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Twelve years of the 'Arabian Seashores' project: How the extensive investigation of coastal Oman changed the paradigm of the Arabian Neolithic

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Abstract

For over a decade, the French mission 'Archaeology of the Arabian Seashores' has been exploring the evolution of the Omani coastline, from hunter–gatherers to the rise of complex societies during the crucial passages from the culmination of the Pleistocene to the Early Bronze Age, passing through the Neolithic. The team extensively surveyed the land spreading from the eastern head of Arabia, Ra's al-Hadd and Ra's al-Jinz, to the last villages of Dhofar, including Masirah Island and the Hallaniyyat archipelago, covering 1000 km. Most Final Palaeolithic, Neolithic and Early Bronze Age sites were tested or excavated. A multidisciplinary approach that involves the joint work of archaeologists and geologists was chosen to include the contribution of environmental factors to modifying the equilibriums between the natural environment and human communities through the study of climatic and eustatic fluctuations. The project provided a substantive perspective on the evolution of maritime communities between 10,000 and 2000 BCE. Moreover, an interdisciplinary and multiscalar approach for describing and analysing the change in the material culture of this region made it possible to transcend the traditional typology and examine the role of human communities' interaction.

KEYWORDS

Arabian Sea, Bronze Age, Neolithic, Oman, survey

1 | INTRODUCTION

2022 witnessed the signing of the 12th anniversary of the French mission 'Archaeology of the Arabian Seashores' in the Sultanate of Oman (referred to henceforth as 'Arabian Seashores'). In the last decade, the team has surveyed the shores of the Arabian Sea in Oman, uncovering considerable evidence of the archaeological features related to human attendance from the end of the Pleistocene to the Middle Holocene.

The mission was founded in 2010 with a bilateral agreement between the Ministry of Heritage and Culture (now the Ministry of Heritage and Tourism) of the Sultanate of Oman and the French Ministry of Foreign Affairs excavation commission. It came about as the natural continuation of 15 years of intensive excavation on the southern al-Sharqiyyah and the United Arab Emirates shores in continuance of the Joint Hadd project, created in 1985 by Cleuziou and Tosi (2007, 2018). 'Arabian Seashores' was, indeed, created as the direct heir of this programme, of which one of the authors (V. C.) has been a part since the beginning. At the same time, it follows in the footsteps of the pioneering research along the central coast started by Biagi (Biagi, 1988; Biagi & Maggi, 1990), Weisgerber and Al-Shanfari on the islands in this area (2015), while the

southern coast of Dhofar (Ẓufār), which was almost unknown until the Trans-Arabia programme run by Zarins (2001) investigated it. Moreover, the vast 'Arabian Seashores' prospection represents the continuation of more than a decade of excavations on the Sea of Oman (Suwayh excavation programme[1]) and in the Gulf (excavation of Akab Island,[2] UAE).

The project's main scope is devoted to understanding how occupational strategies, technological development and population movement affected the evolution of human societies along the Omani coastline, from the eastern tip of Arabia (the Ra's al-Hadd) to the shores of Dhofar at the border with Yemen (Figure 1). Here, we explore and discuss how a long-term archaeological investigation of the south-eastern Arabian coast contributed considerably to the advancement of our prior knowledge of Arabian prehistory, and to the gradual transformation of the research questions as well as the development of new research lines. It will also discuss the importance of transdisciplinary approaches in investigating varying environments.

Through the years, the team had the privilege of collaborating with numerous specialists, research institutes and universities across Europe, enriching the outputs of its research in several directions (e.g., Adnet & Charpentier, 2022; Charpentier et al., 2014; Cremaschi et al., 2015; Maiorano, Al Kindi, et al., 2020; Zerboni et al., 2020).

Covering 1000 km of coastline and two island groups—Masirah Island (Jazīrat Maṣīrah) and the Hallaniyyat archipelago (Ḥallāniyyat)—the project has been exploring the evolution of coastal human societies from the end of the Pleistocene to the Early Bronze Age. The establishment of a chronology was, overall, the main objective. The project was based on three main research questions to allow it to reach such a complex goal. The first objective concerned the processes that drove the change in Palaeolithic hunter–gatherer societies. The second focussed on the emergence of the Neolithic societies in south-eastern Arabia, when and how neolithisation occurred. The third explored the transition between the Neolithic and the Bronze Age, with agriculture, mudbrick dwellings, full domestication of plants and animals and copper exploitation.

However, the project faced several hitches related to studying prehistoric societies in this area that require further research and, in some cases, extensive reassessment. First, stratified sites have a generalised scarcity due to aridity and deflation phenomena in most archaeological contexts. For the same reason, several archaeometric analyses (e.g., DNA, ZooMS) failed due to the absence of organic residues. Second, the sparse discovery of individual inhumation and graveyards made it almost impossible to reconstruct generalised burial behaviours related to Neolithic social practices and structures. Third, the initial theorisation of numerous 'cultural features', also called facies, by several teams that do not always correspond to tangible and consistent material assemblage differences. Fourth is the imbalance between the studies of coastal areas and those of the desert and semidesert (for obvious logistic reasons and different archaeological missions' traditions). Finally, the scarcity, if not the absence, of indicators regarding the relationship between settled and mobile communities and clearly defined seasonal mobility patterns. These are the wherefores and whys of the project and, as discussed below, the principal results after more than 10 years of dedicated research and efforts.

2 | METHODOLOGY: AT THE CROSSROADS OF ARCHAEOLOGY AND PALAEOGEOGRAPHY

To expand the research horizon and overcome the limits given by the environmental differences, a multidisciplinary and multiscalar approach involving the joint work of archaeologists and geologists was chosen to include the contribution of environmental factors in modifying the equilibriums between the natural environment and human communities through the study of climatic and eustatic fluctuations. The surveyed coast still bears the scars of numerous variations in the dynamics of coastal ecosystems (e.g., monsoon fluctuations, emergence and decline of mangroves, aridification, etc.) to which prehistoric societies had to adapt (e.g., Berger et al., 2013; Beuzen-Waller et al., 2019; Decker et al., 2020; Lezine et al., 2017; Zerboni et al., 2020). The choice to investigate different geographical and environmental transects was fundamental to establishing an overarching insight into the prehistoric peopling of the region, from the *sabkha*, the fringes of the Sharqiyyah Sands and the Bar al-Hikman, to the mountainous foothills of the Jebels Qara, Qamar and Samhan, passing through the variously rocky and sandy coasts of the islands (Figures 1 and 2).

The prospecting method was based on the preliminary study of the geological maps and satellite images of a selected coastal portion to detect the most suitable areas for anthropic occupation during the end of the Pleistocene and Early-Middle Holocene. It followed the field truthing, with the reconstruction of the geomorphological framework and the landscape's evolution (Berger et al., 2013; Cremaschi et al., 2015; Zerboni et al., 2020). The survey was conducted on foot across marine terraces, mangroves, lagoons and interdunal areas. In most of these environments, visibility is excellent due to the almost complete lack of vegetation, except for parts of Jebel Qara and Jebel Qamar. After identifying a site, the team recorded all

[1]French archaeological mission 'Suwayh excavation programme' (Charpentier et al., 1998, 2003).
[2]Mission Archéologique Française in UAE (Charpentier & Méry, 2008).

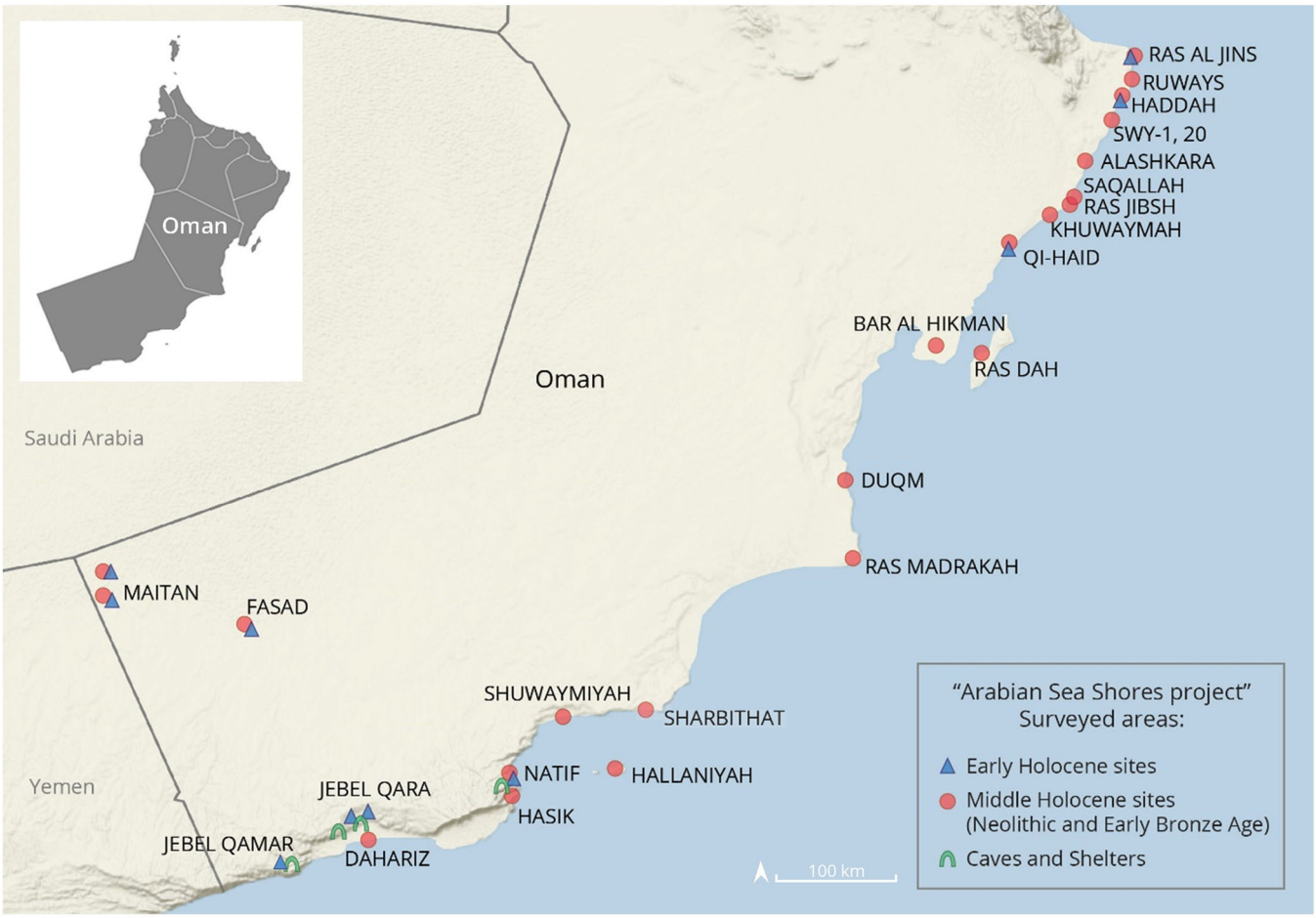


FIGURE 1 General map of the survey area and tested sites in the framework of the Arabian Seashores programme. *Source*: Map by M. P. Maiorano and V. Charpentier. [Color figure can be viewed at wileyonlinelibrary.com]

