Introduction

TRACING A GENEALOGY FOR CROP EXCHANGES

The past is perhaps most foreign in the sensory experience of quotidian life. Half a millennium ago, the world not only looked different but also smelled and tasted different. Imagine Italy without tomatoes, Australia without cattle, Florida without oranges, India without chilies, France without tobacco, Colombia without coffee, and Switzerland without chocolate. The regime of diseases afflicting humans was also markedly different. The peoples of the New World had no experience of smallpox, the now-extinct dreadful pustular rash, and other viral and bacterial infections endemic to the Old World.[1] The Afro-European colonization of the Americas brought little short of a revolution in the biosphere, irrevocably fusing the ecosystems, agricultural regimes, and dietary habits of the Old and New Worlds. Voyaging across the Atlantic from the New World were pumpkins, squashes, maize, peanuts, pineapples, guavas, cacao, chili peppers, cashews, cassavas, tomatoes, papayas, sunflowers, and potatoes, among other crops; while wheat, barley, rice, oats, sugarcane, coffee, bananas, citruses, and other Old World mainstays traveled to the Americas to become part of a labor-intensive, often slavery-based, cash-cropping system.[2] The year 1492 inaugurated a world without biological borders—and, inadvertently, one of the worst ecological-demographic disasters. The influx of peoples, livestock, and food crops also opened a Pandora's box of free-ranging weeds, pests, commensals, and microbes (and their attendant diseases) whose impact on the native

1. Guzmán-Solís et al. 2021.
2. Heywood 2012, 72–73; McNeill 2014, 444–47. For a fuller list of crops, see Hawkes 1998.

populations of the Americas was calamitous.[3] Coining a term for this pivotal biological diffusion, the environmental historian Alfred Crosby called his 1972 book, now held as one of the foundational texts of environmental history, *The Columbian Exchange*.

But the Columbian Exchange is only the most recent and best known of a series of intercontinental biological dialogues involving fl ral and faunal exchanges. Both archeologists and historians have identifi d major thresholds in agricultural history, marked by the introduction of new crops and modifi ations in labor and capital inputs, and have described them as either a revolution or an exchange. The most fundamental "revolution" was of course the Neolithic Revolution, which witnessed the domestication of plants and animals and the related evolution of hunter-gatherers into sedentary farmers some 12,000 years ago in multiple regions of the Old World.[4] The other notable prehistoric "revolution" was the Secondary Products Revolution, which entailed modifi ations in the management of domesticated animals to obtain secondary products like milk, cheese, yoghurt, ghee, wool, and leather—not to mention traction.[5] More recent agrarian "revolutions" familiar to students of modern history include the eighteenth-century British Agricultural Revolution, a prelude to the Industrial Revolution, and the Green Revolution of the 1940s to 1960s; both led to higher crop yields and considerable demographic growth.[6] In most cases, however, *revolution* is a misnomer, since these watersheds in agricultural history were often culminating points of a process long in the making or, as the archaeobotanist Marijke van der Veen puts it, a "time

3. New World populations were not immune to a host of Old World diseases, including smallpox, measles, mumps, whooping cough, influenza, yellow fever, and malaria (McNeill 2014, 442). A genetic study by Llamas et al. 2016, based on mitochondrial DNA from the osteological remains of 92 pre-Columbian South American individuals, draws attention to mass mortality and extinction of lineages during the early phase of European colonization.

4. Barker 2006; Bellwood 2004; Childe 1936. On the issue of multiple centers and protracted processes of crop domestication, see Fuller, Willcox, and Allaby 2011;Meyer, Duval, and Jensen 2012.A DNA study of 44 Middle Eastern individuals dating between 12,000 and 1400 BCE demonstrates that the lineages of the earliest farming communities of the southern Levant and the Zagros were distinct, suggesting that the transition from hunter-gatherer to farmer developed independently in the two regions (Lazaridis et al. 2016).

5. Sherratt 1983, 1999.

6. On the British Agricultural Revolution, see Chambers and Mingay 1966; Overton 1996; Toynbee 1884. On the Green Revolution, see Gaud 1968. The Green Revolution (a term coined by offi als at the US Agency for International Development) was marked by the introduction of high-yield, disease-resistant, genetically modifi d crops to populous developing countries. The most conspicuous feature of more recent agrarian advances is the mechanization of farming, which led to the shift away from peasant agriculture to the agrarian capitalism of the present day. Mechanization freed labor for non-agricultural pursuits, which then, for the fi st time, became more signifi ant than subsistence production in the local and global economy.

period when changes reached critical mass."[7] Admittedly, there are scholars who espouse more gradualist approaches, deploying the notion of a "revolution" as a metonym for a seminal transitional process.[8]

