

EARLY AND MIDDLE HOLOCENE PALEOCLIMATES IN THE SOUTH WESTERN DESERT OF EGYPT – THE WORLD BEFORE UNIFICATION

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Abstract

In the field seasons of 1990 to 2008 the Combined Prehistoric Expedition conducted an extensive archaeological, archaeozoological, archaeobotanical and geomorphological field work at more than a hundred sites in the Nabta, Kiseiba, El Kortain, Gebal El Beid, Gebel Ramlah and Berget El Sheb Areas, South Western Desert of Egypt. The research has helped to develop a long chronological sequence of Late Glacial and Holocene climatic changes in the region. The climatic sequence has been supported by more than 300 ¹⁴C and OSL assays that permitted to place most of the climatic events in a firm chronological frame.

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Key words: South Western Desert, Egypt; Late Glacial; Holocene; prehistoric cultural entities, climatic changes

INTRODUCTION

In the field seasons of 1972–1977, 1979–1980, 1990–1994 and 1996–2008 the Combined Prehistoric Expedition conducted an extensive archaeological, archaeozoological, archaeobotanical and geomorphological field work at more than a hundred prehistoric Holocene sites in the South Western Desert of Egypt at Nabta, Kiseiba Scarp, Gebel El Sheb, Bir Safsaf, El Kortein, Gebal El Beid, and Gebel Ramlah playas, south of the Eocene Sin El Kadab Scarp and north of Sudanese border (Figs 1, 2). The work has helped to develop a long chronological sequence of climatic and prehistoric changes in the area. This sequence has been supported by nearly 300 ¹⁴C and OSL assays that permitted to place most of the climatic and cultural events in a reasonable chronological frame (compare e.g., Schild, Wendorf 2001a, b, c, 2002; Wendorf, Schild 1980; Wendorf *et al.* 2001, 2007).

THE BASE

Stratigraphic and sedimentary data were recorded in the extensive cross-sections opened in archaeological cuttings. A system of numerous stratigraphic trenches supported by sediment coring, up to nearly 10 m in depth, yielded a series of long cross-sections, in some cases reaching a kilometer in length. Large and middle scale geomorphological mapping completed the field work.

A subdivision of the recorded data into wet (Humid Interphase) and hyperarid (Arid Phase) climatic units was based on the presence of apparent, major unconformities recorded in the field, be it truncations resulting from eolian ero-

sion and/or clear, major changes in the character of deposition, e.g., eolian to lacustrine and vice versa. Chronological boundaries of the defined chronostratigraphic units/phases and interphases, although based on a very large number of ¹⁴C assays are apt to be closer to reliability, however, one has to bear in mind that nearly all of the dates from the border zones of two consecutive phases overlap at one Σ .

In spite of a long and intensive work on the Holocene archaeology of the South Western Desert, the recovered biological, data is not always conclusive. The impoverished fauna is monotonous, except for the appearance of domestic animals, and only during the Local Climatic Maximum it becomes somewhat richer (compare Gautier 2001; Bocheński, Tomek 2001). The same goes for the recovered floral ecofacts (Wasylikowa *et al.* 1995).

All of the time/climate units for the paleoecological changes in the South Western Desert coincide with noticeable, sharp twists in the material culture of people colonizing the area, which are particularly visible in techniques and styles of flint working as well in the pottery making methods and decoration motifs. These specific cultural time/space units have been defined, described and named during the course of the Combined Prehistoric Expedition's work in the South Western Desert of Egypt. We decided to give the same names to the time/climate units defined in this area.

THE SEQUENCE

Nine wet pulsations, triggered by the northward migration of the Inter-Tropical Convergence zone (ITZ) and the resulting influx of moist southern air bringing discrete summer



Fig. 1. Major Stone Age sites in Egypt and the location of sites mentioned in the article (compare Fig. 2). Key: Triangles. Various Paleolithic sites and groups of sites; Stars. Various Neolithic sites and groups of sites. After Mahzer *et al.*, 2005.

rains, have been identified in the South Western Desert in the Late Glacial and Holocene (Fig. 3). The oldest of these is recorded in the narrow Nag El Dib Playa, a relatively small basin immediately bordering Nabta Playa on the south-west. The basin is filled with sandy and silty deposits of various ages. At the base of the sequence is a laminated alluvial/lacustrine sand with characteristic concentrically laminated mud balls, suggestive of a sandy beach environment. A few preliminary OSL tests performed by Professor Andrzej Bluszcz may place this bed near the early Greenland Interstadial 1, perhaps in the Bølling (GI-1e) time zone (?) Nowhere in the South Western Desert are the traces of human occupation associated with this period of time.