visible architectural features, main lithic concentrations and raw material outcrops, but generally avoided the systematic collection of surface material, favouring a sampling method. Therefore, a collection of diagnostic pieces[3] was carried out at selected sites, where the concentration of surface materials is high, and the artefacts were recorded and located using a Topcon GMS-2 Pro GPS Receiver. The GMS-2 is a fully integrated handheld controller and GPS receiver. This component can receive, and process GPS+GLONASS L1 signals, improving the accuracy of the survey points and positions with a standard error of a maximum of ±3 m. Points were recorded using UTM coordinates WGS84 mapping datum. The systematic collection was performed only in the case of test sounding, trenches and excavations, following the division system by quadrant (Charpentier et al., 2012, 2022; Maiorano et al., 2018). Another important goal of the pedestrian survey was the creation of an archaeological risk map for the Ministry of Heritage and Culture, especially for the sites affected by construction. All relevant archaeological features were indicated for preservation in case of future landscape modification.

Identifying Neolithic settlements and livelihood strategies in water-stressed environments is particularly interesting for understanding the development of behavioural flexibility and spreading populations and ideas. Given the limited information from the eroded archaeological deposits in arid and hyperarid environments, different approaches and methodologies must be developed and tested in the field. The collaboration with ichthyologists (P. Bearez and A. Marrast) was essential to explore the interactions between humans and aquatic environments over time (Berger et al., 2020; Charpentier et al., 2022; Marrast et al., 2019). Collaborations included those with expert anthropologists (O. Munoz and H. Guy) and zooarchaeologists (C. Lefèvre, E. Maini, and M. Mashkour) and palaeobotanist (M. Tengberg) who are currently involved on several fronts of the research.

The last and most important aspect of the 'Arabian Seashores' project is the study of lithic industries. Over the years, many lithic artefacts have been collected during field prosecutions. These assemblages usually

[3]Functional to the reconstruction of the operational chains.

FIGURE 2 Sample pictures of different archaeological and natural environments: (a) Khuwaymah KHU-2 shell midden; (b) Bar al Hikman sabkha; (c) Sharbithat SHA-10 marine terrace; (d) DUQ-2 shell midden located on the slope underlying the mesa; (e) two caves in Natif; (f) HLY-9 bay in Hallaniyyah Island; (g) shelters and caves in the Jebel Qara; (h) Ra's Jibsh shell midden, eastern side view. *Source*: Photos by V. Charpentier and A. Al-Mashani. [Color figure can be viewed at wileyonlinelibrary.com]

come from surface sites due to deflation and post-depositional processes that destroy the loose sediment, allowing heavy implements to remain in place. Erosion allowed for the easy identification of and accessibility to most sites, but the absence of soil makes dating extremely difficult and the risk of assemblages' co-occurrence very high. That is why lithic artefacts have always been fundamental for understanding Omani—and Arabian—prehistory. Several technical schemes and modes of lithic production, little documented until recently or even unknown, were detected in the region. Combining the technotypological study with the systematic experimental archaeology tests carried out by J. Vosges, the discussion on Fasad points was enlarged and deepened, as well as

FIGURE 3 Natif caves in Hasik, lateral (left) and frontal view (right). [Color figure can be viewed at wileyonlinelibrary.com]

the debate on fluting technique, the identification of parallel-covering retouch and Sharbithat backing (e.g., Charpentier & Crassard, 2013; Crassard et al., 2020; Maiorano et al., 2018).

Surveys and lithic studies associated with test pits allowed reconstructing sites' settlement patterns (e.g., Charpentier et al., 2012, 2013, 2016; Cremaschi et al., 2015; Maiorano et al., 2023). These dozens of soundings, radiometric dating, and the systematic study of lithic assemblages make possible the development of an ever more solid chronology of Oman's coastal prehistory.

3 | FROM FINAL PALAEOLITHIC TO THE EARLY BRONZE AGE: A CHRONOLOGICAL REASSESSMENT

3.1 | The Final Palaeolithic

Affected by the Indian monsoon, in the past as today, Dhofar has many Palaeolithic sites. This area might have provided refuge during the arid climatic phases (Rose, 2022). The end of the Palaeolithic sometimes called the pre-Neolithic (Cremaschi et al., 2015), Epipalaeolithic or Late Palaeolithic (Hilbert et al., 2012; Rose, 2022), has assumed particular research relevance (Charpentier & Crassard, 2013; Hilbert, 2013, 2014; Hilbert, Parton, et al., 2015; Hilbert, Usik, et al., 2015; Rose, 2022). The first solid results concerning the Early Holocene transition between the final phase of the Palaeolithic and the Neolithic here referred to as the Final Palaeolithic, have been corroborated by the discovery and dating of Fasad points in the Jebel Qara (10th millennium BCE, Cremaschi & Negrino, 2002, 2005; Cremaschi et al., 2015). The Jebel Qara massif consists of Tertiary and Cretaceous limestone. It has important karsts, such as shelters, caves and sinkholes that are visible along the slopes of the wadis on the southern fringes of the Nejd Desert. These shelters sometimes include angular breccias at their bases and loess deposits in which land snails, charcoal, and lithic artefacts are present. The shells of the molluscs *Euryptyxis latireflexa* and *Revoilia dhofarense*, characteristic of a humid environment, form actual 'snail beds'. These represent a significant and original discovery since these land snails were the product of intense collection by Final Palaeolithic populations. The team tested the sites KR-213 and GQ-13/23, showing a stratigraphy consisting of fine clastic breccias interspersed with layers rich in charcoal and flint artefacts. A complete Fasad point was found and dated in this level, thanks to charcoal samples from the same level to the 10th millennium BCE (9848–9361 BCE; Cremaschi et al., 2015). Several other shelters and caves have been surveyed, providing evidence of intense human use and habitation in mountainous and plateau environments during this period (Figures 2g and 3). This discovery, together with the similar specimens found at Al-Hatab[4] (Hilbert, Usik, et al., 2015), Khamseen and Ghazal[5] (Hilbert, Parton, et al., 2015) have brought our knowledge of this period one step further.

In parallel, the systematic survey of all of the littoral caves of Hasik resulted in the discovery of exceptional sites. Extraordinary for their preservation and unicity, the rock shelter and cave in Natif-2 (Figure 3) revealed a ninth to seventh millennium BCE occupation and a small Fasad point industry. Currently, it represents the most ancient site of the exploitation of marine resources in the Arabian Peninsula. Apart from the minor points (average height, 15 mm) and a few beads, fish and shells remain to characterise the record (Charpentier et al., 2016). Finally, evidence from this period has also been found in the Rub' al-Khali in the framework of the Franco–Omani geoarchaeological expedition (Maiorano, Al Kindi, et al., 2020).

3.2 | The Neolithic

Around 6500 BCE—or perhaps earlier—the Omani peninsula experienced a significant socioeconomic change with

[4]OSL dated to 12.5 ka (Hilbert, Usik, et al., 2015).
[5]Respectively OSL dated to 9.7, 8.6 and 7.3 ka (Hilbert, Parton, et al., 2015).

the emergence of the first herding group: the advent of the Neolithic. Though the project and the research field are expansive and versatile, the Neolithic is the leading subject of our research. The coastal plain of Dhofar, particularly in Salalah, constitutes a unique environment extremely favourable to human settlement. Although the first reports from J. Zarins pointed out the scarcity of Neolithic remains in this large basin (Newton & Zarins, 2017; Zarins, 2001), later research demonstrated that it was rich in productive areas. Apart from the isolated artefacts reported from Mughsayl (Newton & Zarins, 2017), some flints at Hasik (Zarins & Newton, 2013) and the illustrated two points from Shuwaymiyah (Pullar & Jackli, 1978, fig. 18A and B), not much was known about the area.

3.2.1 | Khor Ad-Dahariz and the Salalah Plain

At the khor and beach-rock junction, a Neolithic group settled at ad-Dahariz 2 (DHZ-2, Figure 1). Khor ad-Dahariz is one of the main lagoons and the plain of Salalah. Discovered in 2013, it covers about 3.5 ha, and its surface suffered partial destruction due to a medieval and modern quarry (Charpentier et al., 2014). Here, the pedestrian survey led to the discovery of a unique fluted projectile point workshop (Crassard et al., 2020). The study of the trihedral points, their preforms and channel flakes led to reconstructing how the 'fluting' technique was performed here. Thanks to the experimental approach by J. Vosges, it was possible to investigate the fluting and the phenomenon of convergence that led to the parallel development of this technique in southern Arabia and on the American continent (Charpentier et al., 2002; Crassard et al., 2020). Its great particularity is represented by a unique set of projectile points with more than 200 specimens. The homogeneous assemblage comprises pieces at all stages of reduction (preforms, blanks, pieces broken during shaping, channel flakes, etc.; Figure 4: 1–4) (Crassard et al., 2020). The assemblage is coherent with standardised points showing the same fine morphological and technical characteristics. These highly sophisticated points are dated to the Middle Neolithic, from the end of the seventh millennium to the sixth millennium BCE. In Dhofar, they can be found in the Nedj at Wadi Ghadun (site 92.11, 14, 42 and 70; Zarins, 2001), in the Rub' al-Khali at Ibn Hamuda (site 92. 39; Zarins, 2001), but also at Natif 1, Sharbithāt SHA-2, and Shuwaimiah SHU-3. Following the beach-rock bank on which ad-Dahariz DHZ-2 is located, surveying various places along the Salalah coast, we tried to identify other concentrations. However, ancient and recent urban development most likely destroyed the other sites. Only ad-Dahariz 6 (DHZ-6), about 2 km east, has disclosed material of this period, including a trihedral point (Figure 4: 5) identical to the one at DHZ-2.

