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Studies in botanical archeology, ethno-botany and plant domestication: honoring Professor Daniel Zohary

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GUEST EDITORIAL

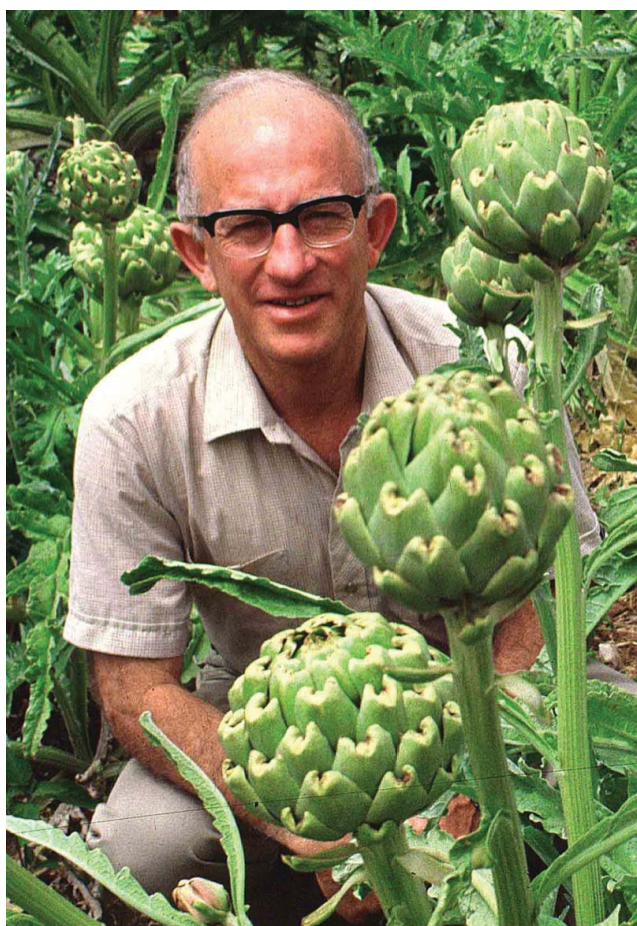
Studies in botanical archeology, ethno-botany and plant domestication: honoring Professor Daniel Zohary

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Professor Dani Zohary with “his beloved artichokes.” With his friend and partner Jehuda Basnizki, Dani Zohary developed seed propagation of the traditionally vegetatively propagated globe artichoke (*Cynara scolymus*) and hence opened the way to transform the globe artichoke from a perennial, manually vegetatively propagated crop into an annual seed-planted vegetable adjusted to modern, mechanized cultivation.

The opportunity to serve as guest editors for this special issue (Festschrift) in honor of Professor Daniel (Dani) Zohary has given us great pleasure, being his “scientific

grandsons,” as Dani was the PhD mentor of Professor Moshe (Music) Feldman, Simcha Lev-Yadun’s Post Doc mentor, and Dafna Langgut was Simcha Lev-Yadun’s

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Post Doc. When serving as guest editors for this special issue, we tried to represent faithfully Dani Zohary's long career, including his long-standing collaborations, the works of his students or students of his students, and other scientists that were influenced by his work, covering various aspects of plant genetics, domestication, ethno-botany, and archeobotany.

Professor Dani Zohary was born in what is now the state of Israel, then the "Mandate" granted to the British Empire by the League of Nations after World War I for establishing a homeland for Jews under the rule of the British Empire. During the years of 1945–1951, Dani conducted his undergraduate studies in biology at the Hebrew University of Jerusalem, interrupted by his participation in the fighting before and during the 1948 War of Independence of the state of Israel. He completed his MSc in botany and geology in 1951 from the Hebrew University, and then went to study for a PhD in genetics at the University of California, Berkeley (1952–1956). His PhD thesis addressed the issue of a polyploid complex in the grass family. When he returned to Israel he was appointed as a lecturer in genetics at the Hebrew University of Jerusalem, where he has remained throughout his professional career and was promoted to the rank of Full Professor. Dani continued studying wild and domesticated polyploids in the wheat group, among many other important genetic studies. In addition to his great interest in plant genetics, Dani has a continuous deep interest in ancient agriculture, the genetic origin of domesticated plants and in the biological principles of plant domestication, issues that gradually dominated his scientific career. Dani Zohary's numerous and influential contributions to the issue of plant domestication can be categorized into several groups.