The second wetting pulsation is clearly evident in numerous playas containing settlements of the *El Adam* archaeological time/space variant. Particularly in the El Adam Playa, south-east of the Kiseiba Scarp (Wendorf *et al.* 1984),

in the large Gebal El Beid Playa, just south of the Eocene Sin El Kadab Scarp (Wendorf, Schild 1980) and in Nabta (Wendorf *et al.* 2001) Playa (Fig. 4). Thick beds of laminated and/or layered sand and silty sand with rich rhizoconcretions are underlying the sandy playa deposits containing El Adam archaeological remains suggesting that they might have been deposited before the EL Adam wet pulsation, perhaps in the middle and late Greenland Interstadial (GI-1c-a). Recovered scanty floral macroremains and wood charcoal indicate poor and monotonous vegetation most probably of contracted desert character tied to small oases in the central parts of playas.

At two other sites: E-77-7, in El Gebal El Beid Playa, some 40 km north-east of Gebel Nabta, and E-06-1, in Nabta Playa some botanical remains were also recovered. In the former the following floral macroremains were identified: charcoal of *Tamarix* sp. (Barakat 2001: 596), charred seeds

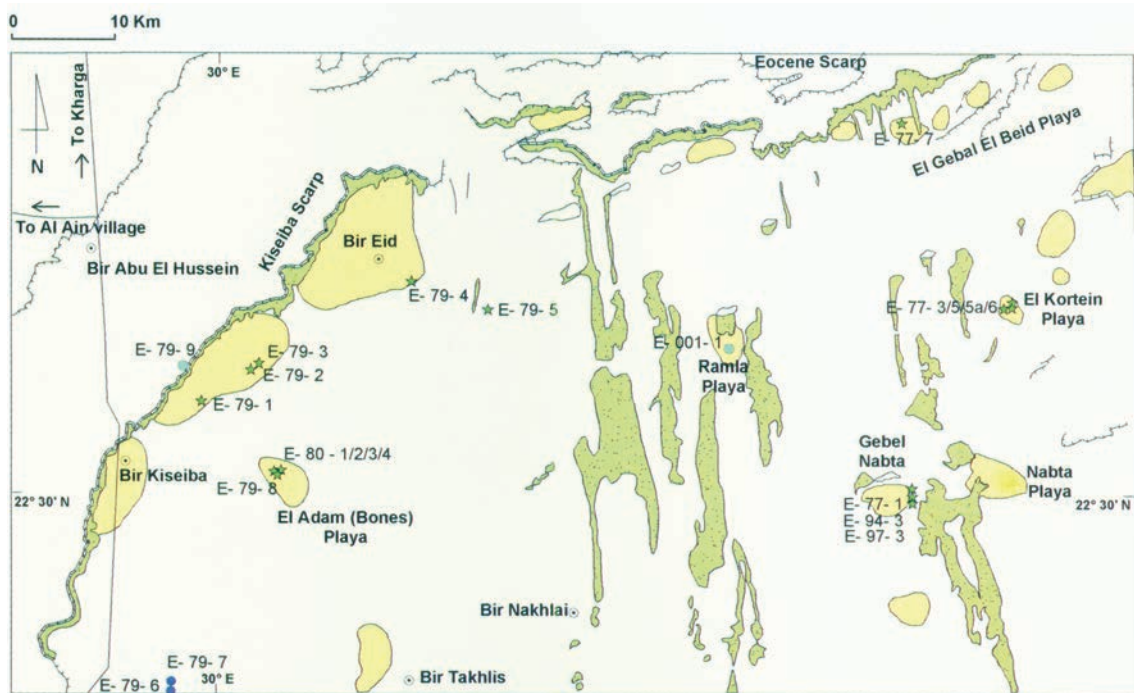


Fig. 2. Important playas (yellow patches), dunes (greenish, elongated forms) and Neolithic Holocene sites in the South Western Desert. Map after Applegate (in Wendorf & Schild, 2001) and Mahzer *et al.* (2005).

identified as wild millet (*Panicum turgidum*), a seed of a plant belonging to *Panicaceae* and four seeds belonging to two taxons, possibly *Leguminosae* (Wasylikowa *et al.* 2001: 606, 1995; Close, Wendorf 2001: 69). Site E-06-1 provided *Tamarix* sp., *Citrullus colocynthis*, *Echinochloa colona*, while in one of the samples from Hearth 35 seeds of the Poaceae grass were found (identification by Maria Lityńska Zajac, compare Jórdeczka *et al.* 2012: 367). The recovered flora with tamarisk as the only tree species indicates to Barakat (2001: 600) an environment similar to that of the extant small oases in the deserts of southern Egypt. Further to the south, however, at Selima, Oyo and El Atrun, Sudan, elements of sahelian flora appear in the pollen samples dated to lower early Holocene (e.g., Haynes *et al.* 1989).