3.2.2 | The Hasik Plain

From 2013 onwards, our research focussed on the narrow coastal plain of Hasik (Ḥāsik), 170 km north of Salalah. Neolithic occupation is well attested at Hasik. While no actual shell midden is currently attested in the Salalah plain, as in the rest of Dhofar, Hasik encloses several of them, up to 3.5 m high in stratigraphy (HBM24). The Hasik sites are, however, disguised in the landscape by more recent occupations, particularly of the Bronze Age or Islamic periods. Along this narrow coast, the shell middens are all located in wadi deltas: this is the case of HBM-4, connected to the massive Wadi Attabarran, HBM24, and Wadi Hasik. HBM-4 is the most prominent shell midden of the Hasik plain. Its prehistoric deposit, almost 4 m thick, covers three millennia, from the fifth to the second half of the second millennium BCE. The main Neolithic occupation is dated between 3703–3534 cal. and 3182–3025 cal. BCE, that is, the five centuries of the second half of the fourth millennium, belonging to the Late Neolithic 2 (3700–3100 BCE; Charpentier, 2008). In a very different environment 10 km south of this plain, SHL-1 is another notable Neolithic settlement. Located on a rocky headland dominating the right bank of the Wadi Samhal delta, this site's assemblage is in the course of study.

In Dhofar, cave dwellings are not exclusive to the mountainous massifs: humans inhabited caves along the coast, too. In Hasik, natural cavities are numerous, both caves and rock shelters, sometimes a very short distance from the ocean. Between 2013 and 2016, we sounded all of the caves, which attested to consistent occupations from the Early Holocene to the Iron Age.

3.2.3 | Shuwaymiyah Bay

About 80 km north of Hasik, Shuwaymiyah Bay, with its 30 km long shoreline, has yet to yield any shell middens. The survey here yielded just a few lithic specimens and an extensive Neolithic encampment (SHU-3). Numerous projectile points of various sizes and shapes were on the marine terrace. Most of them are characteristic of the Middle Neolithic (trihedral and *Concorde* points[6]; Maiorano, Crassard, et al., 2020; Maiorano, Al Kindi, et al., 2020; Figure 4: 6–8); others are more recent (with a long stem and wings; Figure 5: 10–11). The lithic remains show that the site's chronology is quite long, extending from the sixth millennium to the beginning of the fourth millennium BCE. The presence of blanks at different production stages confirms that the lithic assemblage manufacturing was local. A test trench was performed at the site but did not release any datable material.

[6]The so-called 'Concorde' points present a plano-convex medial cross-section with a trihedral tip. These points spread in southern Arabia at the turn of the seventh to sixth millennia BCE.

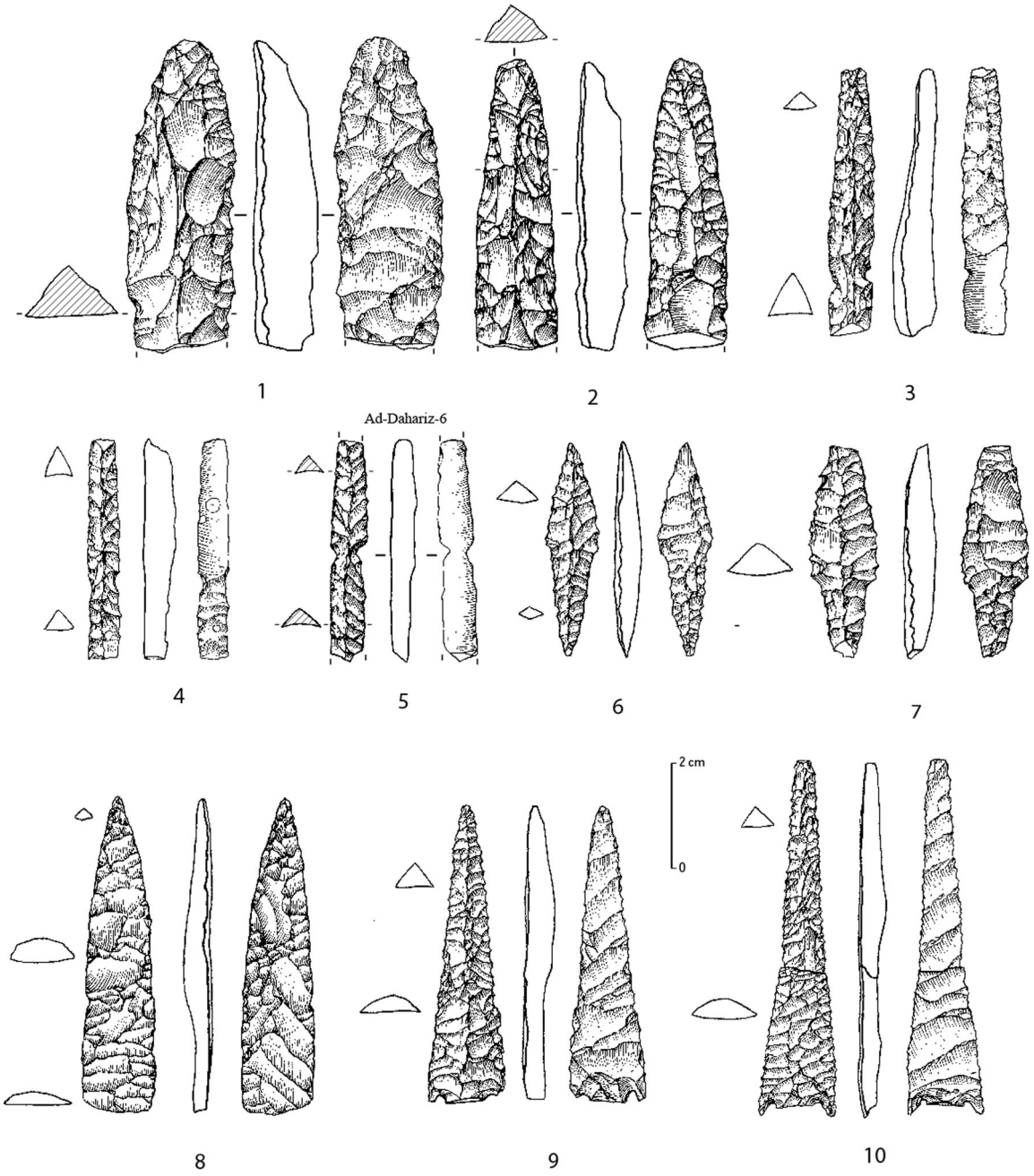


FIGURE 4 Projectile points from the Middle Neolithic period. Selected preforms (1–2) and trihedral points from Ad Dahariz DHZ-2 (3–4); Ad Dahariz DHZ-6 (5); trihedral points from Shuwaymiyah SHU-3 (6–7) and Concorde points from Sharbithat SHA-4 (8–10). *Source*: Drawings by G. Devilder.

3.2.4 | Sharbithāt (Middle and Late Neolithic)

Since January 2016, the team has intensified exploration around the village of Sherbithat (Sharbithāt), a fascinating case study for the recent prehistory of the Sultanate of Oman (Maiorano et al., 2018, 2023). Here, two major periods of Neolithic occupation are present: the Middle Neolithic (6500–5000 BCE) and the Late Neolithic 2 (3700–3100 BCE). Apart from SHA-2, where the co-occurrence of two radically different point production technologies—blade blank points and trihedral—coexist at the site (Maiorano et al., 2018), all other sites present a single-period occupation. A major Middle Neolithic site is Sharbithat SHA-4 (and SHA-3, on the lower slope), a workshop area for foliated tools, trihedral and *Concorde* points,[7] with the systematic application of parallel covering retouch (Figure 4: 9–10). Here the *chaîne opératoire* starts from selected flat plaquettes shaped into

[7]This peculiar type of projectile point is well described in Crassard (2008) and Maiorano et al. (2018) Maiorano, Crassard, et al. (2020); Maiorano, Al Kindi, et al. (2020).

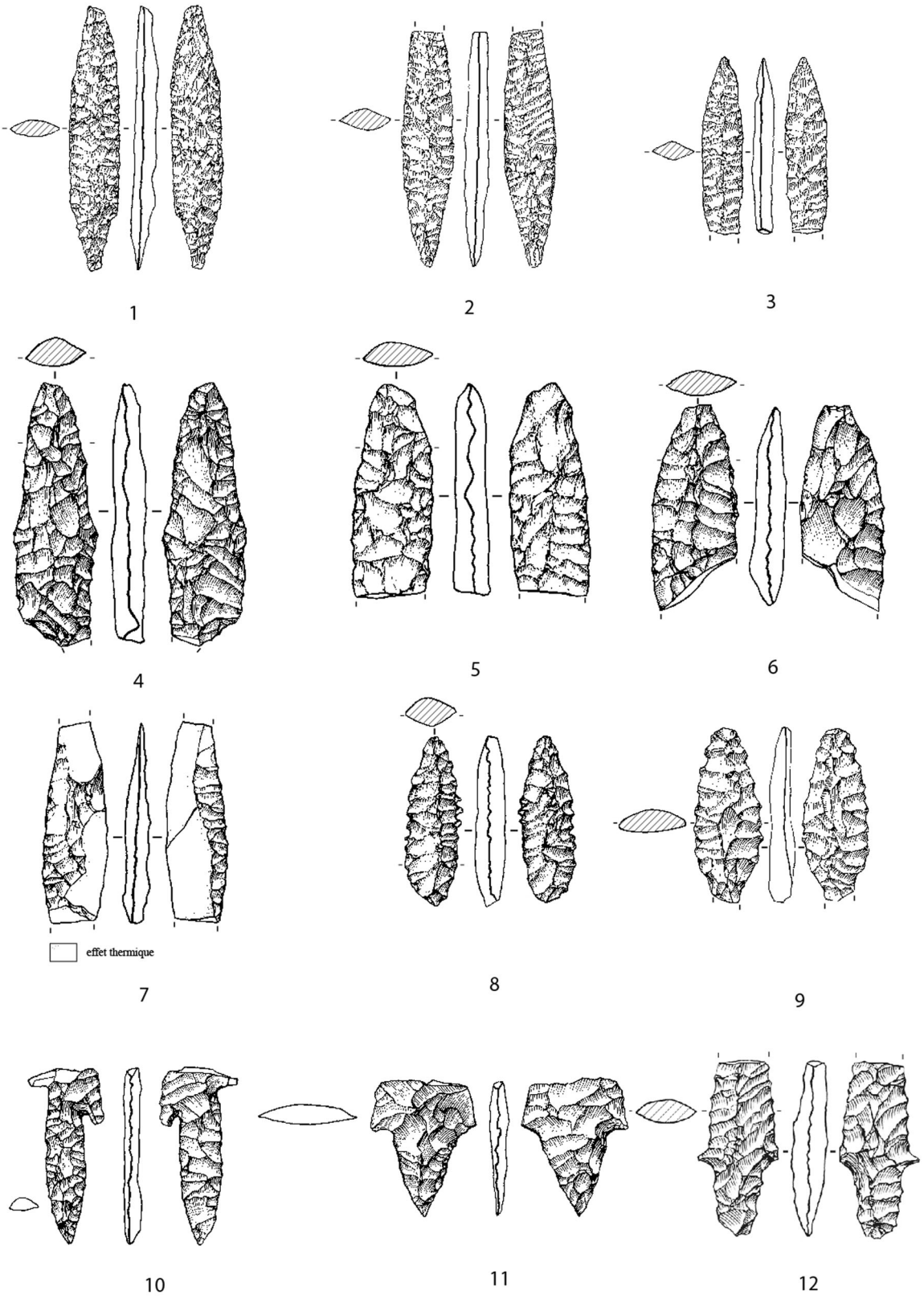


FIGURE 5 Projectile points from the Late Neolithic period. Long fusiform points from Suwayh SWY-20 (1–3); preforms (4–6) and fusiform point (7) from Duqm DUQ-2, short fusiform points from Ra's Jibsh JBH-1 (8–9). Tanged and shouldered bifacial points from Shuwaymiyah SHU-3 (10–11) and Ruways RWY-1 (12). *Source*: Drawings by G. Devilder.

