18. Non-human genetics, agricultural origins and historical linguistics in South Asia

DORIAN Q FULLER

Institute of Archaeology
University College London
31–34 Gordon Square
London, WC1H 0PY
England
d.fuller@ucl.ac.uk

Introduction

In the histories of human populations, the origins of agriculture marks a major demographic watershed. In most cases, hunter-gatherer societies were mobile, or at least mobility was used strategically to cope with seasonal shortages in the surrounding environments. Agriculture made an important change from this situation because, even though it relies on a seasonal cycle of planting, growing and harvesting, it provides a storable surplus that can sustain populations through lean seasons. Other important changes usually associated with the beginnings of agriculture are those brought about by a reliable source of carbohydrate-rich staples such as cereals (or in some tropical regions, tubers). Starchy staples such as cereals, which can be cooked into soft gruel (or porridge), make a useful weaning food for infants. This allows babies to be weaned off mother's milk at an earlier age, and therefore agriculture increases the potential rate of population growth (Cohen, 1991). A related side effect of stored starchy agricultural produce is the increase in starch and sugars in the diet that tends to cause increased dental cavities, an effect usually detectable in the skeletal remains of early agricultural societies, in contrast to those of earlier hunter-gatherer societies (Larsen, 1997). Another side effect of agriculture often visible in skeletal remains is increased malnutrition brought about by the vitamin deficiencies of starch-rich diets, but poor in vegetable diversity, of many early agriculturalists. Thus, although agriculture was fundamental to later developments of civilizations, its beginnings may not have been advantageous to populations when measured in terms of health. This begs the question as to why hunter-gatherers who were successful in most environments ever resorted to cultivation and agriculture. But once agriculture was adopted those groups who employed it had potentially vast demographic advantages, in terms of rate of population growth, over their hunter-gatherer contemporaries.

M.D. Petraglia and B. Allchin (eds.), The Evolution and History of Human Populations in South Asia, 391–441.

It is this demographic advantage of farming which is the fundamental premise of models of prehistory in which significant migration is supposed to have occurred in the Neolithic, with genetic consequences and language replacement. The basic extension of the demographic advantage to patterns of geographical spreads is the 'wave of advance' model of Ammerman and Cavalli-Sforza (1971), which was then related to the dispersal of major language families (or macro-families) by Renfrew (1987, 1996, 2000) and Bellwood (1996, 2001, 2005, Diamond and Bellwood, 2003). In the case of South Asia this premise has been used to propose a Neolithic influx of Indo-European speakers from southwest Asia into India (Renfrew, 1987; Bellwood, 2005), as well as the ancestors of the Dravidian speakers of South India from the same general direction, on the assumption of an Elamo-Dravidian macro-family (Renfrew, 1987; Bellwood, 1996, 2005:210–216). In addition, the Munda languages spoken by hill tribes in Eastern and parts of central India, which are clearly part of the larger Austro-Asiatic family in Southeast Asia, have been suggested to represent an agricultural Neolithic influx from the Northeast (Bellwood 1996, 2005:210–216; Glover and Higham, 1996:419; Higham, 2003). These models have offered alternative populational prehistories, especially in terms of dating, to conventional views in which all major populations coming into South Asia came from the northwest: first the Paleolithic ancestors of the Munda, then the agricultural ancestors of the Dravidians and finally the chariot- and horse-riding pastoralists who brought Indo-European (e.g., Fuchs, 1973; Gadgil et al., 1998; Kumar and Mohan Reddy, 2003, and for more recent linguistic and archaeological data see, e.g., Parpola, 1988; Witzel, 2005). The agriculture/language dispersal hypothesis also provides a clear explanatory framework: that of demographic growth of farmers with a long-term advantage over hunter-gatherers. Despite the potential attraction of a demographic prime-mover for simplifying patterns in prehistory, like all hypotheses, it requires testing against the empirical evidence for human prehistory. As evidence for human prehistory, we can turn to archaeology, historical linguistics and physical anthropology (including human genetics), as all of these sources preserve to varying degrees of precision information about past population histories (Rouse, 1986). The present contribution will attempt such an assessment of the role of agricultural dispersals in structuring the major cultural divisions and linguistic geography of South Asia, by assessing some of the empirical details available from archaeology and historical linguistics. In developing this subject, I will expand upon and update a recent effort to correlate archaeology (especially archaeobotany) and linguistics (Fuller, 2003a). One issue which requires further consideration, but will not be pursued in the present chapter, is the impact of an endogamous, cross-cousin marriage system, which can be inferred for early Dravidian speakers but not other language groups, on genetic patterns and demography.

This chapter will move from genetic and biogeographic evidence of non-human species, through archaeology, towards a revised tabulation of linguistic data with implications for South Asian prehistory. While the picture of human genetics and physical anthropology are best dealt with by others (e.g., see chapters by Endicott et al., Stock et al., Lukacs, this volume), I will start by looking at genetics of selected non-human species, in particular those key companion species of farmers, crops and livestock. The genetics, and, at a less precise level, the general phylogenetic inferences and biogeography of crops and livestock, encodes information about histories of movement, as people have acted as important agents in the dispersal of these species. While this dispersal may occur through exchanges between humans groups, and not necessarily through human population migration, the patterns of origins and dispersals in crops and livestock provides clear geographical and chronological parameters which must be accounted for in any model of human prehistory. Once we have set the scene, in terms of the non-human players and elements, I will turn to the archaeological evidence as it stands today. Archaeology provides the most clear, empirical and datable evidence for past economies and cultural practices, although it remains limited by gaps in the evidence. The patchiness of the archaeological record is particularly stark for the earliest agriculturalists in most parts of South Asia and their hunter-gatherer ancestors. Nevertheless, it is becoming increasingly clear that when farming groups began to settle permanently in villages, they were already agricultural in regionally distinctive ways, with at least three plausible indigenous South Asian foci of plant domestication (Fuller, 2003a, 2003b), plus an important northwestern agricultural tradition with its roots in Southwest Asia. I will then attempt to match this archaeological picture with that available from historical linguistics, in which increasing progress has been made at characterising not just cognates across existing, related languages, such as Dravidian languages of South India, but also in terms of inferring the past existence of now extinct substrate languages that have left their mark through loan words, especially relating to the Indian flora and agriculture.

Where and When: Biogeography and Genetics

Starting from the basics, we must ask what species served as the basis for early agricultural systems and where is it likely that hunter-gatherers regularly engaged and selected such plants as food sources. Biogeography and biological systematics provide essential information about how species known today in domesticated form developed. Through systematics, from traditional taxonomy to the increasingly powerful tools of molecular genetics, the closest free-growing or free-ranging relatives of crops and livestock can be identified, i.e. the wild progenitors. Comparisons between these provide a basis for identifying wild progenitors and how the domesticated forms differ from their wild relatives and may thus be identified archaeologically. Once identified, the ecology and geographical distribution of wild progenitors in the present day provides essential evidence from which to infer where these species would have been available to past human groups, and thus where they could have been first brought under human control. This information about modern distribution does, however, need to be considered in relation to past climate and environmental changes. In the case of southwest Asia there are a number of crops which occur wild in the transitional zone between the Mediterranean oak woodlands, and other trees and open park woodland and the transition to grassland steppe, in a zone that averages 400–600 mm of annual rainfall, especially in the Levant, Anatolia and the parts of the Taurus Mountains (Moore et al., 2000:58; Zohary and Hopf, 2000). These are the founder crops of agriculture in the fertile crescent, most of which were also of importance to the agriculture of South Asia, especially in the northwest and the greater Indus region. The areas in which they were potentially domesticated have been inferred by combining their modern geography with information about paleoecology through the late Pleistocene and early Holocene (Hillman, 1996; Hillman, 2000:327–339; Willcox, 2005). The wild progenitors and ecologies of the most important seed crops of African origin were outlined by Harlan (1971, 1992), with only minimal refinements through more recent work (see Fuller 2003c; Neumann, 2004). The equivalent level of information is not available for crops originating in other regions, and for some South and Southeast Asian species we are still in the early stages of documenting the distribution and environmental tolerance of wild progenitors, let alone trying infer from paleoecological sources their distribution immediately prior to domestication. Nevertheless, a first attempt to synthesize information from agronomic and floristic sources for grain crops of Indian origins has been published (Fuller, 2002:292–296, for some vegetables and fruits, see Fuller and Madella, 2001, although some revision is now possible, see below). For crops originating in China and Southeast Asia, Simoons (1991) provides a useful overview.

Despite there being much to learn about the wild progenitors of many South Asian crops, there is much that is already known which has not been incorporated in the reasoning of many archaeological syntheses. This is notably the case in language macro-dispersal models of the last few years (e.g., Diamond and Bellwood, 2003; Bellwood, 2005), which are contradicted by clear indications for multiple domestications in key subsistence taxa of South and East Asia as well as many indications of indigenous Indian domestications. In the proposals of Bellwood (2005), agriculture came to India from the outside, primarily by human dispersals. This is not a new conclusion, as the earlier attempt by MacNeish (1992) to synthesize early agriculture worldwide suggested essentially the same thing for South Asia. Similarly, Harlan (1975, 1995) viewed South Asian agriculture as a derivative mix of Southwest and Southeast Asian origins. Agriculture is argued to derive from the well-documented early domestications in the Near Eastern 'fertile crescent' brought to South Asia by the ancestors of both Dravidian speakers and Indo-European speakers. Meanwhile, rice-focused agriculture is assumed to derive from early domestication in the Yangzi river basin of China and spread to India from the northeast together with ancestors of the Munda language family (Glover and Higham, 1996; Higham, 2003; Bellwood, 2005). While I will return to the language issues later, I would like to start by examining evidence that indicates that species shared between South and East Asia suggest a recurrent pattern of multiple origins, with separate East Asian and South Asian domestications.

On the Origins and Spread of Rice

Rice (*Oryza sativa*) is one of the most utilized crops of the world today, but the complexities of its early history remains largely unraveled. Rice is now cultivated in a wide range of habitats from temperate northern China and Korea to the eutropical areas of Indonesia. It is grown as broadcast sown crops on hillsides, often as part of extensive slash-and-burn systems, and it is grown in highly labor intensive, flooded 'paddy' lands in which seedlings grown in one paddy are dug up and individually replanted into another field. The assumption, which is widespread in the literature, that all Asian rice derived from a single domestication, somewhere in the wild rice belt from eastern India across northern Indo-China or South China (e.g., Chang, 1995, 2000), has been based more on the presumption of single origins for crops in general, coupled with problematic archaeological inferences. Starting with the assumption that rice was domesticated once, there have been some rather extreme attempts to relate East Asian and South Asian archaeology, such as via comparisons between Neolithic China (sixth through fourth millennium BC) and Neolithic Kashmir (2500-1000 BC) (e.g., Van Driem, 1998), even though the latter had agriculture based on Near Eastern crops (wheat, barley, lentils and peas) and not rice! More recently, Kharakwal et al.'s (2004) attempt to link cord-impressed ceramics with rice agriculture suggests hyperdiffusionism based on superficial similarities in ceramics, including the Jomon of Japan (which is non-agricultural), parts of Neolithic China of the early to mid-Holocene, and much later 4th to 2nd millennium BC material from the Ganges. All such hyperdiffusionist studies are flawed, not only because they stretch archaeological logic by drawing comparisons across such vast areas and time-spans, but most importantly because they fail to take into account what we already know from botany about rice origins. Historical linguists have been mistaken in trying to make sense of a vast array of potential rice words on the assumption of a single centre of rice origin from which such words ought to originate (e.g., Mahdi 1998; Pejros and Snirelman, 1998; Witzel, 1999:30–33). Less explicitly reasoned attempts to link all of South and East Asian rice into a single story, are the grand narratives linking agriculture and language spread, in which the spread of rice from the middle Yangzi to India with demographically expanding and migrating farmers is argued largely on the basis of model assumptions rather than archaeological evidence (e.g., Bellwood, 1996, 2005; Higham and Glover, 1996). Any attempt to make a single narrative about Asian rice is already falsified by phylogenetic evidence from rice itself.

