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# THE EARLY HOLOCENE FLORA OF THE SOUTHERN PART OF THE WESTERN DESERT OF EGYPT

**ABSTRACT**

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The article summarises archaeobotanical data and discusses the importance of plant remains for the reconstruction of ancient flora and vegetation during the development of Neolithic settlements in the southern zone of the Western Desert of Egypt. Such an attempt is possible thanks to archaeological and botanical research carried out there for many years. These studies have led to the identification of numerous plant remains that were found at different sites inhabited by nomadic tribes in various humid interphases of the Holocene.

The recognised subfossil flora includes at least 52 taxa. Archaeobotanical assemblages from individual sites are neither very diverse in plant species nor abundant in plant remains. The exception is Site E-75-6 at Nabta Playa, which yielded exceptionally rich plant material. The most favourable period for the development of flora, vegetation and settlement occurred during the Holocene Climatic Optimum, correlated with the El Nabta and Al Jerar settlement phases. This period was characterised by a relatively rich flora that grew in various habitats in the vicinity of the former settlements.

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# INTRODUCTION

In 1972, the Combined Prehistoric Expedition (CPE), founded in the early 1960s, began research and excavations in the Western Desert of Egypt, which have continued almost uninterruptedly ever since. As a result, dozens of prehistoric sites, with chronology ranging from the Lower Palaeolithic to the Neolithic, have been explored. Studies looking at early and middle Holocene settlements on the outskirts of dried-up palaeolakes (playas) in the southern part of the Western Desert proved to be particularly interesting. In 1974-1975, 1990-1992, 1994, and 1996-2008, work continued in the area of Nabta Playa, a fossil


**Fig. 1.** Location of fossil lakes (playas) with evidence of early and middle Holocene settlement activities in the Western Desert of Egypt (compiled by Przemysław Bobrowski, drawing by Paweł Wiktorowicz)

lake located at the foot of the mountain with the same name (Gebel Nabta). Some time later, the CPE explored several other settlements: in the area of Nab El-Dieb, another fossil lake not far from Nabta Playa (2000-2003); in the area of Gebel Ramlah (2000-2002, 2009-2022); and in the area of a palaeolake at Bargat El-Shab (2005-2006, 2011-2012, 2017-2019) (Fig. 1, see also Bobrowski *et al.* 2010; Schild 2019).

The excavations and interdisciplinary studies in the Nabta and Kiseiba area have made it possible to propose an early and middle Holocene chronological sequence, supported by a long series of radiocarbon and OSL datings. Spanning from the 11th to the 3rd millennium BC, the sequence includes seven humid climatic interphases separated by dry periods. Each humid period in the Western Desert was associated with the presence of specific hunter-gatherer and pastoralist groups (technocomplexes): El Adam (9250-800 cal. BC), El Ghorab (7550-7150 cal. BC), El Nabta/Al Jerar (6950-6150 cal. BC); Ru'at El Ghanam (5950-5550 cal. BC), Ru'at El Bagar (5450-4650 cal. BC), Bunat El Asnam (4550-3550 cal. BC) and Group C (2350-1350 cal. BC) (Schild and Wendorf 2013; Bobrowski *et al.* 2021, 15, tab. 1).

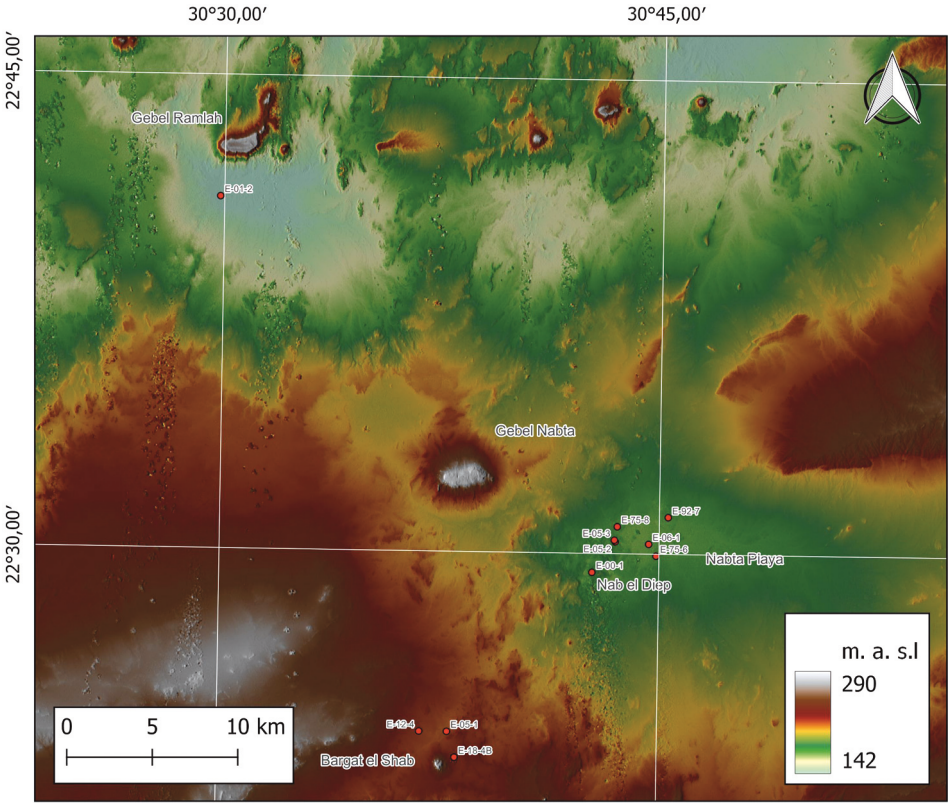


**Fig. 2**. Western Desert sites with sub-fossil flora remains
(compiled by Przemysław Bobrowski, drawing by Paweł Wiktorowicz)

The CPE has always been known for its multidisciplinary research approach. It has placed particular emphasis on archaeobotanical studies looking at the history of vegetation and plant use. This approach has allowed the reconstruction of past vegetation and plant life at and around the studied sites. This paper discusses the analysis of macroscopic plant remains, including seeds and, fruits and charcoal found during the exploration of eleven archaeological sites in the area of Nabta Playa, Nab el Diep, Gebel Ramlah and Bargat El-Shab. The chronology of those sites spans from the oldest Holocene settlement phase in the Western Desert (El Adam) through to the final Neolithic (Bunat El Asnam) (Fig. 2). The sites where macroscopic remains were found are presented below, with references to the aforementioned chronological sequence.