large foliates and, successively, projectile points. At SHA-4, we identified, dug and sampled Dhofar's first Neolithic human burial. Due to the high degree of fossilisation of the bones, no datable organic residues were found on the body. However, the absence of any element relating to later periods leads us to date it as the sixth millennium BCE, with the site itself (Table 1).

Unlike SHA-4, SHA-10 is characterised by circular stone structures made of standing and horizontal flat slabs (Maiorano et al., 2018, 2023), agglomerated at the westernmost part of the long mesa extending parallel to the sea. At SHA-10, two trenches were dug, and an extended excavation was planned for the following field seasons. The deposit here is dense and better preserved than all other sites at Sharbithat. The main classes of remnants were the backed pieces, retouched and unretouched blades, large scrapers made on flakes, blades, and big shells (*Tivela ponderosa*), and tanged points shaped via direct hard hammer percussion and bipolar retouch on an anvil. Projectile points uncovered at the site are similar to those of Fasad but differ in some technomorphological aspects, defining a new type, the 'Sharbitathian points', described and discussed in previous publications (Maiorano et al., 2018, 2023; Maiorano, Crassard, et al., 2020). The site was radiocarbon, dated to the fourth millennium BCE (3949–3712 and 3339–3026 BCE, Maiorano et al., 2023). The radical difference between the assemblages at SHA-4 and SHA-10 highlights a significant change in lithic production and lifestyle between the Middle and the Late Neolithic.

3.2.5 | Duqm Bay (Late Neolithic)

Over the last 10 years, the Bay of Duqm has been affected by extensive development and numerous archaeological sites have been lost. One of the most relevant and better preserved Neolithic sites on this coastal trait is DUQ-2, located at the base of an aeolianite terrace. Datable to the Neolithic and Early Bronze Age, DUQ-2 is very rich, particularly in lithics. At the top of this mesa, several undefined circular structures, sometimes well preserved, are visible. Within this assemblage, the bifacial industry dominates, with daggers and elongated projectile points (with a biconvex cross-section) belonging to the Late Neolithic 1 (5000–3800 BCE) (Figure 5: 4–7).

3.2.6 | Al-Sharqiyyah region: Suwayh 20 (Middle and Late Neolithic)

The first campaign of the Arabian Seashores mission, undertaken in 2010, focussed on exploring the southern al-Sharqiyyah Governorate, following the maritime fringes of the Wahiba desert up to the Bar al-Hikman peninsula. The team identified a set of Neolithic and Bronze Age settlements and encampments along the banks of a vast fossil ria[8] (Charpentier et al., 2012). At that stage of our research, it was crucial to place and test-excavate stratified sites to fix strategic cornerstones for developing a late prehistory chronology of Oman. Most sites have been tested (Charpentier et al., 2012). One of the oldest sites in the area, installed directly on the paleo-rift, is Suwayh SWY-20, located in the middle of the Khor Bani Bu Ali delta. It is a tiny hill extending for a few 100 m. Suwayh SWY-20 could have been a small island at the height of the marine transgression. Here, a test trench revealed the presence of a stone structure built with slabs, confirming the local diffusion of the construction methods used in the latest phases at SWY-1 (Charpentier et al., 2012). Its occupation is well documented by 80 cm of stratigraphy. The oldest levels date to 5700 cal. BCE (7760 ± 80, 5652–5511 BCE 1 sigma; 5731–5454 BCE 2 sigma; ΔR: 210 ± 15). However, the highest attendance at the site was in the early part of the Late Neolithic (ca. 5000–3700 BCE). A grave from this period has been excavated at the southern end of the site. The material culture is characterised by abundant shellfish hooks, small net sinkers, fusiform points (Figure 5: 1–3), large foliates and an intact container made from the conch of a *Lambis truncata sebae*.

3.2.7 | Ruways RWY-1 habitat and necropolis (Middle and Late Neolithic)

Discovered by M. Cremaschi in 1998, Ruways RWY-1 is composed of massive mounds that revealed fifth and fourth millennium BCE artefacts all over the surface. The site has been intensely investigated in the last 8 years, revealing a long period of occupation spanning from the seventh to the fourth millennium BCE (6300–6100 to 3800–3500 BCE, Figure 5: 12) (Berger et al., 2020). After a first analysis of the surface collection, the team speculated on the presence of previous older phases of occupation. This hypothesis was confirmed in 2010 when the main Neolithic settlement (RWY-1) was turned into a quarry, exposing the whole section.

3.2.8 | Ra's Jibsh: The Neolithic phase

Discovered by P. Biagi, Ra's Jibsh has, until very recently, been the object of multiple field research expeditions by the Franco-Italian mission of the Joint Hadd project. However, publications concerning the site are rare (Biagi, 1988; Biagi & Maggi, 1990; Cavallari, 2005). Ra's-Jibsh has a massive stratigraphy (about 3 m) dating from the Neolithic (Figure 5: 8–9) to the Umm an-Nar periods (Figures 7–9). Microlithic industries have been

[8]A drowned river valley (or system of valleys) flooded by the sea during marine transgression.

TABLE 1 Radiocarbon dates result from samples collected in various field seasons.

Site name	Context	Lab code	Sample	Date BP	Cal. BC sigma 2
SHA-10 B	TR2 US0	Lyon 15698	charcoal	975 ± 30	1013–1155
SHA-10 B	TR2 US2	Lyon 15699	charcoal	5035 ± 30	3949–3715
SHA-10 B	TR2 US3	Lyon 15700	charcoal	4470 ± 30	2229–3026
SHA-10 B	TR2 US6	Lyon 15701	charcoal	4500 ± 30	3347–3097
SHA-10 B	TR2 US7	Lyon 15702	charcoal	4525 ± 30	3358–3103
SHA-4	SD US4	Lyon 15703	charcoal	7035 ± 35	5995–5845
KHU-2	SD1 US6 180 US37	Lyon 8522	charcoal	5860 ± 40	4823–4618
KHU-2	ECH42-ENS7-2,30 M	Lyon 8523	charcoal	6200 ± 35	5290–5051
KHU-2	US3 ENS1 20CM	Lyon 8524	charcoal	5475 ± 35	4442–4252
KHU-2	US14 ENS3/4 75-80CM	Lyon 8525	charcoal	5625 ± 35	4530–4363
KHU-2	US27 ENS5-135CM	Lyon 8526	charcoal	5825 ± 35	4778–4599
JBH-1	1 US3A	Lyon 8539	shell	6890 ± 35	5528–5368
JBH-1	1 US6T	Lyon 8540	shell	6950 ± 40	5971–5734
JBH-1	1 UST6	Lyon 8583	charcoal	6595 ± 35	5621–5477
JBH-1	1 US1A	Lyon 8541	shell	7160 ± 40	5767–5603
JBH-1	2 US4G	Lyon 8542	charcoal	6245 ± 35	5306–5077
JBH-1	E USBASE 247CM	Lyon 8543	shell	7050 ± 35	7050–5507
JBH-1	2 US2C	Lyon 8544	shell	6635 ± 40	5311–5093
SM-10	13-20CM	Lyon 9937	charcoal	5100 ± 30	3968–3800
SM-10	40-45CM	Lyon 9938	charcoal	5000 ± 35	3942–3697
SM-10	75-80CM	Lyon 9939	charcoal	5555 ± 35	4455–4344
SM-10	102-108CM	Lyon 9940	charcoal	5845 ± 30	4791–4615
SM-10	133-140CM	Lyon 9941	charcoal	5855 ± 30	4796–4617
SHU-3	US3	Lyon-11590	shell	6590 ± 40	5615–5479
HBM-24	C4 – US15	Lyon-13546	charcoal	3760 ± 30	2287–2044
HBM-24	C4 – US12	Lyon-13547	charcoal	3845 ± 30	2457–2205
HBM-24	C4 – US6	Lyon-13548	charcoal	3835 ± 30	2457–2200
HBM-24	C4 – US1B/2	Lyon-13549	charcoal	3830 ± 30	2456–2152
HBM-24	C1C-US11D	Lyon-13542	charcoal	4115 ± 30	2866–2577
HBM-24	C1C-US5F	Lyon-13543	charcoal	5560 ± 35	4456–4346
HBM-24	C1C-US10C	Lyon-13544	charcoal	4705 ± 35	3632–3372
HBM-24	C1C-US11G	Lyon-13545	charcoal	3940 ± 30	2565–2309
HBM-24	US8	Lyon-11642	charcoal	3740 ± 30	2275–2035
HBM-24	US4	Lyon-11587	charcoal	3770 ± 30	2289–2049
HBM-4	Log4	Lyon-11585	charcoal	5005 ± 35	3941–3700
HBM-4	LOG 1 US 54	Lyon-11584	charcoal	3355 ± 35	1740–1531
HBM-4	LOG 1 US 38	Lyon-11583	charcoal	4380 ± 30	3089–2911

Note: The results of radiocarbon dating were calibrated using OxCal v 4.3.1 and IntCal13 and Marine13 calibration curves (Reimer et al., 2013). SM-10 is published in Charpentier et al. (2013); complete descriptions of SHA-10 and SHA-4 are in Maiorano et al. (2023). The other contexts and stratigraphy are still under study and will be fully reported in future publications.

found on the site's surface, at the base of the slope (most likely belonging to the Middle Neolithic) and in its upper part, dating to the beginning of the fourth millennium BCE. The most remarkable finds are two daggers of exceptional size discovered at the top of the site. One has a slightly broken tip and is 13.6 cm long, 4.8 cm wide and 1.2 cm thick (Charpentier et al., 2012, fig. 8/1), and was shaped by a soft-percussion tool. The second is complete and measures 14.4 cm long, 3 cm wide and 1.3 cm thick, shaped by a soft-percussion tool and then by pressure (Charpentier et al., 2012, fig. 9). Both pieces are made from large flint blades, most likely come from Jebel Saffân (located 110 km away), as is visible from the technique and raw materials used (Charpentier, 1999).

