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Progress in African Archaeobotany

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Contents

Plants and People in the African Past: Themes and Objectives of Archaeobotany

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Africa with its impressive, deep history and ecosystem diversity continues to offer an ideal setting to expand our frontiers of understanding plants and people in the past. Early and unique interrelationships between humans and plants make Africa a critical reference point for interdisciplinary studies of cultural developments and environmental transformations. On-going research in many fields is evaluating the independent patterns of phytogeography and ethnography of Africa's plants and peoples. On the continent, climatic oscillations together with population growth and migration have sparked continual innovations and adaptation to changes over the entire duration of human existence. Palaeoethnobotanical and palaeoecological studies, focusing on vegetation development and natural resources exploitation, are investigating these fascinating issues through interdisciplinary and careful analyses of archaeological and botanical records.

The study of plant micro- and macroremains from archaeological sites, and other human-influenced contexts, is of key importance to investigate the ethnobotany and ecology of the past. The most common themes within this field of research are the knowledge of plants for food and medicine and their processing, the selection and manipulation of wild plants leading to cultivation and in some cases to domestication, foodways, and subsistence strategies of humans living in complex ecosystems, environmental change, the role of human agency in vegetation change, and plant migrations mediated by climate and human activity. Archaeobotany aims at understanding food, fuel and other plant uses as well as environment/habitat transformations, and situated at the nexus of human and the natural spheres, is one of the few reliable approaches to understanding the historical development of plant use and landscapes. The long-term reciprocal relationships between humans and the environment have become the motor of adaptation of living organisms and of the transformation of ecosystems and habitats, in Africa and beyond (Harlan and Stemler 1976; Fuller 2007, 2012; Fuller and Colledge 2008; Mercuri 2008a; Pearsall and Hastorf 2011; Zohary et al. 2012; Pelling 2013; Stevens et al. 2014).

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In Africa, ancient relationships between plants and people may differ from other regions of the world (Garcea 2004; Fuller and Hildebrand 2013; Larson et al. 2014), especially from those where plant domestication has been early (Zohary and Hopf 2000; Aiello 2011). In Africa, plant foods were gathered and foraged for millennia and perhaps they were cultivated in some areas (Wasylikowa and Dahlberg 1999; Mercuri et al. 2018), but unambiguous signs of domestication appear rather recently in the African Middle-Late Holocene archaeobotanical record (D'Andrea et al. 2001; Fuller 2007). On the pathway to food production, other choices were made, other turns taken: wild cereals supplied basic carbohydrate-protein resources, while cattle and small livestock were the main sources of domesticated food for much of the Holocene (Marshall and Hildebrand 2002). Moreover, pottery preceded food production: wild plants, including grasses and aquatic plants, were cooked in vessels as early as 10,000 years ago in the central Sahara (Dunne et al. 2016). In West Africa, tree fruits such as oil palm (*Elaeis guineensis* Jacq.) and incense tree (*Canarium schweinfurthii* Engl.) were significant resources which were likely managed in arboricultural systems as far back as the Early Holocene (D'Andrea et al. 2006; Oas et al. 2015).

Despite the later beginning of plant domestication, the conviction of some early researchers that Africa was a continent without history, implying that its environment had not been shaped to a great extent by ancient peoples, was prejudiced. In recent years, it has become increasingly evident that humans have had an important role in shaping African environments: tropical forests were by no means pristine, and savannas, while not entirely man-made had to a large extent been shaped by human activities. Archaeobotany and palaeoethnobotany are making impressive contributions to this body of research (e.g. van Gemerden et al. 2003; Mercuri 2008b; Höhn and Neumann 2012; Morin-Rivat et al. 2014).

Africa covers about one-fifth of the earth's land surface and encompasses several phytogeographical communities which developed under equatorial, tropical and Mediterranean climates (White 1983). Environmental and ecological conditions are extremely diverse not only passing from rainforest to desert and sea coast but also within similar ecosystems and latitudes. In addition, the continent hosts an immense diversity of peoples, traditions and histories. Together this necessitates more investigations of cultural-environmental changes to provide an extended chronological perspective.

The research presented in this volume includes studies comprising many of these diverse environments and cultures, presenting a clear demonstration of the variability and richness of data relating to African studies in the field of archaeobotany. The subject is crucial for sustainable development by increasing our knowledge of the links between natural resources and exploitation, opportunities and flexibility, changes and adaptation, as evident in long-term interactions of humans and the environment. If the study of one archaeological site can demonstrate local space-time events and the behaviour of a few people, the integration of data from many sites investigated with an interdisciplinary approach will enable regional and cross-cultural landscape reconstructions (Mercuri 2008a, 2014). In the pages of this book, archaeobotanists as botanists, archaeologists, anthropologists, ethnoarchaeologists and palaeoecologists compare and discuss the evidence from the African past with varied scientific languages, approaches, and research objectives. The targets, however, are the same and involve an interest in deepening the complex and fascinating history of this continent, and in the desire to learn from the 'nature and culture' of Africa the lessons on how *to exploit our lands without destroying them* (Plotkin 1994).

IWAA Workshops

The Workgroup for African Archaeobotany was founded by Professor Krystyna Wasylikowa (Kraków) in 1994 with the 1st IWAA meeting held in Mogilany, Poland in May 1994. Following this, International Workgroup for African Archaeobotany meetings have been held regularly every three years as key events where data and knowledge on African archaeobotany are exchanged on a wide range of topics. In following years, IWAA workshops were held in Leicester, England (1997); Frankfurt, Germany (2000); Groningen, Netherlands (2003); London, England (2006); Cairo, Egypt (2009); Vienna, Austria (2012) and most recently in Modena, Italy (2015) (Fig. 1).

Initially the focus of the workshop was on northern African countries and palaeoethnobotany, and included mainly macro-botanical remains. In later meetings the geographical and methodological boundaries enlarged. Today, presented research typically covers the entire African continent from South Africa to Morocco and from Mediterranean environments to the tropical forest zone. Topics have broadened considerably to include the relationships between humans and plants and ancient environments. In addition to macroremains, phytoliths, pollen, and non-pollen palynomorphs, analysed in multidisciplinary archaeo-environmental perspective, are now considered substantial components of archaeobotanical research. Ethnological and linguistic studies are also interdisciplinary elements of ancient plant use studies, as well as molecular and biochemical (for example, nucleic and fatty acids) analyses. The abstracts of conference papers presented in Modena provide a concise overview of the diversity and range of subjects and themes that are currently under investigation in African archaeobotany. They have been published as peer-reviewed long abstracts in Atti della Società dei Naturalisti e Matematici di Modena, Volume 146.