Botanical research in the southern part of the Western Desert of Egypt has helped identify a large number of plants over a dozen archaeological sites. The vast majority of the materials from the Nabta Playa, Gebel Ramlah, Nab El-Dieb and Bargat El-Shab sites have been published (*e.g.*, Neumann 1989, 1989a, 1993; Barakat 1995; 1995a; 1996; 2001; Wasylikowa 1997; 2001; Wasylikowa *et al.* 1995; 2001a; 2001b; Butler 2001; Wasylikowa and Lityńska-Zając 2012; Bobrowski *et al.* 2020; Lityńska-Zając 2010; 2019, in preparation; Lityńska-Zając and Skrzyński 2021). All of those authors have presented reconstructions of vegetation from the individual sites. This paper is intended to provide a summary of archaeobotanical data and discusses the significance of plants in reconstructing the flora and vegetation during the period of Neolithic settlement activity in southern Egypt.

## SITES

The archaeological sites discussed in this paper lie in what is now the most arid part of the Sahara. As mentioned, in some periods of the Holocene, its climate was more humid, and in some periods, the area was located in the transition zone between semi-desert and desert ecosystems. Owing to the lie of the land and the structure of geological strata, water accumulated periodically in the local depressions. Thus, a kind of oases were formed, around which the archaeological sites analysed were located. The conditions at these localities triggered the emergence of relatively abundant vegetation, particularly during the rainy season. In wet periods, human groups would migrate to those locations, attracted by the presence of plant and animal food resources, and water. Traces of settlement activity left by those nomadic communities include graves, houses, various types of pits (including storage pits), wells, post holes, hearths, and campfires, where plant remains have been found.

*Nabta Playa E-06-1* (El Adam)

Site E-06-1 is located in the central part of the Nabta Playa basin, on the eastern shore of an early Holocene lake, on the surface of a phytogenic dune (Fig. 3: B). A few settlement levels were recorded there, associated with the remains of residential structures (huts),

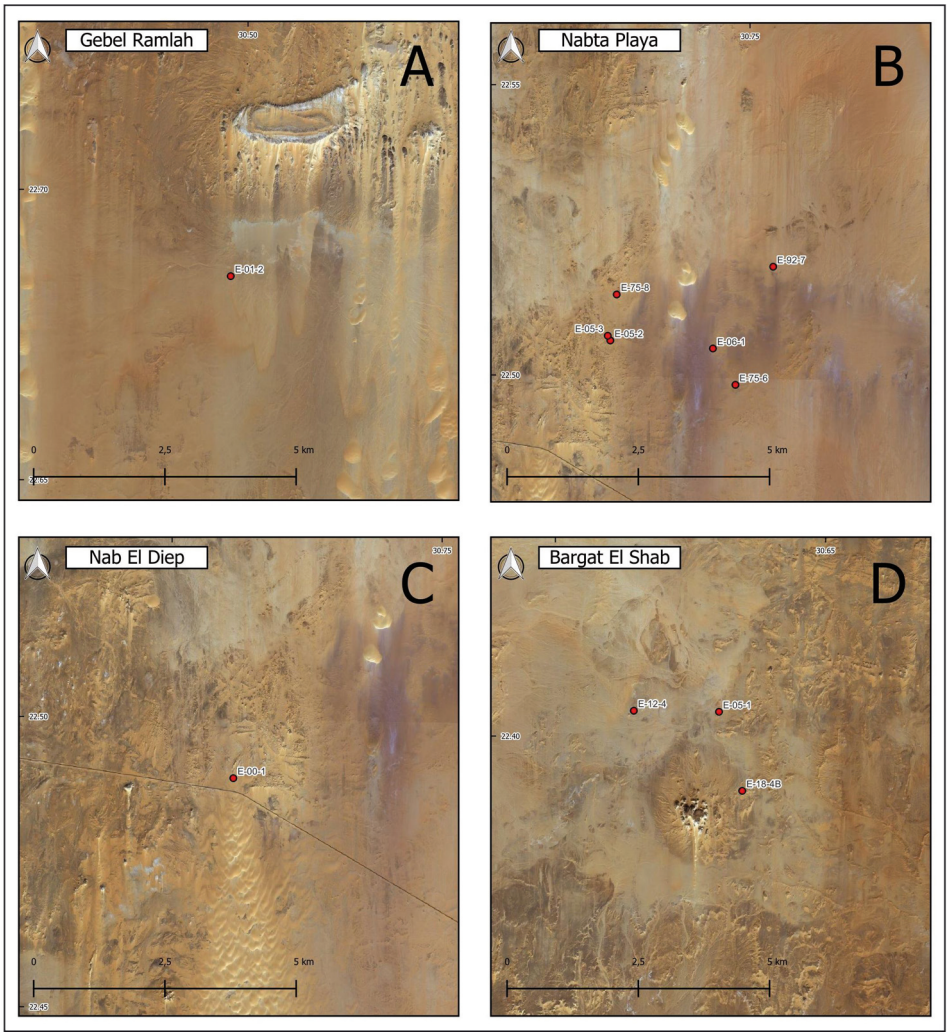


**Fig. 3**. Location of Western Desert sites with sub-fossil flora remains Gebel Ramlah (E-01-2); B – Nabta Playa (E-75-6, E-75-8, E-92-7, E-05-2, E-05-3, E-06-1); C – Nab el-Dieb (E-00-1); D – Bargat El-Shab (E-05-1, E-12-4, E-18-4B) (compiled by Przemysław Bobrowski, drawing by Paweł Wiktorowicz)

hearths and post holes (Jórdeczka 2021, 65-69). All those levels were associated with the oldest (probably recurrent) Holocene settlement activities in the Western Desert, in the El Adam humid interphase. A series of radiocarbon dates obtained from charcoal recovered from residential structures ranges from 8536 to 8011 cal. BC (Jórdeczka 2021, 214, tab. 37). Recorded remains come mainly from foci (*e.g.*, *Citrullus colocynthis*, although in light of recent research, the identification of *Citrullus* seeds at the species level is not justified see: Wolcott *et al.* 2021) and pits (*e.g.*, *Schouvia purpurea*).