The post-Neolithic agricultural regime of the Old World was remarkably fluid, absorbing new cultivars from different biogeographic zones and adapting them to local social and cultural complexes.[9] The histories of anthropogenic crop dispersals are, however, as much about resistance inspired by cultural preferences as they are about absorption. Exotica were fêted in some circles, but met in others with scorn and suspicion. In most cases, the process of crop nativization was long-drawn and dictated not only by climatic-environmental limitations but also, more crucially, by conservative agricultural practices and foodways. It took two centuries for early modern European farmers and consumers to be convinced that the New World tomato and potato were not toxic.[10] Yet the very presence of new crops, and new varieties of old crops, indicates that some traditional agriculturists did experiment and innovate.[11]

Crop dispersals in the post-Neolithic world encompassed calorific staples like grains, pulses, and tubers; cash crops like fiber and oil plants, aromatics, and spices; ornamental plants; and non-staple calorific supplements like fruits and vegetables.[12] Broomcorn millet (*Panicum miliaceum*), an East Asian grain, reached Europe by the late second millennium BCE through the mediation of Central Asian agropastoral communities.[13] While Europe has a species of wild apple (*Malus sylvestris*), a species native to Central Asia (*Malus sieversii*) is the main contributor to the gene pool of the domesticated apple (*Malus pumila*).[14] Other surprising Central and East Asian contributions to the European agricultural landscape of the Iron Age (c. 1200–550 BCE) include apricots (*Prunus armeniaca*), peaches (*Prunus persica*), hemp (*Cannabis sativa*), pistachios (*Pistacia vera*), and carrots (*Daucus carota* subsp. *sativus*).[15]

7. Van der Veen 2010, 8; see also Scott 2017, 10–12, 18–9; Squatriti 2014, 1208.

8. Bar-Yosef 1998; Squatriti 2014.

9. Boivin, Fuller, and Crowther 2015; Harris 1998; McNeill 2014; Sherratt 1999, 26; Zohary, Hopf, and Weiss 2012, 7–8.

10. Albala 2002, 236–37.

11. Johnson 1972.

12. Sherratt 1999, 27.

13. Boivin, Fuller, and Crowther 2012, 459; Cunliffe 2015, 67; Filipović et al. 2020; Herrscher et al. 2018; Hunt et al. 2008; Miller, Spengler, and Frachetti 2016; Motuzaite-Matuzeviciute et al. 2013; Spengler 2019, 59–88; Stevens et al. 2016; Zohary, Hopf, and Weiss 2012, 7, 69–72.

14. Cornille et al. 2012, 2019; Zohary, Hopf, and Weiss 2012, 136.

15. Boivin 2017, 366–68; Dalby 2003, 20; Daryaee 2006–07, 76; Fuller and Madella 2001, 341; Heywood 2012, 71; Iorizzo et al. 2013; Sadori et al. 2009; Stevens et al. 2016; Spengler 2019; Stolarczyk and Janick 2011; Weisskopf and Fuller 2013a, 2013b; Zohary 1998, 126–27; Zohary, Hopf, and Weiss 2012, 7, 106–07, 144–45, 151–52.

Sub-Saharan African crops like sorghum (*Sorghum bicolor*), fi ger millet (*Eleusine coracana*), pearl millet (*Pennisetum glaucum*), hyacinth bean (*Lablab purpureus*), cowpea (*Vigna unguiculata*), and castor (*Ricinus communis*) made their way into South India via maritime routes in a piecemeal process by the early second millennium BCE.[16] The archaeobotanist Dorian Fuller and colleagues dub this process the "Bronze Age inter-savannah translocations."[17] Somewhat later, in the fi st millennium BCE, bananas (*Musa* × *paradisiaca*), taro (*Colocasia esculenta*), and yams (*Dioscorea alata*) were transmitted in the reverse direction from tropical Asia to sub-Saharan Africa, where they remain important calorific sources.[18] These spatially and temporally distinct examples underscore the sheer scale, complexity, and multidirectionality of crop movements across the post-Neolithic Old World.