The workshop in Modena was dedicated to the memory of our colleague Prof. Ahmed Gamal-El-Din Fahmy, who organized and hosted the IWAA6 meeting at Helwan University in 2009. His untimely death in December 2013 has left us deeply saddened. In his honour the "Fahmy Memorial Speaker" award was created and awarded to the top student presentation in Modena. The winner was Ahmed's former student Dr. Mennat-Allah El-Dorry for her presentation on *Grapes, raisins and wine: archaeobotanical finds from the Monastery of St John the Little in Wadi El Natrun (Egypt)*. The second prize was given to Dr. Elshafaey A. E. Attia, and the third prize was given to Dr. Emuobosa A. Orijemie. We also commemorated the memory of Lydia

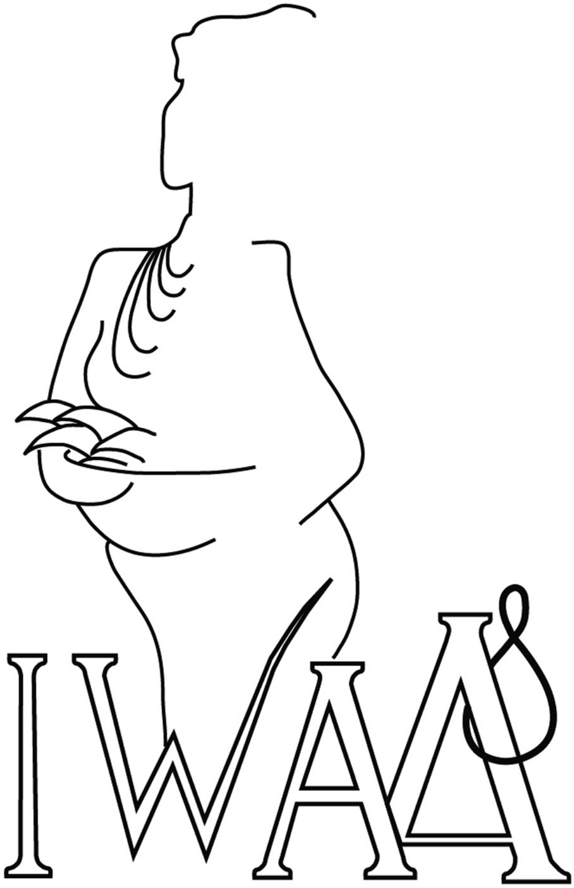

Fig. 1. The logo of the IWAA 8 congress (created and drawn by Serena Ferretti, in Reggio Emilia 2015)

Zapata Peña, another enthusiastic and extraordinary researcher and teacher, working on plant use within and beyond Africa. Indeed she also left us far too soon in January 2015.

Published Volumes from Previous IWAA Workshops

This volume is a compilation of peer-reviewed papers presented to the 8th International Workgroup for African Archaeobotany, held in Modena, Italy in June 2015. Such reference books have been published after each meeting of the International Workgroup for African Archaeobotany. With titles reflecting the main thematic lines of the presented studies, they provide an important outcome of each workshop and guidance for further studies and research in African archaeobotany.

Papers from the 1st meeting in Mogilani, Poland were published in volume 35(1) of *Acta Palaeobotanica* by Stuchlik and Wasylikowa (1995) without a synoptic title. The titles of the following two volumes, by Van der Veen (1999) and Neumann et al. (2003), pointed to plant exploitation, plant use for food and fuel, and trends toward agriculture as the 'green world' has been, and still is, at the base of resource procurement and economy in ancient and modern Africa (e.g., Cunningham 1997). The important subheading "Progress in African Archaeobotany" appeared for the first time with the book by Neumann et al. (2003). It mirrors the vivid and incessant advancement that this science has been able to achieve and contributes to the study of Africa's past.

"Fields of Change" by Cappers (2005) recalls that our cultural—agrarian—landscapes are subjected to adaptations and transformations under environmental—climate—as well as socio-economic changes, a remarkably contemporary theme. With the same awareness, the titles of the books by Fahmy et al. (2011) and Thanheiser (2016) underline the interest of archaeobotanists to open windows to new perspectives and employ diverse methods of deciphering human-plant relationships. The volume by Stevens et al. (2014) points to flora as an archaeological record and identifies it as a fundamental partner in the dyadic cultural-botanical relationship: the African flora, which has peculiar properties and a unique role in human and cultural history of the continent.

The lessons from previous books and IWAA conferences have been incorporated into the themes of this volume which illuminates human-plant interactions in the African past.

The Organization and Themes of This Book

The papers included in this volume represent the most current archaeobotanical research completed by international scholars from Africa, Europe and North America. The book presents a pan-African perspective, including study locales from Mediterranean Africa, the Horn, West, East, Central and Saharan Africa, as well as synthesis papers covering more than one region (Fig. 2). Contributions are data-rich and employ some of the most advanced methods available in archaeobotanical research. General themes touched on by papers in this volume include agricultural systems of sub-Saharan Africa, agricultural history, status of archaeobotanical studies, culinary practices, food and drink production/processing, plant domestication history, landscape reconstruction, anthropogenesis and Holocene vegetation history. Chapters focussing on studies of important species are presented including wild grasses, cotton, barley, sorghum, millet and rice. Much of the presented research focuses on macro-botanical remains, mainly seeds/fruits, but in addition, contributions on anthracology as well as micro-remains, including pollen, starch grains and phytoliths are also presented. Many chapters report on studies completed on key archaeological sites in Africa: Luxor, Helwan, Dakhleh Oasis and Hierakonpolis in Egypt; Takarkori in Libya; Tin Hanakaten Cave in Algeria; Kassala and Sai Island in Sudan; Mezber in Ethiopia; the Niger River basin in Benin; Pangwari and Motako in Nigeria; the Middle Senegal River