3.2.9 | Al-Khuwaymah (Middle and Late Neolithic)

A third main concentration of high-potential preserved sites is al-Khuwaymah. The site was dated to 5300–4300 cal. BCE and, similarly to other areas located on headlands between the sea and the lagoon, it was re-occupied by a later necropolis (Charpentier et al., 2012). Khuwaymah archaeological sites range in extension and chronology. Indeed, KHU-1 to KHU-5 show traces of several phases of occupations from the Neolithic to the Iron Age (Charpentier et al., 2012). At Khuwaymah, three shell middens have been studied (KHU-2, 4–5). Only KHU-2 has a robust preserved stratigraphy (of about 2.3 m) dating between 5294 and 5048 cal. BCE and 4361–4263 cal. BCE (Berger et al., 2013; Charpentier et al., 2012). An extensive excavation (20 m^2) at al-Khuwaymah KHU-2 allowed for identifying the negatives left by circular wooden dwellings fixed on the ground through a long continuous channel measuring up to 4 m in diameter.

3.2.10 | Insular Neolithic: Masirah and Hallaniyya

In Masirah, 127 sites were located, particularly during the 2011–2012 field season. Since then, each campaign on the island has revealed the presence of new archaeological features. The main Neolithic site on the island is on the Ra's Dah promontory (SM-10), dating from the early sixth millennium (5985–5636 cal. BCE) to the beginning of the fifth millennium (3968–3800 BCE) (Berger et al., 2013; Charpentier et al., 2013). This site records the first arrival of humans in the area, most likely in boats with light loads, who brought domesticated fauna and developed extremely specific technology. Fish-catching-related tools are associated with coral containers and many microdrills and beads. Here, the operational chain related to bead production was studied, experimentally reproduced and compared with the archaeological materials (Thomas, 2015). The soft stone and marine shell work is essential at SM-10 and the neighbouring site of SM-5. One of the specificities of both sites is the production of microdrills produced on straight burin spalls, extracted from bladelets, and used in manufacturing ornaments (Figure 6). This chaîne opératoire is absent in other sites along the coast or at Hallaniyya, and currently unique in the recent prehistory of Arabia (Charpentier et al., 2013, 2022; Thomas, 2015).

Alongside the large island of Masirah, we focussed our research in 2014 and 2019 on the small Ḥallāniyyat archipelago (formerly known as Kuria Muria). The survey revealed several intriguing spots for ancient and recent archaeology and ethnographical studies (Charpentier et al., 2022). Al-Hallaniyya HLY-4 site, discovered in 1984 by G. Weisgerber and Al-Shanfari (2015, Site 11.1), was the subject of two test pits. The earliest Neolithic occupations are much later than on Masirah Island. Around 4200–4000 BCE, a Neolithic community settled in the area and introduced goats and dogs. The communities regularly captured large fish, dolphins, sea turtles and nesting birds. From our point of view, the late occupation of Hallaniyya marks the latest step in the conquest of the Arabian Sea (Charpentier et al., 2022). The first occupation of the island is now dated to the end of the fifth to the beginning of the fourth millennium BCE (4500–4200 BCE) and marks the completion of the Neolithic conquest of unreached new territories. Indeed, the first Neolithic boats docked and settled in Masirah Island during the sixth millennium BCE and, 1500 ca. years later, in the Hallaniyyat archipelago.

3.3 | The Bronze Age

The Bronze Age of Dhofar has been identified at various shell middens in Hasik, such as HBM-24 (dated to the third millennium BCE) and HBM-4 (dated to the second millennium BCE), the latter yielding thick layers rich in sea turtle bones and a long point with a socket at the base (Figure 9: 1). At the same time, many cairns were found, although it was impossible to attribute them to a specific chronological period. Before any excavation could be done, construction work destroyed the site.

One of the mission's most significant discoveries is undoubtedly the evidence of the Umm an-Nar period (2600–2000 BCE) well beyond its previously known territorial limits (Ra's al-Hadd, Ra's al-Jinz, Asseelah). Thus, on Masirah Island, three sites of this period were detected: two at Marsis and one at the Jebel Saffaiq with its fortified site, settlement and necropolis of the Hafit and Umm an-Nar periods. Black slip jars, pedestal dishes and carnelian beads (Figure 9: 3) are present in this early Bronze Age settlement.

Since 2017, the anthropologists of the team (O. Munoz and H. Guy) have been excavating one of the main Umm an-Nar graves of Jebel Saffaiq. Human remains and material cultures are under study. However, identifying collective

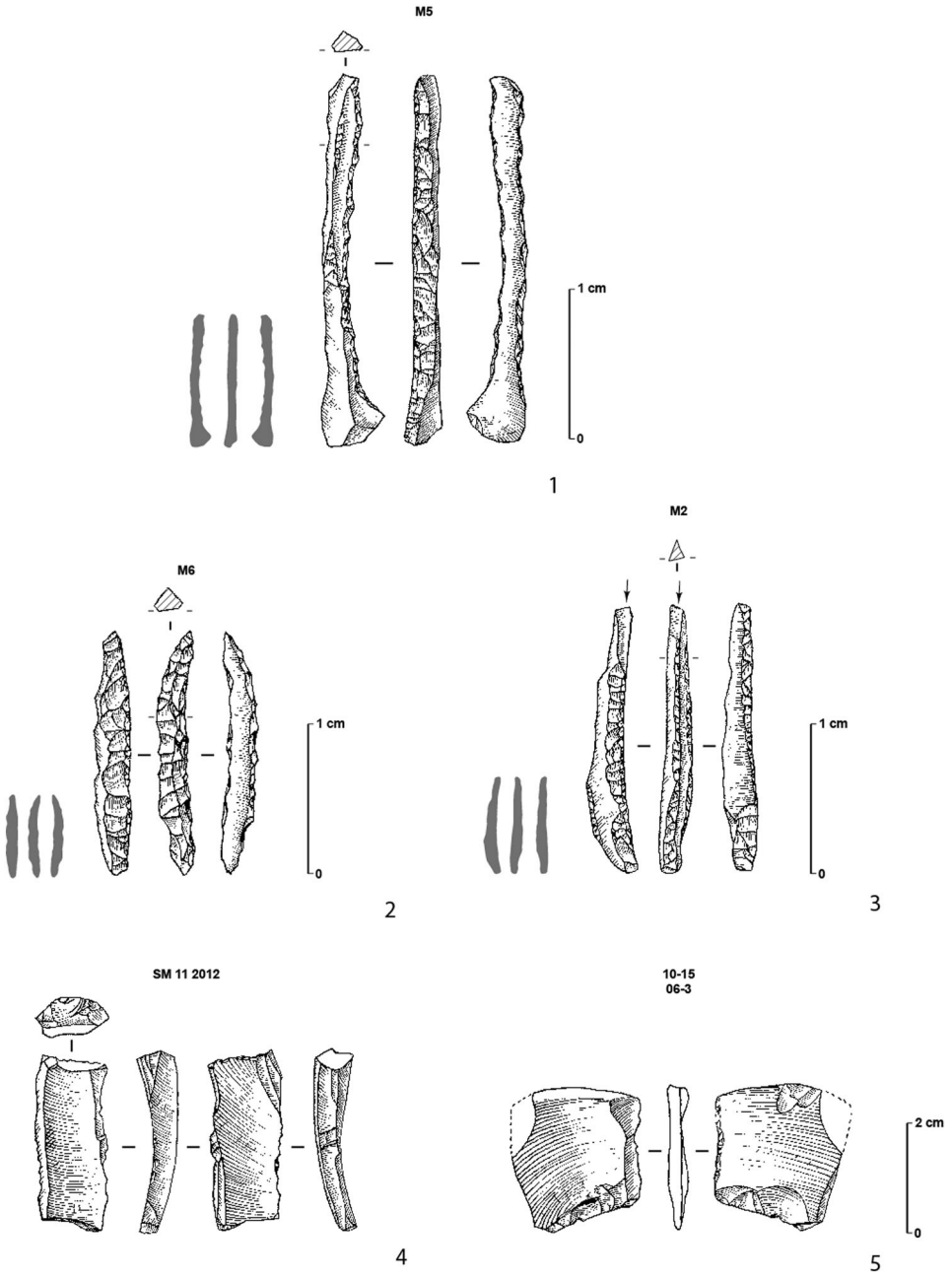


FIGURE 6 Microdrills on burin spall from Ra's Dah SM-10 (1–3); burin on blade used as core, SM-10 (4); pièce esquillée from Ra's Dah SM-10 (5). The actual size is reported in black. *Source*: Drawing by G. Devilder.

tombs from the Hafit (3100–2600) and Umm an-Nar (2600–2000) periods was new on the island, widening the extension of what was previously considered to characterise the northern and central regions of Oman and the UAE.

On the mainland, two sites revealed the Bronze Age Period: Ra's Jibsh JBH-1 and Khuwaymah KHU-1. The site of Khuwaymah KHU-1 revealed some micaceous pottery sherds, including a red slipped specimen, which confirms the presence of the Umm an-Nar period and the contacts with the Indus civilisation. A globular carnelian bead (with a Larsa-type removal) discovered in 2010 is part of the assemblage. However, the black slipped jars, characteristic of the Indus, have not been found until now.