In this book, I trace the origins of and examine one pivotal trajectory within the dynamic and multidirectional Old World exchanges of crops and fauna. The Indian subcontinent encompasses a great variety of ecosystems and is extraordinarily diverse agriculturally, with native crops being supplemented by cultivars from Africa, the Middle East, and Central, East, and Southeast Asia. It is specifically the transmission of crops and fauna of tropical and subtropical Asian origin from the Indian subcontinent to the Middle East and the Mediterranean which the archaeologist Andrew Sherratt describes as the "most important movement of crops before the Columbian Exchange."[19] The region of origin for the crops under consideration in this book falls in the tropical and subtropical zone extending between latitude 28° N and 9° S from Papua New Guinea to northwestern India. Broadly speaking, these crops are frost and drought intolerant and hence are predominantly summer irrigated cultivars in the Middle East and the Mediterranean. Tropical and subtropical South and Southeast Asian crops collectively constitute the single "largest group of introduced aliens" in the Middle East and the Mediterranean.[20] Th s biological diffusion was responsible for the creation of a "unifi d ecological contact zone" of overlapping sets of cultivars and livestock across the southern Eurasian landmass.[21] The growing agro-ecological coherence of Afro-Eurasia in turn abetted processes of cultural coalescence and facilitated the spread of ideas and technologies.

The movement of crops from India to the Middle East and the Mediterranean has been variously styled in the scholarly literature depending on the agency,

16. Blench 2003; Boivin and Fuller 2009; Boivin et al. 2014, 551–52, 561; Fuller 2002, 288–92, 310–12, 2003a; Fuller and Boivin 2009; Fuller, Boivin, Hoogervorst, and Allaby 2011; Fuller and Madella 2001, 334, 342–44; Fuller et al. 2015; Possehl 1998.

17. Fuller, Boivin, Hoogervorst, and Allaby 2011.

18. Boivin et al. 2013, 215, 257–59, 2014, 554; Fuller and Boivin 2009; Rangan et al. 2015, 144–51.

19. Sherratt 1999, 28.

20. Zohary 1998, 127.

21. Mikhail 2011, 92.

routes, and chronology scholars have chosen to privilege. The historian Andrew Watson speaks of this exchange as an Arab Agricultural Revolution or the Medieval Green Revolution (c. 700–1100 CE).[22] The archaeologist Andrew Sherratt opts for a more neutral "trans-Eurasian exchange" but elsewhere describes the same process as part of the "orientalization" of the Mediterranean.[23] John McNeill, a global historian, privileges the maritime routes across the Indian Ocean and names it the Monsoon Exchange.[24] Lynda Shaffer, another global historian, situates the crop exchange within a broader exchange of ideas and technology and describes it as the "southernization" of the Northern Hemisphere.[25] In terms of chronology, scholarship has mostly failed to appreciate the lengthy process of crop transfers and has unhelpfully attributed agency to one or more political actors, including the Romans, the Sasanian Persians, and the medieval Arabs.[26] But this book will show that South Asian crop movements to the Middle East and the Mediterranean extend back to the Bronze Age horizon, and no single political actor can be credited with initiating and sustaining this process.

The "tropical turn" of the Middle East and Mediterranean under consideration here fi st entered scholarly purview with Andrew Watson's groundbreaking 1974 article, "The Arab Agricultural Revolution and Its Diffusion." Th s was followed by another article, "A Medieval Green Revolution" (1981), and fi ally a monograph, *Agricultural Innovation in the Early Islamic World: The Diffusion of Crops and Farming Techniques* (1983). In these works, Watson argued for an agricultural "revolution" in the early Islamic Middle East and the Mediterranean (c. 700–1100 CE) fostered by the diffusion of new Indian crops and improved farming techniques. The tropical South Asian summer crop package discussed by Watson included rice, sorghum, durum wheat, sugarcane, cotton, sour orange, lemon, lime, pomelo, banana, coconut, watermelon, spinach, artichoke, taro, eggplant, and mango. Watson identifi d the cosmopolitan, Islamicate populations of the Middle East and the Mediterranean as the principal agents in this biodiffusion. In Boserupian fashion, he held that the privatized labor-intensive farming of the Islamic lands, which involved equitable distribution of water, enriched irrigation methods (extensive use of water-lifting devices, underground canals, dams, and so on), crop rotation, and greater application of fertilizer, enabled greater crop yields, demographic expansion, and urban development.

But Watson's work is plagued by what one reviewer calls a "profound lack of interest in the pre-Islamic landscape and a host of flawed assumptions."[27] Most of

22. Watson 1974, 1981, 1983.
23. Sherratt 1999: 27; Sherratt 2006.
24. McNeill 2001.
25. Shaffer 1994.
26. King 2015.
27. Decker 2009, 191.

the crops cited by Watson were already introduced well before the Islamic period and certainly did not arrive in a package.[28] Nor was there anything astoundingly novel about the hydraulic engineering of the early Islamic world, which inherited and expanded pre-existing Roman and Sasanian hydraulic technologies.[29] The dispersal histories of individual crops are varied and complex. The notion that tropical South Asian crops were an "exogenous *deus ex machina* to kick-start change" in hitherto static Middle Eastern and Mediterranean economies is misleading.[30] The diffusion of South Asian fl ra and fauna to the Middle East and beyond was not a linear, uninterrupted event but an episodic process with its roots in the interconnected world of the Late Bronze Age. While Watson's study provides the stimulus for thinking about biological diffusions in the Old World, the so-called Arab Agricultural Revolution is far older than supposed and a much more gradual process.