Asian rice, despite being lumped under the species name, *Oryza sativa* (a Linnaean convention in use since the 1750s), is composed of two distinct phylogenetic species, *indica* and *japonica*. This has long been suggested by plant breeding research, in which hybridization between these two cultivars is found to be difficult and imperfect, with the majority of crosses between *indica* and *japonica* cultivars being wholly or partly sterile (Wan and Ikehashi, 1997). As a result, the botanical literature has had a persistent debate between hypotheses of rapid divergence after a single origin or two domestications (Oka, 1988; Chang, 1989, 1995; White, 1989; Thompson, 1996), although it is the single origin that has tended to be assumed in archaeological syntheses (e.g., Bellwood, 1996, 2005; Glover and Higham, 1996; Higham, 1998; Bellwood and Diamond, 2003), perhaps largely due to the influence of T. T. Chang (1989, 1995, 2000). There now is substantial evidence for genetic distinctions between *indica* and *japonica* from a range of data (Sato et al., 1990; Sano and Morishima, 1992; Chen et al., 1993a, 1993b; Sato, 2002; Cheng et al., 2003). Most significant is genetic evidence from the chloroplast (a plant organelle like the mitochondria inherited maternally) and nuclear DNA variants called SINEs. A sequence deletion in the chloropast DNA of *indica* cultivars links them with wild annual "*O. rufipogon*" (i.e., *O. nivara* in the taxonomy used here) (Chen et al., 1993a, 1993b; Cheng et al., 2003; for current rice taxonomy see Vaughan, 1989, 1994). Meanwhile, there are some seven SINEs that separate the *nivara-indica* group from the *rufipogon-japonica* (Cheng et al., 2003). Figure 1 shows the phylogenetic model produced by Cheng et al. (2003), in which the *japonica* cultivars form a very tight group in relation to the dispersed groupings of wild rufipogon types. By contrast, the grouping of *indica* is looser and more interspersed with wild *nivara*. This contrast might even suggest that *indica* is composed of more than one domestication event from wild *nivara* populations. On the basis of the modern geography of wild forms and cultivars at least one of these *indica* domestications in likely to have occurred in northern or eastern South Asia (Figure 2), while the *japonica* domestication can be placed in Southern China, probably the Yangzi basin.

The available archaeological evidence also suggests two distinct centres of early rice cultivation. In China, despite continuing controversies about the antiquity of rice use, cultivation, and domestication, it is widely accepted that rice cultivation was underway in

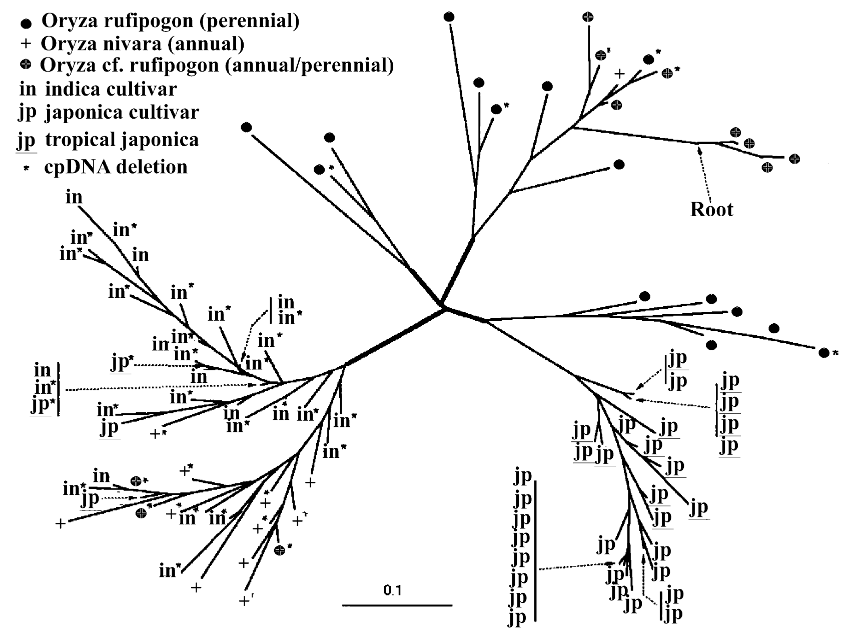

Figure 1. A phylogenetic representation of modern rice cultivars and wild populations based on SINE genetics (after Cheng et al., 2003; taxonomy revised to follow Vaughan, 1994). This shows the clearly distinct lineages of japonica (including most tropical forms, sometimes called javanica) and indica cultivars, which are interspersed with the annual wild populations (Oryza nivara)

the Middle Yangzi, and adjacent South China by the sixth millennium BC (e.g., Crawford and Shen, 1998; Lu, 1999, 2006; Cohen, 2002; Yan, 2002; Crawford, 2006). While rice spreads down the Yangzi river and northwards into parts of central China, and probably the Shandong peninsula during this early period, archaeological evidence from further north, south or the upper Yangzi post-dates 3000 BC (see Figure 2). In India, rice cultivation is quite widespread by ca. 2500 BC from the eastern Harappan zone in the upper Ganges

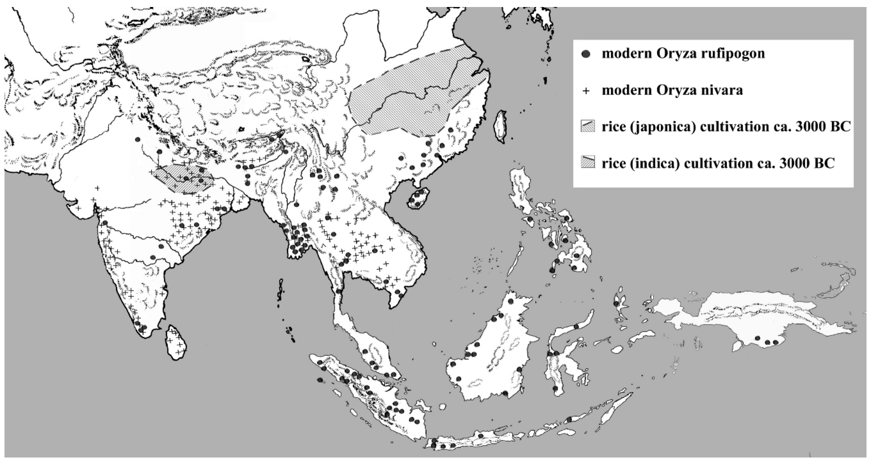

Figure 2. A map of wild rice distribution and likely zones of domestication. The distribution of the two wild progenitors of rice is plotted after Vaughan (1994). Some of these populations may be 'feral', e.g., along the Malabar coast. The extent of rice cultivation ca. 3000 BC indicated, based on archaeological evidence (for China, after Yan, 2002; for India, based on Fuller, 2002, with updated evidence discussed in text)

Book_Petraglia&Allchin_1402055617_Proof2_December 6, 2006

basin (e.g., at Kunal: Saraswat and Pokharia, 2003) and the Swat valley in northern Pakistan (Costantini, 1987) through the middle Ganges (see Fuller, 2002, 2003c; Saraswat, 2004a, 2005). A few sites with evidence for rice impressions in pottery (not necessarily domesticated) date back to the fourth millennium BC (Kunjhun II and Chopanimando), while recent excavations at Lahuradewa have been suggested to put rice cultivation back to as early as ca. 7000 BC, based on an AMS on a piece of a charred mass of rice (Tewari et al., 2003, 2005; Saraswat, 2004c, 2005; I. Singh, 2005). It must be cautioned, however, that criteria for recognizing domesticated rice as opposed to wild gathered rice remains weak and unsubstantiated, and the presence of cultivation practices is unclear. The sample size is very small, with less than a dozen grains recovered from the first season of work. While further research is needed, the recent evidence from Lahuradewa indicates at the very least that foragers were exploiting (wild) rice in the Ganges plain from ca. 7000 BC and perhaps already producing some ceramics at this date (and undoubtedly by the Fourth Millennium BC) (cf. Saraswat, 2005; I. Singh, 2005; Tewari et al., 2005). Sometime after this cultivation began and selection for domesticated rice, which may have taken one or two millennia, had taken place by 3000-2500 BC (see below, 'The Ganges Neolithic'). It is after this time when rice had spread towards the northwest in the first half of the third millennium BC, indicated by finds at Early Harappan Kunal and at Ghaleghay (see Figure 2). Whether early rice cultivation in Eastern India (e.g., Orissa) should be seen as dispersal from this same centre or a separate process, perhaps rather later, requires further archaeobotanical investigation (see below, 'The Eastern Neolithic').

East and South Again: Water Buffalo and Chicken

One of the major animal domesticates of Asia is the water buffalo. Its association with wet rice agriculture in China and Southeast Asia is well-known. Biological and archaeological evidence, however, suggest separate origins, which are unlikely to be tied directly to the centres of rice origins. Traditional taxonomy distinguishes between the swamp and river types of water buffalo, with the latter being prominent in the more semi-arid environments of South Asia and the former from the wetter lowlands of East Asia (Grove, 1985; Hoffpauir, 2000). Pleistocene or early Holocene fossil evidences include Pakistan and north-central China, as well as presumably most of the South and Southeast Asian mainland were in the wild buffalo range (see Figure 3). Traditional taxonomy suggested that distinctive swamp and river morphotypes might be distinguished, possibly with separate domestications (Zeuner, 1963). More recently mitochondrial DNA sequence data suggests at least two distinct clusters of phylogenetic diversity, suggesting two separate geographical sub-samples of the wild genetic diversity (Lau et al., 1998; Bruford et al., 2003:905). Based on modern distributions, this points again towards South Asia and East Asia. Archaeologically the challenge is to use bone evidence to distinguish wild from domesticated populations. Despite claims in the literature for a domestication in the Lower Yangzi (e.g., Chang, 1986; Bellwood, 2005), this has been based thus far on the assumption that finds of buffalo are necessarily domesticated, rather than on any morphometric data. Recently the study of water buffalo from the site of Kuahuqiao (ca. 6000-5400 BC) suggests no clear size reduction in relation to contemporary or early wild populations, and kill-off profiles are consistent with hunting, rather than specialized management (Liu and Chen, 2004). In China the first indication