*Nabta Playa E-75-6* (El Nabta)

The site is located on the eastern shore of the Nabta palaeolake (Fig. 3: B). Traces of intense Early Holocene settlement activity in the El Ghorab and El Nabta/Al Jerar humid interphase were recorded there. Particularly significant were the traces left by the El Nabta period settlers in the form of numerous bell-shaped storage pits, hearths and a few wells. Owing to the specific preservation conditions, a unique collection of charred plant remains was found in the fills of these structures. The collection comprises more than 20,000 specimens representing more than 130 plant taxa, includes forms determined to the level of species, genus and family, but also those that were described as morphological types, identified based on preserved fruits, tubers, seeds, parenchyma and wood charcoal. The most important find is numerous remains of a wild form of *Sorghum bicolor* subsp. *arundinaceum* (Kubiak-Martens and Wasylikowa 1994; Wasylikowa 1997; Hather 2001; Wasylikowa 2001; Wasylikowa *et al.* 2001a; 2001b; Mazher 2005, 31, 32; Barakat 1995; 1995a; 1996).

*Nabta Playa E-92-7* (Al Jerar)

The site is located on the northeastern shore of the Nabta palaeolake (Fig. 3: B). Traces of intense Early Holocene settlement activity from the El Nabta/Al Jerar humid interphase were recorded there. The examined features included numerous hearths with preserved charcoal. Radiocarbon dating indicates that the Al Jerar period settlement activity at this site continued from 7760±240 BP to 7040+80 BP. Plant remains found here include, among others, seeds of *Capparis decidua* (Fig. 5: 2), grains of *Echinochloa colona* (Fig. 5: 3), charcoal from *Tamarix* sp., and *Acacia* sp. (Wasylikowa *et al.* 2001b; Lityńska-Zając in preparation). Samples for botanical studies were collected from campfires.

*Bargat El-Shab E-05- 1* (El Nabta/Al Jerar)

Site E-05-1 is located near a vast monadnock on the eastern shore of a palaeolake situated at the foot of the distinctive Bargat El-Shab rock massif (Figs 3: D and 4). Over an area of approximately 4 hectares, the researchers found traces of vibrant settlement activity from the Western Desert Holocene optimum coinciding with the El Nabta/Al Jerar humid interphase. Remains of recurrent settlement activity (hearths, storage and refuse pits, individual graves and potholes) were identified in several trenches. The fills of most of the features contained abundant plant materials (Bobrowski *et al.* 2021). The greatest number of macroscopic remains were recorded in and around Trench E-05-1/2, located on one of the two distinct culminations of the monadnock. These came from four hearths (H2, H3, H4, and H6), thirteen pits (P1, P3, P4, P5, P6, P7, P8, P9, P10, P12, P13, P15, and P16) and a pothole (F1) (Lityńska-Zając and Skrzyński 2021, 235, tab. 1). More plant remains were found in Trench E-05-1/5 at the southern end of the site, recovered from the fills of three pits and a hearth (The pits – Feature 2, 4, 7 – with an early Holocene chronology, were found under a mound of a presumed late Neolithic barrow, while a date associated

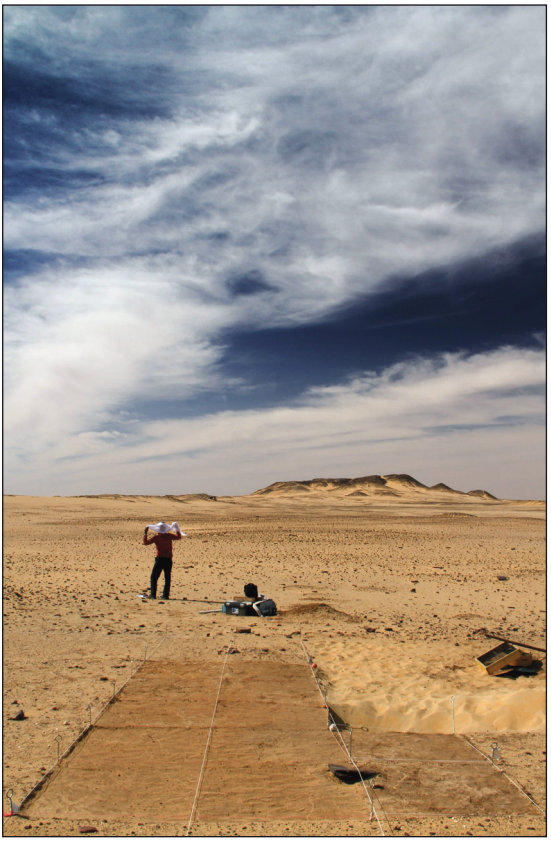

**Fig. 4**. Excavation in Bargat El-Shab at Site E-05-1/2 during research in 2006 (photo Przemysław Bobrowski)

with the settlement phase of the late Neolithic, Ru'at El Bagar, was obtained from a hearth- Feature 1- registered on its surface (see Bobrowski *et al.* 2021, 114, 115, 190), as well as from two other pits (P3 and P4) found in Trench E-05-1/4, in the central part of the site (Lityńska- Zając and Skrzyński 2021, 236, tab. 2, 3). The series of radiocarbon dates for this site spans the period from 7171 to 6232 cal. BC (Bobrowski *et al.* 2021, 190). Plant remains found here include, for example, *Sorghum bicolor* subsp. *arundinaceum* (Fig. 6: 1), *Echinochloa colona* (Fig. 6: 2), *Schouwia purpurea* (Fig. 6: 3), *Grewia* sp. (Fig. 6: 4), *Capparis decidua* (Fig. 6: 5), *Ziziphus* sp. (Fig. 6: 6), and *Astragalus* type (Lityńska-Zając and Skrzyński 2021, tab. 1).