At some sites, e.g., E-06-1, Nabta Playa, eolian sand beds cover the cultural deposits of the El Adam entity (Fig. 5). At Site E-79-4 in Gebel El Ghorab Playa, eolian sand underlies the sandy playa deposits of the following El Ghorab Humid Interphase during which silty sand and occasionally sandy silt were deposited in playa basin. A number of radiocarbon dates securely place this wet pulsation between about 8500 – 8200 uncal. years BP. The onset of the following hyper arid condition is seen in the El Kortain basin, ca. 20 km north of Nabta Playa, in a strong vertisolization of the lacustrine silty sediments in which the El Ghorab (Site E-77-6) cultural material has been buried (Wendorf, Schild 1980: 99). At El Adam Playa, south-east of Kiseiba Scarp, a polished, redeposited El Ghorab cultural material is embedded in alluvial sand of a wadi cutting into the playa deposits of the El Adam wet pulsation and covered by the lacustrine silty sand with the embedded El Nabta archaeology, thus witnessing to a considerable lowering of the base level, presumably due to deflation phenomena during the post-El Ghorab Arid Phase (Schild, Wendorf 1984: 29). At El Ghorab Playa this

pulse of aridization is seen in a noticeable influx of eolian sand in the deposits immediately succeeding the El Ghorab culture layer (*Lower Cultural Layer*) at Site E-79-4 (Schild, Wendorf 1984: 21-23; Kobusiewicz 1984: 137).

A long humid interphase (about 8050–7300 uncal. years BP) follows the Post-El Ghorab Arid Phase. It is the time of the El Nabta and the subsequent Al Jerar settlement of the South Western Desert. Very large campsites occupy both the western and eastern shores of the Nabta Playa lake as well as the El Ghorab and El Adam lakes with complex camp installations in the form of elongated and round huts (Królik, Schild 2001; Schild *et al.* 1996), bell shaped storage pits (Wendorf, Schild 2002, 2006) and water wells. It is the time of fluctuating, but permanent to semi-permanent lake in the Nabta Playa Basin and a dramatic decrease of the clastic material deposition in the lakes owed to the reinforcement of slopes by dense herbaceous vegetation and the development of hydromorphic soils along lake shores (Schild, Wendorf 2001b). An assortment of grasses and trees supported by the seasonal local rainfall is indicated by the plentiful presence of floral macroremains in the dwellings and pits of the extensive encampments. More than 20 thousand charred plant remains belonging to 130 taxa were recovered from the campsites of Nabta Playa. Edible plants were the most common and included morphologically wild sorghum and two millets. Ten different tree and shrub varieties were also identified (Barakat 2001; Wasylikowa *et al.* 2001a, 2001b). Although the mammal spectrum has been largely similar to those encountered during previous wetting pulsations (Gautier 2001), the 12 bird taxa recovered include three non-passage migrants in Africa (*Alopochen*, *Plectropterus*, *Ciconiiformes*) that indicate an environment of a water body surrounded by terrestrial habitats (Bocheński, Tomek 2001: 646).

Greenland Interstadial 1	Pre-El Adam Humid Interphase	Deposits of sandy playa in the area of Nabta (El Dib) and El Gebal el Beid basins located underneath the earliest Neolithic settlements. Occasional rains and sandy playas, seasonal vegetation.
Younger Dryas	<i>Pre-El Adam Arid Phase</i>	Hypothetical arid phase
Ca. 9800-8850 BP	<i>El Adam Humid Interphase</i>	Emergence of phytogenic dunes followed by sandy playas. Oldest El Adam settlements. Contracted desert.
8850-8500 BP	<i>Post-El Adam Arid Phase</i>	Interstratified eolian sand bed in playa deposits.
8500-8200 BP	<i>El Ghorab Humid Interphase</i>	Silty and sandy playa deposits.
8200-8050 BP	<i>Post-El Ghorab Arid Phase</i>	Eolian erosion in El Adam Playa, eolian sand beds between El Ghorab and El Nabta settlements in the El Ghorab basin. Contracted desert.
8050-7300 BP LOCAL CLIMATIC OPTIMUM	<i>El Nabta/Al Jerar Humid Interphase</i>	Maximum of local precipitation, reduced silt deposition due to vegetation cover, small permanent lakes, extensive semi-sedentary settlements. Dry savanna.
7300-7100 BP 8.2 k EVENT	<i>Post-El Jerar Arid Phase</i>	Sharp reduction of vegetation, increased eolian erosion, violent seasonal rains, highly augmented clastic deposition in basins.
7200-6600 BP	<i>Middle Neolithic Humid Interphase Ru'at el Ghanam</i>	Development of phytogenic dunes, local rains resulting in surface washes. Local, perched water tables.
6600-6500 BP	<i>Post-Middle Neolithic Arid Phase</i>	Massive eolian erosion.
6500-5800 BP	<i>Late Neolithic Humid Interphase Ru'at El Baquar</i>	Alluvial deposits in wadis and closed basins.
5800-5750 BP	<i>Post-Late Neolithic Arid Phase</i>	Deflational basins.
5750-4800 BP	<i>Final Neolithic Humid Interphase Bunat el Asnam</i>	Seasonal rains and alluvial washes
4500-4200 BP	<i>Early Post-Neolithic Sites</i>	Sparse human occupation
4200-3900 BP	<i>Arid Phase</i>	Hyper arid desert.
3900-3150 BP	<i>Humid Interphase -Group</i>	Rare small settlements and houses. Local rains.