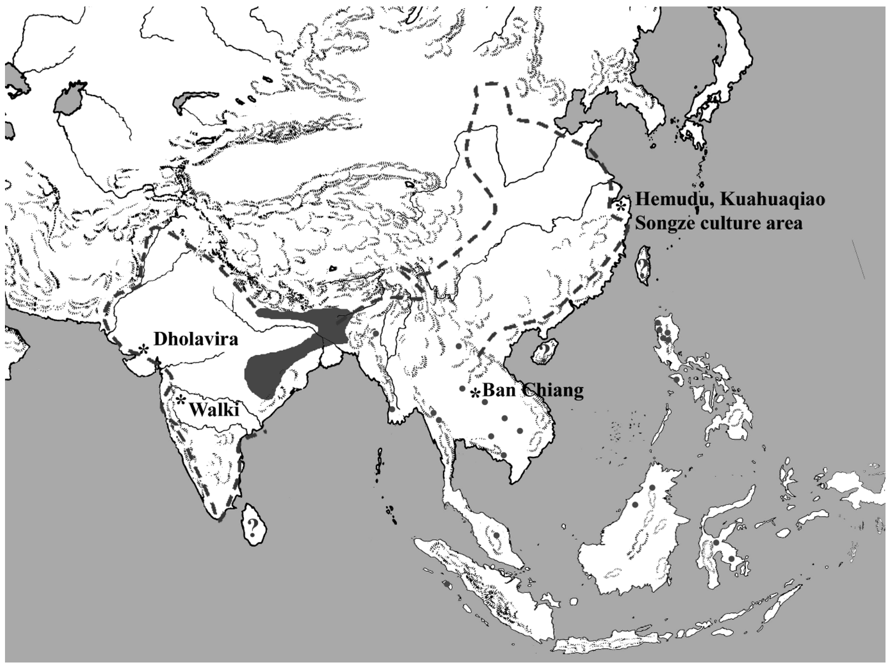

Figure 3. A map of probable Holocene distribution of wild water buffaloes, modern refugia of wild populations and important archaeological sites of buffalo remains. Modern wild distribution shown as grey areas and grey dots, while Early Holcene distribution based on Late Pleistocene/Early Holocene fossil evidence indicated by dash line (after Hoffpauir, 2000). Question marks indicate islands where past presence of wild populations is uncertain. Note that some island populations could represent feral escapes from domestication. Selected archaeological sites, discussed in text, are indicated

for domesticated water buffalo is indirect and artifactual. The presence of large stone plough tips from the Songze Neolithic culture of the Lower Yangzi area occur for the first time by ca. 3500 BC (Shanghai Cultural Relics Protection Committee, 1962:465). These tools imply the use of animal traction, of which the water buffalo is the only indigenous candidate, and the traditional source of power. Assuming that western (or South Asian) cattle had not yet been introduced to China this date provides a minimum age for domestication of water buffalo in the Lower Yangzi. When water buffalo came into use, perhaps by dispersal, in Southeast Asia remains unclear. Water buffalo bones at Ban Chiang in Thailand date back to 1600 BC, although it is not clear whether these represent domestic animals (cf. Bellwood, 1997; Higham and Thosarat, 1998).

In South Asia by contrast, bone evidence comes from the Harappan site of Dholavira by ca. 2500 BC. Here smaller sized animals are present and make up a substantial proportion of the animal bone assemblage and present kill-off patterns that could indicate management (Patel, 1997; Patel and Meadow, 1998; Meadow and Patel, 2003). Water buffalo from Walki on the northern Peninsula from the mid-Second millennium BC have been argued to be domesticated (Joglekar, 1993).

The situation with chickens is similarly problematic in terms of determining domestic status and geographical origins (Blench and MacDonald, 2000). Wild *Gallus* sp. are well-known in South Asia, such as *G. sonnerati* in the peninsula, while the wild progenitors of domestic chickens are distributed across north and northeast India through mainland southeast Asia and Southern China.

In addition, there are several other gallinaceous birds native to South Asia, and clear comparative criteria for determining these are needed. If we give reported identifications the benefit of the doubt, then, in China, the widespread occurrence of *Gallus*-type bones by the fifth millennia BC would seems to argue for husbandry/domestication at the northern margin of the wild distribution in central China (West and Zhou, 1988; Blench and MacDonald, 2000). If we take a similar view of the numerous *Gallus* reports from South Asia, which are by and large restricted to agricultural periods (see Fuller, 2003a: Table 4), we can suggest the pattern of chicken dispersal. In western regions (Gujarat and the Indus Valley), where the wild progenitor is absent today (although this need not have been in the case in prehistory), several finds point to chicken-keeping by the Mature Harappan phase. Similarly, most early finds from north India also come from the second half of the third millennium BC. Amongst these are the quantities of 'chicken' bones from Damdama (Thomas et al., 1995a). This site is culturally Mesolithic in the sense of lacking pottery, but clearly incorporates material dating to the second half of the third millennium BC, including domesticated cereals (see discussion, below), but with an apparently wholly wild fauna (Chattopadyaya, 1996, 2002). This might suggest a particular cultural context in which chickens came to be managed in Northern India.

Thus chickens, water buffaloes and rice show essentially the same pattern, that of likely East and South Asian origins. While it is still possible, even likely, that varieties of these domesticates were introduced to South Asia from the northeast, these would only have been new forms that added to diversity already established in South Asia on the basis on indigenous domestication. Thus there is little basis to attribute agricultural origins in parts of India to demographic influx from the northeast, but we should investigate independent processes in India that paralleled those in China.

In the following section I will begin by addressing the other conventional source for diffusionist models of South Asian prehistory, population entry via the northwest. In this case archaeological, and archaeobotanical, evidence, can be considered. While domesticates of Southwest Asian origin are clearly important in South Asian agriculture, a significant early importance in subsistence is only found in northwestern South Asia. Meanwhile evidence for these Southwest Asian domesticates is limited or absent from the earliest food production in at least three parts of the subcontinent implying that local sources of food production were already established.

Indian Agricultural Traditions: Five Local Centres

In outlining the archaeology of early agricultural traditions in South Asia, I will simplify this into five key zones (Figure 4, building on Fuller, 2002, 2003b). First there is the northwest, including the greater Indus valley and its hilly flanks to the west and north. In these regions summer monsoon rains are limited or unreliable and much cultivation depends either on the limited regular winter rains or else river water, which rises in the spring and summer as Himalayan snow melts (Leshnik, 1973; Fuller and Madella, 2001). Second, there is the middle Ganges zone, an area with the benefits of both significant monsoon rains and numerous perennial river systems that are fed by the monsoons. This area incorporates significant cultural diversity in the archaeological record. Thirdly, it may be necessary to consider Neolithic traditions in Eastern India (Orissa and Jarkhand) as distinct from the Gangetic Neolithic, although the Neolithic there is still poorly documented and could relate to the Gangetic pattern (cf. Fuller, 2003a; Harvey et al., 2005). Fourthly, there is Western India,

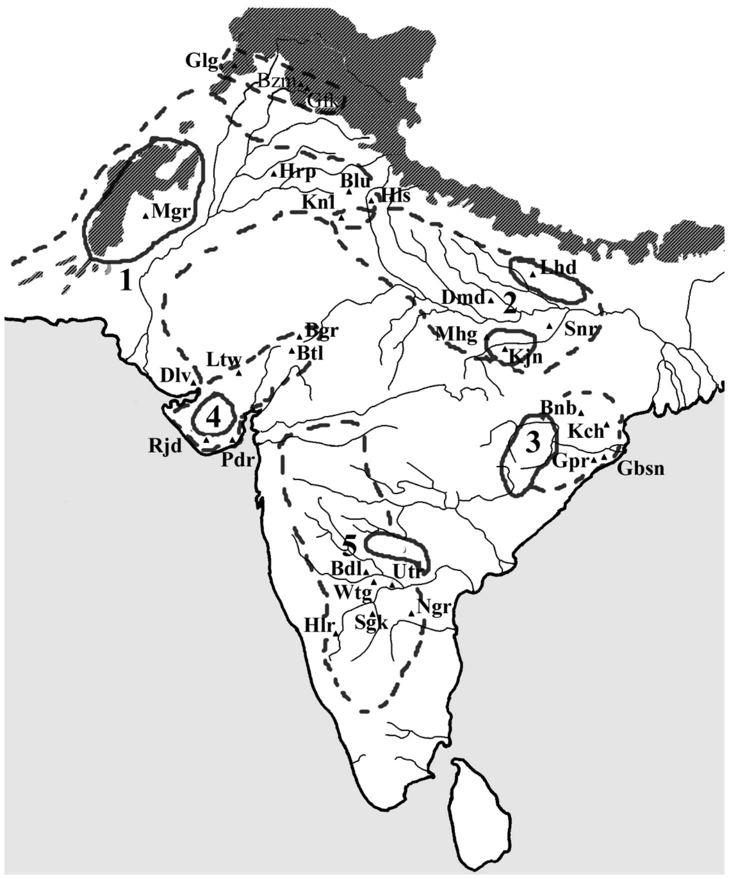

Figure 4. The major independent Neolithic zones of South Asia, with selected archaeological sites. For each zones the solid grey outline indicates best guess region(s) for indigenous domestication processes and/or earliest adoption of agriculture. The dashed lines indicates the expanded region of related/derivative traditions of agriculture; selected sites plotted. 1. The northwestern zone, with the disjunct area of the Northern Neolithic shown: Mgr. Mehrgarh; Glg. Ghaleghay; Bzm. Burzahom; Gfk. Gufkral; 2. The middle Ganges zone with two possible rice domestication areas: Dmd. Damadama; Lhd. Lahuradewa; Mhg. Mahagara; Kjn. Kunjhun; Snr. Senuwar; 3. Eastern India/Orissan zone: Bnb. Banabasa; Kch. Kuchai; Gpr, Gopalpur; Gbsn. Golabai Sassan; 4. Gujarat and southern Aravalli zone: Ltw. Loteshwar; Rjd. Rojdi; Pdr. Padri; Btl. Balathal; Bgr. Bagor; 5. Southern Indian zone: Bdl. Budihal; Wtg. Watgal; Utr. Utnur; Sgk. Sanganakallu and Hiregudda; Hlr. Hallur; Ngr. Nagarajupalle

mainly evidence from Gujarat, especially the Saurashtra peninsula but possibly also parts of Southeast Rajasthan and the area around Mount Abu. This region also is favoured by monsoons and represents the ecological transition from the dry Thar desert into the semi-arid monsoon tropics that support a mosaic of savannahs and deciduous woodlands. Fifthly, there is the Southern Neolithic zone in the semi-arid peninsular interior which has received increasing attention as a region of domestication of monsoon-adapted pulses and millets in the later middle Holocene (Fuller et al., 2001, 2004; Fuller and Korisettar, 2004; Asouti et al., 2005).