3.4 | The Umm an-Nar period at Ras' Jibsh

The pottery sherds collected at the surface of Ra's Jibsh comprise more than 300 specimens. Among them, some of the more relevant are the Indus pottery fragments. These ceramics generally present micaceous red, fine red, and sandy

beige bodies (Blackman & Méry, 1999). One of the most characteristic elements is the black slipped jar, made in a micaceous red paste, linked to transporting goods and dated between 2500–2400 and 2100–2000 BCE. Similar items have been recognised in several coastal and inland settlements in Oman and the UAE and regionally, at Ra's al-Hadd (HD-1, HD-5), Ra's al-Jinz (RJ-2, RJ-3) and Suwayh SWY-3 (Borgi et al., 2012; Cleuziou & Tosi, 2000, 2007; Méry, 2000). At Ra's Jibsh, the ceramic assemblage belonging to the Indus Civilisation is not limited to the jars but rather a range of pottery containers of various sizes and shapes, including cooking pots (Figure 7: 1–5) and thin-walled pots decorated with black painted motifs (Figures 6 and 7).

One of the Ra's Jibsh sherds, belonging to an impressed dish (Dales et al., 1986), bears a series of impressions on one side, regularly imprinted into the clay before heating (Figure 7: 7). Characteristic of the Indus civilisation and widely distributed in the Omani Peninsula, dishes with pedestals have been identified at Ra's al Hadd HD-1 (Blackman & Méry, 1999) and, more recently, on Masirah Island (Charpentier et al., 2013). Fragments of perforated jars produced in different pastes are numerous in the Ra's Jibsh pottery assemblage (Figure 7: 8–10). Coming from Indus workshops are also the straight-walled vessels with multiple perforations, 50 cm high (Frenez, 2018). Present in different contexts of the Ra's al Jinz RJ-2 settlement (Cleuziou & Tosi, 2000), they are uncommon at Ra's al Hadd HD-1 (Cattani et al., 2019, fig. 5a). Locally made pottery is the best represented class in this ceramic assemblage (Figure 8: 1–6). The wares can be sandy, coarse red or fine red. They are often ordinary pots, sometimes with simple geometric decorations, painted in black (chevrons, lines and undulations), and find parallels in the Ra's al-Jinz RJ-2 assemblages (Cleuziou & Tosi, 2000).

During the various surveys, this vast site has yielded different metal objects, such as large, flat, diamond-shaped copper or bronze blades (Figure 9: 2). This spearhead (or dagger), extremely thin, without midrib, must have had a short, flat tang. This spear belongs to the Early Bronze Age and finds good parallels in the material culture of the Indus Civilisation, including, for example, Mohenjo-Daro (Marshall, 1931), Dholavira (Bisht, 2015) and Chanhu-Daro (personal communication, A. Didier, 2021). Harappan metal objects are infrequent in the Omani peninsula, except for a few axes and rare spears, notably those from Ra's al-Jinz RJ-2 and Suwayh, Bani Bu Ali and SWY-3 (Cleuziou & Tosi, 2000, 2007; Méry & Marquis, 1998).

Two bronze or copper rods were also found (Figure 9: 4). The production of small copper rods, usually circular in diameter, is a characteristic of Early Bronze Age metallurgy. The two rods from Ra's Jibsh, one of which is broken, have a quadrangular cross-section, similar to those found in many coastal habitats of this period (e.g., Ra's al-Jinz, Ra's al-Hadd, Umm an-Nar; Cattani et al., 2019; Cleuziou & Tosi, 2000; Frifelt, 1995)—both present traces of vegetable rope embedded in heavy oxidation. Observation at the scanning electron microscope showed that the fibres enveloped the stems to hold them together. Recently, excavations at the third millennium site of Ra's al-Hadd HD-1 have revealed traces of fibre on 22 copper objects, including 14 fishhooks[9] (Cattani et al., 2019; Valsecchi-Gillmeister, 2017).

The soft-stone production consists of five chlorite vessels belonging to the 'recent series' (Figure 8: 7–9; de Miroschedji, 1973) or Umm an-Nar type (David, 1996). Three of them have a decoration of double dot circles; one is undecorated, while the last sherd belongs to a truncated conical container decorated with incised parallel horizontal lines. The first of the two entire bowls is hemispherical and belongs to 'Type 1B' (Figure 8: 8), while the second is a 'Type 1A' bowl (Figure 8: 7; David, 1996). They all find close parallels in the Ra's al Jinz RJ-2 assemblage (Cleuziou & Tosi, 2000; David, 2011). Until recently, the habitats of Ruways RWY-2 and Suwayh SWY-3 in the Ja'alan were the southernmost sites yielding this kind of specimen (Méry & Marquis, 1998).

The production of bowls decorated with horizontal stripes is not frequent. However, they have been recognised, for instance, at Ra's al-Jinz RJ-2, Bat (Tomb 155), DLA of Hili and Bahrain (Cleuziou & Tosi, 2000, fig. 10.1; David, 2011, fig. 227; Frifelt, 1975, 17e; Schmidt & Döpper, 2014, fig. 7d).

The 'recent series' production started around 2300 BCE and extended until 2000 BCE. The soft-stone vessels from Ra's Jibsh are similar to those of periods III and IV of Ra's al-Jinz 2, 2300–2100 BCE and 2100–2000 BCE, respectively. The truncated cone-shaped cups incised with parallel lines from RJ-2 are dated to 2300–2100 BCE. However, the truncated cone shape and decoration already seem to announce specific characteristics developed in the 'Wadi Suq series' productions of the early second millennium (Azzarà & De Rorre, 2018; Cleuziou & Tosi, 2000; David, 2011).

All of the goods from the Indus Valley suggest an Early Bronze Age occupation between 2500 and 2400 and 2100 BCE at Ra's Jibsh, while the chlorite ware of the 'recent series' covers a period between 2300 and 2000 BCE. Ra's Jibsh might be contemporary to Ra's al-Jinz 2 Period II–IV (between 2500–2400 and 2100–2000).

3.5 | The Middle Bronze Age of Khuwaymah

The Wadi Suq period was attested long ago on Masirah Island (Weisgerber & Al-Shanfari, 2015), but no sites were reported on the adjacent mainland shores. The site of Khuwaymah KHU-1, datable to the Bronze and Iron II Ages (based on pottery production), has revealed a preliminary trace of it through the discovery of a beaker-shaped pottery sherd (Figure 8: 11). This fragment shows a straight-walled beaker, with a decoration of opposite

[9]The fibres are under study.

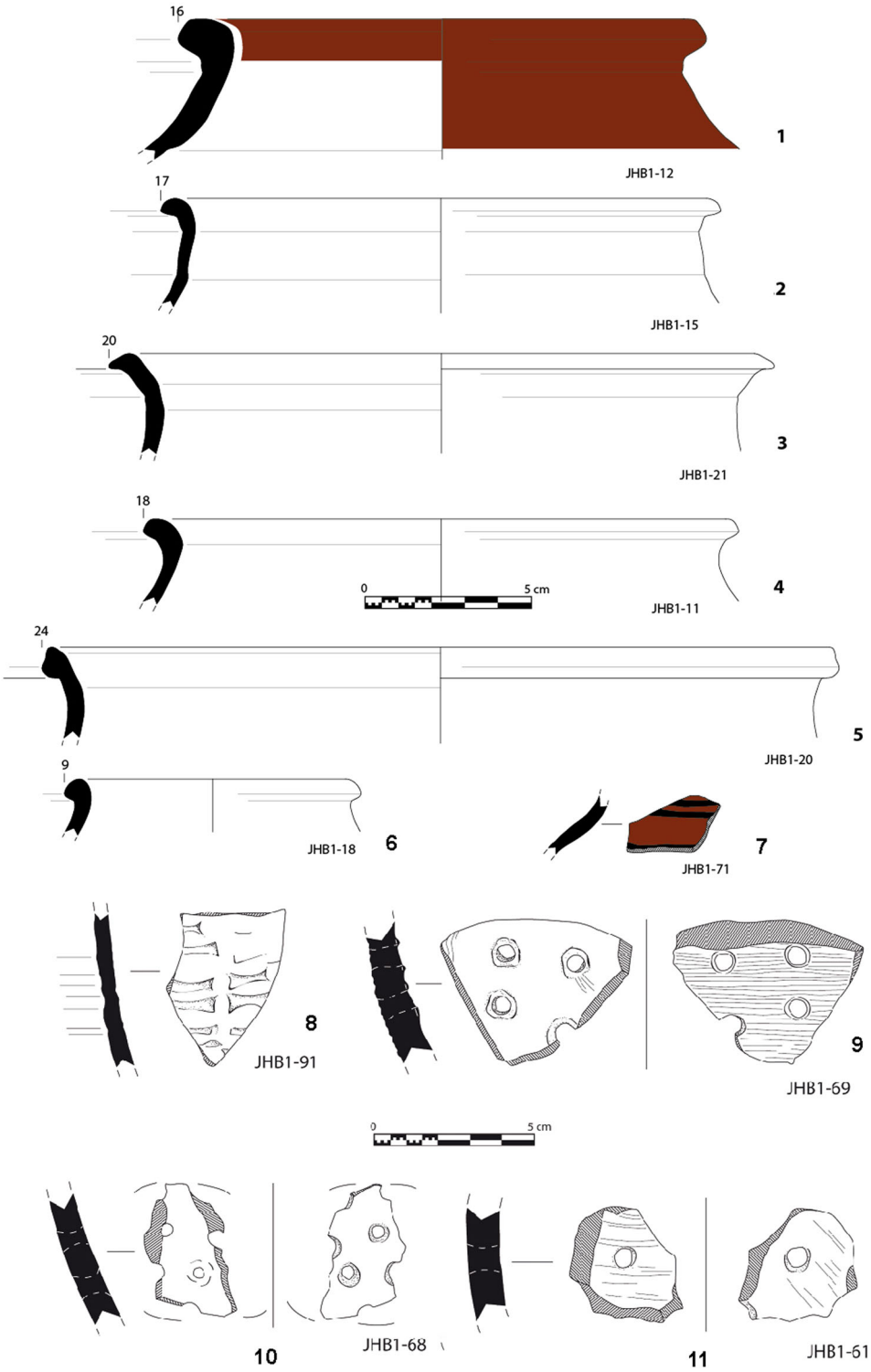


FIGURE 7 Indus pottery from Ra's Jibsh JBH-1. Cooking pots of different sizes (1–6); thin-walled pot decorated with black painted motifs (7); fragment of an impressed dish (8); fragments of perforated jars (9–11). *Source*: Drawings by C. Verdellet. [Color figure can be viewed at wileyonlinelibrary.com]

semicircles and vertical lines combined with curves, typical of the early Middle Bronze Age at an early phase of the Wadi Suq Period (1900–1600 BCE). It finds close parallels, for example, at Shimal, graves 102 and 103 (Donaldson, 1984; Velde, 2003; Figure 2: 5) in the Ra's al Khaimah Emirate. Significant examples were discovered here during the 2009–2010 surveys at Jezirat al Hamra JH-64 (Méry & Charpentier, 2010). The discovery of five Early Bronze Age settlements on the mainland and Masirah Island, extending beyond the territorial limits of

