Invited review

Plant domestication in the Neolithic Near East: The humans-plants liaison

Shahal Abbo a, *, Avi Gopher b, **

a The Levi Eshkol School of Agriculture, RH Smith Faculty of Agriculture, Food & Environment, The Hebrew University of Jerusalem, Rehovot, 7610001, Israel
b Sonia and Marco Nadler Institute of Archaeology, Tel Aviv University, Ramat Aviv, 6997801, Israel

1. Introduction

Plant domestication (PD) research in the Neolithic Near East during the first two decades of the twenty-first century thrived under what might be called (in essence) the protracted-autonomous model. This model emphasizes three major features: (a) a millennia-long, protracted, process of PD; (b) a geographically autonomous, non-centered domestications (i.e., several independent domestication foci within the Near East); and (c) the unconscious (unintentional) nature of PD (e.g., Smith, 2001; Tanno and Willcox, 2006; Fuller, 2007; Purugganan and Fuller, 2011; Fuller et al., 2018). We offer an alternative view of PD in the Near East.

Our Core area-one event model depicts a knowledge-based, conscious move which occurred in a geographically limited core area (i.e., centered), and which transpired during a short, single event (e.g., Lev-Yadun et al., 2000; Gopher et al., 2001; Abbo et al., 2012).

In the framework of the protracted-autonomous model of PD, some scholars suggest that domestication can be viewed as a form of specialized mutualism between humans and their would-be domesticates (Rindos, 1980, 1984; Purugganan and Fuller, 2011) that can be treated in the spirit of other phenomena of co-evolved mutualism, e.g., ants–fungi relationships (Schultz et al., 2005; see Supplement 1 for additional cases). In line, and much in the spirit of the above gradualist view on PD in the Near East, the conceptual

* Corresponding author.
** Corresponding author.
E-mail addresses: shahalabbo@mail.huji.ac.il (S. Abbo), agopher@tauex.tau.ac.il (A. Gopher).
framework of Niche Construction Theory (NCT) was recruited in recent years to explain plant and animal domestication (e.g., Smith, 2007, 2011, 2015; Laland and O’Brien, 2010, 2011; Rowley-Conwy and Layton, 2011; Zeder, 2015, 2016, 2017a, 2018). These two threads (mutualism and NCT) are rather entangled as stated by Zeder (2017): “NCT insights into the development of coevolutionary relationships in the context of niche construction have clear and obvious implications for understanding domestication, best defined as a pairwise, multi-generational coevolutionary mutualism between a domesticator and a domesticate that arises in the context of niche construction.”

Following the major tenets of the core area-one event model for Near Eastern PD (e.g., Abbo et al., 2011a, 2012; 2014a; Gopher et al., 2017), we claim that mutualistic (coevolutionary) approaches as well as NCT-based explanations are inappropriate to describe Near Eastern PD (Abbo et al., 2011a; Abbo and Gopher, 2017).

The major goal of this paper, mostly focused on the “How” question of Near Eastern PD and its pace, is to discuss coevolutionary, mutualistic and NCT-based arguments and the notion that humans engaged in striking up partnerships with plants (and animals) that eventually were later domesticated. While we distance ourselves from this approach, we will briefly offer an alternative model for discussing Near Eastern PD based on direct and intentional human agency that emanated from a new perception, understanding or stance of Humans in the world. Possible changes in psychological aspects (à la Cauvin [2000]) and possibly neuro-biological change (à la Benz and Bauer [2013]; Bauer and Benz, 2013), will be very briefly mentioned too in this regard. We will claim that PD was driven by human initiative, that it was conscious and intentional, knowledge-based, and episodic (biologically punctuated). In addition, we offer a practical, agro-ecological alternative to the discussion of Near Eastern PD that better fits the biology of the respective plant species, the DNA sequence-based phylogeny of the domesticated stocks and their affinities with extant wild progenitors’ populations, and the archaeobotanical record from relevant Near Eastern sites (Abbo and Gopher, 2017; Gopher et al., 2017).

In this paper we bank on the following data sources and tenets:

1] Near Eastern archaeological, botanical/geobotanical/archaeobotanical and ecological data will demonstrate how the framework of thought underlying mutualist/coevolutionary thinking and the recent use of NCT in PD research of the Near East are deeply ingrained in mutualistic/coevolutionary views first formulated in the early twentieth century, specifically, the so-called ‘dump-heap hypothesis.’

2] The assertion that the Low-Level Food Production (LLFP) à la Smith (2001), and the pre-domestication cultivation à la Harris (1989, 2007, 2012) theoretical constructs both relate, amongst other things to the ‘dump heap hypothesis’ (and its logic, see point 1) thereby supporting an unconscious/automatic (unintentional) selection of plants in a protracted (but see Note 2) domestication process (à la Rindos [1980]).

3] Deficiencies found in the protracted reconstruction of Near Eastern PD. Accordingly, we emphasize a) the fact that domestications are cultural phenomena, b) the role of human agency (initiative, consciousness and intentionality included) in the different scenarios of manipulating plant resources (e.g., Zohary, 2004; Abbo et al., 2011b, 2014b) and in PD, and c) the inadequacy of viewing human involvement in PD through the perspective of animal (e.g., mammals, arthropods) niche construction activities as used within the ‘domestication as mutualism’ framework and by some NCT supporters.

4] A distinction between the Agricultural, or Neolithic Revolution as a whole – an overarching transformation in human perception, social order and economy – and plant domestication, which is but one of the components of this revolution. While the distinction is fundamental, there is a growing tendency to overlook it. This, in turn, blurs the historical picture, causes misunderstandings and yields distorted, low resolution reconstructions (e.g., Fuller et al., 2018).

This paper is comprised of two major parts: the first assesses and scrutinizes some of the basic tenets of the protracted, mutualistic, unconscious model of PD in the Near East; the second briefly comments on our alternative model and refers to published supportive evidence. Clearly, the ongoing discourse over domestications (PD included) draws on two closely related yet conceptually distinct spheres – the biological-evolutionary and the socio-cultural. Moving between these two spheres might cause difficulties but we shall do our best to keep matters well-defined and distinct.

2. Domestication as a mutualistic phenomenon

Arguments to support protracted domestication, and or symbiotic/mutualistic, coevolutionary domestication are drawn from several primary domestication centers world-wide (e.g., Smith, 2001, 2007, 2011; Purugganan and Fuller, 2009, 2011; Zeder, 2015, 2017a, 2018). However, each of the primary PD centers has its own
bioclimatic and human cultural landscapes and idiosyncrasies (e.g., Harlan, 1971; Bellwood, 2005). Therefore, such claims for domestication time frames and/or underlying biological and evolutionary mechanisms should first be evaluated on particular regional bases (e.g., Abbo and Gopher, 2017; Neves and Heckenberger, 2019) before moving on to a cross-continental scale (e.g., Diamond, 2002; Smith, 2007; Puruganan and Fuller, 2009; Fuller et al., 2014; Zeder, 2017).

Ever since Rindos presented his mutualism-based models, his statements (1980) whether explicitly or implicitly expressed have been in vogue and have dominated the scene of PD research worldwide, the Near Eastern domestication center included. These models, based on neo-Darwinian thinking and the Optimal Foraging Theory (OFT) emphasize a materialistic (cost-benefit) view in which plant-man or man-plant relationships are measured by the profit netted by both parties to the equation.

Ants-fungi mutualism probably (co)evolved by step-wise accumulation of mutually adaptive mutations and selection exerted on adaptive traits in both ants and fungi (Schultz et al., 2005). This coevolutionary process probably advanced via numerous intermediate stages because it is difficult to see how macro-mutations, conferring suites of concerted mutually adaptive traits that are required to explain an abrupt embarking on such a complex insect-fungal relationship, could occur simultaneously in two unrelated lineages. Authors, who consider domestication and human plant-agriculture in terms of co-evolved mutualism between humans and plants, also consider PD as a gradual process that involved increasing degrees of human environmental interventions (Harris, 1989; Smith, 2001, 2011; Zeder, 2006, 2018) – a process in which naturally occurring alleles conferring selective advantage in populations of the cultivated species were accumulated over time. ‘Gradualist’ statements were already made in the 1960s, e.g., the radical statement by Higgs and Jarman (1969), that “there may not have been a hunter-gatherer age,” suggesting that any classification of human societies as agricultural or non-agricultural is in fact artificial. Although not as radical, additional statements were made in a similar spirit (Ford, 1985; Smith, 2001; Anderson, 2005; Barker, 2013 10). Indeed, ethnographic sources provide records of a multitude of adaptive strategies among historic and more recent human societies with different degrees of reliance on foraging and/or manipulation of wild plant and animal resources (e.g., Smith, 2001; Anderson, 2005; Harris, 2012; Pascoe, 2014). These various subsistence strategies under the umbrella of LLF or ‘traditional resource management’ are viewed as evidence for the existence of a ‘middle ground’ between hunting-gathering-based and agriculture-based economies across the human cultural landscape (e.g., Smith, 2001). In essence, such a perspective rules out rapid domestication and advocates a gradual, protracted domestication process without a clear starting point but with a final destination of 100% reliance on domesticates. Among the management activities performed by ‘low-level food producers’ are vegetation clearance, controlled burning, pruning and coppicing, tilling, wild seed broadcasting, transplanting and tending of selected plants and irrigation of wild vegetation to increase the yield of target species (Smith, 2001, 2011; Anderson, 2005; Carneiro da Cunha, 2019). Such activities, termed proto-agriculture by Anderson (2005) and see Pascoe, 2014; and Gerristen, 2008 for a similar logic in Australia), are in fact cultivation of wild plants. Those cultivation (aboriginal resource management) activities take place in the surrounding landscape, away or near-by dwelling sites (e.g., Carneiro da Cunha, 2019; and see examples in Tristes Tropiques by Lévi-Strauss, 1955, chapter 7). 11 Indeed, many authors consider the cultivation of wild plants as a necessary step leading to PD (e.g., Helbaek, 1959; Harlan et al., 1973; Gepts, 2004; Harris, 1989, 2012; Kislew, 2002; Fuller, 2007; Wilcox, 2012; Riehl et al., 2013).