Fig. 3 Major climatic and cultural changes in the South Western Desert. Approximate ages in radiocarbon years (uncalibrated) BP.

To sum up the climatic setting in the El Nabta/Al Jerar interphase is to suggest that it was the wettest and the most favorable environment in the South Western Desert in the Holocene, a local climatic optimum. It was the time of maximal development of lakes, surrounded by dry savannah, expanding to large water bodies in the summer rain season and shrinking to small perennial lakes in the dry period of the year.

The following Post-Al Jerar short arid phase, coinciding with the 8.2 ka global cold and dry event (Thomas *et al.* 2007) begins with a massive deposition of thick beds of red silts in the lake basins (Figs 6–8) resulting from the dramatic destruction of the plant cover and degradation of soils (Schild, Wendorf 2001a). It is the end of extensive playa lakes in the South Western Desert. Near the end of the phase, wind erosion creates local relatively deep basins carved in the lake muds e.g., at Site E-75-8 in Nabta Playa (Schild, Wendorf 2001b: 30).

Local rains, raised water tables, phytogenic dunes and washes in Nabta Playa (Schild, Wendorf 2001b: 30) as well as renewed wadi activity (e.g., at Gebel Ramlah Playa (Schild, Wendorf 2010: 183) during the Ru'at El Ghanam Middle Neolithic Humid Interphase announce the succeeding wet pulsation. It is followed by massive eolian erosion particularly well represented in the deep deflational basins

(Fig. 9) along the northern fringes of Nabta Playa (Schild, Wendorf 2001b: 39).

A relatively long Ru'at El Baquar Humid Interphase is the time of Late Neolithic rich settlement in the Playa basins in and around Nabta Playa. It is represented by a number of sandy sheet flows in the basins (e.g., suite of beds 4 at Site E-92-7 on the Northern shore of Nabta Playa; compare Fig. 9) development of wadi alluvia and perched water tables (Schild, Wendorf 2001b: 34; 2010). Club rush and two other taxa from the sedge family in the Nabta Playa Site E-75-8 (Wasylikowa *et al.* 2001) suggest the presence of marshy environments in the low section of the basins, while three taxa of acacias and tamarix suggest to Hala Barakat (2001) environments similar to those in uninhabited oases of modern Sudan. There is no evidence of extensive playa lakes. A deflational truncation of the topmost Late Neolithic beds and deflational basins in Nabta Playa are suggestive of the succeeding short arid phase.

Except for a rather intensive human presence in the ancient playa basins in the South Western Desert, there is little proxy evidence concerning the following Bunat El Asnam Final Neolithic wetting recorded in the preserved rock strata. At Site E-75-8 in Nabta Playa muddy washes of Bed 10 contain the Final Neolithic archaeology (Schild, Wendorf 2001a: 47). At the Nag El Dib Playa numerous Final Neo-