*Nabta Playa E-75-8* (Ru'at El Ghanam)

The site is located on the western shore of the Nabta palaeolake (Fig. 3: B). Traces of intense middle Holocene settlement activity in the Ru'at El Ghanam humid interphase

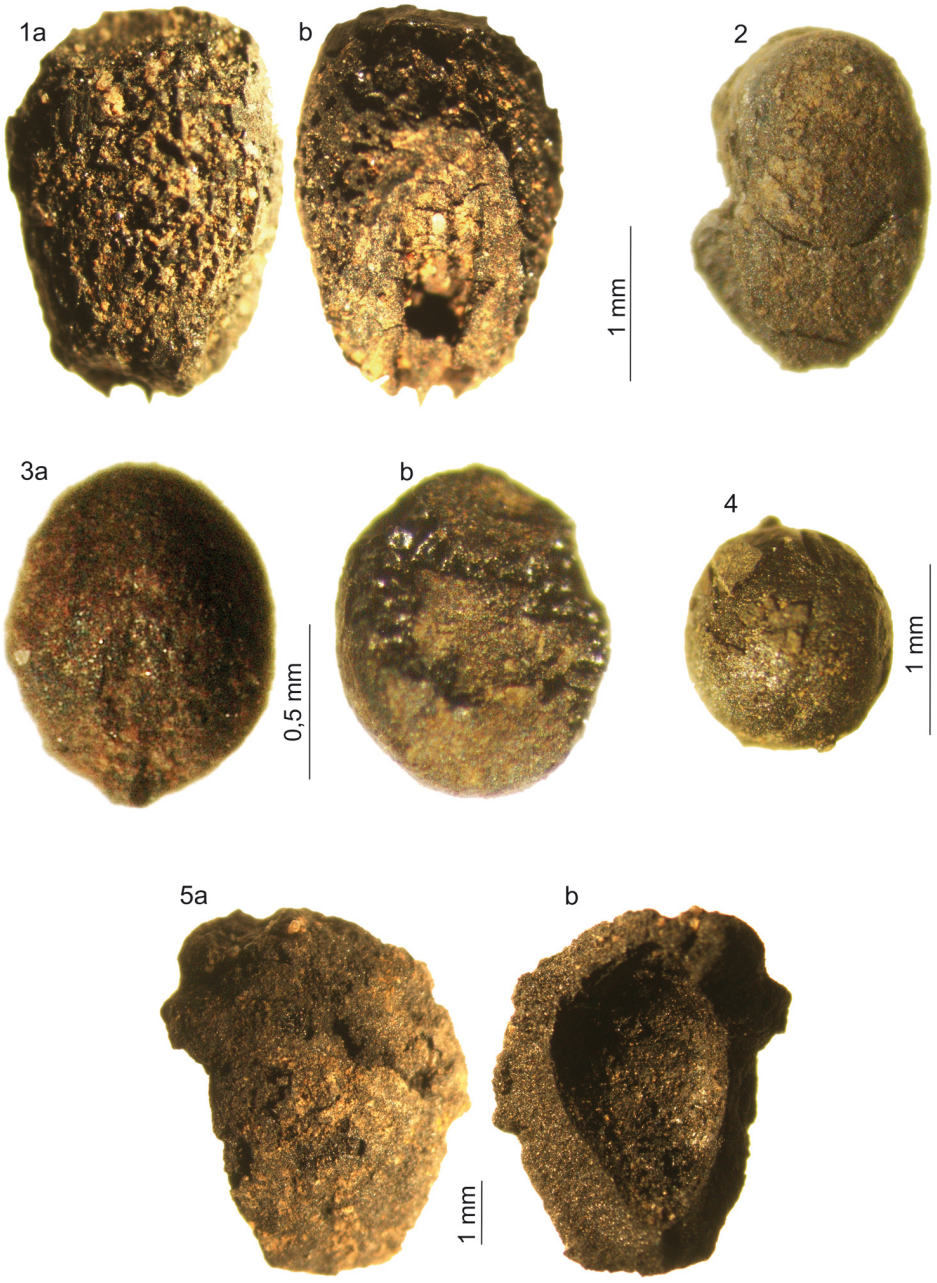


**Fig. 5**. Macroscopic plant remains from different sites in Nabta Playa (photograph by Krzysztof Stachowicz, compiled by Katarzyna Cywa). 1. *Sorghum bicolor* subsp. *arundinaceum*, caryopsis a – ventral and b – dorsal view; 2. *Capparis* cf. *decidua* – seed; 3. *Echinochloa colona*, caryopsis, a – dorsal view, b – ventral view; 4. *Schouwia* cf. *purpurea* – seed; 5. *Ziziphus* sp., a – fragment of fruit stone, b – side with seed cell


**Fig. 6.** Macroscopic plant remains from Site E-01-5 in Bargat El-Shab (photograph by Krzysztof Stachowicz, compiled by Katarzyna Cywa). 1. *Sorghum bicolor* var. *arundinaceum*, caryopsis, a – dorsal view, b – ventral view; 2. *Echinochloa colona* – caryopsis, a – dorsal view, b – ventral view; 3. *Schouwia purpurea* – seed; 4. *Grewia* sp. – half of seed; 5. *Capparis decidua* – seed; 6. *Ziziphus* sp. – broken fruit stones

include numerous pits and hearths. Their fills contained relatively numerous charcoal remains and a number of other finds, such as a few specimens of *Heliotropium* sp. (Wasylikowa *et al.* 2001b; Mazher 2005, 33, 34) and *Ziziphus* (Fig. 5: 5) (Lityńska-Zając in preparation).

*Bargat El-Shab E-12-4* (Ru'at El Bagar)

Site E-12-4 is located on the western shore of the Bargat El-Shab palaeolake (Fig. 3: D). A complex of megalithic features (including barrows, cists, and steles) and hundreds of hearths were identified on a small monadnock and at its foot (Bobrowski *et al.* 2021, 125-142). Plant remains, such as *Echinochloa colona* and *Ziziphus*, were recovered from two campfires near a tumulus containing a child burial (Bobrowski *et al.* 2021, 140, 142). Only a single fragment of an unidentified fruit or seed was found directly in the hearth (H1), while 23 specimens came from its fill (H3). Radiocarbon dates were successfully obtained for both features. The first one was dated to c. 4320-3990 cal BC, and the other one to c. 4780-4500 cal BC. Hence, they seem to be linked with the late/final Neolithic settlement activity in the Western Desert (Bobrowski *et al.* 2021, 190).