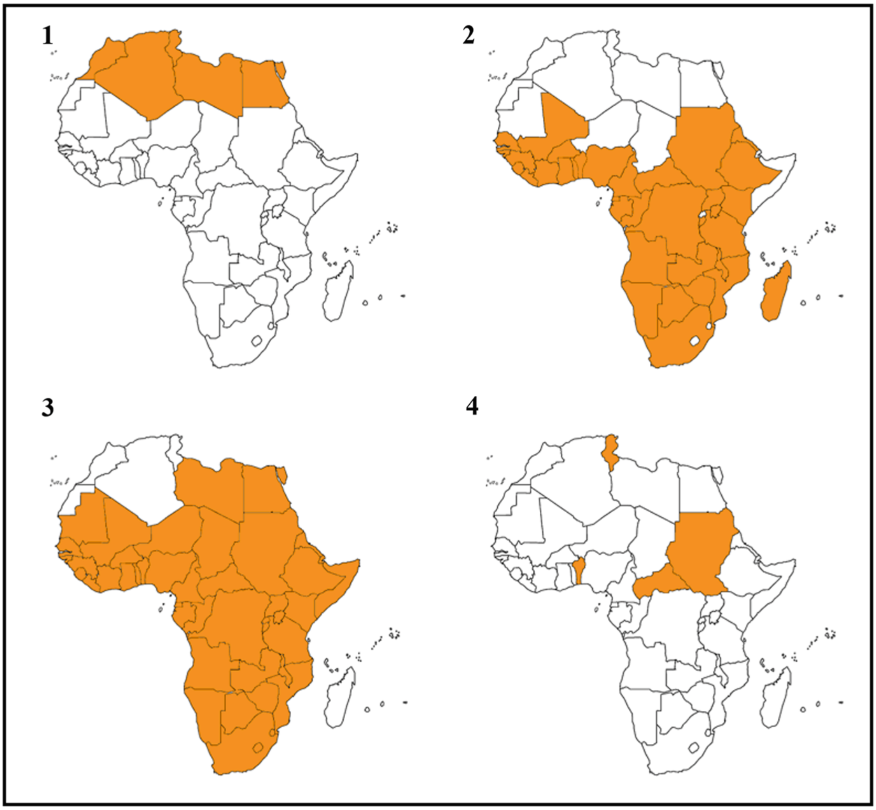

Fig. 2. Map of the country studied in the research papers included in this book, divided into the four themes represented at the Modena conference: (1) Mediterranean Africa; (2) Archaeology and Palaeoecology: Integrated Methods; (3) Plant Use, Agricultural History and Ethnoarchaeology: Foods and Fields; and (4) Climate and Agrarian-Cultural Landscapes.

Valley, and Mtwara Creek in Kenya. All papers present maps and geographical descriptions to make clear the phytogeographical context of the archaeobotanical study.

The volume is divided into four themes represented at the Modena conference: (1) Mediterranean Africa; (2) Archaeology and Palaeoecology: Integrated Methods; (3) Plant Use, Agricultural History and Ethnoarchaeology: Foods and Fields; and (4) Climate and Agrarian-Cultural Landscapes.

The first section, ***Mediterranean Africa,*** includes eight contributions on current research in Egypt, Libya, Tunisia, Algeria and Morocco, covering a temporal period ranging from the Palaeolithic to Late Antiquity (c. 2nd–8th centuries AD). Themes touched upon by these papers include ancient Egyptian Predynastic, New Kingdom and Medieval archaeobotany, and plant use by Holocene forager inhabitants of Mediterranean Africa.

The second section, ***Archaeology and Palaeoecology: Integrated Methods,*** presents five papers that emphasise the use of integrated methods in archaeology and palaeoecology. Contributions from West and East Africa and the Nile region deal with

Fig. 3. Photo of some participants to the IWAA8 in Modena (1. Rossella Rinaldi; 2. Alice Fietta; 3. Chris J. Stevens; 4. Senna Thornton-Barnett; 5. Sahbi Jaouadi; 6. Amanda Logan; 7. Welmoed A. Out; 8. Shannon Hardwick; 9. Sarah Walshaw; 10. Daphne Gallagher; 11. Elshafaey Abdelatif Elshafaey Attia; 12. Federica Riso; 13. Christopher A. Kiahtipes; 14. Roger Blench; 15. Kingsley Daraojimba; 16. Alexa Höhn; 17. Justin Bradfield; 18. Steven Brandt; 19. Ursula Thanheiser; 20. Phylippa Ryan; 21. Ryan M. Szymanski; 22. Claire Malleson; 23. Mats Widgren; 24. Lucia Veronica Collura; 25. Barbara Eichhorn; 26. Charlène Bouchaud; 27. Amy Styring; 28. Samira Amrani; 29. Laurent Bremond; 30. Alemseged Beldados; 31. René T. J. Cappers; 32. Louis Champion; 33. May Lesley Murungi; 34. Elisabeth Hildebrand; 35. Catherine A. D'Andrea; 36. Fabrizio Buldrini; 37. Rim Hamdy; 38. Adel M. Ahmed Ali; 39. Mennat-Allah El Dorry; 40. Christine Sievers; 41. Elisa Nervo; 42. Yolanda Carrión Marco; 43. Katharina Neumann; 44. Sonja Filatova; 45. Anna Maria Mercuri; 46. Marie-Pierre Ruas; 47. Rita Fornaciari; 48. Assunta Florenzano; 49. Paola Torri; 50. Maria Chiara Montecchi).

issues of taphonomy and the difficulties in differentiating anthropogenic and natural environmental changes in the prehistoric archaeological and palaeoecological records.

Section three, ***Plant Use, Agricultural History and Ethnoarchaeology***: ***Foods and Fields***, presents six papers dealing with plant use, foodways and agricultural history, and ethnoarchaeological approaches to African archaeobotany with contributions from West, East Africa and the Horn. Examples are presented of plant use in agrarian and foraging societies, plant domestication and the evolution of ancient agricultural systems in Africa.

The final section, ***Climate and Agrarian-Cultural Landscapes***, presents four contributions on climate change and agricultural-mediated landscapes as documented in various study sites across northern and central Africa. Themes include human-environmental interactions, anthropogenic impacts and new evidence on the spread of early agricultural communities.

In more than twenty years of research activity (1994–2018), archaeobotanists have played a significant role in interdisciplinary cooperation that is needed to understand the detailed and complex history of Africa. This book reflects a portion of these cooperative efforts, and we hope it will encourage further studies of the relationships between plants and people by considering processes from a long-term perspective, and from local to regional scales in Africa.

Acknowledgements. The 8th IWAA was the meeting of about 70 scholars in Modena (Fig. 3—Photo of the participants—group under the big holm oak in Modena). We would like to express our gratitude to the referees whose efforts have contributed to the quality of papers presented in this volume: Aziz Ballouche, Marion K. Bamford, Ortrud Monika Barth, Koen Bostoen, Terry M. Brncic, Alan J. Clapham, Charles R. Clements, Savino di Lernia, Barbara Eichhorn, Mennat-Allah El Dorry, Rodolfo Fattovich, Assunta Florenzano, Daphne Gallagher, Renate Germer, Lara Carretero Gonzalez, Elisabeth Hildebrand, Christopher Hunt, Sarah Ivorra, Andrea Kay, Christopher A. Kiathipes, Chap Kusimba, Amanda Logan, Marco Madella, Evi Margaritis, Elena Marinova, Naomi Miller, Katharina Neumann, Ruth Pelling, Peter Rowley-Conwy, Rita Scheel-Ybert, Christine Sievers, Chris Stevens, Ursula Thanheiser, Mariano Ucchesu, Tania Valamoti, Sarah Walshaw, John-Peter Wild, Martin Williams, Michèle Wollstonecroft, Elsa Yvanez, Andrea Zerboni.