In a similar manner and logic over the years, the concept of cultivation of wild plants often termed in Levantine PD research “pre-domestication cultivation” assumed a central role in the study of the origin of domesticated plants from both the archaeological (Bar-Yosef and Meadow, 1995; Collede, 1998, 2001; Willcox et al., 2008, 2009; Wilcox, 2012, 2013) and biological perspectives (Harlan et al., 1973; Hillman and Davies, 1990, 1999) and inspired some debate (Abbo et al., 2011a, 2012). One of the tenets of the pre-domestication cultivation concept is its gradual unfolding via increased human intervention in both the environment and the life cycle of the target plants (Harris, 1989, 2012; Fuller et al., 2010, 2018; Assouf and Fuller, 2012). Therefore, the gradients of human energy input and degree of reliance on foraging vs. manipulated resources depicted in the descriptive diagrams of Harris (1989, 1996), Fuller (2007) and Assouf and Fuller (2013), are conceptually analogous to gradients of subsistence strategies presented by Smith (2001) of low-level food producing societies based on ethnographic sources (see also Harris, 2012). That is to say, that upon inspection, the LLF scenario and Harris’ gathering-cultivation-domestication continuum emerge as conceptually equivalent, describe similar human management activities and human-plants coevolutionary processes, albeit using different terminologies. We acknowledge that the term LLF devised in the Americas was coined by Smith (2001) to avoid the teleology embedded in the pre-domestication cultivation 12 concept (used in the Near East) since otherwise it would seem to indicate that those activities led to domestication, which was not necessarily the case in his view.13 However, in reality, and because the actual set of activities under the umbrellas of traditional/aboriginal/indigenous resource management/manipulation/husbandry/cultivation/pre-domestication cultivation are practically the same (e.g., Harris, 1989, 1996; Smith, 2001, 2007; Anderson, 2005), the mere use of different terminology can hardly sustain such a nuance in the literature (e.g., Harris, 2012).

2.1. Niche Construction Theory and plant domestication research

Most organisms intervene in their environment and thereby modify their own and their niche companions’ evolution (Odling-Smee et al., 1996). Examples of such activities include nest building by birds, dam building and pond creation by beavers, changes of

10 A seemingly funny questionnaire to be filled out by PPNA and EPPNB individuals in the Levant concerning the way they define their economic system was offered by Barker, 2013. Barker was that close to filling out their forms for them (poor illiterates) based on his “global synthesis”, his wide knowledge of indigenous peoples around the world and his deep involvement in the late prehistory of the Levant. It is a striking example of an act of superiority, as if he holds a monopoly on the way Neolithic or present-day traditional pre-industrial societies or indigenous groups throughout the world (the Near East usually not included as such groups are long gone) view their own world and their place in it. A glance into millennia old Near Eastern historical records might have been of help (see Note 19 below).

11 It is significant that even ethnographies that mention such proto-agricultural activities of (so to speak) pristine foragers, in fact, document the use of well-established local and introduced domesticates. For example, in the Namibviva gardens, Lévi-Strauss (1955. Pp. 359) observed cassava which is native to the Amazon basin but also maize. The wild progenitor of maize (teosinte) is not native to the Amazon basin, but rather to Central America (Doebly, 2004; Wilkes, 1972). This is a clear evidence of deep time interactions between foraging groups and farming societies.

12 Notwithstanding the different terminology, since the discussion revolves around the very same husbandry operations, Smith (2011) could not have avoided using the prefix-free term “cultivation.”

13 Actually, the rewritten text by Harris (2007, noted on by Denham) as well as his later paper (Harris, 2012) make a similar claim.
soil chemistry and texture caused by earthworms, or the acidification of the rhizosphere and secretion of allelo-chemicals by plants, all viewed as and termed ‘niche construction’ phenomena (Odling-Smee et al., 1996). Admittedly, it is hard to think of any life form on Earth that does not (by definition) engage in one or another form (and/or intensity) of niche construction. Likewise, humans have always influenced their environment (e.g., Anderson, 2005; Smith, 2011; Pascoe, 2014). Apart from human ecological impact via traditional resource management, humans have always created a myriad of ecological disturbances in their surrounding environments, along trails, near refuse heaps, latrines or butchering spots. Awareness of those human-crafted disturbances probably led some authors to suggest that PD was the result of human attention to plants with an ecological affinity to refuse or ‘dump-heaps’ (e.g., Anderson, 1952; Hawkes, 1983; Martín-Robles et al., 2019). In this context, we emphasize that we consider the pre-domestication cultivation concept (e.g., Harris, 1989; Fuller, 2007), the view of the origin of domesticated plants via mutualism or symbiosis (Rindos, 1984), and the application of NCT to domestication (Smith, 2007, 2011; Zeder, 2015, 2016, 2017a) as related approaches (see Abbo and Gopher, 2017).

2.2. The ‘dump heap hypothesis’ (or, the commensal pathway to domestication)

One of the early narratives describing the origin of domesticated plants is the ‘dump heap hypothesis’ (Engelbrecht, 1916). It suggests that crop plants originated from plants associated with disturbed habitats at, and surrounding ancient human dwellings and/or with human refuse heaps. This hypothesis has deep roots in the literature. Darwin (1868:326) suggested that “savages” were acquainted with nutritious plants in their homelands and harvested them, and that gradually people began cultivating some of these plants near their dwellings and “…as the soil near the hovels of the natives would often be in some degree manured, improved varieties would sooner or later arise” (Darwin, 1868:327). Such explanations persist in modern literature as well (Laland and O’Brien, 2010; Larson and Burger, 2013; Zeder, 2015; Martín-Robles et al., 2019); if even partly and often with modifications (Schultz et al., 2005; Cunniff et al., 2014). In our view, the lasting tradition of reliance on this hypothesis attests to its strong persistence on thinking in the field.

In Engelbrecht’s (1916) view, seeds and/or vegetative plant materials collected as food were brought to camps for processing and consumption. Such propagules (seeds, bulbs, tubers, stem-cuttings) that were discarded or lost in the process, subsequently germinated (or rooted) around human dwellings or near the refuse heaps. His underlying assumption was that soil fertility was higher in such areas and as a result, these ‘volunteer plants’ attracted the attention of plant gatherers due to their large vegetative mass and/or high seed production, exceeding those of their naturally occurring conspecifics growing elsewhere. Engelbrecht’s (1916) thesis was that some elements of the local flora – i.e., the ‘ruderal’ species that flourish along roadsides, field edges, ruins, refuse heaps and trampled ground; and the ‘segetal’ species that grow mostly in cultivated land, or weeds from around ancient camps and in butchering or other activity areas near human occupations – were adopted as crop plants (Zeven, 1973).14 And note that this is, in effect, the ‘commensal’ domestication pathway as depicted by recent authors (e.g. Zeder, 2012; Larson and Fuller, 2014, and see Window No. 1).

Window No. 1: pathways to domestication

Here are the definitions for the various pathways to domestication offered by Zeder (2012) and by Larson and Fuller (2014). Note that the focus of those two papers was animal domestication and that we shall borrow and modify them where possible to accord with our discussion on plants.

The prey pathway: “The prey pathway does not begin with intentional action on the part of people to bring wild animals (juvenile or otherwise) into their camps. Instead, as people manipulated their immediate surroundings, different populations of wild animals would have been attracted to elements of the human niche, including human food waste and/or smaller animals that were also attracted to the refuse” (Larson and Fuller, 2014:117). This scenario parallels what is known in plant domestication research as the ‘dump heap hypothesis’. There is no human initiative or intention in this scenario. The process is initiated by the animals (or plants) and in the case of the Near Eastern package of domesticated plants may be relevant to bitter vetch, einkorn and/or barley (the association with humans being based on the somewhat weedy tendencies of these species that allows them to survive as weeds of traditional farming in the Near East [see Abbo et al., 2005]). In NCT terms the commensal pathway to domestication is initiated by species that practice relocation or relocative niche construction by moving into anthropogenic environments (sensu Zeder, 2016, 2017a, 2018 pp. 270).

The prey pathway: “Although the early stages of the commensal pathway are necessarily not dependent upon human intentionality, the prey pathway does begin with human action. The primary human motive was not to domesticate, however, but to increase the efficiency of resource management [our addition: i.e., increase fitness]” (Zeder, 2012: 119). That is to say that the human active role in the newly formed relationship with a plant (or animal) was aimed at improving productivity and gain from resources by managing them – a management that leads to domestication (with no deliberate domestication intentions)15. The prey or ‘harvest’ pathway to domestication is thus about manipulating the environment or life cycle of economically important species in a way that promotes their productivity and predictability. Moreover, if it is related to over-hunting in the case of animals (Larson and Fuller 2014) quote Marom and Bar Oz (2013) who suggested over-hunting of cattle and pig for the Pottery Neolithic period Yarmukian culture (8500–8000 years Cal. BP) site of Sha’ar Hagolan in the southern Levant); it is totally incidental, and we quote: “Intriguingly, this pattern of over-hunting before domestication suggests that the prey pathway was as accidental and unintentional as the commensal pathway (Zohary et al., 1998)” (Larson and Fuller, 2014: 120)16. They also state that they use Zeder’s (2012) scheme for pathways to domestication to show (vis-à-vis the prey pathway) that “animals were domesticated in the absence of deliberate human selection” (Zeder,
So, it remains somewhat unclear since the prey pathway involves humans initiating a relationship with a plant species (or ‘pushed’ by an external driver to initiate it) but no intentionality (to domesticate) is involved. This prey (or harvest) pathway relates, à la Zeder, to the rest of the species of the Near Eastern founder crops besides the abovementioned three plant species that might (but not necessarily so) have taken the commensal pathway. Human manipulation to increase efficiency and profit from human-plant or animal relationships in this pathway leads to changed relationships that eventually end in domestication. Here, too, there is no intentionality by humans to begin with but a result of dynamic relationships. Larson and Fuller (2014) do not acknowledge the complexity here, and they say, quoting Zeder (2012), that this is not an initiative but rather a relationship and in certain conditions not at all intentional.173

While Zeder (2012) and Larson and Fuller (2014) both diminish the role of human consciousness and intentionality174 it seems that in her later papers, Zeder (e.g., 2017a) highlights the role of human agency and human behavior and culture in the process (but see Discussion below).

The directed pathway: “The only pathway that began with a deliberate objective to domesticate a species is the directed pathway (Zeder, 2012). Before these taxa were targeted, humans already possessed and were reliant upon domestic plants and animals” (Larson and Fuller, 2014: 120 quoting Zeder, 2012). This pathway relates to the domestication of animals such as the donkey, horse, or camel (and trees among the Near Eastern plants) that is viewed as fully intentional. In this pathway to domestication, humans, operating on the example of existing domestications through either the commensal or prey pathways, set out to deliberately domesticate a species, in order to obtain a desired resource or set of resources that it provides. Yet, this pathway is in fact not relevant to our case here since these domestications took place thousands of years after the early Near Eastern domestication i.e., in a world of domesticates.

Consequently, the most conspicuous aspect in the two first pathways presented here is that relevant to our discussion is the view of human agency and the denial of intentionality in domestication, i.e., viewing it as unconscious, unintentional and clearly not deliberately directed towards domestication but rather to maximize profit (and resource reliability) and minimize investment (implicitly reminiscent of an OFT tenet).