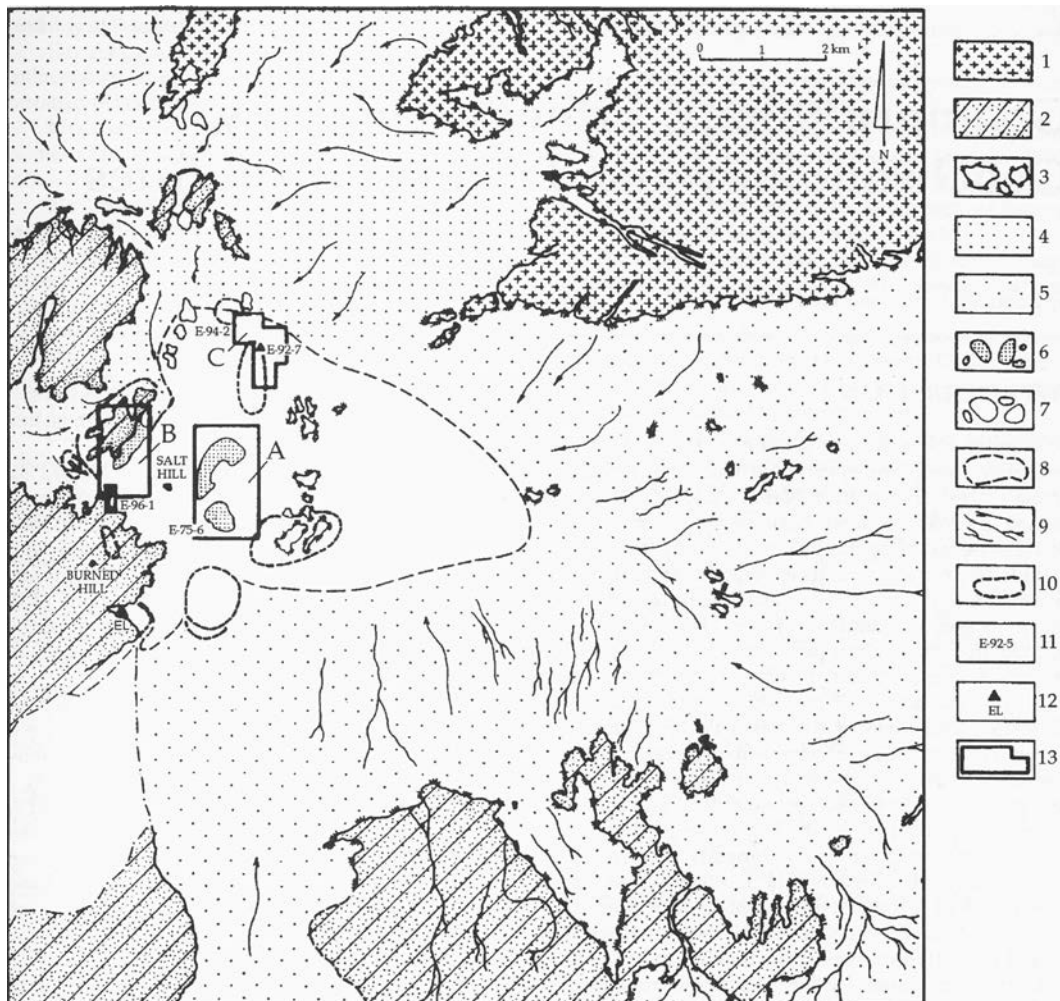


Fig. 4. Map of the Nabta Playa Basin. Key: 1. Basement; 2. Nubia Fm., sandstone and shale; 3. Hillocks of Nubia Fm.; 4 and 5. Alluvial sandy deposits grading into silt in the center; 6. Fossil dunes; 7. Recent dunes and sand sheets; 8. Playa silt; 9. Modern shallow wadi channels; 10. Large artifact concentration on surface; 11. Some site numbers; 12. *Elephant Site*; 13. Areas of detailed mapping. Map by R. Schild, after Wendorf *et al.*, 2001.

lithic large wells (Kobusiewicz 2003) indicate the presence of perched water tables in the near surface basins created in the Nubia Sandstone by an ancient wind erosion (Fig. 10). In Gebel Ramlah Playa, on the other hand, a ponding episode and surface washes with embedded Final Neolithic settlements (Schild, Wendorf 2010: 183) witness to the Bunat El Asnam wet pulsation.

A precise aging of the termination of the Bunat El Asnam wet pulsation is quite difficult due to the lack of reliable radiocarbon determinations of this event. Perhaps the date for the remains of Little Lord of Nabta Playa of about 4800 uncal. years BC (Poz-8267) is close to this important climatic and cultural boundary?

Seemingly two later humid spells can be suggested in the South Western Desert. The date of a surficial archaeological chipped assemblage at Site BT-20, Bir Tarfawi Area, of about 4500 uncal. BP (SMU-74) is in the late Predynastic time range (Schild, Wendorf 2001c: 54). Another still younger date on a surface hearth of about 4150 uncal. BP (Gd-16009) in Nabta Playa comes from Site E-91-1, Area A, and is possibly of Old Kingdom age. Considerably later are the C-Group settlements of the South Western Desert at the

Nabta Playa Slab House (Schild, Wendorf 2001c: 54) and the *villages* in Dungul Playa (Hester, Hoebler 1969: 51) ranging in age from about 3100 (?) to 3850 uncal. BP.

CONCLUSIONS

Paleoclimatic data from the South Western Desert of Egypt are of a proxy character relating to very numerous archaeological sites studied during nearly four decades. They do not yield precise evidence as to the amount of rainfall in the Eastern Sahara during the Late Glacial and Early and Middle Holocene. It is suggested that after an initial rainy pulsation in the Late Glacial there is a steady increase of the amount of rain during the Early Holocene wetting episodes climaxing in the El Nabta/Al Jerar wet pulsation when extensive beaches suggest large seasonal lakes reaching a water depth of several meters. Past the 8.2 dry event, the data indicate a number of northward shifts and retreats of the rain belt ending about 4800 ¹⁴C years BP with a very short and minor pulsation around 4500–4200 radiocarbon years BP and a more pronounced and considerably longer wet oscillation around 3800 cal. years BP in the early Middle Kingdom



Fig. 5. Site E06-1, El Adam variant. Cross-section of a dwelling feature (dark beds) covered with eolian sand. Yellow measure on the balk equals 20 cm. Looking east. Photograph by R. Schild.

