

PLANT DOMESTICATION AND THE ORIGINS OF AGRICULTURE IN THE ANCIENT NEAR EAST

The Agricultural Revolution – including the domestication of plants and animals in the Near East – that occurred 10,500 years ago ended millions of years of human existence in small, mobile, egalitarian communities of hunter-gatherers. This Neolithic transformation led to the formation of sedentary communities that produced crops such as wheat, barley, peas, lentils, chickpeas and flax and domesticated a range of livestock, including goats, sheep, cattle and pigs. All of these plants and animals still play a major role in the contemporary global economy and nutrition. This agricultural revolution also stimulated the later development of the first urban centres. This volume examines the origins of plant domestication in the ancient Near East, along with various aspects of the new Human–Nature relationship that characterizes food-producing societies. It demonstrates how the rapid, geographically localized, knowledge-based domestication of plants was a human initiative that eventually gave rise to Western civilizations and the modern human condition.

Shahal Abbo is an agronomist and plant geneticist at the Hebrew University of Jerusalem, Israel. Through comparative study of grain legumes and cereals, both domesticated and wild, across Mediterranean agro-eco-systems, he has developed several new practical and conceptual tools pertaining to plant domestication and crop evolution.

Avi Gopher is an archaeologist at Tel Aviv University, Israel. He has conducted research on time-space systematics – seriation analyses reconstructing both the chronology and pace of the diffusion of Neolithic cultural elements in the interaction sphere of the early Neolithic in the Near East. Gopher is a member of a research group on plant domestication in the Near East and focuses on the archaeological aspects.

Gila Kahila Bar-Gal is a molecular geneticist at the Hebrew University of Jerusalem, Israel. She studies host–pathogen interaction and human activities that affect animals with the aim of conserving future biodiversity.

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Shahal Abbo , Avi Gopher , Gila Kahila Bar-Gal
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Shahal Abbo and Avi Gopher

With a contribution by Gila Kahila Bar-Gal
Translated by Halo (Hilla) Ben Asher



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FOREWORD

It is with much pleasure that I take the opportunity to contribute a foreword to this work by Professors Shahal Abbo and Avi Gopher, my long-time colleagues in the study of this fascinating and hugely complicated question of the origin of agriculture in the Near East. Plant domestication and the origins of agriculture in the Near East were the most significant innovations of our species *Homo sapiens*, second only to the use of fire, which was initiated hundreds of thousands of years ago by an earlier member of the genus *Homo*. This book tells the plants' part of the story of the Neolithic or Agricultural Revolution, a foundational change in human existence that took place less than 11,000 years ago. Since its beginnings, that revolutionary turn of events has resulted in an increase of more than 1,000-fold in the global human population and remains a cornerstone of modern human life.

After several million years of hominin existence based on hunting and gathering of natural resources, the consequences of both food production and sedentism by most of humanity were enormous. Their technological and cultural outcomes stem from the ability of agriculture to support large human groups where people (at first only a few and later many multitudes) are not preoccupied with food production. Those early free people invented and adopted the usage of measuring, counting, writing, metallurgy, and in due time established urbanization, large social human organizations such as ancient Sumer, Egypt, Greece, Rome, China, and in more recent times modern states, professional armies, art and literature, musical instruments and ensembles, science and technology, modern medicine, people walking on the Moon and sending vehicles to Mars.

The move towards tending the soil and growing crops was at least as much a cultural as a technological phenomenon, and perhaps even more so. It required a dramatic change, involving ideological and spiritual elements, in the perception of nature. Unfortunately, far too little is known about these aspects and their roles in the striking changes taking place in human behaviour and human relationships, both within society (human–human) and towards nature (human–world). This is because some of those aspects are archaeologically transparent, or at least do not lend themselves to an easy reading through the archaeological record. The actual data that are much more amenable to study are those from botanical and zoological finds recovered from archaeological sites, from genetics of archaeological and extant plants, animals and humans, and from archaeological material culture including site characteristics, architecture, stone industries, burial data, language and other features.

To some readers, this book may be considered provocative. That is part of its value. Its fifteen chapters are focused on evidence-based aspects of the subjects pertinent to plant domestication in the relevant chronological (Neolithic) range and geographic (Near Eastern) expanse. To the study of plant domestication in the Neolithic Near East, Abbo and Gopher bring a balanced and complementary fund of knowledge. Shahal Abbo is a geneticist and agronomist who specializes in Mediterranean legume and cereal crops, including field biology and genetics of the wild progenitors of domesticated crops, and Avi Gopher is an expert in the archaeology of the Near Eastern Neolithic period. Their deep and consistent collaborations with botanists, population geneticists, experts in human nutrition and in plant diseases grants them a comprehensive view of this complex and multidisciplinary field of research.