Harris (1969) also argued that disturbed habitats created optimal conditions for the weedy ancestors of crop plants and Hawkes (1969) explained that one of the main features of cultivated plants and their wild relatives is their “weedy tendency,” i.e., ecological adaptation to disturbed or unstable habitats. Hawkes (1983) referred to the ‘weediness’ of both ancestors and crops, pointing out that it is a key feature of domestication. Harlan (1965) also discussed the possible role of weeds in crop evolution, but concluded that “… if we are to look for progenitors, we must look for something that could give rise to both the weed forms and the cultivated forms together.” Harlan (1992: 39–40) also criticized the Sauer/Anderson model (see Note 14), pointing out that some of their presuppositions were incorrect. However, given the occasional resurrection of the hypothesis or some of its components (e.g., Blumler, 1991; Laland and O’Brien, 2010; Larson and Burger, 2013; Cunniff et al., 2014; Martín-Robles et al., 2019) it merits a careful inspection.

2.2.1. Do Near Eastern crop progenitors have weedy tendencies?

The wild progenitors of the Near Eastern grain crops include wild einkorn wheat (Triticum boeoticum Boiss.), wild emmer wheat (T. dicoccoides [Körn.] Thell), wild barley (Hordeum spontaneum C. Koch), wild lentil (Lens orientalis [Boiss.] Hand.-Mazz.), wild pea (Pisum humile Boiss. et Noé), wild chickpea (Cicer reticulatum Ladiz.), wild bitter vetch (Vicia ervilia [L.] Willd.), and wild flax (Linum bienne Mill.). Examining the ecological preferences of the above species, and more specifically, their presence (or absence) in disturbed habitats and/or in segetal Mediterranean plant associations (Supplement 2) shows that only wild einkorn and bitter vetch (in the northern Levant) and wild barley (in the southern Levant) may occur as arable weeds, while the rest of the taxa are mostly confined to primary plant formations (Abbo et al., 2005). The synchronic appearance of domesticated forms that constitute the founder crops package (sensu Zohary and Hopf, 2000) including cereals but also legumes and flax, which have no affinities to anthropogenic disturbances, suggests that the Near Eastern crop package is unlikely to have originated via a ‘dump heap’ scenario (i.e., the commensal pathway). Otherwise, we would expect to see sites in which cereal production based on domesticated einkorn and/or barley (possibly accompanied by bitter vetch) to occur much earlier in the archaeological sequence, predating grain legumes domestication. This however is not the case (Nesbitt, 2002), and for a more detailed discussion on this subject, see Abbo et al. (2005).

Summing up the ‘dump heap’ narrative we may say that undeniably, prehistoric humans in temporary (seasonal) dwellings and in sedentary settlements created new ecological niches that were invaded (relocative niche construction) by certain plant species. However, the likelihood that Near Eastern domesticated plants were derived from commensal taxa that thrived in such niches is low since most of the founder crops do not accord well with the assumptions of this scenario. Using the pathways terminology (Window 1), the commensal pathway is possible (but not imperative) for barley, einkorn and bitter vetch but clearly it is impossible for most grain legumes as well as for emmer and flax and it has little to do with human initiative, consciousness or intentionality. The above notwithstanding, the widespread occurrence of New World taxa such as Lupinus sp., Amaranthus sp. as well as Helianthus sp. (genera from which certain species were domesticated in the New World) in disturbed habitats and their well-documented weedy tendencies may perhaps explain the inclination of American scholars to view PD from such a perspective (e.g., Sauer, 1952; Anderson, 1952). Similarly, an account of the possible way by which grain Chenopodium species were domesticated in the Andes provided by Kuznar (1993) may corroborate such claims.

2.3. Plant domestication against a background of an ‘evolutionary continuum of human-plant relationship’

Ethnographies provide a rich array of data on historic and recent hunter-gatherers from different regions (e.g., Kelly, 1995; Smith, 2001; Anderson, 2005; Gerristen, 2008; Harris, 2012; Pascoe,
As evident from these sources, a wide range of adaptive strategies exists across the human “foraging spectrum” (Kelly, 1995), all fine-tuned to the carrying capacity of the different environments. The intimate (‘scientifique à la Lévi-Strauss, 1962) and detailed knowledge of the natural environment including plants and animals (e.g., Terashima, 2005) enabled hunter-gatherer groups to prosper from the polar circle through to equatorial environments (e.g., Vievedes de Castro, 2019). Clearly and by definition, all foraging strategies involve some degree of environmental intervention, extending from the mere effect of removal (harvest) of food stuffs, to more elaborate management techniques used to regulate or promote growth of target species for a variety of uses (e.g., Anderson, 2005; Pascoe, 2014; Carneiro da Cunha, 2019; Neves and Heckenberger, 2019) including broadcasting of wild (annual species) seeds or the transplantation/displacement of perennial species (Smith, 2001, 2011; Harris, 2012). This wide range of subsistence strategies demonstrated by ethnographic research may be one of the reasons for interpreting PD as a protracted continuum or at least for viewing it as such (e.g., Harris, 1972). It is most important to realize that the range of hunters-gatherers subsistence variations was mostly recorded by recent ethnographers of the 19th and 20th centuries. It thus relates to communities, societies and cultures that have been aware of farming and agriculture for a very long while, everywhere on the globe. An important contribution to modeling PD was made by Harris (1989, 2012 and citations) based on field-work and ethnographic sources. Harris’ (1989) highly cited model is structured as an evolutionary continuum of people-plant interaction leading to PD. This model (and its variations) can be summarized by the following four stages: (1) foraging, or wild food gathering (and hunting), (2) cultivation of wild plants, or in Near Eastern terminology, pre-domestication cultivation, (3) systematic cultivation of wild plants, and eventually, (4) agriculture based on domesticated plants (see Fuller, 2007). Implicit in Harris’ (1989) model is the idea that the commencement of stage 4 is mediated by the selective propagation of certain phenotypic variants (domesticated genotypes) during stage 3 (see Figure 1.1 of Harris, 1989). While Harris expanded (adding animals) and fine-tuned his model over the years (Harris, 1996, 1998, 2002, 2012), the basic evolutionary continuum remained unchanged (Fig. 2.1 in Harris, 2007). The republishing of Harris’ (1989) paper in Denham and White (2007) was accompanied by a short update by Demham (2007a) who pointed out Harris’ emphasis on “transitional” (subsistence strategies in between “hunting and gathering” and agriculture) life modes and their flexibility, either to develop into agriculture or not. Denham also stressed another aspect of Harris’ approach, namely, the decoupling or at least the partial disassociation of agriculture from domestication, thereby blurring the conceptual boundary between these two terms. In 2007 Harris depicted three (rather than four stages) modes of food procurement and production. These are: (1) wild-food procurement (foraging), (2) wild food production (pre-domestication cultivation) and (3) agriculture (based mainly on domesticated crops). Indeed, Harris (2007) stressed that the distinction between the above three subsistence modes is made for analytic purposes, while the reality they represent is made of mixed systems, in which a gradual decrease in the dependence on wild foods occurred in parallel with the gradual increase in the dependence on domesticates (Fig. 2.1, therein).

This “stepwise” scenario of agricultural origins represents a common-sense (of linear progression, so to speak) view of human cultural evolution vis-à-vis agriculture and the evolution of domesticated plants, and this is probably its main appeal among wide scholarly circles. For example, Merrill’s (1933:328) view on how the New World hunter-gatherers became farmers: “First the gathering of the wild seeds for food, then the primitive cultivation of those plants best adapted to his needs, and finally the evolution of a really high-grade agriculture, the breeding of varieties …”. And note that Merrill’s three (theoretical) stages resonate perfectly in Harris’ writings. His second stage accords well with the concepts of LLFP or pre-domestication cultivation, and his third stage includes domestication and a fully-fledged agricultural system. Here, too, like for Harris, if even implicitly — we look at a timeline of progressing stages, each dependent on the one predating it although a calendric chronology is not mentioned.

Since the wide range of foragers’ subsistence strategies represents a gradient in the degree of human environmental intervention, these strategies can also be arranged in a parallel gradient of human energy input. Harris also suggested that all the specific activities embedded in the term “cultivation” are still practiced today in both agricultural and non-agricultural contexts and some are assumed to have predated agriculture (ibidem: 18).

Both Smith (2001) and Harris (1989, 2012) stressed that the mere fact that the different foragers’ subsistence strategies can be arranged in a seemingly “progressive” order from minimal intervention through to “proto-agriculture” (i.e., including sowing and/or irrigation, Anderson and Wohlgemuth, 2012) does not suggest that agriculture originated via such a prehistoric sequence. Harris (1989, 2012) and Smith (2001) also explained that prehistoric cultural change, economy included, was not necessarily unidirectional along such gradients. Indeed, as pointed out by Smith (2001) and Harris (2012), environmental manipulation of wild plants did not lead to PD in several world regions including Australia and northwestern America, and therefore cannot, in our view, be seen as a prerequisite or prelude to agriculture. This latter point by itself, we would argue, is more than sufficient to make many of the ethnographic observations (e.g., cited by Smith [2001, 2011; Anderson and Wohlgemuth [2012] or Harris [2012]) of rather limited merit for discussing Near Eastern PD and the embarkation on agriculture as a socio-cultural and economic system. Hence, and given the regional idiosyncrasies, it is doubtful if North American, Amazonian or African ethnographic records contribute much to reconstructing Near Eastern PD (e.g., Neves and Heckenberger, 2019; and see Supplement 3).

Another no less important aspect is that the ethnographies recruited by the advocates of the protracted domestication...
evolutionary continuum (e.g., Smith, 2001; Harris, 2007, 2012) and/or by the supporters of NCT-based models (e.g., Smith, 2007, 2011) are all drawn from world regions in which the aboriginal communities have knowingly opted for socio-economic alternatives that do not involve farming (domesticates) and perpetual (economic) growth/intensification (e.g., in Australia [see Pascoe, 2014]). A novel conceptualization of such aboriginal resource management was recently advanced by Carneiro da Cunha (2019) pointing out that Amazonian swidden cultivation should be seen as an antithesis to Western notions of land tenure, farming, agriculture and domestication (much in the spirit of Lévi-Strauss’ Tristes Tropiques). In Western thought, these involve objectification of natural resources (land, plants and animals alike) and domination (e.g., Ingold, 2000), while this is not the case for Amazonia, and therefore the indigenous ethnographic examples from this region should be viewed in terms of Antidomestication (à la Carneiro da Cunha, 2019; for more see Supplement No. 3).