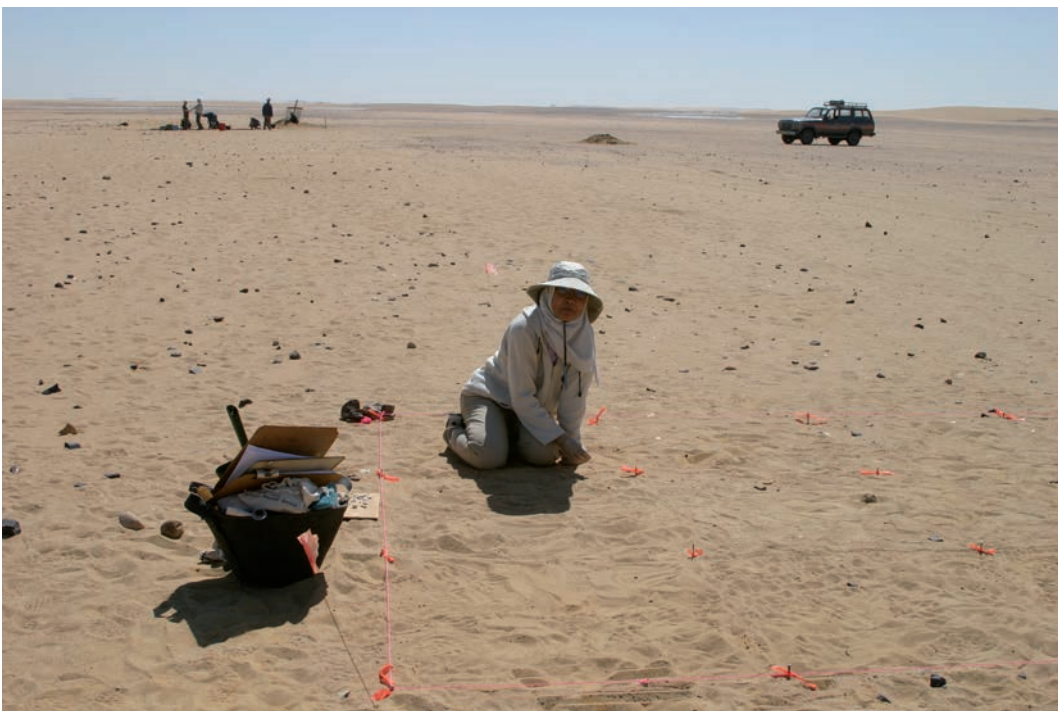


Fig. 6. Center of Nabta Playa. Note a fossil dune with artifacts on surface (in foreground) overlain by playa silt; car is parked on the silt, looking west. Photograph by R. Schild.

when the C-Group pastoralist entered the South Western Desert.

REFERENCES

Barakat, H. N. 2001. Anthracological studies in the Neolithic sites of Nabta Playa, South Egypt. In: Wendorf F., Schild R. and As-

sociates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 592–600. Kluwer Academic/Plenum Publishers, New York.

Bocheński Z., Tomek T. 2001. Holocene bird remains from Nabta. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 636–647. Kluwer Academic/Plenum Publishers, New York.

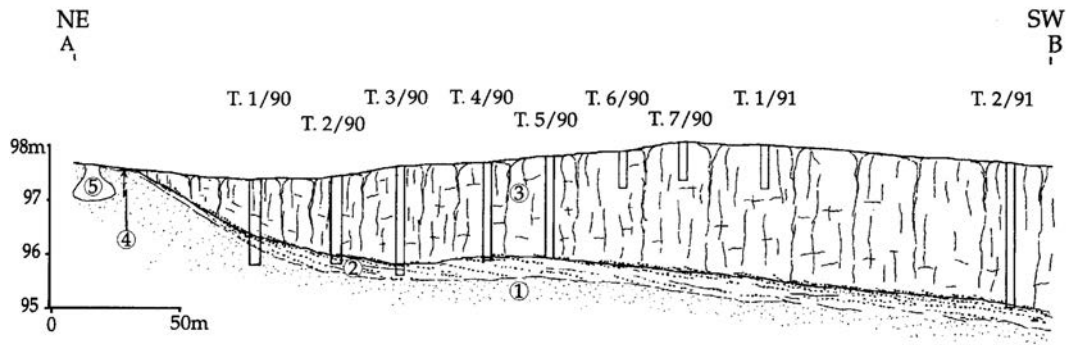


Fig. 7. Nabta Playa. Site E-75-6. General composite cross-section. Key: 1. Old (fossil) Dune; 2. Sand of consecutive littoral facies; 3. Massive playa silts; 4. Stabilization Zone; 5. Neolithic pits. After Schild & Wendorf, 2001b (profile by R. Schild).

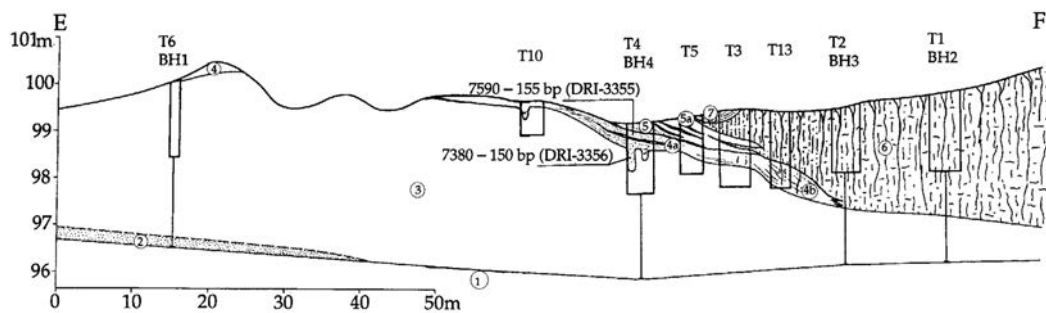


Fig. 8. Nabta Playa. Site E-91-1. Composite cross-section. Key: 1. Nubia Fm.; 2. Alluvial sand and gravel; 3. Old Dune; 4. Littoral sand and silt; 5. Beach sand interfingering with silt; 6. Massive playa silt; 7. Reworked Younger Dune; T. Trenches; BH. Boreholes. After Schild & Wendorf 2001b (profile by R. Schild).