SCOPE AND LIMITS

Th s book, in essence, offers an ecological reading of long-distance connectivity in the ancient world by investigating tropical and subtropical botanical transfers via maritime and overland routes, from South Asia to the Middle East and the Mediterranean, with the aim of assessing the motivations behind and impact of this phenomenon on ancient Middle Eastern and Mediterranean societies. The discussion of individual crops will be prefaced by a detailed and much-needed sketch of the Middle East and the Mediterranean's relations with South Asia from prehistory to the late centuries BCE. Th s *longue durée* narrative of interactions between the Middle East, the Mediterranean, and South Asia, whose full contours have yet to be appreciated by ancient historians and archaeologists alike, forms an essential backdrop to both early and later crop movements.

The textual and archaeological materials assembled in this book have yielded evidence for the introduction and naturalization of several South Asian cultivars in the ancient Middle East and the Mediterranean. The strategy employed here has been to maximize the available evidence while offering a selection of different

28. While Watson's case for the introduction of new tropical crops in the Middle East and the Mediterranean during the early centuries of Islam has been shown to be an invalid causal association (Decker 2009; Kelley 2019; King 2015; Ruas et al. 2015; Samuel 2001, 418–22), there are many scholars who continue to cite his conclusions, albeit with modifi ations (e.g., Amar and Lev 2017, 49–53; Fuks, Amichay, and Weiss 2020; McNeill 2014, 439; Mears 2011, 153; Zohary 1998). See Squatriti 2014 for a discussion of the lasting influence of the "Watson thesis" on historical studies and other academic disciplines. There have, however, been strong critics of the "Watson thesis" from its inception. See Johns 1984 and Aubaile-Sallenave 1984 for early critiques of Watson's work which argue that it is shoddy in the details.

29. Angelakıs et al. 2020, 24–25; Avni 2018; Decker 2009, 190; Kamash 2012.

30. Squatriti 2014, 1212.

types of economic plants: cereal (rice), fiber (cotton), timber (sissoo), tuber (taro), legume (lotus), and fruits and vegetables (citruses and cucurbits). Of course a good number of these plants had non-comestible functions as well. And this list of new crops is far from exhaustive. A variety of Indian millet, sugarcane, eggplant, sebesten plum, and sambac jasmine are known from pre-Islamic Middle Eastern and Mediterranean contexts, but the textual and archaeological evidence for their dispersal and cultivation is meager.[31] Yet crop transfers that were seemingly insignifi ant in their earliest phases could hold great potential in the future, as is the case with sugarcane. As our focus is strictly on economic plants from tropical Asia which were cultivated in the ancient Middle East and the Mediterranean, the survey excludes tropical species which were available as long-distance commodities but not taken into cultivation. Dozens of spices, for instance, have been moving between South Asia, the Middle East, and the Mediterranean throughout the ages, among them economically important ones like black pepper, ginger, cardamom, cinnamon, and cassia. These will not be discussed in any detail as they deserve a separate treatment of their own.

Heading in the opposite direction, Mediterranean and Middle Eastern cultivars, most prominently barley and wheat, were also transmitted to South Asia in antiquity.[32] A number of commonly used spice and aromatic plants in South Asia, including coriander, cumin, black cumin, ajwain, fenugreek, saffron, marjoram, and licorice, originate in temperate zones west of the Indian subcontinent.[33] Although coriander (*Coriandrum sativum*), a native of the Middle East, was already identifi d as seeds in a late-third-millennium BCE context in Miri Qalat in Pakistani Baluchistan, its widespread use in South Asia is probably due to culinary exchanges with the Achaemenid Empire in the fi st millennium BCE.[34] Th s is suggested by the use of an Akkadian or Aramaic loanword for the plant in Sanskrit: *kustumburu* (Akkadian *kusibirru*, Aramaic *kusbara*).[35] Similarly, almonds, walnuts, pomegranates, and apples are not native to the Indian subcontinent but derive from Central Asia and the Middle East.[36] Asafoetida (*Ferula asafoetida*), whose

31. Indian millet: Pliny *HN* XVIII.55; Dalby 2003: 306. Sugarcane: Dioscorides *Mat. Med.* II.82.5; Pliny *HN* XII.32; Brust 2005, 563–64; Floor 2009; Watson 1983, 26, 160. Eggplant: Aet. Amid. *Med.* I.210; Aubaile-Sallenave 1988. Sebesten plums (*Cordia myxa*): van der Veen 2011, 151–53. Sambac jasmine (*Jasminum sambac*): Agatharchides of Knidos, ap. Diod. Sic. III.46.2 (plausible reference); TB *Shabbat* 50b; Amar and Lev 2017, 155; Germer 1985, 153; Newberry 1890, 47; Schweinfurth 1884, 314; Woelk 1965, 238.