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Mediterranean Africa

Archaeobotanical Study at the Early Dynastic Cemetery in Helwan (3100–2600 BC), Egypt: Plant Diversity at Early Dynastic Memphis

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Abstract. Recently, several studies have been published dealing with the analysis of plant remains from archaeological sites in the Memphite region. These investigations covered different archaeological periods. However, until now, no research has be completed on plant remains from the Early Dynastic period in this area. This paper will focus on analysis of macro-botanical remains from sealed pots discovered inside ten tombs at the Early Dynastic Cemetery in Helwan, 30 km south of Cairo (3100–2600 BC). The main goal is to study the economy and ecology relating to the site rather than the offering practices of ancient Egypt. In addition, this research will reconstruct agricultural practices, to shed light on plant diversity and to increase our understanding about non-elite lifeways that prevailed during Early Dynastic times in Memphis. Analysis of the plant remains retrieved from Helwan Cemetery has yielded a total of 25,743 fragments of charred plant macroremains. These remains were classified into two major groups: cultivated crops, including cereals, flax and legumes; and wild/weedy plants comprising wild edible fruits, field weeds, plants of moist habitats, plants of dry habitats and other indeterminate taxa. Cereal remains from the studied tombs consisted of chaff and grains. The study revealed that the arable economy of Memphis during this period was based on the cultivation of cereals primarily *Hordeum vulgare* L. subsp. *vulgare* (hulled barley) which was associated with *Triticum turgidum* L. ssp. *dicoccum* (Schrank) Thell. (emmer wheat).

Keywords: Archaeobotany · Cemetery · Early dynastic · Egypt Helwan · Plant macroremains

Introduction

In Egypt, archaeobotanical studies have greatly contributed to our knowledge of plant diversity, economy, agricultural production and the environment that prevailed in the past with the help of substantial finds of plants within Pharaonic tombs and also by representations of plants, livestock and agriculture-related activities in ancient paintings and reliefs depicted in tombs and temples. In addition, many archaeobotanical

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investigations from settlement sites have increased our understanding of human diet and nutrition in the Egyptian past.

Research into Egyptian archaeobotany has a long history. Kunth (1826) identified fruit remains found by the French archaeologist J. Passalacqua in a XIXth dynasty tomb (1570–1070 BC) at Thebes. Unger (1866) drew our attention to the significance of mud bricks as a useful source of archaeobotanical information. He studied plant macro remains preserved in mud bricks from the Pyramids of Dahshur and from the City of Ancient Rameses (Fahmy 2004). Schweinfurth (1882, 1883, 1884, 1887) included brief morphological descriptions of more than 100 plant species represented in archaeological sediments by different types of plant fragments, including grains, seeds, floral heads and leaf fragments.

During the 20th century, considerable advances were made in Egyptian archaeobotanical research by Keimer (1924), Täckholm (1939, 1940, 1951, 1961) and Greiss (1949, 1957). The works of Täckholm et al. (1941), Täckholm and Drar (1950, 1954) provided ample evidence of cultivated and wild plant remains retrieved from different sites across the country. In addition, Murray (2000) provided an extensive summary of earlier archaeobotanical works. Recent studies have increased our knowledge of past relationships between humans and plants in ancient Egypt through different historical periods including Maadi (Kroll 1989; van Zeist and Roller 1993; van Zeist et al. 2003), Hieraknopolis (Fahmy 1995, 2003, 2004; El Hadidi et al. 1996; Fahmy et al. 2011), Adaïma (Newton 2004, 2007) and Giza (Murray and Gendy 2015; Malleson 2016). Nevertheless, at present the only publications dealing with the analysis of plant remains include data from the Neolithic period ‘El-Omari’ (Barakat 1990), the Predynastic period ‘Maadi’ (van Zeist et al. 2003) and the Old Kingdom period sites of Abusir and Giza (Murray 2004, 2005, 2007a, b; Gerisch 2007a, b; Pokorný et al. 2009; Pokorná and Pokorný 2010; Beneš 2011a, b; Pokorná 2011; Pokorná and Beneš 2014) in the Memphite region. Accordingly, our analysis and publication of plant remains from the Helwan cemetery as representative of the Early Dynastic period will help to fill a considerable gap in the agricultural and subsistence history of the Memphite region (Fig. 1 shows archaeological sites mentioned in the text).

Archaeological excavations at the cemetery of Helwan (Protodynastic—early Old Kingdom, c. 3200–2700 BC) revealed the presence of sealed pots inside tombs containing ash and soil which included botanical materials (seeds, fruits and charcoal) as well as a variety of plant remains from other contexts (wood associated with burials, coffin wood and organics in stone vessels). Most plant materials were preserved by charring and others, such as wood, were desiccated. Also, a considerable quantity of animal bones have been retrieved from the cemetery. In this regard, the Helwan cemetery is a noteworthy archaeological site because it has not only produced seeds and grains of both cultivated and wild plants, but also considerable quantities of charred and desiccated materials (charcoal, desiccated wood and other organic materials). This paper will focus on the analysis of plant macroremains (seeds, fruits and other vegetative parts) retrieved from sealed pots from 10 tombs excavated in Operation 4 to understand the economic and ecological characteristics of the site in the past. The aim of the present study is to elucidate the agricultural economy that flourished in

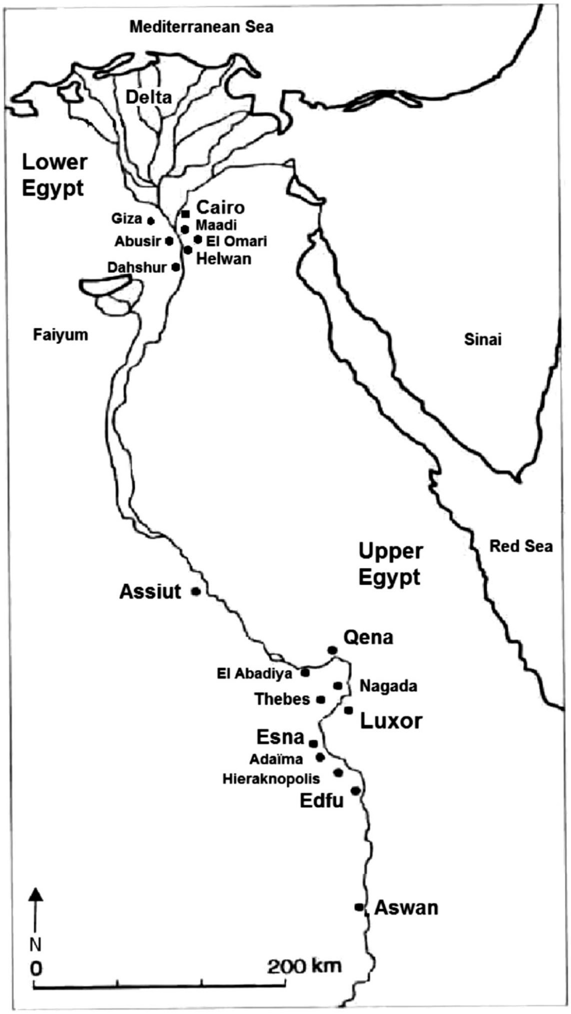

Fig. 1. Map showing archaeological sites mentioned in the text.