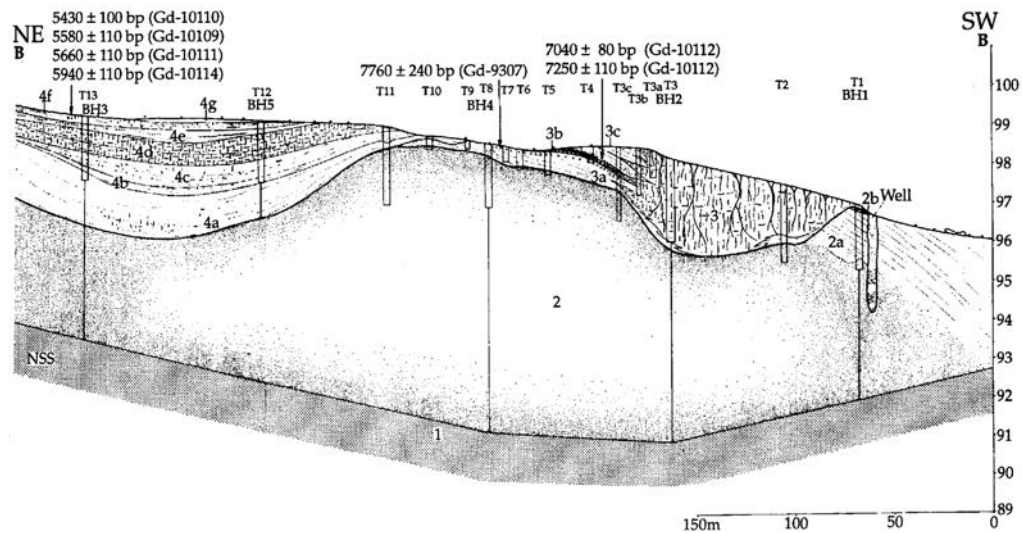


Fig. 9. Nabta Playa. Site E-92-7. Composite cross-section. Key: 1. Nubia Fm.; 2. Old Dune; 3. Massive playa silt; 3a-c. Playa silt grading into silt with archaeology; 4. Alluvial sand and silty sand; T. Trenches; BH. Bore Holes. After Schild & Wendorf, 2001b (profile by R. Schild).

Close E. A., Wendorf F. 2001. Site E-77-7 revisited: the Early Neolithic of El Adam type at El Gebal El Beid Playa. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I*, pp. 57–70. *The Archaeology of Nabta Playa*, pp. 592–600. Kluwer Academic/Plenum Publishers, New York.

Gautier A. 2001. The Early to Late Neolithic archeofaunas from Nabta and Bir Kiseiba. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 609–635. Kluwer Academic/Plenum Publishers, New York.

Haynes C. V., Jr., Eyles C. H., Pavlish L. A., Ritchie J. C., Rybak M.



Fig. 10. Nag El Dib Playa. Truncated by deflation circular Final Neolithic walk-in well mouths, looking south. Photograph by R. Schild.