Needless to say, we do not deny the importance and contribution of these ethnographies in shedding light on the extraordinary range of hunter-gatherer modes of subsistence before agriculture had assumed global domination. However, readers should be aware of the fact that there are deep-seated problems in transforming a collection of ethnographic observations into an evolutionary scheme and to what might in effect be a decontextualization of the ethnographic data (e.g., Lévi-Strauss, 1952, pp. 13–19). Relevant to our case, one cannot rule out the possibility that some of those documented aboriginal groups may have had a history of engagement with farming and animal husbandry (e.g., Headland and Reid, 1989). Taking such data from contexts of hunter-gatherer societies that have been familiar with farming for thousands of years (and/or may have even practiced farming in their past), and (mis)using it to develop progressive evolutionary continuums (e.g., sensu Harris, 2012) may lead to problematic results often inclined to draw single-line (linear) developmental models (Lévi-Strauss, 1952, pp. 13–19), regardless of the validity of the information itself.22 Therefore, by definition, it is impossible to treat such ethnographic information as a reflection of (or a time window into) pristine pre-farming foragers’ strategies.23

Smith (2001) and Harris (2012) stress that it is very difficult to obtain archaeological evidence for many of the supposed plant manipulation operations (pruning, transplanting, sowing, weeding, etc.) contrary to manipulations that involve earth works that left detectable impacts (e.g., Erickson, 2000; McKey et al., 2010). Why then does this evolutionary-subsistence continuum play such a role in discussions of PD and agricultural origins? First, because these hunter-gatherer ethnographies supposedly evoke a sense of, and attest to the (Paleolithic) antiquity of these human eco-intervention techniques (e.g., Genew-Inbar et al., 2002; Lev et al., 2005; Mercader, 2009; Melamed et al., 2016). This enables a discussion of human-plant interactions in the context of an evolutionary scale process. Second, as pointed out by Harris (1998, 2012), these ethnographies are highly relevant because they draw one’s attention to the ‘phenomenon’ of pre-domestication cultivation. As stated above, many authors consider ‘pre-domestication cultivation’ or the cultivation of wild plants as a necessary prerequisite for the emergence of domesticated plants (e.g., Wilke et al., 1972; Gepts, 2004; Fuller, 2007; Willcox, 2012; Riehl et al., 2013).24 Accordingly, immense efforts were dedicated to obtaining archaeological (archaeobotanical) evidence for this supposedly imperative stage leading to PD (see the monumental work on the Tell Abu-Hureyra archaeological remains [Hillman, 2000] and other studies [e.g., Willcox et al., 2008, 2009; Willcox, 2012; Riehl et al., 2013; Arranz-Otaegui et al., 2016]) and to interpret such finds (Fuller et al., 2012a, 2012b; Caracuta et al., 2015; Arranz-Otaegui et al., 2016). Since we take issue with the pre-domestication cultivation concept (e.g., Abbo et al., 2012), let us now consider it in light of the relevant Near Eastern archaeobotanical evidence.

2.4. Pre-domestication cultivation and its presumed role in Near Eastern plant domestication

We elaborate on pre-domestication cultivation since this term is used in Near Eastern PD research (much in the way LLFP is used for the Americas, but see above) and it promotes the protracted-autonomous model of PD with which we take issue. Another reason is that (pre-domestication) cultivation, although practiced in a man-made niche does not emphasize human intentional but rather promotes a claim of automatic (unconscious) selection driven by human management (e.g., Purugganan and Fuller, 2011). Experimentation by the Neolithic cultivators and false starts are often added to those reconstructions that may (or in many cases may not) lead to domestication given the right conditions for plant and man. The goal of the pre-domestication cultivation activities is often presented in the spirit of an increased profit for the lowest possible price.25 Hence, the whole argumentation in support of pre-domestication cultivation (and LLFP) is subject to a constant tension between actual OFT-like statements in the spirit of the Modern Darwinian Synthesis (MS) (although OFT has been repeatedly rejected by Zeder and/or Smith and indirectly by Harris as well) and statements on management or relationships between humans and target populations of plants (or animals) directed towards high (evolutionary?) profit for both sides — even if not fully

22 Interestingly, relevant Near Eastern historical sources including the Biblical records and other historical records from throughout the region starting as early as the 5th millennium Cal. BP — all portraying a fully agricultural landscape — are not referred to. We acknowledge the differences between historical written sources and ethnographic records, and the fact that the Near Eastern record originates in societies that were fully agricultural, yet, recorded information on agricultural practices as old as ca. 5000 years in the very region studied should not in our view be discarded.

23 These ethnographies are valuable for discussing other topics including various aspects of the adoption of agricultural life ways by foragers (e.g., Rindo, 1989; Zvelebil, 2009; Naveh and Bird-David, 2014) or the co-existence of foraging cultures adjacent to farming societies (Rowley-Conwy, 1984). The Nave and Bird-David (2014) paper presents an interesting relevant and unique case concerning a group from India with a hunting-gathering based economy that in recent years had to (was forced to) move to a food producing economy. In the very particular set of circumstances of this case, and with an awareness of the anthropologists to the potential of studying this move, the paper emerging sheds light on the centrality of the change in epistemological (and ontological) issues of this transition reflecting a new perceptual landscape through which domesticates are treated. Therefore, the available ethnographic record is only partially relevant for the discussion on PD and the origins of agriculture in the Near East and should be used with due caution (Abbo et al., 2012).

24 Of course domestication takes place in a cultivation environment — it is impossible otherwise — yet, PD in the Near East is based, first, on the choice of species to be domesticated (out of the standing variation of the region), then, the specific and learned choice of types/mutants within the populations of these species (spike non-shattering for cereals, non-dormant seeds for legumes), and only then their cultivation in man-made plots (environments). Following this logic PD would be a very fast (episodic) event that is beyond present-day archaeological resolution.

25 Interestingly, it was argued that in certain cereal species morphological domestication was rather a “labor trap” (Fuller et al., 2010), and thus non-profitable in terms of human energy input.
symmetrical.26 What is the “domesticiatory partnership” (Zeder, 2016, 2017a) between humans and plants or animals that distances this view from Rindo’s (1980) mutualism (or, his interaction)? Does this ‘partnership’ mean something other than that plants or animal species (and humans alike) took advantage and leveraged the relationships between them to increase fitness relative to other species that “failed” to strike such partnerships (sensu Zeder, 2018)?

The notion that pre-domestication cultivation was a necessary stage for PD probably stems from the view that a regime of human management exerted upon wild plant species by cultivation (land clearing, seed corn selection, sowing, tending, weeding, harvesting, seed stocking) provides the required selection pressures envisaged as part of what was called automatic selection (occurring inadvertently as a result of the above husbandry operations) leading to the emergence of morphologically domesticated plant stocks (Helbaek, 1959; Harlan et al., 1973; Zohary, 2004; Fuller, 2007). The recognition that domesticated phenotypes (e.g., non-brittle wheat spike, indehiscent pea or lentil pod, free germinating lentil, chickpea or pea) are ill-adapted to natural settings, and the significant adaptive value of such phenotypes under a cultivation regime, led to the assumption that the first and most decisive (practical) step in PD occurred when certain seed stocks were subjected to repeated cycles of sowing-harvesting-stocking (Harlan et al., 1973; Zohary, 2004). Note that while for certain species (emmer, barley) such a scenario is biologically and agronomically probable, it cannot certainly explain grain legumes domestication due to their seed dormancy (Ladizinsky, 1987, 1989; 1993; Abbo et al., 2011b).

Even if one adopts such a pre-domestication cultivation scenario for cereals, the question of how pre-domestication cultivation activities can be identified in archaeological and archaeobotanical assemblages is crucial. Reliable evidence for pre-domestication cultivation may in turn answer when and where such activities commenced and how long it took before morphologically domesticated plant populations were established in the ‘cultivation’ arena. Beside answers based on theoretical constructs (Fuller et al., 2010) or indirect evidence (e.g., Kujit and Finlayson, 2009), direct answers are dependent upon the archaeobotanical record.

Let us discuss some of the prominent test cases used and some arguments made to support the claim for wild plant (pre-domestication) cultivation. We do it in great detail since we think that those very details are at the heart of the matter.

i) Weiss et al. (2006) argued that the “large number” of lentil seeds identified in Pre Pottery Neolithic A (PPNA) ca. 11,500–11,000-year-old Netiv Hagdud in the Jordan Valley and at Jerf el-Almah in the middle Euphrates (205 and 267 seeds, respectively) is evidence for pre-domestication cultivation. However, such an amount of lentil seeds may be obtained from naturally occurring populations in near-by mountainous areas where they grow naturally. Indeed, 247 lentil seeds identified in the ca. 60–55,000-year-old Mousterian layers of Kebara Cave provoked no claim for cultivation although it was studied in the same laboratory (Lev et al., 2005).

ii) The case of einkorn wheat found at Jericho, in the Lower Jordan Valley near the Dead Sea is often mentioned as a case of displacement of a plant species several hundred kilometers to the south of the nearest known natural population of its wild progenitor. This meagre find of einkorn in PPNA Jericho, interpreted from mudbrick impressions, was sufficient for a claim of an early appearance of cultivated einkorn in the southern Levant (Garrard, 1999; but see Nesbitt, 2002: 127). However, problems with the stratigraphy, the dating of the mudbricks and the 14C dating of the levels from which these indirect archaeobotanical finds originate, generated disagreement regarding the status of cereals in the PPNA of Jericho (Nesbitt and Samuel, 1998: Note 3; Nesbitt, 2002, 2004; Colledge et al., 2004).

iii) Following work at Middle Pre-Pottery Neolithic B (MPPNB) at Tell Halula on the Euphrates, Ibáñez et al. (1998) argued the presence of limestone hoes interpreted as tillage tools. This however remained a single isolated claim and no further evidence has been added since. Water harvesting techniques were interpreted as some type of irrigation following work at Tell Halula (Araus et al., 1999, 2001, 2007) but the irrigation claim was subsequently withdrawn (Araus et al., 2014). Even if we accept both these arguments, Tell Halula, dated mainly to the tenth millennium Cal. BP is too late in the PPNB to be relevant to PD in this area let alone pre-domestication cultivation.

iv) Upon inspection, the role of ‘lost crops’ in supporting Near Eastern pre-domestication cultivation appears at best as an unproven hypothesis, since no unequivocal evidence to support it has ever been presented. Therefore, we have to wait until genuine evidence (as was done for the north American knotweed, Polygonum erectum L. [Mueller, 2017]) for the genuine status of the respective taxa as prehistoric crops in their own right will be presented (reviewed by Abbo et al., 2013a and references therein). For details on the issue of lost crops see Supplement No. 4.

