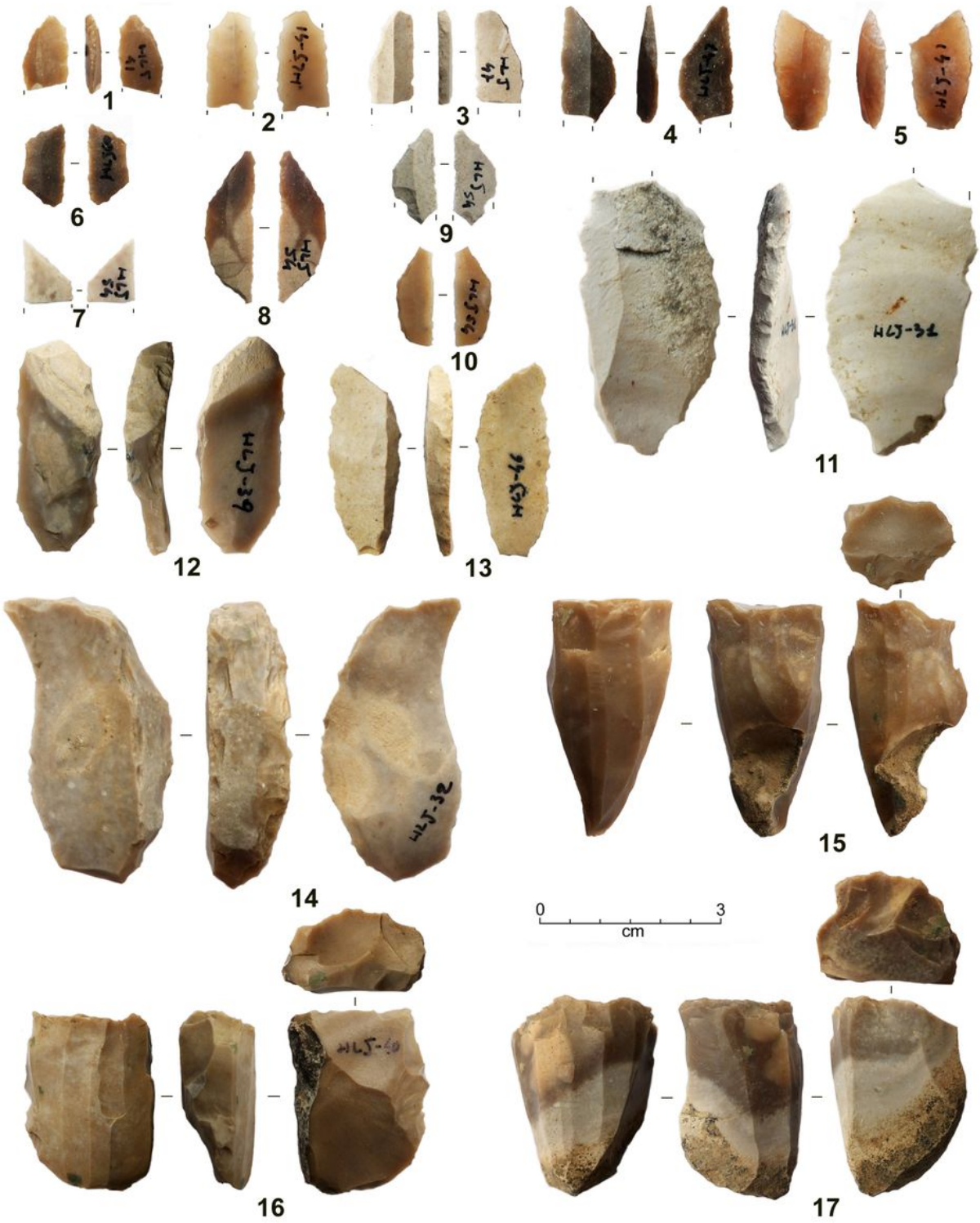

Figure 6

Haleji: knapped stone artefacts from different sites: abrupt-retouched tools (nn. 1-13), crested flake (n. 14), cores (nn. 15-17) (photographs by E. Starnini).

Figure 7

Haleji: Site HLJ-22 along the slope in the centre of the image (top), and site HLJ-39 with knapped stone artefacts (black dots) and oyster shell fragments on its surface (red dots) (bottom) (photographs by P. Biagi, 2022).

Supplementary Files

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- Table1.xls