- (1) Processes of domestication and the origin of cultivated plants: Dani's research has been focused upon crops that had their origin in the "Old World" (Asia, Africa and Europe), particularly: wheat species, barley, pea, lentil, olive, carob, and globe artichoke. Dani's main aims have been: (i) identification of the wild progenitors from which these crops could have been derived; (ii) delimitation of the wild relatives' areas of distribution, and assessment of their major adaptations in the wild; (iii) evaluation of the various genetic systems (cross-pollination, self-pollination, vegetative propagation, sex determination, self-incompatibility, polyploidy, etc.) that characterize the wild relatives, and their impact on plant domestication; (iv) assessment of the kinds of modifications these plants underwent under cultivation, and the selection pressures that molded them. Dani then combined the evidence obtained from the living plants with the archeobotanical information retrieved

from archeological excavations to seek answers to the questions: when, where, and how these crops were taken into cultivation?

- (2) Wild genetic resources of crops: work focuses on the study of the range of variation (and the structuring of genetic variation) in the wild relatives of cultivated plants native in the Mediterranean basin and southwestern Asia. The main aims have been the preparation of the ground for more sound *in situ* conservation of the wild progenitors, and a better understanding of how to utilize these wild gene pools in current and future breeding work.

Professor Dani Zohary mentored many research students, several of whom became senior scientists in universities and research institutions. Dani Zohary's career as a plant geneticist developed at the same time as molecular genetics and he progressed as a scientist with it. His first important contributions to plant genetics involved classic crosses and cytogenetics (e.g. Stebbins & Zohary 1959; Zohary 1959) and gradually advanced to the use of isozymes (a phenotype) and later, with technological and theoretical progress, to the use of DNA markers. After becoming more and more involved with the question of the origin of domesticated Near-Eastern plants (e.g. Zohary 1960, 1969, 1970; Harlan & Zohary 1966), in the 1970s, Dani Zohary began his long and fruitful collaboration with the German archeobotanist Maria Hopf, first on legume domestication (Zohary & Hopf 1973), and later on a broader scale. At the same time, with Pinhas Spiegel-Roy, he progressed in the question of fruit tree domestication (Zohary & Spiegel-Roy 1975). Later, he published with Maria Hopf three editions of their classic book *Domestication of plants in the Old World* (Zohary & Hopf 1988, 1993, 2000). When Maria Hopf passed away, Dr Ehud Weiss, an archeobotanist at Bar-Ilan University, took her place in writing with Dani the fourth edition of this immensely important textbook (Zohary et al. 2012).

In this journal (*Israel Journal of Plant Sciences*), Dani published many of his papers throughout the four stages of the journal's evolution. Some of his papers were published in the first version of the journal, founded while the region was under the rule of Great Britain's Empire, named the *Palestine Journal of Botany, Jerusalem Series*. There was a parallel series, *Palestine Journal of Botany, Rehovot Series*. Some years after the founding of the State of Israel and until 1963 the journal was named *Bulletin of the Research Council of Israel, Series D*. The name of the journal was changed again to *Israel Journal of Botany*, and some three decades later changed to the current name, *Israel Journal of Plant Sciences*.

The set of papers of this special issue starts, like Dani Zohary's career, with the Negev Desert. His first independent scientific efforts, when studying the vegetation and

ancient agriculture in the then empty and wild Negev Desert reflected his excellent field abilities (Zohary 1951, 1953, 1954). The contribution of Ashkenazi et al. (2015) deals with remnants of fruit tree orchards in the highlands of the Negev Desert. In the same line, the use of abandoned *Agave sisalana* fiber crop plantation in the Negev Desert as a source of firewood for local Bedouins is described (Lev-Yadun 2015).

The next group of papers is devoted to the genetics of crop domestication. The first was contributed by Professor Eviatar (Eibi) Nevo, Dani Zohary's friend and partner for many fruitful years (e.g. Nevo et al. 1979, 1982, 1986), and is on barley genetics (Nevo 2015), mirroring the very important contributions to barley genetics by Dani Zohary (e.g. Zohary 1959). The second paper, on the wild gene pool of globe artichoke by Aharon (Aharale) Rottenberg (2015), one of Dani Zohary's PhD students, represents the fruitful study and breeding of globe artichoke varieties by Dani and his long-standing partner, Jehuda Basnizki (e.g. Basnizki & Zohary 1994). This section also includes a paper on the defensive mechanisms of the wild members of the genus *Pisum* (Aviezer & Lev-Yadun 2015), reflecting Dani's critical contribution to *Pisum* genetics and to the identification of the genetic stock that was domesticated in the Neolithic (e.g. Ben-Ze'ev & Zohary 1973).