v) The presence of “weeds of cultivation” is apparently the strongest argument in favor of pre-domestication cultivation. However, can one really distinguish in the archaeobotanical data between species identified as weeds of cultivation (segetal) and naturally occurring species typical of disturbed and natural habitats regardless of human activity (see Hillman, 2000; de Moulins, 2000; van Zeist and de Rolly, 2000), or ruderal taxa naturally thriving along human (or animal) tracks around the sites, where they may simply have enjoyed some advantages? Does the limited archaeobotanical record of taxa considered as weeds allow for a statement on the presence of field weeds? And how can such remains be separated from non-food or non-target plants brought into the sites, or from plant remains in secondary use (Nadel et al., 2004; and see van Zeist and de Rolly, 2000)? For example, in our controlled harvest exercises of wild lentil and wild chickpea in Israel, and the post-harvest cleaning of the gathered material, grains from both the target taxa (wild lentil and chickpea) and non-target (often toxic, i.e. Lathyrus sp.) were obtained in certain proportions. Therefore, it appears that in certain instances, the imperative of food stuffs cleaning prior to cooking and consumption
may result in charred plant remains from habitation sites that may perhaps be considered as a portion of the procured and discarded plant material rather than the target species or consumed types thereof (Abbo et al., 2008: 3176). So, even with meticulous identification to the species level (lacking in most cases), the documented effect of selective species enrichment (on-site discarded ones) calls for caution in the interpretation of data sets of archaeobotanical plant remains before granting a ‘weed’ (Riehl et al., 2013) or for the same matter ‘food-remains’ status (à la Lev et al., 2005) to any particular species (Abbo et al., 2012).

vi) The suggested pre-domestication cultivation of wild cereals and legumes in PPNA Chogha Golan (twelfth and first half of eleventh millennium Cal. BP) may help clarify the state of affairs vis-à-vis data and interpretations of archaeobotanical remains (Riehl et al., 2013, 2015; Weide et al., 2018). We discuss the archaeobotany of this important site in Window No. 2.

Window No.2: the site of Chogha Golan

Work at Chogha Golan exposed two very small areas: one was 2 × 4 m excavated to a depth of 1.5 m corresponding to Horizons I and II (the latest); the second was a deep sounding that reached the base of the site. A modern looter’s round shaft (ca. 1.5 m in diameter) exposed the full sequence of the site. It was sampled in 2009, and a new 2 × 1.5 m pit was excavated on the edge of the looters’ pit down to site base for high quality samples in 2010 (Zeidi and Conard, 2013). Despite the small scale of the excavation, plant remains were recovered in abundance. They were studied and discussed by Riehl et al. (2013, 2015) and by Weida et al. (2018). For the sake of evaluating the quality of evidence and arguments concerning pre-domestication cultivation in PPNA Chogha Golan we find it sufficient to consider the following five points:

1) Chogha Golan is located in an area with 100–200 mm of annual precipitation (similar to parts of the lower Jordan Valley, Israel), not an ideal (to say the least) ecology for dryland grain production. Indeed, Riehl et al. (2015: 5) refer to the vegetation around the site as “desert type.”

2) Riehl et al.’s (2013) argument for alleged ‘arable weeds’ relies mostly on identification to the genus level (ibi-dum). The identified genera hold hundreds of species in regional floras, often with only a few (or single) species known as weeds. Only two presumed weeds were defined to the species level at Chogha Golan – Reseda luteola, an ancient dye plant (Cannon and Cannon, 1994) and Medicago radiata typical of steppe habitats. Here we ask, if “possible arable weed” remains from the early Horizon XI throughout to the later Horizon II of Chogha Golan are indicative of cultivation, and if indeed “domesticated species evolved through management of their wild progenitors,” as asserted by Riehl et al. (2013), why does the proportion of these arable weeds (relative to wild progenitors’ remains) decline during the proposed (some 1.5 millennia) cultivation period (Riehl et al.‘s Fig. 2 and supplementary materials)? Note that the that the suggested weed remains increase only in the PPNB occupations where morphologically domesticated emmer appears. Furthermore, in a later report, Riehl et al. (2015) admit that trends in barley and Aegilops sp. seed remains are only “partially reflected in the potential arable weed species” (mostly identified to the genus level).

3) Weide et al. (2018) have reassessed the Chogha Golan data and stated that the temporal increase in barley grain size and the parallel delta-13C values (presented by Riehl et al., 2015) are indicative of enhanced growing conditions, and may reflect management practices over Horizons V to II. However, Figures 7 and 10 of Riehl et al. (2015) show no statistically significant trends neither in the average dimensions of the recovered barley grains nor in their delta-13C values.

4) Weida et al. (2018) discuss the large proportions of Aegilops sp. seed remains in certain horizons and consider them to have been economically important and as a possible cultivated (pre-domestic) species around the site. Aegilops seed remains from Chogha Golan were identified only to the genus level, and the authors do not provide information on any current Aegilops sp. native to the Chogha Golan environs. There are more than 20 Aegilops species, 13 of which are less than 30 cm in stature, bearing spikes that hold 3–10 spikelets with tough glumes (Kimber and Feldman, 1987). Based on our work in Aegilops populations in Israel, Morocco, Turkey, the Trans-Caucasus and Central Asia (Abbo, unpublished field diaries) we can confidently testify that Aegilops species that prevail in low rainfall habitats (as reported for the site by Riehl et al., 2015) are mostly low statured taxa with a flimsy grain yield. In our view, discussing the economic importance of Aegilops sp. from Chogha Golan (with its 100–200 mm of annual rainfall), as a foraging target let alone its alleged pre-domestication cultivation, while using as an example the mixed rich stands of wild barley, wild emmer and Aegilops from the upper Galilee grasslands of Israel (near the city of Safed, Fig. 10 of Weida et al., 2018), an area with ca. 800 mm of annual rain, is unjustifiable and misleading to say the least.

5) Riehl et al. (2013) suggest pre-domestication cultivation of lentil. However, our experiments (Abbo et al., 2011b) have re-affirmed Ladizinsky’s (1987, “Domestication before Cultivation”) hypothesis that there is no profitable option of wild legume cultivation due to their strong seed dormancy. Hence, lentil cultivation required a non-dorman (domesticated) phenotype from the outset (Ladizinsky, 1987, 1989, 1993). Thus, accepting the suggested PPNA lentil cultivation means that they were in fact domesticated, thereby making assumptions regarding millennia long management (cultivation) processes as a pre-requisite for domestication (Gepts, 2004; Tanno and Willcox, 2006; Riehl et al., 2013) redundant altogether (Abbo et al., 2013b).

To conclude the discussion of the Chogha Golan archaeobotanical remains and the different interpretations offered by Riehl et al. (2013, 2015) and Weide et al. (2018), we refer readers to statement from Weide et al.’s (2018) discussion: “patterns from Chogha Golan basically fulfill the criteria commonly used to apply the pre-domestication hypothesis.” No less relevant, and probably true to life, are two additional statements by Weide et al. (ibidum): [i] “Whether the wild cereals were ever cultivated at Chogha Golan is therefore not clear” … and [ii] “the traditional concept of pre-domestication cultivation seems unsuited for
Another relevant example cautiously suggesting cultivation of wild cereals is the claim for “proto-weed” remains at the 23,000-year-old site of Ohalo II (Snir et al., 2015). Hawkes (1969) suggested that in pre-agricultural times species with weedy tendencies inhabited naturally disturbed niches such as riverbanks, landslide areas or gravel. Note that Ohalo II is a lake-shore site, in close proximity to the Jordan River southern outlet from the Sea of Galilee. A location rich in a range of niches such as unstable banks and landslide areas repeatedly affected by seasonal changes of water level and flow intensity, just a few minutes’ walk from the site. Such an ecological setting may provide an alternative (and more parsimonious) explanation for the presence of seed remains from the species listed by Snir et al. (2015) and see a similar claim by Wood and Lenné (2018).

Here we wish to address another methodological problem with the logic of the prevailing argumentation regarding the role of weeds in claims supporting pre-domestication cultivation. When one assumes that there was necessarily a (long) stage of production (cultivation) that preceded morphological domestication (Fuller, 2007; Weiss et al., 2006; Wilcox, 2012; Riehl et al., 2013), such (presumed weeds) seed remains may be interpreted as ‘weeds of cultivation’ (Wilcox et al., 2008). However, to use the presence of identified remains, after making the above assumption (regarding the necessity of a pre-domestication cultivation phase) as a proof of pre-domestication cultivation is a case of circular reasoning. After all, it was evidence for cultivation that we were after in the first place (quad erat demonstrandum). Furthermore, Wilcox (2007:33) also stated that under certain circumstances cultivation would not have left any “detectable sign in the archaeobotanical record.” Thus, upon accepting Wilcox’s attitude, how can remains of certain seeds be considered as a reliable indication of cultivation? And we further wonder about the ecological settings that allow cultivation to take place with, or without archaeobotanical traces? We argue that without explicit reference to the respective cultivation scenarios that are likely to leave or not leave archaeobotanical signatures, Wilcox (and those who rely on such argumentation) in fact relieve themselves of any responsibility of an investigation aimed at the identification of the (presupposed) pre-domestication cultivation. As such, and liberated from the burden of presenting genuine evidence, these authors confirm that pre-domestication cultivation will remain a mere theoretical construct (see Note 29).

Finally, for the time being, and due to the millennia of land management across the Near East, the presumed ‘cultivated’ fields will most probably remain elusive and we would need extremely

28 Weida’s assertion of Aegilops sp. pre-domestication cultivation can be read as a claim for auditioning (à la Smith, 2007) as would be candidates for resource management, or as an attempt to imitate a domesticate partnership that eventually failed (à la Zeder, 2017a, 2017b; see note 27).

29 In a seminal paper Wilke et al. (1972:204) presented their view on the relationship between harvest techniques and PD and said: “Domestication of seed plants can occur only if a practice of reseeding has been previously established.” In the preceding paragraphs, Wilke et al. (1972) engaged in what they have termed “theoretical constructs” pertaining to the subject of PD and stated that their discussion concentrates on the importance of reseeding and harvesting as selective forces. It is legitimate to discuss the potential role of reseeding and/or harvesting in plant domestication. However, with Wilke et al.’s (1972) above cited statement as the prelude, the whole discussion assumes a circular nature, if even an inevitable consequence of the process of constructing working hypotheses.
part of humanity’s journey between a pristine foraging era to a fully-fledged agriculture? Consequently, these constructs can hardly avoid being part of a linear model based on meager first hand archaeobotanical data while carrying circular and teleological flavors.