*Nabta Playa E-05-2* and *E-05-3* (Bunat El Asnam)

These two sites are part of a complex of prehistoric sandstone quarries associated with the ceremonial centre at Nabta Playa. Located on the western shore of the palaeolake, they were situated in close proximity to the so-called western stele group (Bobrowski *et al.* 2010, 17-21) – see Fig. 3: B. Charcoal fragments were found in the remains of several hearths surrounded by burnt stones, identified in the trenches. Their fills also contained a seed of *Schouwia purpurea* (Fig. 5: 4) and a caryopsis of *Sorghum bicolor* subsp. *arundinaceum* (Fig. 5: 1) (Lityńska-Zając in preparation). Based on the several dates obtained for these finds, they may be reasonably linked with the Bunat El Asnam communities of the final Neolithic.

*Nab el- Diep E-00-1* (Bunat El Asnam)

Site E-00-1 is located on the shore of Nab el Diep, a small playa approximately 5 km south of the Nabta Basin (Fig. 3: C). Traces of final Neolithic settlement activity were recorded there. In the fill of one of the features (pit/hearth), three fragments of the fruit stone of *Ziziphus* sp. were found (Lityńska-Zając in preparation).

*Gebel Ramlah E-01- 2* (Bunat El Asnam)

Site E-01-2 is located on the southwestern shore of the Gebel Ramlah palaeolake (Fig. 3: A). It is the first in a series of Neolithic cemeteries investigated in the area (Kobusiewicz *et al.* 2010; Kabaciński *et al.* 2019). The cemetery consisted of 15 richly furnished burials. Plant remains, usually charcoal fragments, were found in most of them. Two seeds of cf. *Grevia* sp. were found in the fill of one grave (Burial 4), and a single caryopsis of *Sorghum*

*biocolor* subsp. *arundinaceum* was found in another one (Burial 6), deposited in a small vessel (Lityńska-Zając 2010, 242, tab. 7: 1). All the graves are associated with Final Neolithic communities, and the radiocarbon date series ranges from 4700 to 4350 cal. BC (Kobusiewicz and Kabaciński 2010, 119, 120).

*Bargat El-Shab E-18-4B* (Bunat El Asnam)

Site E-18-4b is located on the southern edge of a palaeolake at the foot of the Bargat El-Shab massif (Fig. 3: D). It is a cluster of ritual features consisting of a series of tumuli, stone steles and rings, as well as hundreds of hearths, presumably associated with the Late and final Neolithic settlement activity. The investigated features included a campfire (H1), radiocarbon dated to the middle Neolithic (Ru'at El Ghanam). Its fill contained a single seed of *Malva* sp. (Lityńska-Zając and Skrzyński 2021, 237, tab. 5; Bobrowski *et al.* 2021, 181).

## RESEARCH METHODS

As mentioned, the present study is based on archaeobotanical remains from selected archaeological sites in the southern part of the Western Desert of Egypt. As briefly discussed above, the sites have been dated to different phases of the Holocene. The taxa and the numbers of identified specimens vary from site to site. All of them have been entered into a database, and for the purposes of this study, only those that may carry ecological information (*i.e.*, those identified at least at the family level) have been selected. The taxa described as morphological types given in the original papers from Nabta Playa (NP) or Bargat El-Shab (BS) were omitted as separate forms. They have been classified as belonging to a specific family. For instance, caryopses differ considerably in terms of structure and size, originally described as Poaceae indet. types BS1, BS2, BS 3, and BS 4 (Lityńska-Zając and Skrzyński, 2021) have been included in the aforementioned family, *i.e.* grasses. The results so obtained are shown in Table 1 which presents the taxonomic composition of the remains, their kind and the number of specimens of a particular taxon identified at each site. Importantly, all preserved plant remains are charred. Plant names are given according to L. Boulos (1995).

The plant material identified at the Western Desert sites served as a basis for palaeoecological reconstructions aimed at describing plant communities that may have existed in the past. This method is based on the principle of actualism, the assumption being that the ecological and edaphic requirements of the prehistoric plants and the communities they formed were similar to those of today. Importantly, this assumption may be more or less accurate and may lead to a number of interpretation errors, as species may change their status and now occupy habitats different from those occupied in the past. If so, present-day plant communities are unlike the prehistoric ones (Lityńska-Zając and Wasylikowa 2005, 437-455). A good example of such a species is *Echinochloa colona*. Today, it is found

**Fig. 7**. Bargat El-Shab. A single tamarisk *Tamarix* sp. (photo Maria Lityńska-Zając)

**Fig. 8**. Vegetation from the small oasis of Bir Nakhlai (photo Maria Lityńska-Zając)

on the banks of the Nile, the Mediterranean and the Red Sea, as well as along canals, in oases, and often as a weed growing on cultivated fields (Boulos 2005, 291). It is part of the plant communities in wet salt marshes (Zahran and Willis 1992, 89). Yet another research challenge associated with this particular species has not been definitively resolved thus far. Namely, *Echinochloa colona* is a species native to India (Subhashini and Swamy 2015), which seems to make its presence in Neolithic archaeological deposits in Egypt highly unlikely. The issue requires further research and discussion (see also Lityńska-Zając and Skrzyński 2021).

When interpreting the sources, studies on the present-day flora of Egypt were taken into account (Boulos 1983; 1995; 1999; 2000; 2002; 2005; 2008; Boulos and El Hadidi 1994; Boulos *et al*. 2001; Täckholm 1974). Also, a study looking at the flora of the analysed part of the Western Desert, which identified as few as 14 plant species (Bornkamm 1986), was also taken into account. Single trees may occur in this region, although given the current lack of rainfall, their life forms may vary (Fig. 7). To the north-west of the analysed Holocene settlement activity area, there is a small oasis known as Bir Nakhlai (Fig. 8). Its waterline is mainly overgrown by *Phragmites australis*. Several other angiosperm species can also be found here (*e.g*., El Hadidi 1980).