The Northwest and the Indus

In northwestern South Asia, the dominant crops from the time of earliest evidence derived from the Southwest Asian Neolithic Founder crops (Zohary, 1996; Zohary and Hopf, 2000). These crops, especially wheats and barley, but also lentils, peas, chickpeas, grasspea, flax and safflower, can now be placed in the Levantine zone and southeastern Anatolia. Cultivation of some of the cereals has now been postulated for the Late Pleistocene, after ca. 11,000 BC, while domesticates are clearly widespread in the region by the beginning of the Pre-Pottery Neolithic B (ca. 8800 BC) (Harris, 1998a; Willcox, 1999, 2002; Garrard, 2000; Moore et al., 2000; Hillman et al., 2001; Colledge and Conolly, 2002; Charles, 2006). Representatives of this crop package had spread to Central Asia by ca. 6000 BC, the time of the Djeitun Neolithic (Harris, 1998b) and to western Pakistan by the time of Neolithic Mehrgarh. The second ceramic phase at Mehrgarh begins ca. 6000 BC, as recent stratigraphic reassessment indicates (Jarrige et al., 2006). The earlier aceramic period at the site is estimated to have begun by ca. 7000 BC (Jarrige, 1987; Meadow, 1993; Possehl, 1999; Jarrige et al., 2006). Despite some arguments in favor of cereal domestication in Pakistan (e.g., Possehl, 1999), the lack of wild progenitors (for wheats, all the pulses, flax and safflower) and the late available dates by comparison to Southwest Asia, points towards the spread of crops, and this could have involved the spread of farmers, although diffusion of just the crops is possible too. This Southwest Asian agricultural package was well-established and widespread in the Indus region by the time of Harappan urbanism in the Third Millennium BC (Meadow, 1996, 1998; Fuller and Madella, 2001), although it is not yet clear whether all of the crops which were present by then had arrived already by the Neolithic.

While the staple crops were all introduced, livestock and other crops indicate a number local domestications. The best documented of these is the domestication of zebu cattle inferred from metric changes in bones through the Mehrgarh sequence as well as distinctive humped cattle figurines (Meadow, 1984, 1993). Phylogenetic evidence from DNA is also clear in indicating a separate domestication (or two) of humped zebu cattle from Near Eastern (and African) taurine cattle (MacHugh et al., 1997; Bradley et al., 1998; Bruford et al., 2003; Kumar et al., 2003; Magee et al., this volume). Goats appear domesticated from the earliest occupation at Mehrgarh, but recent genetics suggests one or two domestications of goats additional that of the Near East (probably Iran) (Luikart et al., 2001; Bruford et al., 2003:905). Genetic evidence for sheep is similar, with a plausible domestication in Central Asia or Baluchistan (Hiendleder et al., 2002; Bruford et al., 2003:905). Bone evidence from Mehrgarh could indicate a sheep domestication process in this region (Meadow, 1984, 1993). In addition the fibre crop cotton appears at Mehrgarh during the Neolithic, perhaps by 5000 BC, and is a likely domesticate of this region (Costantini and Biasini, 1985; Fuller, 2002; Moulherat et al., 2002). The native cotton, *Gossypium arboreum*, is a woody shrub and as such was likely to have been cultivated in perennial orchards like fruits. Mehrgarh also provides evidence for grapes and jujube that might have been cultivated or managed for fruit. The status of the large true date seeds from Mehrgarh is problematic as they are uncharred and undated, but at the Harappan site of Miri Qalat in Makran wild type date stones (probably *Phoenix sylvestris*) occur confirming date consumption (and probably cultivation) in this region (Tengberg, 1999), while true dates (*Phoenix dactylifera*) were certainly present in Iran (Tengberg, 2005). Sesame is also domesticated in this region although the earliest finds are from the Mature Harappan period (Fuller, 2003d; Bedigian, 2004). Another important domesticate of the Indus region is the water buffalo, which has been well-documented as a domesticate at the Harappan city of Dholavira in the great Rann of Kutch, culturally and climatically an outlier of the Sindh region (Patel and Meadow, 2003).

This Harappan agricultural system, with a large component derivative from further west, was constrained by a major climatic frontier from spreading further east. The greater Indus region and the Indo-Iranian Borderlands lack reliable monsoon rainfall, whereas in the eastern zones of the Harappan civilization (such as eastern and northern Punjab and Haryana), monsoon rains are consistently more reliable. It is such a zone where we would expect reliance on rainfed summer crops to have been important, and indeed Early Harappan and Mature Harappan archaeobotanical evidence from this region consistently shows the presence of native Indian monsoon crops alongside the Harappan (Near Eastern) winter crops (e.g., Saraswat, 1991, 1993, 2002; Willcox, 1992; Saraswat and Pokharia, 2002, 2003). While many of the monsoon crops may have spread to the region from areas to the east, such as the middle Ganges, hard evidence for this is yet to be established for this origin. It is possible that some indigenous domestication occurs in the Himalayan foothills or the Ganges-Yamuna Doab region. Of particular interest in this regard is the presence of small, Indian millets from Early Harappan levels at Harappa (back to the Ravi Phase, ca. 3200 BC), especially *Panicum sumatrense* (Weber, 2003) as this hints at domestication of monsoonal millet crops that is earlier than and perhaps independent of those further south, in peninsular India, or in Gujarat. Further archaeological evidence is needed to document the emergence of agricultural villages and pre-Harappan sites in this eastern Harappan zone and the upper Ganges as well as their cultural relations to developments in the middle Ganges.

The Northern Neolithic

Another but later Neolithic tradition is documented from Kashmir and the far north of Pakistan (the Swat Valley). Generally known as the Northern Neolithic, this tradition is best represented by sites in the Kashmir valley, although related sites can be identified in Swat (Northwest Pakistan). Here sites occupy the milder valley bottoms and begin to be occupied in the later Fourth Millennium BC in an aceramic phase, known from recent exacavations at Kanishpur (Mani, 2004) as well as older work at Gufkral (Sharma, 1982). Ceramic production has begun ca. 3000 BC and sites appear to be significantly more widespread by the end of the third Millennium BC (e.g., Allchin and Allchin,1982:111–116; Sharma, 1982, 1986; Mani, 2004). The earliest phases are characterised by broad deep pits, with bell-shaped profiles. While these have conventionally been interpreted as pit houses, recent debates have raised the likelihood that they were large storage features (Conningham and Sutherland, 1998). Whatever the case it is clear from these sites that the dominant crops were winter wheat (including free-threshing and emmer), barley, peas and lentils (Kajale, 1991; Lone et al., 1993; Pokharia and Saraswat, 2004), and thus derive from the same ultimate Near Eastern source. Faunal evidence includes sheep, goat, and cattle, while the status of buffalos and pigs requires confirmation (see review by Kumar, 2004). The plant evidence is therefore opposed to the idea that the Kashmir Neolithic can be related to a westward dispersal of millet-growing Sino-Tibetan speakers as some have argued (Parpola, 1994:142; Van Driem, 1998:76–84; Possehl, 2002:39). The crops and livestock species present are clearly not those of Yangshao China. The presence of Chinese like stone harvesting knives in Kashmir remains curious but must be regarded as a technological diffusion given the subsistence data, and these forms only occur in later Neolithic phases such as Burzahom

II and Gufkral 1C (Allchin and Allchin, 1982:figure 5.9; Sharma, 1982; Kumar, 2004). These harvesters also appear around this time further south in Baluchistan in the Late Harappan era, as at Pirak (Jarrige, 1985,1997). The agricultural situation might therefore be congruent with the suggestion of a distinct linguistic substrate in Kashmir (Witzel, 1999:6–7). It is possible that the Near Eastern crops had diffused to local hunter-gatherers from the Indus region to the South or from Central Asia (the latter favoured by Lone et al., 1993), together with domesticated animals. Although an immigration of farmers from these directions is also possible. It is tempting to suggest that the late arrival of agriculture here was due to an ecological barrier, as cultivation here requires winter tolerant, vernalizing forms of cereals and might therefore be compared to the processes involved in the delay of agricultural spread between Southeast Europe and the central European plains (cf. Bogaard, 2004:160–164).

Subsequently, early in the Second Millennium BC, during the Late Harappan transition, we can infer that the northern Pakistan/Kashmir region had developed contact with cultural groups to the north/east in the Chinese cultural sphere, indicating either long-distance trade or immigration into adjacent Himilayan zones of Sino-Tibetan speaking groups. At this time stone harvest knives appear in Kashmir, and similarly they appear further south in Baluchistan in the Late Harappan era, as at Pirak (Jarrige, 1985, 1997). As discussed by Jarrige (1985, 1997) this period sees important changes in cooking techniques as well. Impressions in pottery from Ghalegay, together with grains from Bir-Kot-Gwandhai, suggest some localized *indica* rice cultivation by 2500 BC (Constantini, 1987), which must have diffused from the Gangetic region to the Southeast. By contrast later Harappan rice from Pirak (after 1900 BC), has notably shorter, plumper grains, suggesting *japonica* type (Costantini, 1979), which is also supported by the form of bulliform phytoliths from the site that suggest *japonica* (Sato, 2005), which therefore supports the contention of diffusion from China by the early Second Millennium BC.

The Ganges Neolithic

Although there is much to be resolved in terms of dating and domestication status of remains from the middle Ganges, this region is a likely centre of domestication. The earliest well-sampled levels contain potentially native crops, including rice, millets and slightly later monsoon pulses, while later levels include introduced winter crops. This suggests that when wheat, barley and lentils diffused from the west they were adopted into already established systems of cultivation. At the site of Mahagara, south of Allahabad on the Belan river, the adoption of these winter crops occurs ca. 1800-1700 BC (Harvey et al., 2005; Harvey and Fuller, 2005, unpublished dating evidence), whereas further north and east at Senuwar this adoption occurred perhaps ca. 2200 BC (Saraswat, 2004a). Recently directly dated barley from Damadama is ca. 2400 BC (Saraswat, 2004b, 2005a), while from new research at Lahuradewa, it occurs in Phase 2, 2500-2000 BC, directly dated to ca. 2200 BC (Saraswat and Pokharia, 2004; Saraswat, 2005). The crop that is consistently present at all these sites from the earliest phases in rice, although small millets are also consistently reported. In the case of Mahagara these include the widespread *Brachiaria ramosa* and *Setaria vertcillata*, whereas *Setaria pumila* is reported from Senuwar and Lahuradewa. While there remains room for concern over consistency of millet identification criteria, as well as problems of intrusive millets from later periods, it is nevertheless clear that one or more small millets were part of the early cultivation systems of the Ganges. Native Indian pulses are also present, especially *Vigna radiata* and *Macrotyloma uniflorum*, but these are in no case present from the earliest levels of sites and might therefore be adopted from an adjacent region of India. While the mungbean has wild progenitor population in parts the Himalayan foothills and central Indian hill ranges, wild horsegram is not yet documented close to this zone, which therefore suggests dispersal of native pulses from further south, or perhaps west, by ca. 2000 BC, although extinct progenitor populations might conceivably have occurred in drier parts of central India or the southern Vindhyas. Although there are cucurbit (gourd) crops native to north India (Decker-Walters, 1999; Fuller, 2003a), hard archaeological evidence is still limited to ivy gourds (*Coccinia grandis*) from (early?) Harappan Kunal (Saraswat and Pokharia, 2003), Balu (Saraswat, 2002) and Late Harappan Hulas (Saraswat, 1993), and *Luffa cylindrica* after it had dispersed to South India (Neolithic Hallur) by the mid-Second millennium BC (Fuller et al., 2004).