3. Are mutualism or Niche Construction Theory suitable frameworks to explain Near Eastern plant domestication?

Rindos (1980) has advanced the concept that “Domestication is the result of the evolution of a symbiosis between man and plant” (original italics) and stated: “Domestication is best understood as an interaction between man and the plants on which he feeds” (original emphasis). Predator-prey interactions are universal biological phenomena and some have developed into forms of symbiosis which, according to some authors, bear striking similarities to human relations with (domesticated) plants (Schultz et al., 2005). Indeed, Rindos (1980:753) considers non-human agricultural systems (ant-fungal, ant-acacia) as examples promoting a coevolutionary view of domestication and agricultural origins. Thereby, Rindos (1980) views human agriculture as just one example for the more general phenomenon of animal-plant (or fungus) interactions that have co-evolved over evolutionary time scales via gradual intensification of their mutualistic relationship and draws several lines of similarity between human-domesticated plant relations and insect-fungal relations, partly listed in Supplement 5.

The elements of Rindos’ reconstruction (see Supplement 5) reflect (by analogy) concrete ways by which humans engage with their food resources leading to domesticated plants, and rely heavily on certain aspects of the (commensal) ‘dump heap hypothesis’. These include the supposed weedy tendencies (and origin) of crops, the role of land disturbance in creating suitable niches for would-be crops, the role of discarded plant parts in rich niches in giving rise to attractive plants, and the crowding of target plants around human dwellings. As outlined above and elaborated by Abbo et al. (2005), Rindos’ (1980) model is not an appropriate framework for describing the domestication of most Near Eastern grain crops (they simply do not show the traits needed for such a relationship to have developed) and certainly not for the establishment of the founder crop package (see above). In fact, Rindos’ (mostly commensal) reconstruction does include an element of the prey (harvest) pathway to domestication (agriculture). The difference lies in his use of the term ‘interaction’ rather than relationship and/or ‘partnership’ as does Zeder (2012; and see Larson and Fuller, 2014, and Window 1 above). Following Zeder (2012), the prey pathway initially involves some kind of human action yet the ‘motivation’ for striking partnerships was rather to secure resource yield and increase its predictability for humans, while on behalf of the target species it was to initiate reciprocal niche construction activities in order to maintain the partnership. 30 This, in our view, exemplifies the subtle inter-relatedness of the different coevolutionary, mutualistic, gradualist approaches.

A different, albeit intimately related, approach to the origin of domesticated plants is based on the application of the NCT or “ecosystem engineering” (Smith, 2007). Prior to counting on NCT as a conceptual framework for the origin of agriculture, Smith (2001) considered plant (and animal) domestication in the context of a continuum of human subsistence strategies extending from foraging via a wide range of LLFP activities, up to full-fledged agriculture. Presence of domesticated plants (morphologically domesticated as seen in the archaeobotanical record) was used merely to distinguish low-level food producing societies as either with, or without domesticated plants (Smith, 2001). Like Harris (1989, 2012), Smith (2001) envisaged numerous routes that were available to those low-level food producing human societies to traverse the subsistence range between pristine foraging and agriculture. With respect to the causal biological mechanism responsible for the morphological domestication of plants, Smith (2001) accepted the thesis of Harlan et al. (1973) that bringing plants under a cultivation regime is likely to “release” the manipulated plant population from the selective forces prevailing in nature and promote selection in favor of phenotypes associated with the domestication syndrome traits (e.g., loss of seed dispersal mechanisms, larger seeds, compact heads).

Later, Smith (2007) argued that the application of NCT to the study of domestication may provide an essential link between two levels of PD research: the level of individual plant and animal species with respect to the specifics of the “What, Where and When” questions on regional scales, and that of the causal “macro” (“Why”) variables (e.g., climate change, population pressure). According to Smith (ibidum) and Zeder (2015) the linking of these two (allegedly disconnected) levels of PD research may be achieved by applying NCT that offers insights into the “How” question of domestication. Namely, according to Smith (2007), NCT helps to highlight the specifics of human actions that eventually resulted in “human-plant/animal relationships of domestication.” In other words, given the macro-ecological settings that led humans and plants to embark on their domestication partnerships, NCT helps us to understand what those human behaviors (resource management or niche-construction activities) were (Zeder, 2015).

Interestingly, while explaining what those human interventions in the life cycles of their target plants were, Smith (2007) in fact depicted the ‘good old’ cultivation scenario, namely “the sustained planting of stored seed stocks in prepared planting area,” which echoes the scenarios of Wilke et al. (1972) or Harris (1989). This accords well with the prey (harvest) pathway (à la Zeder, 2012, 2017a; Larson and Fuller, 2014). Smith (2011) dwelled on the long history of human niche construction, and suggested that some of these human management efforts led to the domestication of plants and animals. The human management types presented by Smith (ibidum) mostly concern North America, but two of his six categories of management and environmental manipulation listed as prevalent among pre-industrial societies (see Supplement 6) are relevant to the Near East and deserve notice.

First is the broadcast sowing of wild annuals. Under this category Smith refers mostly to lake edges, and riverbanks and echoes Sherratt’s (1980) seasonal reconstruction for Neolithic Near Eastern cropping (similar to décru [post-flood sowing] agriculture [Harlan and Pasqueruel, 1989]). As we understand it, for the Near East such a reconstruction (of sowing near lake edges or riverbanks) would mean early spring sowing after the winter water receded. Admittedly, the Near Eastern grain crops are all broadcasted under traditional farming practices. However, the suggested seasonal pattern is irrelevant to the Near East, since the local founder grain crops are all winter (cool season) annuals. And note that Sherratt’s (1980) scenario of spring sowing of cool season cereals along lake edges was already rejected by Limbrey (1990). Smith (2011) also refers to the (re)population of cleared ground by “early succession annual seed plants,” also irrelevant to the Near East since the wild progenitors of the Near Eastern crops are not early succession...
immediately dooms it irrelevant to most of the founder crops of the ant and human agriculture are based on viewing the origin of human domestication as including the ability of modern humans to act with conscious intent (Zeder, 2012, 2017a), see window no.1.

The second category of human environmental intervention mentioned by Smith (2011) pertaining to Near Eastern PD is the transplantation of perennial fruit-bearing species. For decades, fruit tree domestication in the Near East was considered a development postdating the emergence of domesticated grain crops (Zohary and Spiegel-Roy, 1975; Abbo et al., 2015). However, the identification of parthenocarpic (seedless) figs in the PPNA (twelfth millennium Cal. BP) site of Gilgal I in the lower Jordan Valley by Kislev et al. (2006) led them to suggest that fig growing may have predated grain farming in this region. As explained by Lev-Yadun et al. (2006) and Denham (2007b) the identification of six parthenocarpic fruits is by no means an indication for fig horticulture. At best, this find can support such an interpretation among other more likely explanations, such as foraging from the wild. Furthermore, as indicated by Kislev et al. (2006), the decisive stage in the establishment of the proposed fig horticulture was the identification of such a parthenocarpic mutant in the wild, and its recruitment by vegetative propagation from branch cuttings. Such a scenario is not in line with the need for a lengthy auditioning or resource management à la Smith (2007 or 2011), nor is it in line with Kislev et al.’s own arguments on a protracted domestication process, but it is akin to the recruitment of free germinating pulses as suggested by Ladizinsky (1987). As such, it should therefore be considered in terms of an almost instantaneous domestication rather than as a long-term predator-prey (harvest) interaction.

So it seems that while Smith’s (e.g., 2007, 2011) conceptualization of plant domestication by way of NCT may apply to certain crops in certain world regions (but still awaits concrete evidence beyond the ethnoarchaeological records), it does not quite accord with the Near Eastern archaeobotanical record, nor with the biology of the relevant plant taxa.

Laland and O’Brien (2010), who advocate the application of NCT in archaeology, treat PD as a special case of co-evolved mutualism between animals and plants. Laland and O’Brien (2011) specify the niche-construction activities that contribute to PD as including: a) selective propagule stocking and their transportation and storage, b) burning of grasslands, c) tree cutting, d) land tilling, and the inevitable “creating organically rich dump heaps” (Laland and O’Brien, 2010: 316). Zeder (2006) also portrayed domestication as an evolving mutualism between humans and commensal31 populations of plants and animals citing Schultz et al. (2005) who see an analogy between human agriculture and ant-fungal symbiosis. While Schultz et al. (2005) list a number of differences between human driven plant and animal domestications and fungi ‘domestication’ by ants, including the ability of modern humans to “act with conscious intent” (ibidum); they maintain that the “earliest stage of human domestication probably involved unconscious, incidental associations with plants and animals.” And note that almost all the similarities mentioned by Schultz et al. between ant and human agriculture are based on viewing the origin of human agriculture via a commensal, dump heap scenario, which immediately dooms it irrelevant to most of the founder crops of the Near East.

4. Discussion

Lately, domestication research as a whole (PD included) assumed a role as an important test case in a broad debate on evolutionary theory between the Modern Darwinian Synthesis (MS) and the Extended Evolutionary Synthesis (EES) including NCT (Gremillion et al., 2014a, 2014b, 2014c; Laland et al., 2014; Smith, 2014, 2015; Wray et al., 2014; Zeder, 2014, 2015, 2017a; Piperno, 2017; and see Mohlenhoff and Codding, 2017 for an additional perspective). For example, Zeder (2017a) stated her interest in using domestication research for “extending the conceptual framework of evolutionary biology” and for “exploring major tenets” and “core assumptions” of the EES. In doing so, Zeder targets mainly the “How” question of domestication through NCT as “one of the pillars of the EES.” She discusses a series of NCT-related issues (e.g., coevolution, evolvability, ecological inheritance, cooperation and the pace of evolutionary change), two of which — coevolution (agency) and the pace of evolutionary change — are discussed herein. We are not in a position, nor do we intend, to join a debate on evolutionary theory. Our point in this regard is that even if one opts for the EES and grants NCT a special role in formulating evolutionary theory, especially vis-à-vis domestications, the biology (of plants) and the cultural aspects of Neolithic Near Eastern PD remain a specific case that need be discussed within its own idiosyncratic — particular cultural and biological contexts.

The debate on evolutionary theory and domestication that revolves around the “How” question, also refers to cultural aspects including human agency. As such, it also reflects, if even roughly, dynamics in the deep divides of the last two generations separating archaeological schools of thought concerning the way human culture and the role of human agency in domestication are viewed (Abbo and Gopher, 2017; Piperno, 2017). Since tying biological and cultural evolution has grown to be an active sub-discipline (Mesoudi, 2017 and references therein), we find it proper to briefly address the issue. Clearly, evolutionary theory and archaeological schools of thought interact only to a certain extent; yet because we assign great importance to the cultural aspect of PD, and since the cultural element has assumed a role in the evolutionary discussion, we will outline a correspondence of sorts between evolutionary and archaeological frameworks of thought while emphasizing cultural aspects and the role of human agency (consciousness [intentionality] and the degree of the direct involvement). This would also entertain some comments on ‘cultural niche construction processes’ as presented in recent years (Laland and O’Brien, 2011; Smith, 2012) vis-à-vis human agency in domestication from the viewpoint of archaeological thinking. We are using Zeder’s (2017a) Table 2 that compares the Neo-Darwinian Modern Synthesis and the Extended Evolutionary Synthesis as explanatory frameworks of (initial, see below) domestication in an attempt to translate these into archaeological schools of thought and comment on their relevance to the issues discussed here (human agency [coevolution] and pace).32

31 Clearly, in later papers she established a wider terminology and she relates to additional pathways to domestication of which the prey (harvest) pathway is the one relevant here (Zeder, 2012, 2017a), see window no.1.