This book is a continuation of a long list of scholarly essays by leading scientists such as de Candolle, Vavilov, Braidwood, Harlan, Zohary, Ladizinsky and others, who, for over a century, have advanced our understanding of the origins of agriculture in the Neolithic Near East. Since plant domestication is essentially a cultural phenomenon, it must be reconstructed and understood in the context of its cultural background – that is to say, of its make-up and its time-space systematics. These must relate firstly to the time, and secondly to the place of plant domestication. The earliest evidence for the origin of any cultural element is likely to be found in the area where the phenomenon first appeared. The absolute and accurate dating of the cultural element (in the case of this book, plant domestication) becomes central, and when data are lacking, or are marred by inaccuracy or selective use or confusion, misunderstanding might result. Archaeological data are carefully collected and assigned to archaeological entities (such as archaeological cultures), following well-established systematics. When such cultural entities lose distinctiveness and their temporal borders become blurred, as was done and even prized by some scholars, the potential for further mistakes in reconstructing past phenomena and processes grows exponentially. For instance, some basic facts, too often overlooked, are that not a few Neolithic cultural phenomena and materials within the Near East spread from the northern to the southern Levant, and that such diffusion of

innovations from the north to the south could take a couple of centuries. Disregarding this possibility might interfere with the construction of models of the origin of agriculture and mislead scholars discussing Neolithic plant domestication and agriculture. It is imperative, therefore, that all archaeobotanical and genetic data be considered in light of the archaeological facts and cultural dynamics as revealed by the many excavations of the Pre-Pottery Neolithic period. This book, without delving into detailed discussions on the relevant periods, emphasizes the law and order that are essential in these respects.

The same philosophy applies when contemplating the biology of the progenitors of the eight-species package constituting the founder crops of Near Eastern Neolithic agriculture, namely, emmer wheat (*Triticum turgidum*), einkorn wheat (*T. monococcum*), barley (*Hordeum vulgare*), pea (*Pisum sativum*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), bitter vetch (*Vicia ervilia*) and flax (*Linum usitatissimum*).

Abbo and Gopher systematically present the essence of the issues that relate to the origin of Near Eastern agriculture in the Pre-Pottery Neolithic B period some 10,500 years ago, as well as to the origin of fruit tree domestication that occurred several millennia later. Their book illuminates and reconstructs plant domestication in an accessible way to a readership of knowledge-seekers. It is also aimed at students, scholars, archaeologists, geneticists, archaeobotanists, botanists, plant breeders and anyone interested in human culture and this fascinating critical aspect of history.

Still currently under debate are some of the partly unresolved questions about the geographic origin of Near Eastern plant domestication, its mechanisms and pace and the consciousness of the active prehistoric communities who established it. Rather than going into detailed polemic discussions on those issues, this book presents the coherent view of the authors (with which I agree) that plant domestication originated in a limited region in south-eastern Turkey/northern Syria, and that it was a knowledge-based initiative, conscious and episodic in time.

As an experienced scientist, I expect that the views presented here will stimulate further relevant studies, and I am certain that this book will help others to deal carefully with the complicated story of the origin of agriculture in the Pre-Pottery Neolithic B of the Near East.

Simcha Lev-Yadun

FOREWORD

It is hard to overestimate the significance of events that took place some 10,000 years ago and more or less contemporaneously in different places across several continents. The Earth, coming out of the latest Ice Age episode, had started warming up by fits and starts. Humans inhabiting the Earth adapted gradually to the higher temperature, variable precipitation regimes, changing seasons and higher carbon dioxide concentrations in the atmosphere. Whether out of necessity to increase their food security or as an opportunity, hunter-gatherers made a momentous change in the way they procured food: they started planting some of the plants that were well-known to them but which earlier they merely harvested. This apparently simple planting gesture became seminal in the development of agriculture: at that time, an entirely new way of acquiring food and other plant resources (*'le geste auguste du semeur'* of Victor Hugo). The initiation of planting represented – depending on one's viewpoint – either the apotheosis of the hunting-gathering era or the dawn of the agricultural era. It represented a major milestone in the evolution of the human lineage up to this day. The whence and whereto, when, how and, above all, why of agricultural origins in the Fertile Crescent of the Middle East are the topic of this most interesting book authored by Professors Shahal Abbo (Hebrew University) and Avi Gopher (Tel Aviv University).