the Memphis area during Early Dynastic times and to shed light on past agricultural systems and the main sources of plant foods. It also will examine the weed flora to inform on Early Dynastic agricultural practices, including irrigation and harvesting technique. A detailed study of all botanical materials from Operation 4 at Helwan cemetery including charcoal and wood as well as details of the archaeological contexts will be published at a future date, with archaeobotanical raw data in a separate bioarchaeological volume.

The Study Area

The materials reported in this study were excavated from the archaeological site of Helwan/Ezbet El Walda, about 30 km south of Cairo, where non-elite inhabitants of early Memphis were buried. This site is considered to be the largest necropolis of the Early Dynastic Period in Egypt (Köhler 2008, 2014) and is located on the east bank of the Nile between the modern villages of Ezbet Kamel Sedqi el-Qebleyah in the north and Ezbet el-Walda in the south. The cemetery stretches over a distance of c. 1.5 km from north to south along the riverbank and rests on a Pleistocene palaeofan of Wadi Hof (Köhler 2008). Figure 2 shows the position of the site in relation to Cairo, the Nile and other sites in Memphite area.

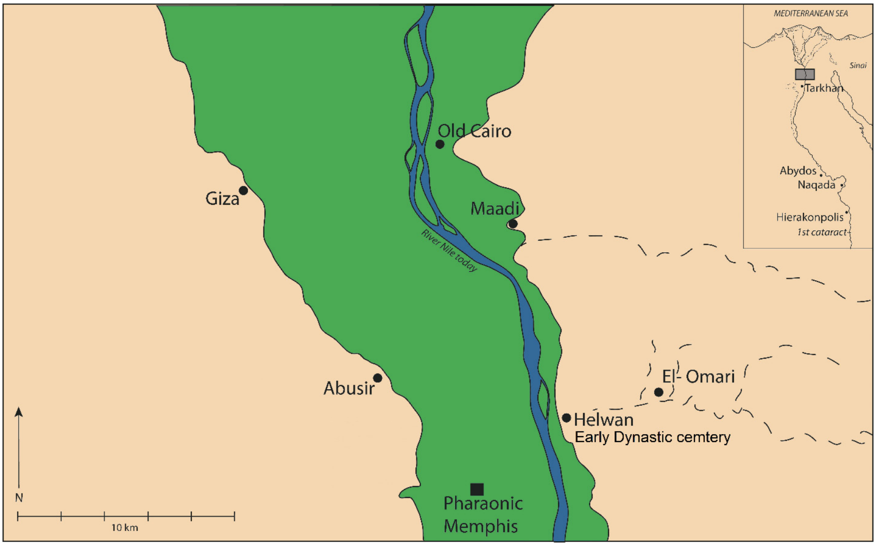

Fig. 2. Map showing relationship of Helwan site to Cairo and the Nile.

Six graves of the cemetery were excavated by Larsen in the 1920s followed by more than 12 years of excavation by Zaki Saad between 1942 and 1954 where more than 10,000 graves were uncovered. This was followed by two more excavation seasons organized by the Egyptian Antiquities Organization in 1966 and 1975 (Köhler 2008). Köhler began fieldwork at the cemetery in 1997 with support of Macquarie University in Sydney. Currently the work has continued as a joint project, led by Köhler for Macquarie University, Sydney and the University of Vienna (Köhler 2008). The excavations have now ceased and the project has entered a phase of analysis and publication.

The period of occupation probably began during Naqada IIIA (c. 3300 BC), continued well beyond Naqada IIIC and IIID (3100–2700 BC), and into the Old Kingdom (after 2700 BC) (Köhler 2015). There is evidence to suggest that certain parts of the site were also occupied throughout much of the Pharaonic period and into the Late Roman and Medieval ages (Köhler 2008). The 218 excavated tombs since 1997 primarily date from Late Naqada IIIC to early Old Kingdom (1st–4th Dynasties) times (Köhler 2015). A series of well-preserved samples of plant macroremains were obtained from ten tombs in the Early Dynastic Cemetery at Helwan/Ezbet El Walda (Operation 4). Table 1 presents the number of samples taken from each tomb, its date, and the age and sex of the occupant. The data reported here should be considered preliminary and pending final analysis. Figure 3 shows the grid plan of the excavated area and illustrates the distribution of the tombs under study.

Table 1 Occupant data and date of the Operation 4 tombs included in this study. Dating is according to Köhler (2014 & in preparation).

Tomb	Number of samples	Cultural dating	Relative chronology	BC dating	Age	Sex
48	1	Late Dynasty 1/early Dynasty 2	Group IIIC3-D1	3100–2900	Adult	Female
68	3	Mid Dynasty 2/Late Dynasty 2	Group IIID2-3	2700	Adolescent	Unknown
71	1	Late Dynasty 2/early Dynasty 3	Group IIID4	2700–2600	Mature Adult	Female
76	4	Dynasty 1-2/Mid Dynasty 2	Group IIID1-2	2700	Adult	Unknown
77	1	Dynasty 1-2/Mid Dynasty 2	Group IIID1-2	2700	Adult	Male?
83	11	Dynasty 1-2/Mid Dynasty 2	Group IIID1-2	2700	Adult	Male
88	4	Mid Dynasty 2	Group IIID2	2700	Mature Adult	Female
91	2	Dynasty 1-2	Group IIID1	3100–2900	Adult	Male?
100	2	Mid Dynasty 2	Group IIID2 (-3?)	2700	Adult	Unknown
104	1	Dynasty 2	–	3100–2900	Adult	Male