Still to be clarified is whether there was one main trajectory towards agriculture or dispersed parallel trajectories in different local traditions, and what role interactions between early farmers and hunter-gatherers played. At present we might discern at least three contemporary cultural/economic traditions in the region. At present three distinct cultural traditions can be defined, each of which passed through two or three economic stages. First there is a tradition located in the eastern part of this region. Its earliest stage, represented by the site of Lahuradewa shows evidence for occupation on a lake edge back to the 7th millennium BC (Tewari et al., 2003, 2005;Saraswat, 2004c, 2005; I. Singh, 2005). Already in this period, or certainly by sometime in the the fifth millennium, ceramics had begun to be produced, and rice was part of the diet, and may even have been cultivated, although the very limited evidence available to date is inconclusive and is more suggestive of wild rice collecting. All the fauna thus far studied from that period were wild (Joglekar, 2004), and it is likely that occupation was intermittent (with hiatuses), or else highly seasonal to account for the long timespan of 3000–3500 years that relates to this lowest layer less than 50 cm thick). Intriguingly, the ceramic assemblage does not yet suggest much perceptible change during the period, although the third millennium levels include several new forms including some that suggest influence from the Harappan zone to the west. In the third millennium and certainly during the period 2500-2000 BC, settlement probably became more regular, evidence for cultivation is less ambiguous, and new species from external sources were adopted, in particular barley (Saraswat, 2004c, 2005), as well as pulse species that may also be non-local. In this period at least some domesticated sheep/goats are present (also adopted from the west). At this period agricultural village settlements are being founded over a wider region, such as Senuwar (Saraswat, 2004a, 2005), suggesting the filling in of the landscape with agriculturalists and the emergence of sedentary settlements. After 2000 BC a wider crop repertoire is present, including summer and winter pulses and the faunal assemblage is predominantly domesticated including cattle, sheep and goats. Clay lined storage bins suggest more investment in permanent facilities at the site. A second tradition that shows parallel economic developments, but possibly following regionally distinct timing is found in the northern Vindhyan hills and the Son and Belan river valleys. An earlier phase of seasonal settlement, ceramic production and some rice use (if not cultivation) is indicated by sites like Kunjhun II and Chopanimando, dating back to the fourth millennium BC, with earlier preceramic roots (Sharma et al., 1980; Clark and Khanna, 1989). It should be noted that the pottery from Chopanimando is a distinct cord-impressed style that does not match that from most other sites in the region, and suggests a local ceramic

'Mesolithic' tradition that developed amongst some Vihdyan hunter-gatherers. It is only in the early second millennium BC that sedentary village sites are widely founded in the region, including sites like Mahagara and Koldihwa (the latter possibly seasonal) (cf. Sharma et al., 1980; Harvey and Fuller, 2005; Harvey et al., 2005) and Tokwa (Misra et al., 2001, 2004). These sites have evidence for monsoonal crops, such as rice and millet from the earliest period and then at later levels the addition of Indian pulses, and winter crops like wheat, barley and lentils. By this period there is also clear evidence of animal herding, including sheep/goat and cattle, and features such as an animal pen with hoof impressions at Mahagara (Sharma et al., 1980).

The third tradition in the region is a persistent tradition of hunter-gatherer-fishers focused on oxbow ponds of the greater Ganges floodplain. Numerous Mesolithic sites are known in the region, especially in the region north of the modern Ganges river, such as Damadama (see Pandey, 1990; Lukacs and Pal, 1993; Chattopadyaya, 1996; V.D. Misra, 1999; Kennedy, 2000:200–205; Lukacs, 2002, see Lukacs, this volume). Although the available dates from these sites (Mahadaha, Sahar-Naha-Rai, and Damdama) range widely from the start of the Holocene (8000–10,000 BC) to 2000 BC, there are now clear grounds for assuming at least some overlap between this aceramic 'Mesolithic' cultural tradition and the ceramic 'Neolithic' food producers in adjacent regions to the South and East. This comes in the form of two direct AMS dates of the second half of the Third Millennium BC on barley (an introduced domestic) and rice (plausibly a domesticate, especially by this time) from Damdama (Saraswat, 2004b, 2005). Thus crop cultivation, or at least significant quantities of traded cereals, must have contributed to the economy of the hunter-fishers of the Ganges at least after 2500 BC; these groups remained hunting wild fauna and did not use pottery. The interrelationships between these traditions still need to be elucidated (cf. Lukacs, 2002) and the role of local domestications versus crop adoptions needs to be assessed. The presence of crops that plausibly originated in this zone, such as rice, by the early third millennium BC in the upper Ganges region, e.g. at Kunal (Saraswat and Pokharia, 2003) and further afield in Swat (Ghalegay, Costantini, 1987) suggest that agriculture was established in the middle Ganges by 3000 BC, but if so, the communities of these early farmers have remained largely undiscovered, and were presumably less sedentary than their late third millennium successors.

The Eastern Neolithic

Early agriculture in eastern India (Orissa) is still largely unknown. As has often been discussed this region has widespread populations of wild rice (*O. nivara* and *O. rufipogon*). The native millets and *Vigna* pulses could also be domesticated in this region, as could the north Indian cucurbits and the tuber crop taro (*Colocasia esculenta*). Uniquely wild in this region is the pigeonpea (*Cajanus cajan*). At present the main excavated sites are late Neolithic mounds from the coastal plains or the Mahanadi River valley, such as Golbai Sassan, Gopalpur and Khameswaripalli established by the end of the 3rd millennium BC or during the 2nd millennium BC (Sinha, 1993, 2000; Mohanty, 1994; Kar, 1995, 2000; Kar et al., 1998; Behera, 2002; Harvey et al., 2006) These sites probably relate to the settling down of already agricultural populations, and the earliest phases of agriculture in this region are yet to be documented archaeologically. Archaeobotanical evidence from the later and better established phases of Gopalpur and Golbai Sassan (after 1500 BC) indicates cultivation of rice and native pulses (mung, urd, horsegram and the local pigeonpea). Small millets are present (including *Panicum* *sumatrense, Setaria* sp. and *Paspalum sp.*) but these may occur as rice weeds or subsidiary crops (Harvey et al., 2006). A single winter crop, lentils, is present indicating a contrast from the Ganges where a wider range of winter crops is prominent. The available faunal data indicates domestic fauna (including bovines and caprines), while artifacts point to the importance of riverine fishing. Reconnaissance of upland Neolithic sites in the Orissa hills suggests a very different Neolithic tradition. Here, sites such as Banabasa (Harvey et al., 2006), appear to have been non-sedentary and largely non-ceramic, suggesting the likelihood of a pattern of shifting cultivation. An older excavation at the site of Kuchai, in the northern Orissa foothills, can probably be connected to this upland tradition, and showed a transition from microlithic technology to ceramics with ground stone axes (including the shouldered celts which are a typical component at these upland sites) (Thapar, 1978, *Indian Archaeology 1961–62-a Review*). Ceramics are reported to include rice husk impressions (Vishnu-Mittre, 1976), but there is no further basis for inferring a more complete subsistence system.

Pre-Harappan Western India: Gujarat and Adjacent Rajasthan

Gujarat is likely to have been a centre for the domestication of local, monsoon-adapted crops, after livestock was adopted into this area from the Indus region to the west. Archaeobotanical evidence for the beginnings of cultivation in this region is not yet available, and the earliest ceramic bearing sites, of the Padri and Anarta traditions (ca. 3500–2600 BC) have so far not yielded plant remains. Nevertheless, these sites have produced evidence for some domestic fauna, including directly dated cattle bones from the fourth millennium BC from Loteshwar (Patel, 1999; Meadow and Patel, 2003) and probable domestic fauna from Padri (Joglekar, 1997; Shinde, 1998a) and Prabas Patan (P. Thomas, 2000). Other sites, such as Bagor, which are often cited as evidence for adoption of livestock by mid-Holocene hunter-gatherers (e.g., Possehl, 1999), need archaeozoological reassessment in light of a refined understanding of the difficulties of separating sheep and goat from blackbuck antelopes (cf. Meadow and Patel, 2003). While livestock are being adopted into this region, it is plausible that ceramic bearing sites in the wetter Saurashtra, as opposed to the desert fringe sites, were sites of communities of cultivators. In the Mature Harappan period (from 2600 BC), a period from which systematic archaeobotanical evidence is available, a stark contrast can be drawn between millet-dominated agriculture of Saurashtra and wheat-barley-winter pulse agriculture of the Indus valley and the Harappan core (Weber, 1991; Reddy, 2003). While there have been recent controversies over identification of millets in this region (Fuller et al., 2001, 2002, 2003b), it is clear that native Indian small millets were predominant.

The crop, little millet (*Panicum sumatrense*, which is native to monsoonal India), and a species (or two) of *Setaria*, were cultivated (probably those which are native such as *S. verticillata* and *S. pumila*). In addition, it is now apparent that *Brachiaria ramosa* was present at Rojdi (probably replacing the reported identifications of the introduced *Setaria italica*) (Weber, personal communication). It is possible that these species were domesticated in Saurashtra, although hard evidence for the process is lacking and other regions may also have witnessed domestication of these species (such as *Brachiaria ramosa* in South India and *Panicum sumatrense* in Punjab). By the latest period of Rojdi C (2000–1700 BC), crops from Africa were introduced, including sorghum, pearl millet and finger millet – the presence of some of the latter now seems clear on morphological grounds despite earlier

Book_Petraglia&Allchin_1402055617_Proof2_December 6, 2006

concerns (Weber, personal communication, cf. Fuller, 2003c), although a full reassessment of contextual dates of these crops is needed. The pulse urd, *Vigna mungo*, which is native to the northern Peninsula or the southern Aravallis, is present from early Rojdi (ca. 2500 BC) and could represent a local domesticate, while horsegram (*Macrotyloma uniflorum*) and mungbean (*Vigna radiata*) are adopted by Rojdi C (2000-1700 BC). In general despite ties in trade and culture with the Harappan Indus valley, the archaeobotany of Gujarat is much more peninsular in character, suggesting a tradition of cultivation distinct from that of the Indus valley but plausibly from hunter-gathering roots similar to that of the Southern Neolithic. Recent research in Rajasthan on the Ahar/Banas culture region, indicates that agricultural villages were clearly established by ca. 3000 BC, as at Balathal (Shinde, 2002). What is less clear is whether this should be connected with Gujarat and indigenous domestications or agricultural dispersal from the Indus region (as postulated in Fuller, 2003b). The archaeobotanical evidence from the mid to late third millennium BC (Kajale, 1996), indicates predominance of the Near Eastern winter crops, a clear contrast with Gujarat.