32 We find this necessary since domestication is a cultural move and since domestication research is based, in many ways on data originating in archaeological sites.
Zeder’s (2017a) Table 2 entries describing how the MS (through an Optimal Foraging Theory [OFT] perspective) would explain (initial) domestications represent a rather coarse reflection of ‘New Archaeology’ principles as viewed in its early days — that is, a neo-evolutionary view, in which the environment assumes a major role, and where culture is viewed as an external (extra somatic) means of adaptation operating as an organic (functional) system with eternal dynamics of sustaining equilibrium. Human activities are viewed as targeted at a higher foraging efficiency (in the OFT spirit) criticized by Zeder (2014, 2015) as having little or no explanatory power (as far as domestication goes). Domestication in this context is depicted as a coevolutionary relationship (partnership) between humans and the target resources (à la Rindos) while the social sphere and ritual activities when relevant are no more than another means of increasing successful natural selection (a “cultural OFT” of sorts). Change in this perspective is viewed in the common MS perspective as a slow, gradual, accumulative process shaped by natural selection.

On the other hand, the table entries relating to how domestication is viewed by holders of the EES (through its NCT perspective, as presented by Zeder [2017a; 2018]) would generally be more in the spirit of what has been termed “Post Processual (or Contextual) Archaeology” partly mixed with archaeological elements originating in earlier twentieth century archaeological schools of thought. Culture here is viewed as humans’ means of defining and interpreting the world. It emphasizes the ideological landscape (see Note 5) and its central role in human behavior and decision-making, human agency and its central role in explaining culture change, and it is viewed (again) in a particularistic, historical perspective (context). A radical interpretive view that relates to material culture as a text, once more emphasizes past society’s active agents, but also present-day researchers’ contexts and agendas. Domestication in this case (à la Zeder, 2017a) is depicted as free of environmental stress, taking place in a rich environment (“time of plenty”) with predictable resources and a stable, ‘low’ demography. Libratered from external (environmental or other) ‘push’ movers of domestication, the human agent (and his/her perceptual/ideological landscape) assumes, at least in theory, a central role. Yet, human actions (seen as cultural niche-construction) are increasingly intensified to maintain the environment (available resources) and — population (demographic) balance, thus implicitly retaining a somewhat Darwinian (MS) flavor. Social and ritual activities are viewed, in this case, as key elements in enhancing community (group) cohesion and inter-generational knowledge transmission — a ‘Normative’ ‘Old Archaeology’ (Culture History), and to some extent a ‘Post Processual, contextual Archaeology’ view of culture divorced from adaptive ‘New Archaeology’ thinking. Change in this context includes “periods of rapid change” (punctuations) “turbo-charged” by human “goal-directed” behaviors and periods of stasis with no, or almost no, change (Zeder, 2017a).

This state of affairs (as outlined above, modified from Zeder, 2017a) is rather confusing, in our view, because the nature of the goal-directed human aspect is unclear and the temporal scale of the mentioned rapid changes was not specified (single years, generations, centuries or millennia) and likewise, the time frame attributed to ‘initial domestication’ (see above and Note 33). If indeed the domestication process as seen by EES (and NCT) supporters has human goal-directed elements, would that mean that these are cultural considerations? And how would that ‘live in peace’ with evolutionary change and with fitness considerations for both sides involved in the active (mutualistic/coevolutionary) relationship/partnership of humans and plants (or animals)? Moreover, if this is a rapid “turbo-charged” punctuation, i.e., a rapid domestication scenario, then would it possibly mean that what is termed ‘initial domestication’, is what we view (as in the core area—one event model) as the episode of domestication itself while all that followed (to this very day) should be referred as crop (or animal) evolutionary processes occurring (post) under domestication (for plants see Abbo et al., 2012, 2014). However, if ‘initial domestication’ remains as an undefined/ flexible time-window along resource management continuums (e.g., Harris’s [2007, 2012] pre-domestication cultivation, or Smith’s [2001] LLFP),34 then it still reflects a protracted (and thus almost inevitably unconscious) domestication dynamic. Phrased differently, the very choice of the term ‘initial domestication’ (while arguing for a punctuated model) would in itself raise a question about whether and how this stage is isolated from stasis (or very slow change) periods suggested by Zeder. Moreover, would a fast (initial) domestication be possible unless based on human initiative (agency) especially if assuming, as Zeder (2015, 2017a) does, that humans are special for their capability to transmit knowledge and information rapidly and change their behavior accordingly. Hence, it would still be prudent to ask how the application of NCT to PD research helps distinguish (initial) PD from pre-domestication cultivation and/or from post domestication crop evolution, e.g., local adaptive changes, improvement, cultivar and/or breed development (Abbo et al., 2012, 2014a). We would of course prefer the rapid domestication reconstruction since rapid in our view is episodic, almost instantaneous (the selection of species and suitable mutants of these species) or no more than a generation or two.35

Let us look at the issue from another angle, if even heuristically, and try to understand whether we can promote a clearer understanding of the issues dealt with above as presented for example by Zeder (2017a, 2018). To do that we assume that as in the rough generalization we made above — that the MS (processual archaeology) model better represents the protracted, unconscious (mutualistic, coevolutionary) model of PD, while the EES (post processual, or contextual archaeology) has the potential to represent a rapid, cultural, historically particular, goal directed—conscious and of course, intentional PD. This however is not of much help since the reconstructions of domestication in the spirit of the EES with its major NCT component, do not explicitly advance claims that are in line with a conscious, rapid domestication. There seems to be a gap between the first impression the reader may get on these domestication-related issues (vis-à-vis PD in the Near East) and the formally written statements (Zeder, 2017a, 2017b). Although it is never specified that human agency and intentionality are missing altogether, it is also true that the human social agent is far from being presented as playing a major and influential role in the process of domestication beyond being on one side of an interaction-relationship-partnership while plants and/or animals are situated on the other side. This is what renders the process protracted, free of a particular historical context and, in effect, free

---

33 The term “initial domestication” is confusing. Are there also middle, late or final domestications? And if so, how are these defined? Is initial domestication a stage such as those presented by Fuller et al. (2018) in a long process of pre-domestication cultivation or does it refer to the phasing by Harris (2007, 2012)? And likewise, what exactly is “the threshold of plant domestication” (sensu Zeder, 2017a) and how long does it take to pass through this metaphorical doorway into domestication?

34 Or like the subdivided pre-domestication cultivation process as by Fuller et al. (2018) where an “incipient pre-domestication cultivation (IPDC)” sub stage was suggested.

35 Actually, below the resolution of present-day archaeology based on 14C dates (±100 or even ±50 years).
of cultural and ideological elements.

Zeder and Smith attribute denial of intentionality or human agency to Rindo’s model (and the MS) which is supported by the fact that Rindo (1980, 1984) based most of his arguments on the commensal pathway to domestication.36 However, Zeder and Smith also view domestication in terms of mutualistic (partnership-relationship) terminology as in social insects (e.g., Schultz et al., 2005), albeit with some distinctions for human domestications (see above). The goal of the (NCT-viewed) process is still seen through a cost-benefit perspective and the human goal is still to enhance resource predictability and returns from the targeted — would be — ‘partner’ species (or the engaged species) that lead to domestication partnerships (e.g., Zeder, 2015). At the same time, while using NCT (within EES) they acknowledge the special qualities of human capabilities in rapidly transmitting relevant knowledge and behaviors through social learning which makes them a successful and fast player in the domestication arena. It therefore remains to be decided (again): To what extent was the process [A] intentional and goal directed, and [B] how does this translate in terms of domestication pace. It seems that the economic cost-benefit (biological, evolutionary) element is governing the coevolutionary partnerships for both humans and plants or animals. This is however concealed under the active and significant human roles (agency) are given in what is called ‘Cultural Niche Construction activities’, and under what is termed ‘relationships’ or ‘partnerships’. These may seemingly depict an interpretative landscape that looks as if reflecting an almost ‘post-processual (contextual)’ reasoning in nature (see Note 28, and see above discussion on the Zeder’s [2017a] Table 2) where the human agent is given a central role and an apparently free space of intentionality in initiating and promoting moves like domestication. A perceptual/ideological space that is central to this way of thinking is also not part of their reconstruction. Yet, statements of no intentionality are repeatedly mentioned by various authors both for the commensal and the prey (harvest) pathways to domestication reflecting a kind of discrepancy with agency statements previously mentioned. Dynamics in perceptual/ideological37 or socio-cultural arenas that result in a mental and behavioral change (and action) are hardly discussed. If mentioned, these aspects are looked at through prisms of cultural niche-construction, environmental maintenance (management, manipulation), and demographic stability and such is also the use of social and ritual activities viewed in a context of community cohesion and knowledge transmission — all for the sake of securing resource yield and predictability, thereby enhancing fitness.

An important point is that under EES-NCT domestication explains the relationships (partnership) between humans and the species engaged in the process of domestication are, if even implicitly stated, practically symmetrical in the sense that not only humans, but also the plant (and animal) partners are in one way or another active (e.g., Zeder, 2015: 3192).38 It seems that plants and animals involved make adjustments (changes) that improve their chances of success and their benefit from the (developing-evolving domestication) partnerships. An extreme case of such a view is the claim that following megafauna extinctions, certain plant species have recruited humans as their seed dispersers thereby making the first step towards domestication (Spengler, 2020). Simplification of such descriptions would mean that not only do humans engage in the relationship using their unique capabilities (e.g., for knowledge transmission and rapid behavioral adjustments) for an enhanced profit but animals and plants are also involved in order to satisfy humans while at the same time making their own benefit from the partnership. Thus, such EES-NCT modelling implicitly depicts a process that basically accords well with a mutualistic-coevolutionary domestication scenario/model, that may, at least partially, be related to MS-like elements, yet differently framed.39

The picture portrayed in the literature vis-a-vis the “How” question of domestication mostly includes protracted, millennia-long processes of unconscious (thus unintentional, automatic) selection (pre-domestication cultivation; low-level food production), as well as an emphasis on scenarios based on mutualism or coevolutionary relationships between humans and target species that resulted in domestication (e.g., Fuller, 2007; Smith, 2007, 2011; Willcox, 2012; Fuller et al., 2014, 2018; Zeder, 2015, 2017a; Spengler, 2020). The manner in which this picture was presented (as evident from the discussions above), conceptualizes PD via an evolutionary continuum of human-environmental-resource manipulations (niche construction), and this has a great deal in common with the LLFP continuum, with the pre-domestication cultivation concept (the prey [harvest] pathway relations), as well as with the early 20th century ‘dump heap hypothesis’ (commensal pathway). Phrased differently, this view would maintain that across the metaphorical middle ground of LLFP (or pre-domestication cultivation in the Near East), humans were conducting endless domestication auditions (Smith, 2007), constructing niches (e.g., creating land disturbances, broadcasting seeds of annual plants, transplanting desired specimens, burning vegetation, and creating dump-heaps [e.g., Anderson, 2005]), thereby providing the arena for genetic changes within the manipulated plant populations (e.g., Zohary, 2004; Purugganan and Fuller, 2011; Zeder, 2018). These changes occurred via the accumulation of adaptive mutant alleles that condition plant traits (phenotypes) associated with the domestication syndrome (e.g., Harlan et al., 1973; Smith, 2001; Zeder, 2017a, 2017b, 2018).