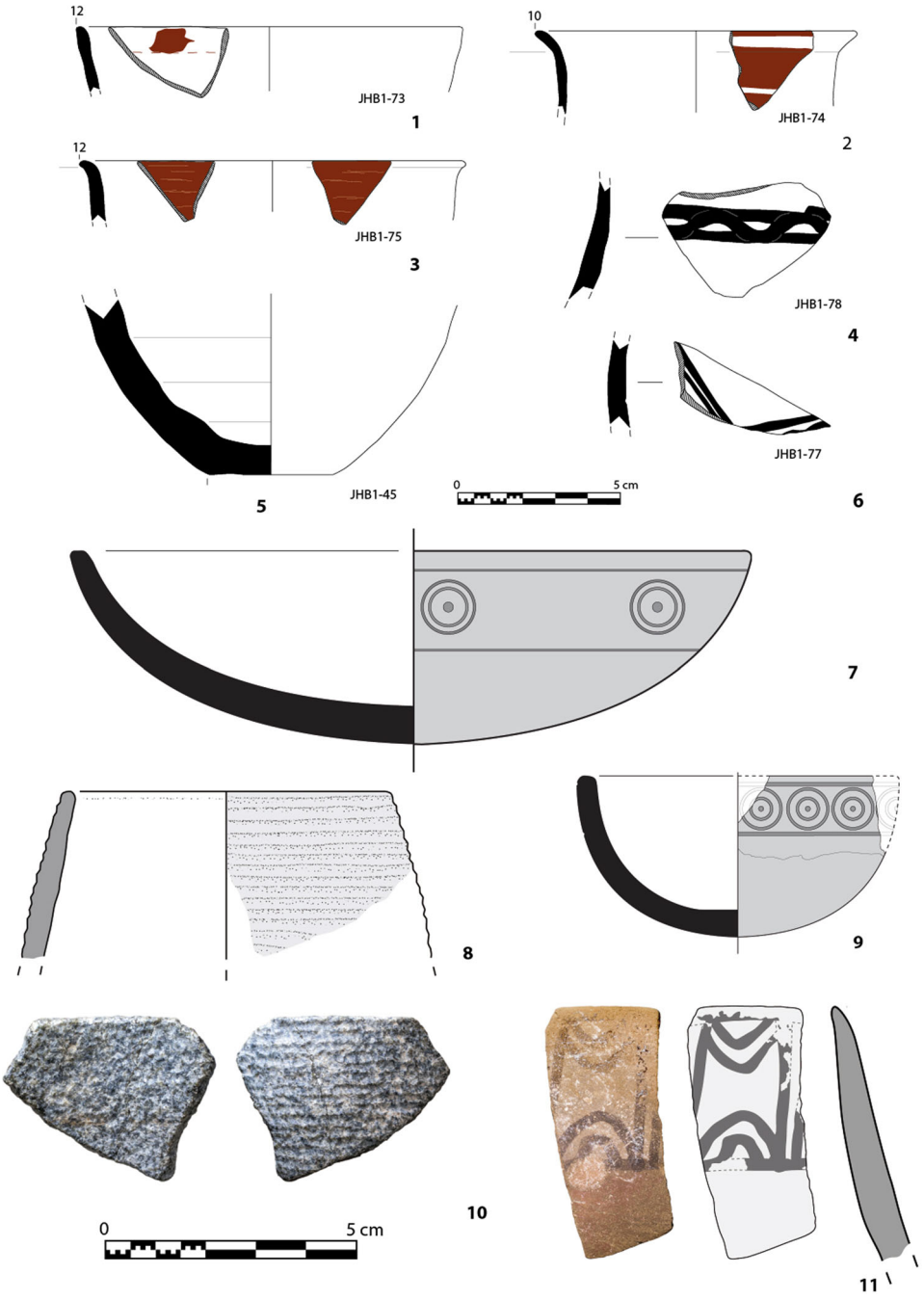


FIGURE 8 Artefacts from Ra's Jibsh JBH-1 and Khuwaymah KHU-1. Umm an-Nar pottery sherds (1–6) and soft-stone vessels from Ra's Jibsh (7–10); Wadi Suq beaker fragment from Khuwaymah KHU-1 (11). *Source*: Drawings by C. Verdellet and H. David. [Color figure can be viewed at wileyonlinelibrary.com]

the known Hafit and Umm an-Nar occupation, is one of the significant achievements of the mission. More than 130 km from Ra's al-Hadd, the settlements of Ra's Jibsh and Khuwaymah show that the Wahiba Desert cannot be addressed as a natural barrier for the EBA human groups (Charpentier et al., 2012). Between Ra's al-Hadd and Masirah, a new series of landing points for the navigation and exchange networks in the Bronze Age is now attested along the Arabian Sea.

4 | CONCLUSIONS

In synthesising the latest discoveries and research path of the Arabian Seashores project, we attempted a summary of the new perspectives developed for studying the Omani Arabian Sea coast from the Final Palaeolithic to the Bronze Age (8500–2000 BCE). The development of specific knapping technologies, settlement strategies, subsistence economy, the circulation and exchange of

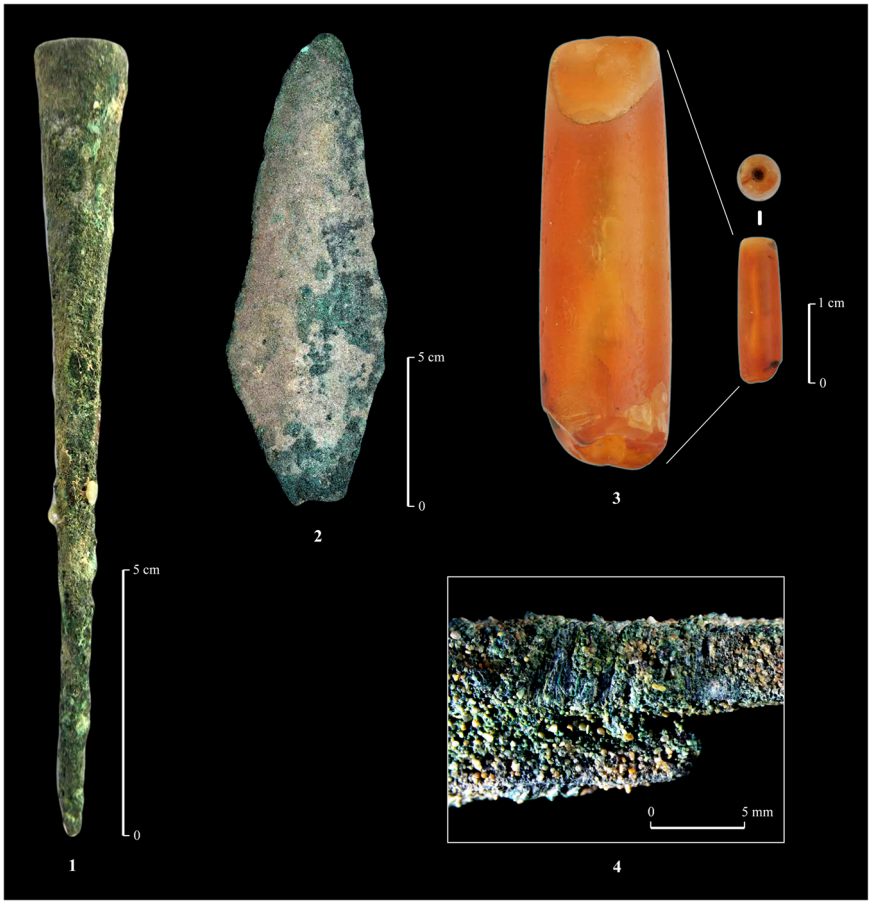


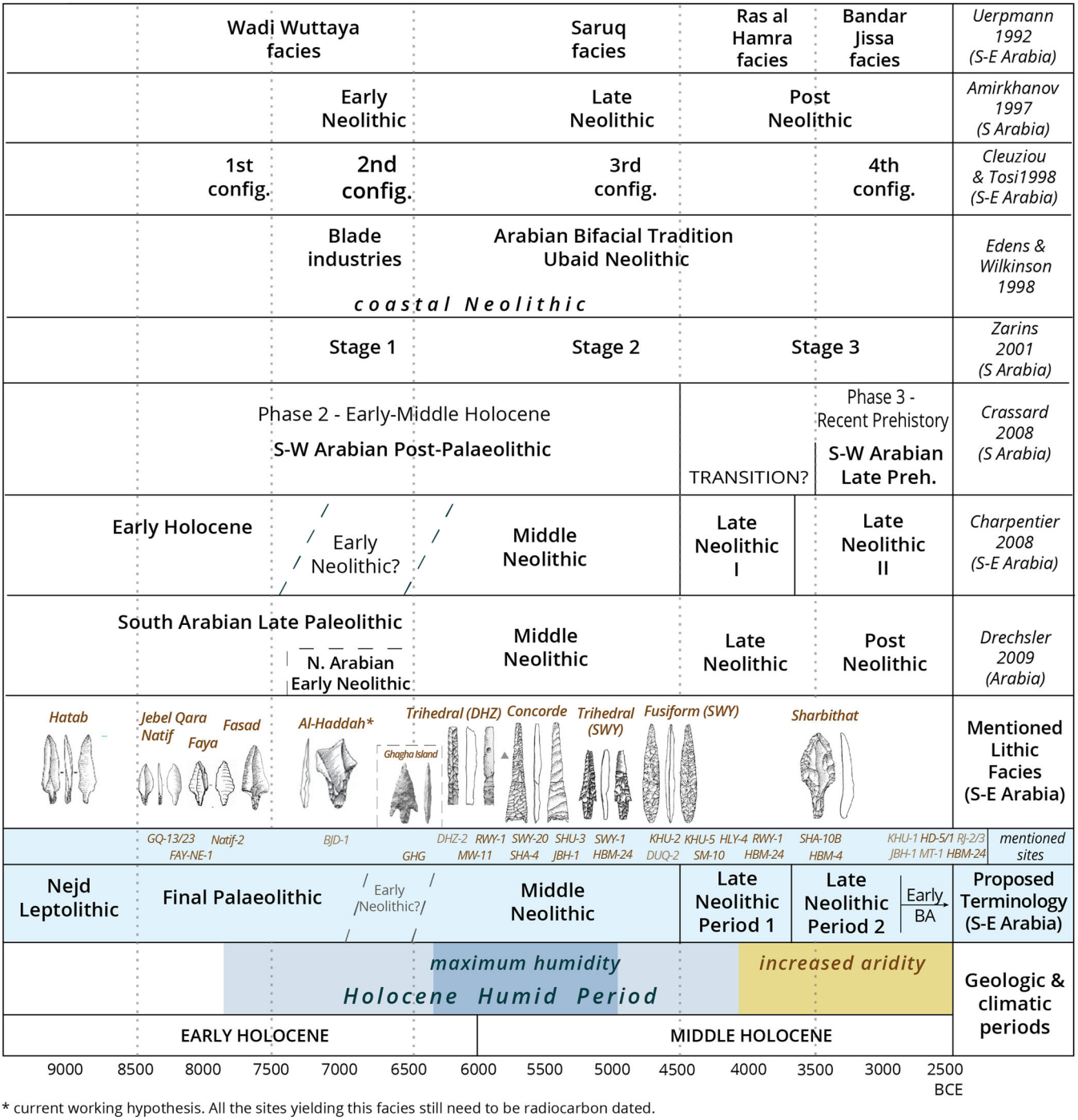
FIGURE 9 Bronze Age artefacts from Ra's Jibsh JBH-1, Masirah Island and Hasik. Copper/bronze point with a basal socket from Hasik HBM-4 (1); Indus spear point from Ra's Jibsh JBH-1 (2); Indus long carnelian bead from Jebel Saffaiq MT-1 (3). Detail of two copper/bronze rods: both present traces of vegetal rope embedded in heavy oxidation (4). *Source*: Photos by J. Vosges and C. Moulhérat. [Color figure can be viewed at wileyonlinelibrary.com]