The Southern Neolithic

The Southern Neolithic, of northern Karnataka and southwest Andhra Pradesh, provides the earliest evidence for pastoralism and agriculture in Peninsular India (Korisettar et al., 2001a, 2001b; Fuller, 2003b, 2006). A well-known site category of the Southern Neolithic is the ashmound, which has been shown (especially at Utnur and Budihal) to be an accumulation of animal dung at ancient penning sites that have been episodically burnt, sometimes to an ashy consistency, and sometimes to a scoriaceous state (Allchin, 1963; Paddayya, 1998, 2001). Animal bones (at all sampled sites) indicate the dominance of cattle in the animal economy, with a smaller presence of sheep and goat (Korisettar et al., 2001a, 2001b). Although Allchin and Allchin (1974, 1995) have made a case for local domestication of zebu varieties in the South, this suggestion is not yet corroborated by archaeological bone evidence. Their argument is based on the morphology of rock art depictions which contrast with contemporary Harappan depictions and suggest the kind of varietal differentiation between southern and northwestern zebus was already established. Recent archaeobotanical research has provided a picture of recurrent staples and occasional secondary crops of the Southern Neolithic (Fuller et al., 2001a, 2001b, 2004; Fuller, 2003b, 2006). The staples include two native species of millets (*Brachiaria ramosa* and *Setaria verticillata*) and two pulses (*Vigna radiata* and *Macrotyloma uniflorum*). What is known of the ecology of these species suggests that domestication occurred in a Dry Deciduous woodland zone that interfingered with savannah scrub (favoured by *Macrotyloma uniflorum*) and moist deciduous woodland (favoured by *Vigna radiata*). The millets would have occurred patchily throughout these zones. While this zone has been argued to be on the inside of the Western Ghats (Fuller and Korisettar, 2004), patches along the Eastern Ghats between the Krishna and the Godavari river are now favored on the basis of recently gathered data on wild progenitors of the *Vigna* pulses (Fuller and Harvey, 2006). The modern distribution of these ecological zones in the peninsular region is illustrated in Figure 5. When climatic conditions were wetter during much of the early and mid-Holocene we would expect the Moist Deciduous zones to have expanded (especially eastwards towards the central peninsula, and for the savannah/scrub zones to have been reduced by impinging dry deciduous woodlands (Fuller and Korisettar, 2004). Some of the areas that are today Dry Deciduous forests with a significant teak (*Tectona grandis*) element that occur in

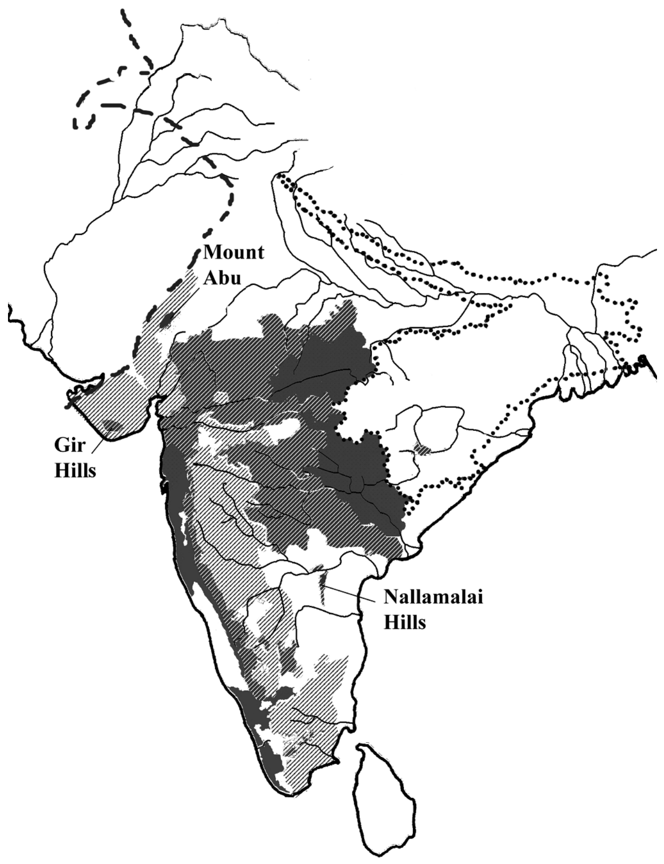

Figure 5. Map of important ecological zones of peninsular India relevant to understanding agricultural origins (after Asouti and Fuller, in press; based on Puri et al., 1983, 1989; Meher-Homji, 2001). The dark grey zone indicates Moist Deciduous forests with teak (*Tectona grandis*) as an important element, while the black dots indicates the western extent of the sal tree (*Shorea robusta*). The Dry Deciduous teak forests are darkly hatched (*Hardwickia* dominated dry deciduous forests have been excluded), while savannah-scrub areas are lightly hatched. The grey dashed line indicates the western boundary of the monsoon zone, east of this line summer rainfall averages more than 40 cm per year

the hills of the eastern peninsula (Eastern Ghats) would have been Moist Deciduous in character. It is such forests where we might expect former extensions of the wild mungbean, from which domestication could have occurred.

In addition there are data that non-native taxa were adopted into cultivation during the Southern Neolithic. These include wheat and barley by ca. 1900 BC (but only on a minority of sites), hyacinth bean (*Lablab purpureus*, probably a native of East Africa), African pearl millet (*Pennisetum glaucum*) and pigeonpea (*Cajanus cajan*, from Orissa or adjacent parts of eastern India) and the vegetable *Luffa acutangula* (from North India), all of the latter by ca. 1500 BC. There is still no clear sequence from foraging to farming, and indeed archaeobotanical evidence to assess the earliest Southern Neolithic agriculture is still lacking from archaeological Phase I (3000–2200 BC). Nevertheless, the existing evidence indicates dependence on a group of species that are native to the peninsula, with non-native species being rare (on a minority of sites) or occurring only in the latest Neolithic period (Phase III), e.g., the African crops. Although there are a few grains of rice from Hallur, these are most likely grains from a wild form (Fuller, 2003b:378, n.2), which could have infested millet fields along the upper Tungabhadra as a weed. Evidence for cultivation and consumption of rice occurs only in the Iron Age (Kajale, 1989; Fuller, 2002). The archaeology of the Southern Neolithic suggests increasing sedentism over most of the region only after 2000 BC and especially during Phase III. This suggests that population densities began to fill in the landscape by comparison the earlier phases of the Neolithic, when we might expect forms of shifting cultivation (and perhaps shifting settlement) to have been practiced. This filling in of the landscape is reflected in the west coast pollen evidence for deforestation focused on ca. 1500 BC (Fuller and Korisettar, 2004).

It is only at this time that settled agricultural villages become widespread on the peninsula, consistent with a model of demographic expansion of early peninsular farmers. For example, the millet-pulse-livestock agriculture of the Ashmound Tradition dispersed southwards and eastwards to adjacent regions. Evidence from the Kunderu river basin, just beyond the eastern distribution of the ashmounds indicates that the same subsistence package was established between 1900 and 1700 BC (Fuller et al., 2001b; Fuller, 2006). There is now new evidence for contemporary hunter-gatherer groups living in caves of the Erramalai hills who were in interaction with the ceramic producing farmers of the Kunderu plains. The cultural differences, in terms of the lack of ashmounds and some distinctive aspects of ceramic style, might suggest that this represents cultural diffusion, it is equally likely that this represents an immigrant group with some cultural traits that set out from the core ashmound tradition into agriculturally virgin land where they could continue traditions of shifting cultivation rather than more intensive methods that would have been adopted in the Southern Neolithic core. This is suggested for example by limited evidence for thin ashmound-like deposits at the base of the Nagarajupalle Neolithic site in the Kunderu river basin (author's data). It may also be the case that this Southern Neolithic agricultural tradition dispersed northwards, but if so it was of a less sedentary and less visible form of settlement than the later Malwa tradition, which became established ca. 1800 BC with well documented village sites on the middle Tapti river, the upper Godavari and the upper Bhima (Shinde, 1998b; Panja, 1999, 2001). At this later stage agriculture had a large component of Harappan elements, wheat, barley and the winter pulses, but also the native (or Southern Neolithic) pulses and small millets. Full identification details of Malwa/Jorwe millets is not available, but it is clear the *Brachiaria ramosa* is amongst them (Kajale, personal communication; for important published datasets see, e.g., Kajale, 1979, 1988, 1990, 1994), in addition to the urd bean which may have originated in this northern peninsular zone (or Gujarat).

A general process which can be perceived in the archaeological evidence is the replacement of older millet species by more productive millet types and in many cases by rice. This has clearly occurred in Peninsular India since Neolithic *Brachiaria ramosa* and *Setaria verticillata* have largely given way to Central Asian/Chinese *Setaria italica* and African *Pennisetum, Sorghum* and *Eleusine*, a process that can be perceived in Early Historic archaeobotanical samples and has finished by the colonial period. These later cereals are more productive and, in the case of the African cereals, generally free-threshing making them less labor intensive to prepare. In other areas millets have been replaced with rice, a process which began when rice first appeared at some sites in the first millennium BC, after 1000 BC. Dry rice cultivation is essentially equivalent in ecology to the wetter forms of millet cultivation, such as river bank cultivation of *Panicum sumatrense* or *Echinochloa* and in some areas such as the drier Bellary and Kurnool district has occurred in the past couple of decades with the expansion of irrigation canals. A significant implication of this process is that we might expect a semantic shift to have occurred from more ancient millets to more recent introduced millets or rice which came to take their place in agricultural and dietary importance. We must therefore consider the possibility that linguistic evidence may prove to be biased towards these modern replacements and mask prehistoric semantic shifts which have occurred in parallel across separate language family branches.

Setting the Speech Scene: Languages Real and Inferred

Historical linguistics is doubtless a reflection of past population movements and interactions, as are genetics. Much recent research on integrating linguistics with archaeology (and genetics) has happened in the past two decades since the publication of Renfrew's (1987) *Archaeology and Language* (see also Blench and Spriggs, 1999; Renfrew, 2000; Blench, 2004). As physical anthropology cannot define races, neither can pure languages be defined. The process of language change *and mixing* is complex, as variants enter a pool in which selection takes place for a variety of social and cultural reasons (Mufwene, 2001). Variants from different speakers are pooled, recombined and selected for transmission to subsequent generations. In cases of general cultural homogeneity, without significant migration, the variants are all similar, thus most language lineages have traditionally remained stable through time, but in some contexts speakers of diverse origins may influence each other and thus transmit to future generations a mixed linguistic heritage. All historical linguists accept that substrate languages have left their mark on now dominant languages, implying considerable periods of interaction amongst different language speakers and bilingualism (Crowley, 1997:197; Witzel, 1999; Southworth, 2005a:98–125); this is perhaps difference in *degree*, but not in kind, to the kinds of processes of language transmission involved in creating historical creole languages, where the speakers contributing to a speech variant pool are from much more diverse backgrounds (see Mufwene, 2001). Thus while it is undoubtedly true that languages are carried with the movement of speakers (Bellwood, 2001, 2005:190–193), the number of speakers vis-à-vis pre-existing populations is a matter that is more difficult to infer (but for a model, see Ehret, 1988). In order to get at this we need to try to frame periods of language interaction in time and space so that we can consider the likely historical and social circumstances that were involved, which ultimately can be informed by archaeological evidence.