I am proud to count S. Abbo and A. Gopher as colleagues in the scientific area of crop evolution and agricultural origin studies. My own focus is on the origins of crops in Mesoamerica and the Andes, with emphasis on *Phaseolus* beans, but I have always followed the research of my two colleagues with great interest for their innovative approaches and thought-provoking writings on the topic. Plant genetics/breeding and

archaeology are the two main, complementary sources of evidence on the origins of agriculture and domestication. The two authors have an extensive record of collaborative research that has led to this publication and speak with authority about the complex topic of the origins of agriculture and crop domestication.

The transitions from hunting-gathering to agriculture took place independently and more or less simultaneously in multiple regions of the world. Not only were multiple new technologies introduced around that time such as domesticated plants and animals and pottery, giving rise to the term ‘Neolithic Revolution’, but the practice of agriculture was associated with major changes in human society around the time of the hunting-gathering to agriculture transitions, including a more sedentary lifestyle, the development of city-states and ultimately the appearance of ancient and more recent civilizations. While these new societal structures and civilizations were not involved in the transitions to agriculture, they were one of the most significant outcomes. Agriculture was a necessary condition for the development of civilizations such as Sumer, Assur, Akkad and Babylon in Mesopotamia and the Olmecs, Mayas and Mexicans in Mesoamerica, further highlighting its crucial importance.

Nevertheless, the specific causes and conditions of these transitions from hunting-gathering to agriculture remain difficult to ascertain, in part because the biological, climatic, economic and social circumstances that surrounded the transitions differed in the various regions of agricultural origins. The plant (or animal) characteristics (such as its genome attributes, life history and reproductive system), the environment (including its climate and biological interactions with pollinators, herbivores and microbes) and human factors (for example, cultural advancement such as plant and animal knowledge and tools) varied markedly. This is illustrated by the contrasting crops that were the founder domesticates in their respective regions. These included annual herbaceous crops such as cereals (wheat, barley), grain legumes (chickpea, lentil, pea) and flax in the Fertile Crescent, as a consequence of the Mediterranean climate; perennial herbaceous plants such as bananas and sugarcane in south-east Asia; and perennial lignified plants such cacao, peach palm and cassava in the Amazon. It is, therefore, not a surprise that the transitions from hunting-gathering to agriculture followed different trajectories in different regions of the world.

One of the best-studied regions in this respect is the Fertile Crescent. This region includes the Levant, southern Turkey and northern Syria, and eastern Iraq and western Iran, encompassing the mountainous regions surrounding Mesopotamia. The richness of the scientific record can be attributed to a relatively dry climate, conducive to the conservation of archaeological remains, and a long-standing interest by a multidisciplinary group of plant and animal scientists, including Abbo and Gopher. They address several issues that are the subject of current controversies in this scientific field, not only in the Fertile Crescent but in other regions of agricultural origins as well.

For example, where were crops that originated in the Fertile Crescent domesticated? Did they all trace back to the same ‘core’ area or did they have a dispersed origin across

this region? Abbo and Gopher propose a core area in south-eastern Turkey and northern Syria, based on the overlapping distribution of the wild progenitors of crops such as einkorn wheat, barley and chickpea, and the oldest ^{14}C isotope dates of archaeobotanical remains.

The dispersed domestication origin across the Fertile Crescent proposed by others is part of the current paradigm of the origin of agriculture, which posits a slow progression from hunting-gathering to agriculture with limited human agency, in which crop domestication would have happened as – in the authors’ words – ‘an unguided, unintended and mostly unconscious development’, a sort of ‘immaculate domestication’ (in my own words). Instead, Abbo and Gopher argue that this paradigm ignores the significant knowledge accumulated by hunter-gatherers about their environment, including the life history, uses and adaptation of plants that surrounded them. Such knowledge was essential for their thrift and is still present among hunter-gatherers today and, in my experience, also subsistence farmers, who play an active role in the maintenance and development of their seed stocks.

Abbo and Gopher argue that the transition to agriculture resulted from the hunter-gatherers’ awareness of plant (and animal) characteristics, which drove their intentionality and conscious selection of domesticated plants (and animals). They further posit a significant change in attitude towards the natural world on the part of hunter-gatherers, immediately preceding the transition to agriculture: from one that used natural resources to one that – through the acts of planting and domestication – created and exploited resources, which perdures to this day although in a markedly intensified way, with all the health and environmental consequences thereof.