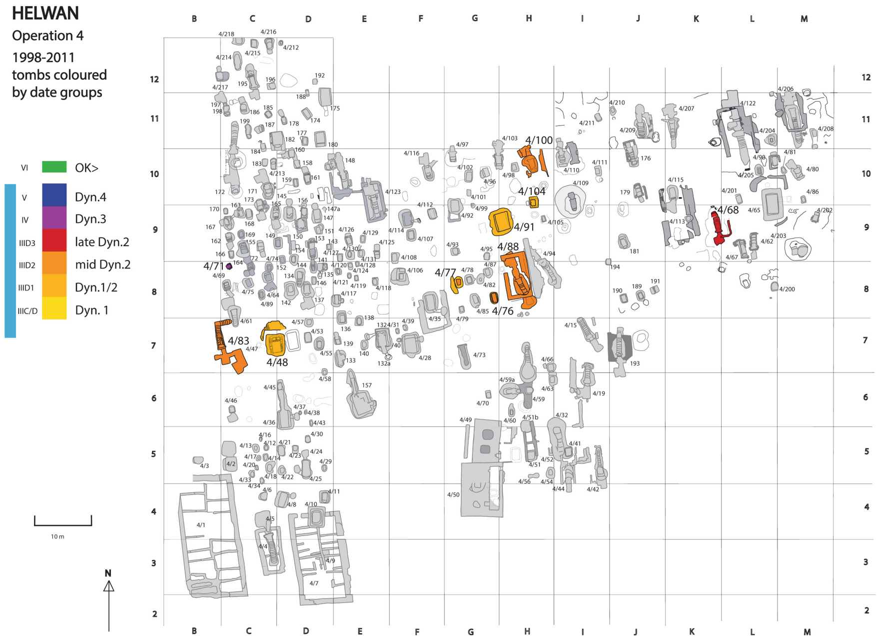

Fig. 3. Grid plan showing the distribution of 10 tombs from Operation 4 mentioned in the text (with kind permission from Prof. Dr. E. Christiana Köhler).

Materials and Methods

Thirty sediment samples were collected during the excavation seasons between 2003 and 2006 from sealed pots inside tombs. The volume of these samples range between 0.3 and 7.1 of ash as well as ash mixed with clay.

Water flotation processing was used for the separation of plant macroremains from the archaeological sediments found inside the pots. The volume of each sample was measured and samples were processed using bucket flotation. Floating macro-botanical remains were skimmed from the surface using a tea strainer (0.5 mm) and placed onto fine cheesecloth. This process was repeated until no more floating charred remains were observed. The cheesecloth was carefully folded over and set aside to dry while the heavy fraction was processed. After drying, each sample was stored in a small plastic box. The volume of plant macroremains was recorded in ml. Only charred materials were retrieved from these thirty samples and they appeared to be in a homogenous state of preservation.

All charred remains of cultivated and wild plants were sorted into categories using a binocular microscope (magnification: 10x–20x) and counted. Only nine samples were sub-sampled because of their large size, where 50% by volume of each sample was analyzed.

For Scanning Electron Microscope (SEM) studies, seeds and grains were coated with gold and examined by a JEOL JXA-840 SEM. It operated at an accelerating voltage of 15 kV at the Electron Microscope Unit, National Research Center, Dokki, Egypt.

Identification of cereal remains was based on Jacomet (2006) and Zohary et al. (2012). Remains of wild plants were identified using morphological descriptions and illustrations in the Flora of Egypt (Täckholm 1974; Boulos 1999, 2000, 2002, 2005), in addition to Willcox et al. (2002), Cappers et al. (2006) and online data bases and websites including those at the United States Department of Agriculture (USDA 2016). Specimens were identified according to their gross morphological features and compared to a modern reference collection of seeds and fruits held at the Helwan University Herbarium. The nomenclature of the wild taxa is according to Boulos (2009), while that of cultivated plants follows Zohary et al. (2012).

Results

Analysis of Helwan samples has yielded a total of 25,743 fragments of charred plant macroremains including grains, seeds, achenes, nutlets, capsules, pods and vegetative parts of cultivated and wild plants. Table 2 and Fig. 4 summarize the plant macro remains which were classified into two major groups: cultivated crops including 10,303 remains of cereals (40.02%), 6 flax (0.02%) and 2530 pulses (9.83%); and wild plants including 2 remains of wild edible fruits (0.01%), 11,480 field weeds (44.59%), 644 plants of moist habitats (2.50%), 10 plants of dry habitats (0.04%) and 768 indeterminate records (2.98%) (Fig. 4). Cereals and field weeds together dominate plant remains with a combined percentage of 84.61%, which are attributed to 40 species, 47 genera and 18 families.

Table 2 Plant macroremains separated from the Operation 4 tombs in Helwan Early Dynastic cemetery. (A) Number of plant macroremains, (F) Number of samples in which a taxon occurs.

Types/Families	Taxa	Plant element	A	F
1. Crops				
1.1 Cereals				
Poaceae	*Hordeum vulgare* L. subsp. *distichum*	Grain	37	9
		Rachis internode	62	16
	Hordeum vulgare L. subsp.*vulgare* (hulled)	Grain	706	29
		Rachis internode	6299	29
	Hordeum vulgare L. subsp. *vulgare* (naked)	Grain	9	6
	Hordeum sp.	Grain	144	16
		Spikelet	3	2
	Triticum turgidum L. ssp. *dicoccum* (Schrank) Thell.	Grain	75	20
		Glume base	697	23
		Fork	75	11
		Rachis internode	92	14
		Spikelet	3	3
	cf. *Triticum durum* Desf./*aestivum* L.	Rachis internode	2	2

(*continued*)

Table 2 (*continued*)

Types/Families	Taxa	Plant element	A	F
	Triticum sp.	Grain	19	12
	Cereal indeterminate	Grain	9	2
		Glume base	4	1
		Culm	1233	24
		Grain fragment	825	27
		Internodes unknown	9	2
		Cereal total	**10303**	
1.2 Flax				
Linaceae	*Linum usitatissimum* L.	Seed	3	2
		Capsule	3	3
		Flax total	**6**	
1.3 Pulses				
Fabaceae	*Lens culinaris* Medik.	Seed	5	3
	Trifolium alexandrinum L.	Seed	2460	26
		Fruit	65	7
		Pulse total	**2530**	
2. Wild plants				
2.1 Wild edible fruit				
Rhamnaceae	*Ziziphus spina-christi* (L.) Desf.	Fruit	2	2
		Wild plant total	**2**	
2.2 Field weeds				
Asteraceae	*Anthemis retusa* Delile, Descr.	Fruit	7	2
	Senecio aegyptius L.	Capitula	34	4
	Centaurea sp.	Capitula	1	1
	Pulicaria sp.	Fruit	2	2
Brassicaceae	cf. *Camelina* type	Seed	1	1
	Lepidium sativum L.	Fruit	4	2
Chenopodiaceae	*Chenopodium murale* L.	Seed	8	5
Fabaceae	*Lathyrus hirsutus* L.	Seed	12	6
	Lathyrus aphaca L.	Seed	1	1
	Lens sp.	Seed	4	3
	Lupinus type	Seed	4	3
	Medicago polymorpha L.	Seed	151	18
		Fruit	32	7
	Medicago lupulina L.	Seed	1245	25
	Melilotus type	Seed	25	7
	Pisum sp.	Seed	60	12
	Scorpiurus muricatus L.	Fruit	1	1
	Trifolium type 1	Seed	54	6