Our improving grasp of early agricultural traditions in South Asia (at least those that were becoming sedentary), and the biogeography of their cultivars as well as wild flora, means that there is a basis for assessing linguistic data. The assessment that follows improves upon and revises that of Fuller (2003a). This earlier study began with an assessment of the antiquity of different plants in the archaeology of South India and then looked at the distribution and probable antiquity of words for these selected species across the Dravidian languages (building on Southworth, 1988). Some initial comments were also formulated on possible north Indian domesticates and unknown substrate language(s) of Indo-Aryan (based on Masica, 1979) as well as Proto-Munda agricultural vocabulary (based on Zide and Zide, 1976). In addition to archaeobotanical advances, there have been significant linguistic advances in recent years. Of note are efforts to identify distinct substrata that have influenced Indo-Iranian and Indo-Aryan languages at different periods and a relative chronology of these substrates (Kuiper, 1991; Witzel, 1999, 2005, 2006; Southworth, 2005a, 2005b; Southworth and Witzel, 2006), and new efforts to reconstruct early Dravidian vocabulary (Krishnamurti, 2003; Southworth, 2005a; but see some reservations, below). Recent analysis that explains much of the evolutionary divergence of Austroasiatic into Munda and Mon-Khmer, which are opposite in many linguistic structures, also has significant historical implications (Donegan and Stampe, 2004). One clear indication of this work is that we need to break free of the present as a complete key to the past: there were languages spoken in the past that are not reflected directly in those known at present. There are dead language families. But these have nevertheless left their mark through loanwords and other substrate features.

In this consideration of South Asian linguistic prehistory I focus on the three major living language families: Dravidian, Austro-Asiatic and Indo-European. For the present consideration I will leave aside the complex Himalayan situation and the northwestern periphery of the subcontinent with its isolate Burushaski and the Dardic group of Indo-European languages (but see Witzel, 1999, 2005). There are thus three major families, plus the isolate of the upper Tapti river, Nahali. Indo-European languages are represented by the Indo-Aryan languages located today throughout northern and northwestern South Asia, with earlier linguistic forms preserved in Sanskrit literature such as the Rig-Veda (Southworth, 2005a). The peninsula is predominantly Dravidian. While Munda language groups are concentrated in the hills of Eastern India, where they often encapsulate smaller Dravidian languages, including the poorly documented North Dravidian Kurux (Oraon) and Malto. On the hills of northern Maharashtra the isolated South Munda Korku language, occurs adjacent to the isolate Nahali (Figure 6). Nahali has been related by some authors to a hypothetical extinct Bhil language (Witzel, 1999:62–63; Southworth, 2005a). In addition, extinct substrate languages are clearly indicated for the Nilgiri hills (Emeneau, 1997; Witzel 1999:64) and the Veddas of Sri Lanka (Witzel, 1999:64; Southworth, 2005a). While most of these substrate languages are likely to have been of hunter-gatherers, two major extinct agricultural languages can be inferred for north and northwest South Asia (see below).

Although there has been archaeological discussion of an agriculturally-driven dispersal of Indo-European (specifically Indo-Aryan) into India (e.g., Renfrew, 1987; Bellwood, 2005), this hypothesis lacks support from specific linguistic or archaeological evidence (cf. Fuller, 2003a). Witzel (2005) provides the most recent, comprehensive attempt to infer the route and historical context of Indo-European entry into the subcontinent, including inferred substrate words from a lost Central Asian language, attributed to the Bractria-Margiana archaeological complex of the third millennium BC (e.g., wheat, hemp, sheaf, seed, Bactrian camels and donkeys), as well as words shared with northwestern substrates of the northwestern frontier (Burushaski) and Kashmir. The important evidence for an inferred Harappan substrate is taken up below. A model of two different branches of Indo-Aryan, an 'inner' branch focused on the central Ganges and an outer branch that extended from Sindh through the northern Peninsula and central India towards the east, will not be pursued below as these must relate to cultural processes that occurred after the establishment of agriculture in most regions but they may nevertheless be significant elements in Late Chalcolithic/Iron Age cultural processes in parts of India (for discussion, see Southworth,2005a).

Book_Petraglia&Allchin_1402055617_Proof2_December 6, 2006

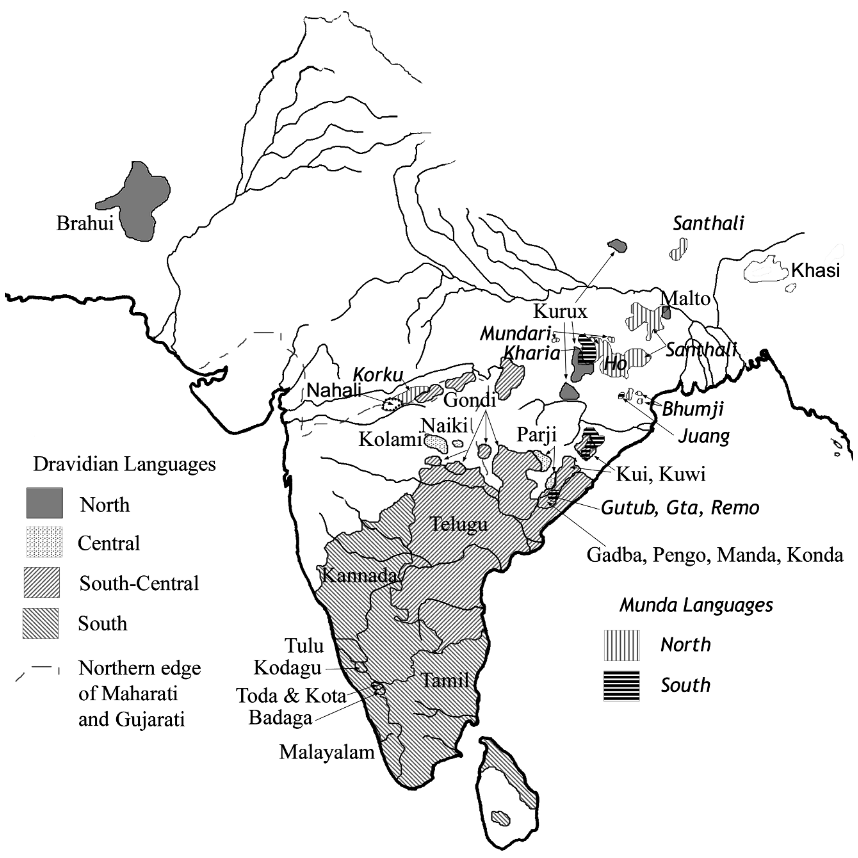

Figure 6. Map of non-Indo Aryan languages in South Asia (excluding Himlayan zone)

There is still room for some controversy with regards to how to represent Dravidian phylogenetically. Four major Dravidian subgroups are well-established (Figure 7), although recent controversy has arisen about how these should be grouped in a hierarchical, phylogenetic framework (Krishnamurti, 2003:figures 11.2A, B; Southworth,

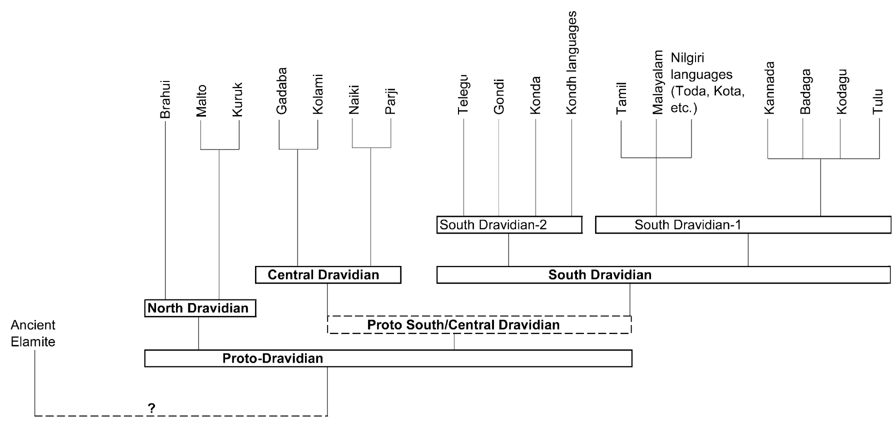

Figure 7. A phylogenetic representation of the Dravidian languages. Well-established groups are indicated by solid boxes (North, Central and South) (Krishnamurti, 2003). I have retained the hypothesis of a Proto-South/Central group, indicated by dashed box (after McAlpin, 1981; Southworth, 1988; Fuller, 2003d) for reasons offered in the text

2005a:233–236). A major issue concerns whether or not a nested hierarchy can be inferred between north, central and southern (including south-central) Dravidian subfamilies. I will continue to use the nested hierarchy of North, Central and South (Fuller, 2003a; following McAlpin, 1981, Southworth, 1988), as opposed to the more cautious but less historically informative three-branch polytomy of the most recent books. As the first botanical assessment of Fuller (2003a) revealed, there appears to be some archaeobotanical grounds for accepting this order of branching. Latecomer crops are generally only documented in South Dravidian, while native crops tend to be documented as cognates with Central Dravidian, while for the most part wild peninsular species may sometimes be documented for the North Dravidian languages as well (see below). As discussed by Southworth (2005a:234–5) there is evidence for a longer and more recent history of contact between the South and Central subfamilies, and there are cases of shared innovations in semantics in South and Central Dravidian as opposed to North Dravidian languages. Thus, even if clear shared phonological or morphological changes are absent, there are grounds for suggesting a phylogenetic hierarchy which groups Central and South Dravidian (Proto-South/Central Dravidian); the lack of clear phonological innovations may suggest that these branches diverged quite rapidly as we might associate with rapidly expanding and dispersing (Neolithic) populations.

Another issue has been the placement Brahui, spoken by pastoralists in Western Pakistan surrounded by Baluchi speakers (an Iranian language). This isolated location has often been taken to indicate a dispersal of early Dravidian speakers from the northwest, with a subsequent language shift to Indo-European languages. It seems to now be increasingly accepted that the ancestral Brahui, found today in Baluchistan, migrated within the past millennium from a North Dravidian area in central India (Elfenbein, 1987, 1998; Witzel, 1999:30, 63; Southworth, 2005a; but for a dissenting view see Parpola, 1994:161). As noted by Witzel (1999:63), there is a lack of older loanwords from Iranian languages such as Avestan or Pashto, but only from modern Baluchi. In addition, it was the latter position, which implied an early divergence of Brahui, that has long been taken to support to dispersal of the early Dravidian speakers from the northwestern subcontinent, perhaps to be connected with a shared ancestral relationship to the ancient Elamite speakers of Iran (McAlpin, 1981; Fairservis and Southworth, 1989; Bellwood; 2005). As will be argued below, the evidence of lexical reconstructions relating to flora, as well as placenames, modern language geography and archaeological correlations all point to Proto-Dravidian located on the peninsula, and thus Brahui must be accounted for by a migration from the Peninsular region (possibly including Saurashtra or parts of Rajasthan) towards Iran.