## GENERAL OVERVIEW OF THE FLORA

The remains of the Early Holocene flora recovered from the eleven archaeological sites in the southern part of the Western Desert of Egypt discussed here include at least 52 taxa of various ranks, including 17 taxa identified to the species level (Table 1). Importantly, this number does not include the morphological types from the Nabta Playa and Bargat El-Shab sites, as their taxonomy could not be at least approximated. This group includes herbaceous plants, such as grasses (Poaceae), *e.g*., *Brachiaria* sp. and *Urochloa* sp., or sedges (Cyperaceae), *e.g*., *Scirpus maritimus* and *Carex* sp. These were identified mostly based on their fruits and seeds. Trees and shrubs include various species of acacia (*e.g*., *Acacia ehrenbergiana* and *A. nilotica*), tamarisk *Tamarix* sp., as well as *Salvadora persica,* and also a few representatives of the Chenopodiaceae family. They were recognised mainly based on the wood charcoal found in the features, usually in large quantities. Fruits and seeds were far less numerous (*e.g*., *Capparis decidua* and *Ziziphus* sp.).

In general, it is reasonable to conclude that although a considerable number of samples from a dozen archaeological sites were examined, the qualitative variability of the preserved plant remains is rather small. In this respect, site E-75-6 at Nabta Playa is exceptional for its taxonomic diversity and quantitative abundance of plant material (Wasylikowa 1997; Wasylikowa *et al*. 2001a; Barakat 1995; 1995a; 1996).

The plant remains identified at the sites in question belonged to 17 plant families. The legume family Fabaceae is represented by the greatest number of taxa (at least 10). These

**Table 1.** Results of the analysis of macroscopic plant remains from archaeological sites near Nabta Playa and Bargat El-Shab

| Taxa name | Kind of remains | El Adam | El Nabta | Al Jerar | El Nabta/ Al Jerar | Middle Neolitic | Middle Neolitic | Final Neolithic | Final Neolithic | Final Neolithic | Final Neolithic | Late/Final Neolithic | Number of sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Nabta Playa | Nabta Playa | Nabta Playa | Bargat El-Shab | Nabta Playa | Bargat El-Shab | Nabta Playa | Nabta Playa | Nab El Dieb | Gebel Ramlah | Bargat El-Shab | |
| | | E-06-1 | E-75-6 | E-92-7 | E-05-1 | E-75-8 | E-12-04 | E-05-2 | E-05-3 | E-00-1 | E-01-2 | E-18-04B | |
| *Arnebia hispidissima* | fruit | | 630 | | 10 | | | | | | | | 2 |
| cf. *Arnebia hispidissima* | seed | | 35 | | | | | | | | | | 1 |
| *Astragalus vogelli* | seed | | 7 | | 11 | | | | | | | | 2 |
| *Capparis decidua* | seed | | | 4 | 60 | | | | | | | | 2 |
| *Citrulus colocynthis*+ cf. *C. colocynthis* | seed | 3 | | | | | | | | | | | 1 |
| *Coronilla scorpioides* | seed | | 2 | | | | | | | | | | 1 |
| *Echinochloa colona* | grain | 4 | 2806 | 1 | 8 | | 5 | | | | | | 5 |
| *Hyoscyamus* cf. *muticus* | seed | | 3 | | | | | | | | | | 1 |
| *Panicum turgidum* | grain | | 576 | | | | | | | | | | 1 |
| *Schouwia purpurea* | seed | 1 | 7588 | 5 | 29 | 3 | | 1 | | | | | 6 |
| *Scirpus maritimus* | fruit | | 46 | | | 6 | | | | | | | 2 |
| *Sorghum bicolor* subsp. *arundinaceum* | grain | | 816 | 2 | 10 | | | | 1 | | 1 | | 5 |
| *Sorghum bicolor* subsp. *arundinaceum* | spikelet | | 8 | | 1 | | | | | | | | 2 |
| *Sorghum bicolor* subsp. *arundinaceum* | glume | | 28 | | | | | | | | | | 1 |
| *Abutilon* type | seed | | 1 | | | | | | | | | | 1 |
| *Astragalus* typ | seed | | | | 9 | | | | | | | | 1 |
| *Brachiaria* sp. | grain | | 20 | | 3 | | | | | | | | 2 |
| *Boerhavia* sp. | seed | | 1695 | | 1 | | | | | | | | 2 |
| *Capparis* sp. | seed | | 295 | 4 | | | | | | | | | 2 |
| *Carex* sp. | fruit | | | | | 1 | | | | | | | 1 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Digitaria* sp. | grain | | 62 | | 4 | | | | | | | | 2 |
| *Fuirena* type | fruit | | 69 | | | | | | | | | | 1 |
| *Grewia* sp. | seed | | 4 | | 7 | | | | | | 2 | | 3 |
| *Grewia* sp. | fruit | | 4 | | | | | | | | | | 1 |
| *Heliotropium* sp. | fruit | | 6 | | | 2 | | | | | | | 2 |
| *Indigofera* sp. | seed | | 20 | | | | | | | | | | 1 |
| *Malva* sp. | seed | | | | | | | | | | | 1 | 1 |
| *Rumex* sp. | fruit | | 1 | | | | | | | | | | 1 |
| *Salvia* sp. vel *Stachys* sp. | fruit | | 8 | | | | | | | | | | 1 |
| cf. *Scirpus* sp. | fruit | | | | 5 | | | | | | | | 1 |
| cf. *Setaria* sp. + *Setaria* type | grain | 1 | 33 | 3 | 3 | | | | | | | | 4 |
| *Sida* type | seed | | 2 | | | | | | | | | | 1 |
| cf. *Urochloa* sp. | grain | | 7 | | 2 | | | | | | | | 2 |
| *Ziziphus* sp. | seed | 3 | 24 | | 6 | | 2 | | | | | | 4 |
| *Ziziphus* sp. | fruit | 6 | 677 | 9 | 115 | 9 | 9 | | | 3 | | | 7 |
| Asteraceae indet. (syn.=Compositeae) | fruit | | 28 | | 3 | | | | | | | | 2 |
| Brassicaceae indet. | seed | 1 | | | | | | | | | | | 1 |
| Capparidaceae indet. | seed | | | 15 | | | | | | | | | 1 |
| Caryophylaceae indet. | seed | | | | 2 | | | | | | | | 2 |
| Cucurbitaceae indet. | seed | | 27 | | | | | | | | | | 1 |
| Cyperaceae indet. (ic. Type, A, B, C, D, NP21) | fruit | | 16 | 3 | 12 | 2 | | | | | | | 4 |
| Fabaceae indet. (type BS 1, BS 2, BS 3, BS4, NP. 13, 19, 30) | seed | | 1051 | | 7 | | | | | | | | 2 |
| Lamiaceae indet. | seed | | | | 6 | | | | | | | | 1 |
| Paniceae indet. | grain | | 60 | | 8 | | | | | | | | 2 |