1989. Holocene palaeoecology of the eastern Sahara: Selima Oasis. *Quaternary Science Review* 8: 109–136.
- Hester J. J., Hobler P. M. 1969. *Prehistoric Settlement Patterns in the Libyan Desert*. University of Utah Anthropological Papers No. 92, Nubia Series 4. University of Utah Press, Salt Lake City.
- Jórdeczka M., Królik H., Masojć M., Schild R. 2012. Early Neolithic settlements of El Adam type from Nabta Playa. Site E-06-1. *Studies in African Archaeology* 11: 365–407.
- Kobusiewicz M. 1984. Report on Site E-79-4: The archaeology of El Ghorab Playa. In: Wendorf F., Schild R. (assemblers), Close A. E. (ed.), *Cattle-Keeper of the Eastern Sahara: The Neolithic of Bir Kiseiba*, pp. 135–164. Department of Anthropology, Institute for the Study of Earth and Man, Southern Methodist University, New Delhi.
- Kobusiewicz M. 2003. Neolithic wells of the Western Desert. *Studies in African Archaeology* 8: 95–104.
- Królik H., Schild R. 2001. Site E-75-6. An El Nabta Al Jerar Village. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 111–146. Kluwer Academic/Plenum Publishers, New York.
- Mazher A. A., El Hinnawi M., Radwan A. M., Barakat A. A., Mohsen I. A. 2005. *Prehistoric Human Cultures in Egypt*. EGSM and NARSS, Cairo.
- Schild R., Wendorf F. 1984. Lithostratigraphy of Holocene lakes along the Kiseiba Scarp. In: Wendorf F., Schild R. (assemblers), Close A. E. (ed.), *Cattle-Keeper of the Eastern Sahara: The Neolithic of Bir Kiseiba*, pp. 9–40. Department of Anthropology, Institute for the Study of Earth and Man, Southern Methodist University, New Delhi.
- Schild R., Wendorf F. 2001a. Geoarchaeology of the Holocene climatic optimum at Nabta Playa. *Geoarchaeology* 16: 8–28.
- Schild R., Wendorf F. 2001b. Geomorphology, Lithostratigraphy, Geochronology and Taphonomy of Sites. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 11–50. Kluwer Academic/Plenum Publishers, New York.
- Schild R., Wendorf F. 2001c. Combined Prehistoric Expedition's radiocarbon dates associated with Neolithic occupations in the Southern Western Desert of Egypt. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 51–55. Kluwer Academic/Plenum Publishers, New York.
- Schild R., Wendorf F. 2002. Palaeo-ecological and palaeo-climatic background to socio-economic changes in the South Western Desert of Egypt. In: Friedman R. (ed.), *Egyptian and Nubian. Gifts of Desert*, pp. 21–27. The British Museum Press, London.
- Schild R., Wendorf F. 2010. Geomorphology, lithostratigraphic environment and paleoecology of Neolithic camps and cemeteries at Gebel Ramlah Playa. In: Kobusiewicz M., Kabaciński J., Schild R., Irish J. D., Gatto M. C., Wendorf F., *Gebel Ramlah. Final Neolithic Cemeteries from the Western Desert of Egypt*, pp. 159–188. Institute of Archaeology and Ethnology, Polish Academy of Sciences, Poznań Branch, Poznań.
- Schild R., Królik H., Wendorf F., Close A. E. 1996. Architecture of Early Neolithic huts at Nabta Playa. *Studies in African Archaeology* 5: 101–114.
- Thomas R. E., Wolff E. W., Mulvaney R., Steffensen J. P., Johnsen S. J., Arrowsmith C., White J. W. C., Vaughn B., Popp T. 2007. The 8.2 ka event from Greenland ice cores. *Quaternary Science Reviews* 26, 70–81.
- Wasylikowa, K. with contributions by Barakat H. N., Boulos L., Butler A., Dahlberg J. A., Hather J., Mitka J. 2001a. Site E-75-6: Vegetation and subsistence of the Early Neolithic at Nabta Playa, Egypt, reconstructed from charred plant remains. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 544–591. Kluwer Academic/Plenum Publishers, New York.
- Wasylikowa, K., Barakat H. N., Lityńska-Zajac M. 2001b. Nabta Playa sites E-75-8, E-91-1, E-92-7, E-94-1, E-94-2, and El Gebal El Beid Playa Site E-77-7. Seeds and fruits. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 11–

- tian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 605–606. Kluwer Academic/Plenum Publishers, New York.
- Wasylikowa K., Schild R., Wendorf F., Królik H., Kubiak-Martens L., Harlan J. R. 1995. Archeobotany of the Early Neolithic Site E-75-6 at Nabta Playa, Western Desert, South Egypt. *Acta Paleobotanica* 35(1): 133–155.
- Wendorf F., Schild R. 1980. *Prehistory of the Eastern Sahara*. Academic Press, New York.
- Wendorf F., Schild R. 2001. Introduction. In: Wendorf F., Schild R. and Associates, *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*, pp. 1–10. Kluwer Academic/Plenum Publishers, New York.
- Wendorf F., Schild R. 2002. Implications of incipient social complexity in the Neolithic in the Egyptian Sahara. In: Friedman R.(ed.), *Egypt and Nubia. Gifts of the Desert*, pp. 13–20. The British Museum, London.
- Wendorf F., Schild R. 2006. The emergence of village settlements during the Early Neolithic in the Western Desert of Egypt. *Adamatu* 14: 7–22.
- Wendorf F., Karlén W., Schild R. 2007. Middle Holocene environments of north and east Africa, with special emphasis on the African Sahara. In: Anderson D. G., Maasch K. A., Sandweiss D. H. (eds). *Climate Change & Cultural Dynamics. A Global Perspective on Mid-Holocene Transitions*, pp. 189–264. Academic Press, Amsterdam.
- Wendorf F., Schild R. (assemblers), Close A.E. (ed.). 1984. *Cattle-Keepers of the Eastern Sahara: The Neolithic of Bir Kiseiba*. Department of Anthropology, Institute for the Study of Earth and Man, Southern Methodist University, New Delhi.
- Wendorf F., Schild R. and Associates. 2001. *Holocene Settlement of the Egyptian Sahara. Volume I. The Archaeology of Nabta Playa*. Kluwer Academic/Plenum Publishers, New York.