The next and largest group of papers, arranged according to the order of archeological periods in discussion, is about botanical archeology. It starts with pre-agricultural wild flax fiber exploitation (Abbo et al. 2015), a paper showing the possibility of harvesting wild flax plants, extracting their bast fibers and producing yarns. This study mimics pre-agricultural flax fiber production and uses a practice at least 30,000 years old (Kvavadze et al. 2009). The second paper in this group (Namdar et al. 2015) deals with the analytical identification of olive oil in pottery vessels from the Late Pottery Neolithic, the earliest find of actual prehistoric olive oil. This finding, along with others (e.g. Galili et al. 1989, 1997), indicates that olive oil production on a large scale was already practiced in the late stages of the Pottery Neolithic, possibly indicating that olive was domesticated somewhere in the Eastern Mediterranean region even before the Chalcolithic, a view supported by genetic data of olive cultivars (Besnard et al. 2013). The third paper in this group (Weiss 2015) provides a historical view about the question of the beginning of fruit tree growing, 40 years after the seminal paper by Zohary and Spiegel-Roy (1975) about this subject, indicating that the progress in research did not change much the conclusions and suggestions posited in that seminal paper. In addition, it gives a personal testimony about working with Dani on the fourth edition of the book (Zohary et al. 2012). The fourth paper (Kislev 2015) describes the weeds and insects that infested wheat during growing and storage in the Iron Age of Tel Hadar, a site

located on the Eastern shore of Lake Kinneret. A rich insect fauna was found and identified, illuminating some of the difficulties in grain storage in Biblical times. The fifth paper (Langgut 2015) reviews the archeobotanical evidence of the arrival of several prestigious fruit trees (*Juglans regia*, *Citrus medica*) to ancient Israel. It supplements the line of study of the origin and spread of agriculture in the Old World reviewed in Zohary's classic volumes (Zohary & Hopf 1988, 1993, 2000; Zohary et al. 2012). This group of papers ends with the contribution of Langgut et al. (2015), describing pollen analysis as evidence for the composition of King Herod's Royal Garden at the Promontory Palace, Caesarea. The most surprising find at Caesarea was of hazel nut trees (*Corylus* spp.) growing there, trees that were introduced from other countries in southern Europe or from Asia Minor (Turkey) along with the more expected Mediterranean cypress (*Cupressus sempervirens*), which was a common planted tree in the Roman Empire elite's gardens.

The last group of papers illuminates ancient and current plant uses from very different points of view. The first (Lev 2015) presents the use of medicinal plants in Medieval times as reflected by the wealth of medical documents found in the Cairo Genizah and analyzed by the author. The last paper of this group and issue (Lev-Yadun et al. 2015) describes and discusses the harvesting habits of harvester ants exploiting current fields of bread wheat as a manifestation of the ecological influence of agriculture as practiced by humans on other organisms.

We are certain that in the coming years, understanding of the issue of the origin of agriculture, Professor Dani Zohary's major scientific effort in the last four decades, will continue to progress due to recent developments in dating methods, the increasing integration of traditional analysis of archeobotanical remains during excavations with the ever-increasing involvement of new tools in the field (e.g. better archeological methods, geoarchaeology, experimental archaeology, analysis of chemical residues, phytolith analysis, ancient DNA studies, and modern genetic studies). The accumulation of new data together with methodological developments within the next years and decades will probably shed more light on issues that are currently under scholarly debate, such as whether agriculture originated in a core area in a limited region in the Fertile Crescent (southwest Turkey) as suggested by Lev-Yadun et al. (2000), or whether it evolved independently in several places across a wide area, including in the southern Levant and in the northern parts of the Fertile Crescent (e.g. Willcox et al. 2008).

This special issue thus reflects the major chapters in Professor Dani Zohary's long and very productive, influential, and successful career. We hope that Dani, his family, and his colleagues enjoy this special issue published in his honor.

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