(*continued*)

Table 2 (*continued*)

Types/Families	Taxa	Plant element	A	F
	Trifolium type 2	Seed	24	5
	Trifolium type 3	Seed	7	3
	Vicia sativa L.	Seed	184	22
	Vicia ervilia (L.) Willd.	Seed	55	18
	Vicia type	Seed	7	5
	Vicia type 2	Seed	13	6
Malvaceae	*Malva* cf *parviflora* L.	Mericarp	1	1
	Malvaceae type1	Seed	11	8
	Malvaceae type2	Seed	13	5
Poaceae	*Agropyron* type	Grain	4	2
	Avena sp.	Grain	1	1
		Rachilla	7	6
	Bromus sp.	Grain	296	26
	Digitaria sanguinalis (L.) Scop.	Grain	2	2
	Lolium temulentum L.	Florets	1984	19
		Grain	870	10
		Internode	57	8
	Phalaris minor Retz.	Spikelet	45	10
		Grain	2981	30
	Phragmites type	Leaves	26	1
	Setaria type	Grain	2	2
	Grasses indeterminate	Grain	319	18
		Rhizome	47	13
		Fragments	871	23
		Culm fragment	75	6
		Internode	3	1
		Glume base	219	12
		Small branch	2	1
		Branches	721	21
Polygonaceae	*Persicaria senegalensis* (Meisn.)	Seed	2	2
	Polygonum equisetiform Sm.	Seed	12	8
	Polygonum sp.	Seed	4	3
	Polygonaceae type	Seed	6	4
	Rumex dentatus L.	Seed	692	25
		Fruiting bodies	183	13
	Rumex sp.	Seed	3	3
Portulacaceae	*Portulaca oleracea* L.	Seed	15	5
Solanaceae	*Solanum nigrum* L.	Seed	3	1
		Field weed total	**11480**	

(*continued*)

Table 2 (*continued*)

Types/Families	Taxa	Plant element	A	F
2.3 Plants of moist habitats				
Asteraceae	*Ceruana pratensis* Forssk.	Capitula	11	5
Brassicaceae	*Coronopus niloticus* (Delile) Spreng.	Fruit	1	1
Cyperaceae	*Carex divisa* Huds.	Fruit	1	1
		Seed	3	2
	Cyperus articulatus L.	Seed	3	3
	Cyperaceae type 1	Seed	225	23
	Cyperaceae type 2	Seed	3	1
	Eleocharis palustris (L.) Roem. & Schult.	Seed	63	11
	Fimbristylis bisumbellata (Forssk.)	Seed	1	1
	Scirpus type 1	Seed	29	1
	Scirpus type 2	Seed	4	1
Juncaceae	*Juncus rigidus* Desf.	Seed	1	1
Rosaceae	*Potentilla supina* L.	Seed	299	9
		Plants of moist places total	**644**	
2.4 Plants of dry habitats				
Asphodelaceae	*Asphodelus fistulosus* L.	Seed	1	1
Asteraceae	*Nauplius graveolens* (Forssk.)	Capitula	5	5
Boraginaceae	*Echium* sp.	Seed	3	3
Brassicaceae	*Zilla spinosa* (L.) Prantl	Fruit	1	1
		Plants of dry places total	**10**	
2.5 Indeterminate taxa				
Boraginaceae	Boraginaceae type	Seed	16	1
Brassicaceae	Cruciferae type	Seed	4	4
Euphorbiaceae	*Euphorbia* type	Seed	2	2
Fabaceae	Fabaceae 1 (*Vicia* type 1)	Seed	1	1
	Fabaceae 2	Seed	44	12
	Fabaceae 4 (*Vicia* type 3)	Seed	20	7
	Fabaceae 5 (*Vicia* type 4)	Seed	2	1
	Fabaceae unidentified	Seed	332	18
	Fabaceae fragments	Seed	149	7
	Fabaceae broken seed	Seed	194	19
Lamiaceae	Labiatae type 1	Fruit	2	2
	cf. Labiatae type 2	Seed	1	1
Poaceae	Poaceae type	Spikelet	1	1
		Indeterminate total	**768**	
		Total remains	25,743	

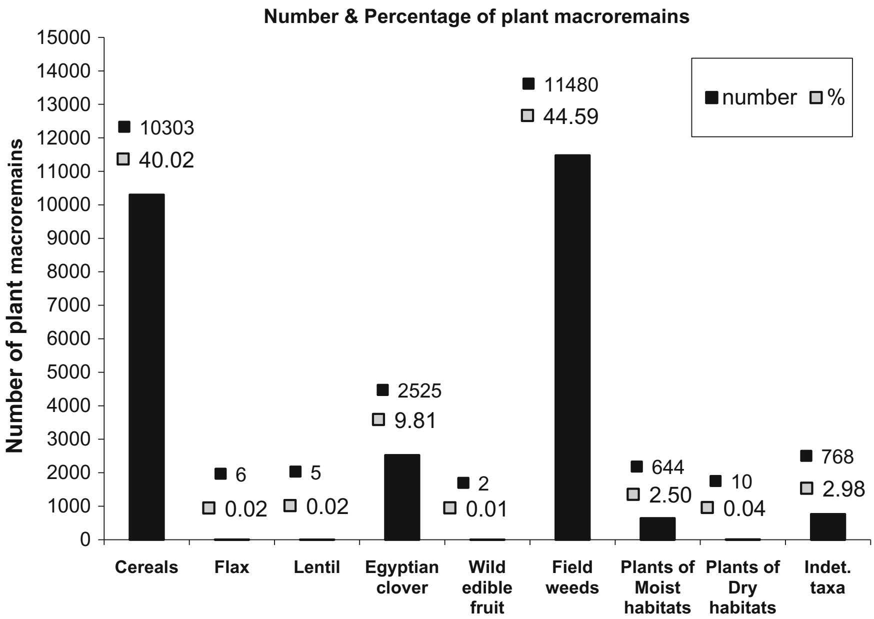

Fig. 4. Frequencies and percentages of plant macroremains from 10 tombs of Operation 4 at the Helwan Early Dynastic cemetery.

Crop Plants

Crops represent 49.87% of the total number of plant macroremains (Fig. 4), which are mostly of cereals, 40.02%, while 0.02% comprises flax and 9.83% are legumes.