| Taxa name | Kind of remains | El Adam | El Nabta | Al Jerar | El Nabta/ Al Jerar | Middle Neolitic | Middle Neolitic | Final Neolithic | Final Neolithic | Final Neolithic | Final Neolithic | Late/Final Neolithic | Number of sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Nabta Playa | Nabta Playa | Nabta Playa | Bargat El-Shab | Nabta Playa | Bargat El-Shab | Nabta Playa | Nabta Playa | Nab El Dieb | Gebel Ramlah | Bargat El-Shab | |
| | | E-06-1 | E-75-6 | E-92-7 | E-05-1 | E-75-8 | E-12-04 | E-05-2 | E-05-3 | E-00-1 | E-01-2 | E-18-04B | |
| Poaceae indet. (BS1, BS2, BS 3, BS 4) | grain | 11 | 70 | 4 | 27 | | 7 | | | | | | 5 |
| Poaceae indet. | chaff | | | | 1 | | | | | | | | 1 |
| Trifoliaee | seed | | 1560 | | | | | | | | | | 1 |
| *Acacia ehrenbergiana* | charcoal | | 816 | 3 | | 34 | | | | | | | 3 |
| *Acacia* cf. *nilotica* | charcoal | | 77 | 8 | 4 | | | | | | | | 3 |
| *Acacia raddiana* type | charcoal | | 13 | | | 41 | | | | | | | 2 |
| *Capparis decidua* | charcoal | | 113 | | 23 | | | | | | | | 2 |
| *Maeura crassifolia* | charcoal | | 2 | | | | | | | | | | 1 |
| *Senna alexandrina* | charcoal | | 11 | | | | | | | | | | 1 |
| *Salvadora persica* | charcoal | | 18 | 5 | | | | | | | | | 2 |
| *Acacia* sp. | charcoal | 1 | 78 | 53 | 426 | 188 | 240 | | 6 | 12 | 21 | | 9 |
| *Tamarix* sp. | charcoal | 101 | 490 | 102 | 2284 | 149 | 2048 | 12 | 31 | 25 | 274 | 18 | 11 |
| *Ziziphus* sp. | charcoal | | | | 39 | | 8 | | | 1 | | | 3 |
| Capparceae indet. | charcoal | | | | 5 | 4 | | | | | | | 2 |
| Chenopodiaceae indet. | charcoal | | | | | | 21 | | | 1 | | | 1 |

include genera such as *Acacia*, *Astragalus* and *Senna*. Another richly represented group is the grass family Poaceae, with nine different taxa including the species: *Echinochloa colona*, *Panicum turgidum* and *Sorghum bicolor* subsp. *arundinaceum*. A few families are represented only by one genus (*e.g.*, Tamaricaceae, represented by *Tamarix* sp.) or one species (*e.g.*, Solanaceae, represented by *Hyoscyamus* cf. *muticus*).

## VEGETATION CHARACTERISTICS

Plant materials from the oldest Early Holocene humid El Adam phase were found only at site E-06-1 at Nabta Playa (Table 1). These include rather scarce remains of *Echinochloa colona*, *Schouwia purpurea*, Poaceae and *Citrullus* sp. Woody plants are represented by tamarisk, which is the most common species and a single piece of acacia wood charcoal. This is indicative of relatively sparse vegetation (Neuman 1993; Jórdeczka 2021, 47-49), including grasses that are adapted to moist habitats. Conversely, *Schouwia* was presumably part of herbaceous communities growing in dry and sandy habitats. *C. colocynthis*, the present-day representative of the genus *Citrullus* in the Egyptian flora, is a xerophyte commonly found on sandy soils and desert wadis (Boulos 2000, 139, 140; Wasylikowa and Van der Veen 2004). The latter may have been a habitat for single tamarisk trees.

Another humid interphase (El Nabta, El Nabta/Al Jerar and Al Jerar) coincided with the Holocene climatic optimum. In the Egyptian Sahara, this period was characterised by relatively abundant rainfalls, resulting in the formation of permanent small lakes filling fairly deep basins (Wendorf and Schild 2001, 650). Plant material dated to this interphase comes from three sites: E-75-6 and E-92-7 at Nabta Playa and E-05-1 at Bargat El-Shab (Table 1). Notably, material from two of the sites (E-75-6 and E-05-1) contained plant remains that surpassed those from any other site in the vicinity of the palaeolakes discussed in this paper, both in quantity and diversity.

The quantity of remains recovered from site E-92-7 in Nabta Playa was significantly smaller. Nevertheless, it is reasonable to assume that the Early Holocene vegetation in the vicinity of Nabta Playa and Bargat El-Shab was fairly diversified. The distribution of plant communities, either in the form of a mosaic or a zonal arrangement, was determined by groundwater availability (Wasylikowa 1997). The communities comprised both herbaceous plants on the one hand and trees and shrubs on the other, many of which are typical of the Saharan or sub-Saharan flora. A fine example is *Setaria* sp., the remains of which were found at all three of the sites in question. Other important species, such as the already mentioned sorghum *Sorghum bicolor* subsp. *arundinaceum* are absent from the flora of present-day Egypt (Boulos 2005, 329), although they are fairly common in the African savannah (Wasylikowa and Dahlberg 1998). Similarly, species of the genus *Urochloa* sp. are characteristic of the savannah and are not found in the flora of present-day Egypt, although some of these grasses occur in Sudan (Wasylikowa 1997). The presence of the caryopses of these taxa (sorghum found at three sites and *Urochloa* sp. found at two

sites) in Early Neolithic features may suggest that the plant zones were arranged differently than today and that the prehistoric Sahelian communities, including savannah, were shifted northwards (Lityńska-Zając and Skrzyński 2021).