It is this integrated vision of plant (and animal) characteristics, environmental circumstances and human agency that makes this book so interesting. The combination of the multidisciplinary technical information gathered by scientists studying the origins of agriculture represents the foundational scientific research and information on which books such as *Guns, Germs, and Steel* by Jared Diamond and *The Botany of Desire* by Michael Pollan are largely based.

I will end on a personal note. As an undergraduate in agricultural sciences in Belgium, I spent some time harvesting crops in Kibbutz Hamadyah, north of Beit Shean, in the Jordan Valley. The kibbutz grew wheat, pomegranates and dates, among other crops. Little did I know then that I would include my first-hand knowledge of these iconic crops of the Middle East in my course on crop evolution and agricultural origins at UC Davis.

Paul Gepts

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PREFACE AND ACKNOWLEDGEMENTS

This book is about plant domestication that occurred in the Near East some 10,500 years ago. For a long time now, we have been investigating various aspects of plant domestication and the origins of agriculture in the region: Shahal Abbo studying aspects of agronomy, biology and genetics, and Avi Gopher studying archaeology. Shahal Abbo, as a dedicated student of Professor Gideon Ladizinsky, has been focusing on different aspects of legumes, particularly on the chickpea, while Avi Gopher, a disciple of the late Professor Ofer Bar – Yosef, has been concentrating on the origins of agriculture and investigating the Neolithic period – a prominent key research issue for over a century. Professor Simcha Lev-Yadun, a third partner (see the first Foreword), whose expertise lies in the botany, ecology and evolution of Near Eastern plants, chose not to partake in the writing of this book, yet his contribution is undisputed.

Our joint work was publicly recognized when it was first published in the year 2000 in *Science* as an original paper conceived by Professor Lev-Yadun. There we claimed that plant domestication originated in a small, well-defined geographic core area spanning south-eastern Turkey and northern Syria, and that it occurred in a single, fairly rapid event (singular timing). Later, domesticated plants spread to other parts of the Near East and beyond – to Mediterranean islands (such as Cyprus), Europe, south-east Asia and Africa. This claim is based on (archaeo)botanical findings of various archaeological sites combined with geobotanical, genetic, agronomic and cultural considerations.

Over the years we have published many papers in well-known international journals (see Further Reading at the end of this book) in which we explored diverse aspects of

plant domestication. The research included fieldwork and controlled experiments and our findings support our original suggestion from 2000. Nevertheless, and despite other published works that supported our view, we found ourselves in a minority: most researchers of this issue did not and do not accept our arguments. In 2016, we presented our views and the full breadth of our research on the knowledge we have accumulated regarding plant domestication in Hebrew to a broad Israeli readership. That book (*Plant Domestication and the Beginning of Agriculture in the Near East*, Resling Publishing House, Tel Aviv) was written not only for an academic audience but for students and the broad readership of knowledge-seekers, including those interested in the origins of agriculture and plant domestication in the Near East. We believe that some of the topics discussed in this book are also relevant to modern plant breeders, agronomists and farmers. Feedback from Israeli readers was surprising and rewarding. It became clear to us through various professional and non-professional readers that a clear statement summarizing plant domestication in the Near East was necessary, and we decided to translate the Hebrew book into English before embarking on the original mission, namely, to write a detailed, fully referenced polemic discussion on plant domestication in the Near East.

In the volume presented here, we refrain from reviewing the dynamic discussion and details of plant domestication that we have presented in professional publications. Rather, we state our opinion and ideas in full, yet concisely, acknowledging differences of opinion. We will attempt to convince the reader that our suggested reconstruction of plant domestication and the emergence of agriculture stands the test of both available Near Eastern data and results of recent professional analytical research work carried out in the Near East. We acknowledge that our reconstruction must be tied to the fact that we live in Israel, and it cannot be divorced from that or from our respective professional and personal backgrounds.

We wish to thank the many good people who collaborated with us.

First and foremost, we thank Professor Simcha Lev-Yadun, our partner, who read an early draft of the Hebrew text and the published Hebrew version of this book and made valuable remarks. We thank Professor Gila Kahila Bar-Gal, who kindly contributed a chapter on animal domestication in the Near East.

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We thank the Resling Publishing House for accepting our Hebrew version of this book for publication and for the good work of their editors and staff. We thank Ms Halo (Hilla) Ben Asher, who translated this book into English, and Ms Myrna Pollak for copy-editing the English translation. We also thank Beatrice Rehl and Edgar Mendez of Cambridge University Press and all who partook in the creation of this book and its print production process.

Naturally, responsibility for this book's content (including any mistakes or inaccuracies) is solely ours.

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