Thus, while the different scholarly attitudes of PD students such as Hawkes (1970, 1983), Harris (e.g. 1989, 2012), Zeder (2006) and later Zeder (2015, 2017a, 2018); Fuller (2007), Smith (2001, 2007, 2011) or Laland and O’Brien (2010), may seem different from one another in their anthropological (cultural), or certain evolutionary theory perspectives, and/or in jargon, they all rely on a similar biological “How?” of plant domestication. This “How?” question, so ultimately important as indicated by Smith (2007) and Zeder (2015), requires that we approach these PD reconstructions precisely from that same direction and ask ourselves if this is the most likely “How”? Or is it at all a possible evolutionary mechanism by which Near Eastern plant domestication could have unfolded?

Investigating the “How” question, we argue that Near Eastern plant domestication is unlikely to have occurred via a commensal ‘dump heap’ pathway (Abbo et al., 2005). Moreover, while a model of domestication via a relatively rapid (e.g., Zohary, 2004) or protracted (NCT based) prey/harvest (management) pathway (namely, a cultivation [and/or pre-domestication cultivation] mediated domestication) or a mutualistic relationship between humans and

36 Rindo has also partly related to the prey (harvest) pathway and depicted an interaction (Zeder’s relationship) between humans and the target species (see text above).

37 As well as psychological (à la Cauvin, 2000), or even neurological (à la Benz and Bauer, 2013; Bauer and Benz, 2013), although these are not easily detectable.

38 The quoted statement saying that EES (and NCT) “... neither negates or downplays human culture, nor glorifies it as something exceptional that resides outside of nature, while also acknowledging its unique and powerful role in shaping the evolutionary trajectory of humans and biota affected by human actions” (Zeder, 2017b:282) is in a nutshell, we think, a representation of the tension that accompanies the difficulties in finding the right “status” for the human element in the process of domestication.

39 We are aware of non-random processes in evolution but will not expand on it here (see Way et al., 2014; Laland et al., 2014). Clearly, these do not deny the random, mutation trajectory of evolution which is always there.
target species (LLFP) may be applicable to the Near Eastern cereals, it certainly does not apply to flax, the grain legumes or to vegetatively propagated fruit trees (Ladizinsky, 1987; Abbo et al., 2011b, 2015). If one attributes the domestication of the Near Eastern cereals and grain legumes to Neolithic communities operating within the same cultural interaction sphere, and acknowledges their ability for rapid domestication of fig trees40 (Kislev et al., 2006) and grain legumes (Ladizinsky, 1987; Abbo et al., 2011b) why assume the necessity of a protracted pre-domestication cultivation stage for cereal domestication? Therefore, we reiterate that none of those related theoretical constructs (individually or in combination) provide a satisfactory or biologically suitable framework to the “How” question regarding PD in the Neolithic Near East.

Viewing Zeder (2015, 2017a, 2018) as a representative statement of the EES (NCT) in domestication research, and attempting to accommodate it with our own (rapid and conscious) Near Eastern domestication model, would experience quite severe difficulties and would be possible only if we interpret her statements as representing a rapid domestication led (intentionally [consciously]) by human agents (see more in Supplement 7). However, what we take issue with are the entanglement with evolutionary theory (NCT included) and the remoteness from the cultural perspective. It seems as if a paradigm shift is required to cross the Rubicon and state that ideology, perception and political (manipulative) power of individuals and/or communities are the major (socio-cultural) movers of the human agents who consciously and intentionally brought about PD.

We, on the other hand, view the major behavioral change that characterizes the Neolithic as moving away from such (past, Paleolithic hunter-gatherer) trajectories of existence into a new sphere of consciousness based on a changed perception/ideology (a new world view). The essence of this new sphere is a departure from pristine human-plants (and likewise human-natural resources in general) relationships as expressed by Ingold’s (2000) ‘trust’ or by Naveh and Bird-David’s (2014) ‘relational epistemology’ that do not (and cannot possibly) include any ‘domination’ à la Ingold (2000) or any element of objectification à la Naveh and Bird-David (2014). Interestingly, in other world parts, different cultural trajectories have unfolded; the case described by Carneiro da Cunha (2019) encapsulating her antidomestication concept, provides a vivid example of a critique on the imposition of the Western view prevailing in certain domestication research realms. Plant and animal domestication, as seen in the Neolithic Near East, could have taken place only within a perceptual, ideological and belief system sphere that have already changed in this respect enabling full domestication relationships (objectification and domination eventually included). Trust and domination (relational epistemology and objectification, respectively) are two very different past modes of existence (two perceptions, two ideologies) and two very different present-day ways of thinking, separated by a wide and deep divide — a barrier that relates to deeply entrenched habits of thought — and this is why we fail to comply or join in with the coevolutionary and NCT elements. The post processual (contextual) interpretation, in our view, grants humans an active and even a manipulative role in creating worlds and changing them, including the relationships between humans (culture) and the world (nature) as well as the supernatural. We may entertain the idea that the picture presented by EES-NCT supporters may in fact be acceptable in a way (with reservations) for deep Paleolithic hunters-gatherers. However, once the Neolithic era of the Near East starts, and later on, when domesticated plants (and animals) and farmers overtake the stage, the ‘rules of the game’ have already changed and humans become the central actor while plants (and animals) assume a minor (dominated, objectified) role in the relationship. So, domesticitary (or even initial domesticaty) relations are thus no longer partnerships of any sort (neither symmetric nor asymmetric), but rather reflect a struggle for domination (of culture over nature [and likewise of humans over their own animality in Ingold’s terms]).

5. Epilogue

Readers may note that Zeder; and likewise, Smith, Piperno, Gremillion, Mohlenhoff and Codding, Laland and Obrien, and others participate in the broad discussion of evolutionary theory in which domestications are grasped as research models. Consequently, while discussing PD in global41 evolutionary terms the particular idiosyncrasies, and regional scale details (e.g., Near East) are relegated to secondary importance. We, on the other hand limit the scope of our work to depicting the fine details of a PD history of a specific package of cereals, legumes and flax in a specific region — the Near East. We believe that work on the local scale provides an opportunity to construct detailed scenarios and micro-models that may eventually converge to allow for the formulation of broader, regional and supra-regional or global models.

It is our contention that the domestication of the Levantine plant package was all about choosing the species for domestication and identifying and selecting the suitable mutants (from the standing genetic variation), and thus knowledge-based, conscious, rapid (once having selected seed corn for sowing, she/he were in possession of a domesticated stock rather instantaneously) episode (Abbo et al., 2011a, b). All being intentional actions by an assertive human agent, that had taken place in a specific, single core area in southeast Turkey and north Syria, which is well-defined geographically, botanically, and culturally (Lev-Yadun et al., 2000; Gopher et al., 2001; Abbo et al., 2010a). We view PD in a local Near Eastern perspective — a particularistic history (a Culture History in terms of archaeological frameworks of thought) — taking place in a highly dynamic cultural interaction sphere (koine).42 We envisage a unique and intelligent human initiative, i.e., a choice of a package of cereals and legumes (species and mutants) of high dietary value and perfectly adapted to the local environmental regimes providing a successful and compensating agronomic array (Abbo et al., 2010b). More importantly, this move was encouraged (and mediated) by a new human perceptual (ideological) landscape (Cauvin, 1999, 2000; Watkins, 2004, 2008; 2010; Watkins et al., 2011; Hodder, 2011; Benz and Bauer, 2013; Özdogan et al., 2014; Busacca, 2017), new behaviors, and a new relationship with, and perception of plants and animals (the world) — (a post processual [contextual] archaeological framework of thought). Without such a new perceptual landscape hunters-gatherers would not have opted for

40 And likewise in other world regions; the single-step domestication of pineapple (Chen et al., 2019).

41 Great Synthesizing; e.g., amassing data from Old and New World regions (and likewise tropical and temperate) and using recent ethnographies from certain ecologies to discuss deep-past processes in totally different environments which often may result in comparing the incomparable (sensu Pickersgill, 2018; and see Neves and Heckenberger, 2018).

42 All groups are aware of innovations of all sorts within a short time (in Neolithic terms) that is possibly shorter than our resolution of ±50 years can detect — thus change of any sort can turn new ideas (the use of new materials, new technologies, new economic elements) into new realities.

43 The mere fact is that throughout history, little has been added to this plant (and animal) repertoire of the Near East and to domesticated plant packages in other primary domestication centers throughout the world. These continue to constitute major feeders of Humankind and even modern agronomy and breeding efforts are concentrated on species of these old packages — modesty is thus recommended (and see Levi-Strauss, 1952).
domination over natural resources but would rather maintain their ‘antidomestication’ relationships with their gathered (and/or cultivated food resources, e.g., Carneiro da Cunha, 2019; Lévi-Strauss, 1955, Chapter 7). Stated differently, we believe that every change in human culture, society or economy is ingrained in the human mind (Lévi-Strauss, 1962) and no significant human action and change would be possible otherwise.

Our suggested reconstruction for PD in the Near East is based on a multitude of archaeological, botanical, ethnobotanical and agronomic-dietary lines of evidence and is free from many of the assumptions, and theoretical constructs underlying the (coevolutionary, mutualistic) protracted or NCT-based approaches (see Table 1 of Abbo and Gopher, 2017). It is practically free of using ethnographic data as a major evidence source that we consider problematic and in not a few cases irrelevant to the pre-agricultural pristine (“antidomesticatory”) world views. As such, our core area-one event model (Abbo and Gopher, 2017; Gopher et al., 2017) provides a viable (more reliable) reconstruction for plant domestication in the Near east.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.quascirev.2020.106412.

References