A major group in the Early Holocene plant remains assemblages is made of various types of grasses (*e.g.*, *Echinochloa colona*, *Boerhavia* sp. and *Panicum turgidum*). They may have formed communities in small areas offering favourable edaphic conditions. Various species of the genus *Brachiaria* sp., today common in the Nile valley and oases (Boulos 2005), may have been part of communities dominated by *Panicum turgidum* (Wasylikova 1997). Another important group were plants from the sedge family Cyperaceae, such as *Fuirena* type, and *Scirpus maritimus*. Their presence indicates moist habitats, mudflats and marshes, typically located on the shores of palaeolakes or wadis, where specific species may have found favourable conditions (Lityńska-Zając and Skrzyński 2021). Conversely, *Schouwia purpurea* probably grew in dry and sandy places.

In features dated to the Holocene climatic optimum, the remains of tamarisk (commonly found across all settlement phases, see Table 1) were accompanied by charcoal from the following trees: *Acacia ehrenbergiana* (two features), *Acacia* cf. *nilotica* (three), *Acacia raddiana* type (one), *Capparis decidua* (two), *Salvadora persica* (two) and unspecified fragments of the genus *Acacia*. In addition, *Maeura crassifolia* and *Senna alexandrina* were also found at site E-75-6 at Nabta Playa. These plants formed diverse communities (Neumann 1989; Barakat 1995a and other sources cited there, 2001; Lityńska-Zając and Skrzyński 2021). The various species of the genus *Tamarix* are drought- and salinity-tolerant trees or shrubs adapted to adverse and arid climatic conditions. They grow in desert areas, as well as in oases and wadis (Boulos 2000, 126-130, Barakat 1995a). Their presence in the archaeological record may suggest a climate with an annual rainfall below 100 mm (Peters 1998). Acacias require more moisture than tamarisks. It is generally assumed that they occur in habitats where summer rainfall totals remain between 250-750 mm (Lityńska-Zając and Skrzyński 2021 and other sources cited there). Today, acacias are typical, mainly in semi-arid and savannah areas (Neumann 1989; Barakat 1995a). *Acacia nilotica* has slightly different edaphic and, above all, moisture requirements, as it needs high groundwater levels. It is a Sahel-Saharan, Sahel-Sudanese and Sudanese species. The presence of its remains in archaeobotanical assemblages from the Early Neolithic indicates that the palaeolakes at Nabta Playa and Bargat El-Shab were permanently filled with water and recharged by abundant summer rains. Acacia communities may have additionally included small trees and/or shrubs such as *Capparis decidua* and the genus *Ziziphus*. Both of these woody species/genus suggest the presence of well-developed vegetation formations thriving under favourable conditions along the shores of lakes or the banks of seasonal rivers (Lityńska-Zając and Skrzyński 2021).

Site E-75-8 at Nabta Playa has been dated to the Middle Holocene humid Ru'at El Ghanam interphase. While the herbaceous remains are rather scarce here, charcoal remains have been frequently recorded. Remarkably, this is the only site discussed in this

paper where acacia remains outnumbered tamarisk remains (Table 1). This taxonomic composition, with remnants of Capparceae, suggests the presence of desert vegetation similar to that known today from uninhabited oases in northern Sudan (Barakat 2001). An interesting genus is *Heliotropium* sp., represented by 17 species found in the present-day flora of Egypt (Boulos 2000, 271-281; Täckholm 1974; see also Wasylikova 1997). These include annual and perennial plants, as well as small shrubs growing in the deserts of present-day Egypt.

Site E-12-04 at Bargat El-Shab contains traces of settlement activity in the Western Desert from the late/final Neolithic period. The taxonomic composition suggests an even more limited flora than in the earlier periods. Charcoal from the Chenopodiaceae family appears here for the first time. The small quantity of acacia charcoal remains, the absence of *Acacia nilotica,* and the presence of Chenopodiaceae all suggest a gradual regression of savannah vegetation and the emergence of new desert elements, first and foremost trees or shrubs from the Chenopodiaceae family (Barakat 2001; Lityńska-Zając and Skrzyński 2021).

E-05-2 and E-05-3 at Nabta Playa are two other sites associated with the final Neolithic. Although a considerable number of samples from these sites were analysed, little plant material was found (Lityńska-Zając in preparation). The only remains include single seeds of *Schouwia purpurea* and grains of *Sorghum bicolor* subsp. *arundinaceum*. An anthracological analysis identified mostly the remains of tamarisk, accompanied by a small quantity of acacia (Table 1). Site E-00-1 at Nab El Diep is yet another site with the same chronology. The materials from here contained a few charcoal fragments of *Tamarix*, *Acacia* and Chenopodiaceae. In addition, single fragments of *Ziziphus* sp. fruit stone and one piece of wood charcoal of this genus were also found (Table 1). The plant remains from site E-01-2 at Gebel Ramlah were equally mediocre. They included charcoal of acacia and tamarisk, as well as sorghum grain and *Grewia* sp. seeds (Lityńska-Zając 2010). This scarcity of plant remains may be due to the nature of the finds from those sites (see above). However, it is also possible that the sites were affected by the gradual loss of vegetation, characteristic of the final stage of the Neolithic (Barakat 2001).

The last of the analysed sites (E-18-4B in Bargat El-Shab) yielded only a few charcoal pieces of tamarisk and a seed of *Malva* sp. This genus includes several species of herbaceous, annual and perennial plants known from various regions of present-day Egypt (Boulos 2000, 92-97). These scarce findings once again confirm the depletion of flora during the final Neolithic.

## CONCLUSIONS

The plant material from these archaeological sites in the southern part of the Western Desert of Egypt is neither particularly diverse in terms of taxonomic composition nor abundant in quantity, with the notable exception of the finds from site E-75-6 at Nabta Playa. The macroremains assemblages primarily represent plants collected for food and

fuel, and possibly also as raw materials. As a result, they likely reflect only selected components of the local vegetation. Scarce as they may be, the recovered remains indicate a degree of variation between older and younger chronological periods. The most favourable period for vegetation and, thus, for settlement activities was the Holocene climatic optimum, corresponding to the El Nabta and Al Jerar phases. The period saw the development of relatively rich flora composed of herbaceous plants and tree-shrub vegetation. Campsites from this period were probably set up in areas densely covered with such vegetation. The most common trees were tamarisks, accompanied by acacias and a few other species. Grassland communities were likely fairly common, too. During the Holocene climatic optimum, Cyperaceae communities flourished in moist habitats.

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