32. Boivin 2017, 356–58; Fuller and Lucas 2017, 313, 316.

33. See Dalby 2003 for further literature on individual cultivars.

34. Tengberg 1999, 6, 10; Zohary, Hopf, and Weiss 2012, 163. On fenugreek at Harappan sites, see Bates 2019, 881.

35. References to coriander in the early Sanskrit medical corpus have been collected in Singh 1999, 113.

36. Archaeobotanical evidence indicates familiarity with almonds and walnuts in northwestern India by the late Harappan period, c. 1800 BCE (Bates 2019, 881; Fuller and Madella 2001, 340).

pungent resin is a popular spice across South Asia, was (until trial cultivation in Himachal Pradesh in 2020) imported to India from the arid regions of Iran and Afghanistan, where it grows wild.[37] The movement of cultivars from the Mediterranean and the Middle East to South Asia is, on the whole, poorly documented. While these crop movements in the reverse direction shared the same routes and mechanisms with the tropical Asian crops moving to temperate zones, the Middle Eastern and Mediterranean contribution to South Asian agriculture, diet, and culture is beyond the scope of the present book.

Like the Columbian Exchange, the tropical "Indian" exchange entailed the transfer of human populations, animals, commensals, pests, microbes, and diseases which left an irrevocable ecological imprint on host landscapes in the Middle East and the Mediterranean. The animals transmitted to the Middle East and the Mediterranean from South and Southeast Asia included both domesticates and exotica: chickens, peafowl, parakeets, Asian elephants, tigers, mongooses, langurs, water buffaloes, caprids, and even cat and dog breeds.[38] The movement of fauna had a significant impact on agricultural practice, communications, warfare, and leisurely pursuits. The westward dispersal of chickens (figures 1 and 2) ensured that egg consumption could become regular rather than seasonal as is generally the case with eggs produced by geese and ducks.[39] But calorific needs were not the only motivation for the chicken's westward march. In classical Greece, cockerels appear as important courtship gifts in pederastic relationships and were intimately connected to one of the most common modes of gambling across the Old World: cockfighting.[40]

Pests and commensals trailing humans, animals, and plants along Indian Ocean routes included the black rat (*Rattus rattus*), house mouse (*Mus musculus*), Asian house shrew (*Suncus murinus*), house crow (*Corvus splendens*), gecko (*Hemidactylus* spp.), and a great variety of insects.[41] Trade in grain and farinaceous products

37. Sood 2020.

38. Bodson 1999, 75–78; Boivin 2017, 359–62; Çakırlar and Ikram 2016; Laursen and Steinkeller 2017, 83–88; Ottoni et al. 2017, 5; Pareja et al. 2020a, 2020b; Secord 2016.

39. The wild red junglefowl (*Gallus gallus*) is the main contributor to the domesticated chicken's gene pool. The native habitat of this species stretches from northeastern India to southern China and Southeast Asia. Introgression with another species of wild fowl in South Asia, the gray junglefowl (*Gallus sonneratii*), was responsible for the yellow-legged feature of many varieties of modern chicken. Chickens were known in the Middle East from the mid-to-late second millennium BCE on but only became common in the first millennium BCE. For zooarchaeological, iconographic, and literary materials on the dispersal of chickens from tropical Asia to the Middle East and Europe, see Borowski 1998, 156–58; Carter 1923; Coltherd 1966; Corbino et al. 2022; Ehrenberg 2002; Fuller et al. 2011, 551; Laursen and Steinkeller 2017, 87–88; Lawal and Hanotte 2021; Perry-Gal et al. 2015; Peters 1913; Peters et al. 2022; Trentacoste 2020, 8–11. On the dispersal of chickens in Africa, see Boivin et al. 2013, 252–54, 2014, 553, 556.

40. Dalby 2003, 83. On the importance of social and cultural factors (with an emphasis on cockfi hting) in the westward spread of the chicken, see Sykes 2012.

41. Boivin 2017, 359, 362, 374–75; Boivin et al. 2013, 246–49, 264; Fuller and Boivin 2009, 29–31.