socially significant artefacts and changes in funerary practices all support the idea of autonomous, locally developed Neolithic cultures. When placing prehistoric Oman in its broader peninsular context, several relative and absolute chronology issues arise (Figure 10).

Despite being a term related explicitly to the geological periods, the latest publications related to the final phase of the Palaeolithic often report 'Early Holocene' societies, referring to nomadic and seminomadic human groups living by hunting and gathering but also on the exploitation of marine resources (as in Natif, Charpentier et al., 2016). J. Rose (2006) initially referred to sites bearing unidirectional blade technology as 'Nejd Leptolithic', successively revised into 'Late Palaeolithic' (Hilbert et al., 2012), which included 'Hatabian' facies (12–10 ka) and 'Khashabian' facies (10–7 ka; Hilbert, 2014). Recently, he has combined these facies under the unique term 'Epipaleolithic' (Rose, 2022). However, the terms Mesolithic and Epipaleolithic have specific typological, chronological and economic connotations linked to the prehistory of Europe and the Levant. At the same time, given its wide diffusion across south-eastern Arabia, the definition of 'Fasad' facies continued to spread (Charpentier, 1996; Charpentier & Crassard, 2013). In 2008 R. Crassard suggested using 'Post-Palaeolithic' for south-western Arabian Early and Middle Holocene complexes.

Nevertheless, using several terms related to the same complex might be misleading. Due to the sparse radiocarbon data, we still need to fix the whole technocomplex to a defined chronological phase (for instance, Natif, Faya, Jebel Qara KR213 and Hatab have all been dated with different methods). As no proof of animal husbandry has been collected from the available stratified context, and the technical exploitation of bladelets seems to derive from the Upper Palaeolithic one, we associate the Fasad technocomplex with a generalised Final Palaeolithic phase. What is here reported as Final Palaeolithic represents something different from the Upper Palaeolithic cultures and refers to the Fasad technocomplex (Figure 10). In this period of Arabian prehistory, the growing divide in cultural behaviours found along the Gulf coast where the bidirectional blade technology of Qatar-B versus that of the Arabian interior is highlighted.

During the Early Holocene, human groups in different parts of Arabia began experimenting with new subsistence strategies. Seminomadic communities exploited the coast and the interior, procuring marine and terrestrial resources available at different times of the year. In a subsequent phase, the Holocene Climatic Optimum offered these populations abundant freshwater and biomass (Rose, 2022). It is precisely in this period,



* current working hypothesis. All the sites yielding this facies still need to be radiocarbon dated.

FIGURE 10 Comparative table of all the theorised chronologies for Arabian/Southern Arabian Neolithic. The used abbreviations for sites names are listed here: Ad Dahariz (DHZ), Suwayh (SWY), Sharbithat (SHA), Wadi Attabarran (HBM24), and Wadi Hasik (HBM-4), Khuwaymah (KHU), Ra's Jibsh (JBH), Wadi Samhal (SHL), Shuwaymiyah (SHU), Duqm (DUQ), Ruways (RWY), Al-Haddah (BJD), Ras al Jins (RJ), Ras al Hadd (HD), Ras al Hamra (RH), Hallaniyya (HLY), Ras' Dah/Sur Masirah (SM), Jebel Saffaiq (MT), Marawah (MW), Ghagha Island (GHG). The last four records report the terminology proposed by the authors, associated with the main lithic facies, the approximate chronology of the mentioned sites and geological-climatic periods mentioned in the text. The site names in light orange refer to the sites without absolute date. *Source*: Modified after Maiorano (2020). [Color figure can be viewed at wileyonlinelibrary.com]

roughly ranging between 7500 and 6500 BCE, that the beginning of the Neolithic is expected (Figure 10). However, a clear Early Neolithic still needs to be recognised in the Oman Peninsula, though clear Early Neolithic phases have been recognised in Qatar and the desert fringes of the Rub al Khali in Saudi Arabia. Human communities within the Gulf basin transformed into stable and possibly permanent societies that developed seafaring, long-distance trade networks, and villages with public architecture (Beech et al., 2022).

After 6500 BCE, the domesticated goat was introduced into southern Arabia, most likely by small groups of herders, heralding the Neolithic within the Peninsula (Martin et al., 2009; Uerpmann et al., 2009). The rapid spread of domesticated cattle and goats across the Arabian Peninsula speaks to the adaptive success of animal herding during the Holocene Humid Period, allowing human communities high mobility with a constant source of nourishment (Rose, 2022; Figure 10). In Oman, particularly in southern regions, some cultural features show strong and even long-distance connections with central and eastern Yemen, as demonstrated by the jade trade and the fluting technique (Al Kindi et al., 2021; Crassard et al., 2020). However, most finds were manufactured from locally available materials, showing that the transfer of knowledge was more impactful than the transfer of materials themselves. The distinctive development of specific technological features such as the fluting, parallel covering retouch and the spread of Concorde type draws a virtual cultural cut in the Abu Dhabi region, where the influence of the lower Gulf culture seems to stop and leave space to the autochthonous development of southern and south-eastern Arabian 'Neolithics' (Figure 10). As demonstrated through the excavation in Marawah, here, human communities built well-structured architecture, produced plaster vessels and maintained some domestic animals. At the same time, they continued to hunt and relied primarily on marine resources (Beech et al., 2022; Lidour & Beech, 2020).

At the beginning of the fourth millennium BC, increasing aridity destabilised the human groups that lived in the Gulf as well as in Inner Arabia (Figure 10). The presence of stone structures at SHA-10 suggests that the increased aridity and physical constraints might have played a role in the isolation of certain human groups that experimented, adapted and developed their own specificities and sustenance systems, relying almost exclusively on marine resources. This is evident in all of the fourth millennium sites along the coast. At this stage of the Late Neolithic, sites along the coastal traits of the Sharqyyiah show common cultural traits, as well as those in Muscat and Northern Shaqiyyah. What once was fractioned into several Neolithic facies (Ras al Hamrian, Saruq, Bandar Jissa, Shabian, etc.) now assumes a different aspect, mainly settled on broader technological markers and environmental components. However, we are sure that the proceeding of fieldwork, geomorphological and paleoenvironmental research, together with faunal studies, will change and refine the picture again.

5 | FUTURE DEVELOPMENTS

Further excavations on Sharbithat SHA-10, SHA-4, Natif-2 and DHZ-2 have been planned for the following years. They will continue providing additional insights into the transition between Final Palaeolithic and Neolithic cultures in southern and south-eastern Arabia. Moreover, the development of new analytical methods[10] and the additional data gathered from interior Oman and desert regions (e.g., Al Kindi et al., 2021; Maiorano, Al Kindi, et al., 2020), together with new prospection in peculiar areas such as the Jazir Plain, will permit further investigations in terms of the distribution of assemblages and formation of settlements. Neolithic settlement patterns and subsistence strategies combined with coastal and desert trades identify interrelated human groups within southern and south-eastern Arabia, in contrast to other Neolithic communities elsewhere in the Levant, northern Arabia and the upper Gulf. With upcoming work, we aim to further the knowledge of Final Palaeolithic societies and their relationships with Early Neolithic ones. First, it must be assessed whether an Early Neolithic period in south-eastern Arabia has precise specificities or is a feature extending up to the lower Gulf (as the Qatari PPNB). At the same time, it can be merged with what has always been reported as Middle Neolithic in Oman and the Eastern UAE. For this purpose, the identification of cultural transmission paths, the relation between the desert and the coast, seasonality and population movement patterns are still of central importance. Climate change is not the only variable that determines human cultural development. Cultural change, technological innovation and cultural transmission processes have been little studied in complex areas like the Arabian Peninsula. However, we are confident that the latest development and the rapid improvement of scientific approaches and methodologies in archaeological exploration will help us unravel the ancient history of this exceptional region.

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[10]Started with the quantitative analysis conducted by Maria Pia Maiorano in her PhD thesis 'A quantitative analysis of change in Neolithic projectile points of southeastern Arabia (eigth–fourth millennium BCE)', 2020, University of Naples 'L'Orientale'.

help of the local population who welcomed and supported our field activities. Finally, we wish to thank all the colleagues who took part in the mission and contributed to its success with their experience, including Andrea Zerboni, Jean-François Berger, Rémy Crassard, Olivia Munoz, Marc Lacaze, Hervé Guy, Jean-Loic Lequellec, Philippe Béarez, Gourguen Davtian, Mauro Cremaschi, Elena Maini, Frederique Duquesnoi, Anaïs Marrast, Yann Ardagna, Adrian Barra, Eleonora Fortini, Mohammed Al-Kindi, Martin Pickford and Dominique Gommery. Open Access funding enabled and organized by Projekt DEAL.

DATA AVAILABILITY STATEMENT

The data supporting this study's findings are available from the Ministry of Heritage and Tourism of the Sultanate of Oman. Restrictions apply to the availability of these data, which were used under license for this study.

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