Cereals

Cereal remains appeared in all studied samples and included grains, rachis fragments, glume bases, and spikelet forks. These elements consist of 90.3% chaff and 9.7% of grains. Remains of five cereals have been identified: *Hordeum vulgare* L. ssp. *vulgare* (hulled barley), *Hordeum vulgare* L. ssp. *distichum* (two-row barley), *Hordeum vulgare* L. ssp. *vulgare* (naked barley), *Triticum turgidum* ssp. *dicoccum* (Schrank) Thell. (emmer wheat), *Triticum aestivum/durum* (free threshing bread/macaroni wheat). The latter category was represented only by articulated rachis segments. As shown in Fig. 5, the remains of hulled barley dominate the macro-botanical assemblage with 70.7% of the total number of cereal grains and 67.7% of the total number of chaff elements. On the other hand, emmer, free threshing wheats, two-rowed and naked barley are represented by comparatively lower percentages.

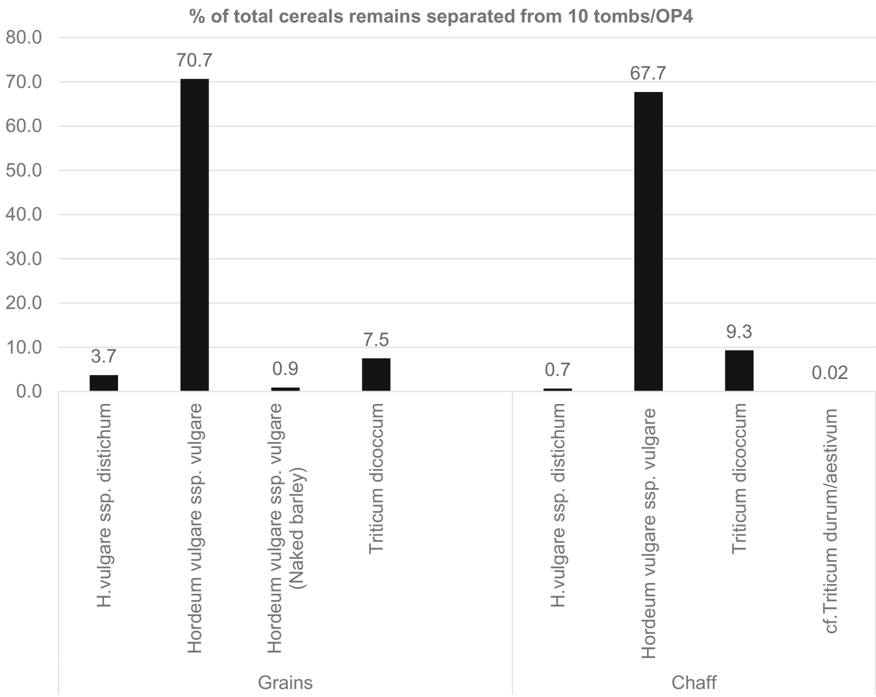

Fig. 5. Percentages of total cereal remains (grain and chaff) separated from 10 tombs of Operation 4 in the Helwan Early Dynastic cemetery.

Hulled barley remains vary in percentage among the 10 tombs, where chaff ranges 23.0–90.3% and grains range 0.2–23.2% of the total number of cereals remains retrieved from each tomb. Rachis internodes (Fig. 6) of barley were found in all studied tombs. The dominance of barley in all samples may suggest its significant role as a symbol of resurrection. Also, short and plump grains of naked barley which are characterised by the presence of transverse ridges on their dorsal side (Fig. 7) were recorded in low numbers, which may reflect the minor role of this crop in the Early Dynastic agricultural economy at Memphis. It also may represent a contaminant in fields of hulled barley. Van Zeist and Roller (1993) reported that all barley grains from the site of Maadi were of the hulled type. A total of 37 grains of *Hordeum distichum* were recorded from 9 samples with average dimensions of 3.1 × 1.5 × 1.05 mm (length x breadth x thickness). Rachis internodes of this variety (Fig. 8) were recorded in 16 samples. Although it can be difficult to distinguish between two and six-row barley (*Horedum vulgare* ssp. *hexastichum* L.), based on grain shape and the presence of associated rachis internodes, we conclude these grains are the two-rowed form (Table 2).

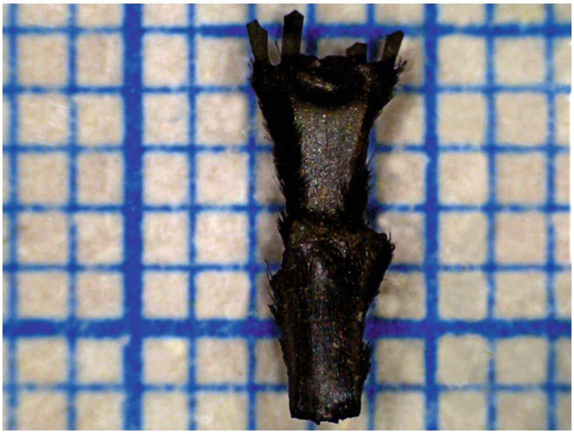

Fig. 6. Rachis internode of hulled barley. Each unit = 1 mm.

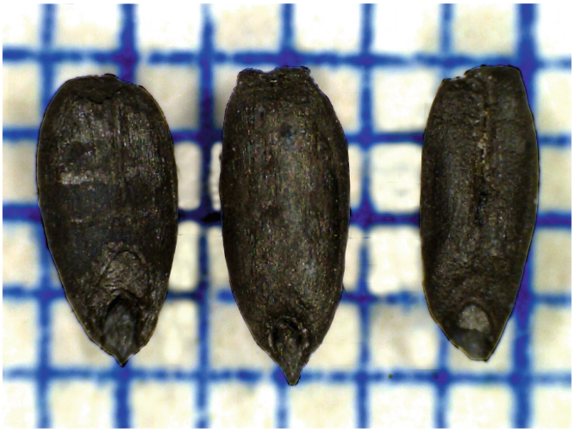

Fig. 7. Grains of naked barley. Each unit = 1 mm.

Emmer wheat remains were not abundant in the Helwan samples. They represent only 7.5% of the total number of cereals grains and 9.3% of the total number of chaff elements (Fig. 5). In addition, emmer grains were recorded in low numbers with percentages ranging 0.3–2.3% of the total number of cereals remains in each tomb while emmer chaff occurred in very small percentages ranging 0.2–26.1% of the total number of cereals remains retrieved from each tomb. Emmer chaff included glume bases, spikelet forks (Fig. 9), rachis segments and whole spikelets.

Rachis internodes of free threshing wheat were represented by 2 elements. This demonstrates that it was likely a contaminant of emmer/barley fields. As reported by van Zeist and Roller (1993), van Zeist et al. (2003) and Cappers et al. (2004), free-threshing wheat was not cultivated in Predynastic and Pharaonic Egypt.