The Munda language family includes a number of relatively small and often isolated languages in two main sub-groups (Bhattacharya, 1975; Zide and Zide, 1976; Donegan and Stampe, 2004; Southworth, 2005a): South Munda, including the Sora and Kharia languages, and North Munda, including Santali of northern Orissa and Bihar, and the grouping of Mundari, Ho and Bhumij, further south (Figure 8). The isolated Korku in Madhya Pradesh is also grouped more distantly with the Northern group. This disjunct location of the Korkus suggests that the Mundaric dispersal westward (or alternatively eastward) preceded the northward expansion of Gondi (central Dravidian) speakers, who presumably moved from the southeast. Nahali, further west still, includes many Munda elements but is now generally excluded from this group (Bhattacharya, 1975; Tikkanen, 1999), and has been suggested as

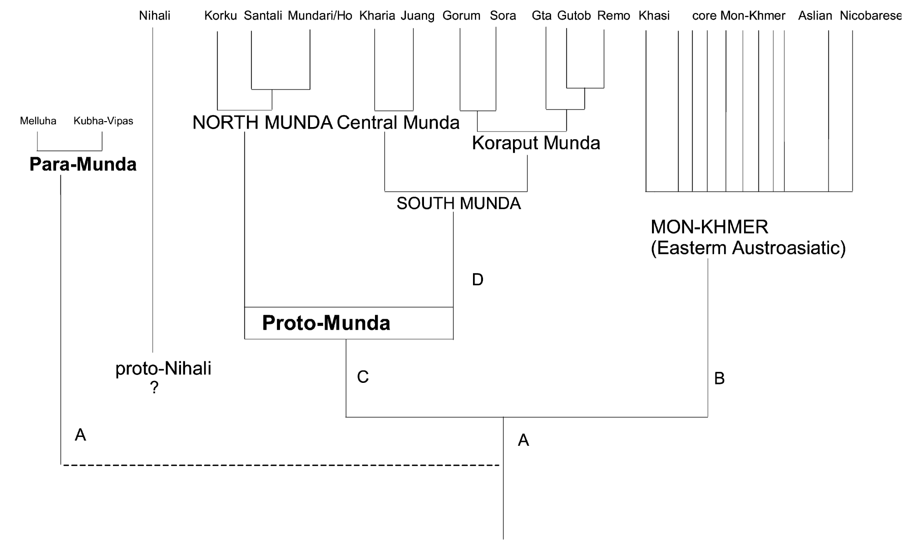

Figure 8. A phylogenetic representation of the Munda and Austroasiatic languages (top), with a hypothestical macro-phylogeny incorporting Witzel's 'Para-Munda' languages and the Mon-Khmer branches. Important cultural developments (derived traits) are indicated by letters (see text for discussion). It remains unclear whether Nihali should be incorporated in this phylogeny

a linguistic remnant of the earliest modern human dispersal out of Africa on the basis of possible distant relations with extinct Ainu (of north Japan) (Witzel, 1999:63). The entire Munda group is placed more as a distinct distant branch of the Austroasiatic family of languages, which is widely distributed in mainland Southeast Asia including the literary languages of Mon and Khmer in Burma and Cambodia (Blench, 1999:66; Diffloth, 2005). Of crucial significance to population history is how the Munda group is related to the rest of the Austro-Asiatic family, and whether the direction of spread should be seen as to or from India, an issue to which I return below. The centre of gravity of the Munda is clearly Eastern India, with the highest language diversity in Southern Orissa (the greater Koraput region), where the north and south Munda subfamilies overlap and where the highly diverse Koraput group of South Munda languages occur. One important lexical item, reconstructed by Zide and Zide (1976), which points also towards an Eastern India focus for Proto-Munda is the sal tree (*Shorea robusta*) since this species is confined to eastern India and through the Central Ganges, but absent from the west, south and southeast Asia (although related species occur there).

Extinct North Indian Languages

Beyond the modern languages, there is possible evidence for at least two major extinct language groups (see especially Witzel, 1999, 2005). Of particular significance is the evidence for agricultural and botanical terminology borrowed into Indo-Aryan (Table 1), and to a lesser extent Dravidian, which appears to be neither Dravidian nor Munda (Mascia, 1979, 1991:42; Fairservis and Southworth, 1989:137; Kuiper, 1991:14–15; Fuller, 2003a). This includes a possibly earlier, and more upper Gangetic centred 'Language X' (Masica, 1979), which I have previously suggested might be linked to the Neolithic of the Ganges valley, or to be more precise the dispersal of the 'Language X' might be connected with the spread of rice, pulse, millet and cucurbit agriculture in northern India, from a possible epicentre in the hilly flanks of the

Table 1. Vegetation and agricultural loanwords from the Harappan substrate(s) in Indo-Aryan languages (Based on Masica, 1979; Witzel, 1999, 2005a, 2005b; cf. Fuller, 2003d: Table 16.8). Words marked with a 'kv' have been identified by Witzel as etyma of the Kubhā-Vipāś or "Para-Munda" language with phonological affinities to Munda/Austro-Asiatic. Witzel has divided those from Vedic sources into 'levels' in terms of probable relative chronology within the textual corpus, with 1.1 being earliest and 1.5 being latest. Some of Masica's substrate words are only attested in more recent languages (MIA = Middle Indo-Aryan, NIA = New Indo-Aryan)

Term/species	*Sanskrit/OIA*	*Vedic Level*	*Origins/Archaeology*	*Linguistic Comments*
Plough (ard)	*Lāngala*	1.1	Present in Early Harappan period (Kalibangan Ardmarks); Harappan models. Also Bronze Age Mesopotamia, Late Neolithic Europe	Also to Dr. and to PMunda. From a Sumerian original for 'sickle' (Witzel, 1999:16)?
Sow	*Vap-*	1.1		Possibly also in Indo-Iranian from Hittite?
Ploughman, two ploughmen	*Kinasa,*[kv] *Kinara*[kv]		See plough (above)	
Sow, furrow	*Sītù*	1.1		
Winnowing basket	*Śúrpa*	1.2		
Lentils, *Lens culinaris*	*Masura*	1.2/3	Domesticated in Near East probably by PPNB (8500 BC)	see Table 5.
Linseed (flax), *Lnium ussitatissimum*	*Atasī*	1.1	Domesticated in Near East probably by PPNB (8500 BC)	Similar source for PSDr word, see Table 5.
Date, *Phoenix* sp.	*Khajúra*[kv]	1.2/3	*P. sylvestris* wild in Sindh and through most of India; *P. dactylifera* possibly wild in Iranian plateau, or domesticated in Arabia/Mesopotamia	Distinct from PDr and PMunda words, see Table 2.
Cotton, *Gossypium arboreum*	*Karpasa*[kv]	1.5	Probably domesticated in Pakistan/Baluchistan. At Mehrgarh by c. 5000 BC	
Indian jambos, *Syzygium cumini*	*Jambu*	1.5	Moist and Dry Deciduous woodlands of South Asia	
Indian jujube, *Ziziphus mauretania*	*Badara-*	1.5	Wild throughout drier savanna and steppe zones of South Asia	
	Karkandu[kv]*-*	1.5		
Chaff, straw	*Busa*	1.5		From *busá* (Vedic 1.1)
Setaria italica	*Priyángu*	1.2/3	Domesticated in North China by 5000 BC. Also in Caucasus(?). Finds in South Asia in Late Harappan period. Related *Setaria* spp. Native to South Asia (see Fuller 2002; 2003b)	

Table 1. Continued

Term/species	*Sanskrit/OIA*	*Vedic Level*	*Origins/Archaeology*	*Linguistic Comments*
Panicum miliaceum	*Ánu*	1.2/3	Domesticated in North China by 5000 BC. Also in Caucasus(?). Finds in South Asia in Late Harappan period (see Fuller 2003b). Similar *Panicum sumatrense* native to South Asia, cultivated at Harappa by 3000 BC (Weber, personal communication).	
Vigna radiata	*Khálva*	1.2	Domestication(s) on peninsula (south/east) and northern India. Neolithic finds from Ganges and Southern Neolithic.	
Vigna mungo	*Mása*	1.2	Domestication on northern peninsula/S. Rajasthan. Early finds from Harappan Gujarat and Neolithic Ganges(?)	
Horsegram, *Macrotyloma uniflorum* (syn. *Dolichos biflorus* auct. pl.)	*Khala-kula*, [=Skt. *kulattha*]	1.4/5	Domestication(s) Indian savannah zones from Rajasthan through peninsula. Widespread Neolithic finds (Ganges, South India)	Ultimately from PDr, biogeographically less likely from PMunda.
Sesame, *Sesamum indicum*	*Tila*$^{\text{kv?}}$		Domestication in southern Harappan zone(?)	Kv > Skt.;also > SDr1 *ellu*; > Sumer. *ili*; > Akkadian *ellu/ūlu*
Wild sesame, *Sesamum malabaricum*	*Jar-tila*$^{\text{kv}}$		Wild in Sindh(?), Punjab, Malabar coast	
Sieve, filter	*kārotara*$^{\text{kv}}$			
Silk-cotton tree, *Bombax ceiba* (syn. *Salmalia malabarica*)	*śalmali*$^{\text{kv}}$		Native to Moist Deciduous forests and wetter variants of Dry Deciduous (e.g. teak zone)	
Papal tree, *Ficus religiosa*	*Pippala*		Wild throughout monsoonal South Asia, formerly in Baluchistan(?)	
Chickpea, *Cicer arietinum*	*Canaka* CDIAL 4579		Domesticated in Near East probably by PPNB (8500 BC)	See Table 5. Attested in Pali, Pkt.
Grasspea, *Lathyrus sativus*	*K(h)ēsārī* CDIAL 3925		Domesticated in Near East probably by PPNB (8500 BC)	
Pea, *Pisum sativum*	*mattara CDIAL 9724		Domesticated in Near East probably by PPNB (8500 BC)	Only in NIA

Table 1. (Continued)

Term/species	*Sanskrit/OIA*	*Vedic Level*	*Origins/Archaeology*	*Linguistic Comments*
Cucmber, *Cucumis sativus*	*Ksīraka* CDIAL 3667, 3698, 3703		Domesticated in northern India/Himalayan foothills	Only in NIA. Cf. Munda. Remo *Sarlay*, Kharia *kenra*, Santali *taher*
Bitter gourd, *Momordica charantia*	*Kāravella*^{kv}		Domesticated in northern India/Himalayan foothills	MIA
Ivy gourd, *Coccinia grandis*	*Kunduru*		Domesticated in northern India/Himilayan foothills. Archaeological finds from Ganges plain by 1800 BC	Unconvincing Iranian and Austro-Asiatic etymologies have been suggested.
Sponge gourd, luffa, *Luffa acutangula*	*tori CDIAL 5977		Domesticated in northern India/Himalayan foothills. Southern Neolithic finds from mid-Second Millennium BC (Fuller et al., 2004)	
Okra, *Abelmoschus esculentus*	*Bhindā*		Domesticated hybrid of Gangetic *A. tubercu-latus x A. ficulneus*, of semi-arid western/peninsular India. Could originally refer to cultivars or wild forms of either parent species.	
Grape, *Vitis vinifera*	*Drākshā*		Domesticated in Southwest Asia, also Indo-Iranian borderlands (?). Present in Pre-Harappan Baluchistan. Harappan fruit crop.	Southworth, 2005:107
Sheep, *Ovis aries*	*Bhedra*		Domestication in Near East by late PPNB; additional Asian domestication(s) may include Afghanistan/Baluchistan	MIA, NIA, <?> PMunda **medra*

middle Ganges zone (from Allahabad towards western Bihar). Early texts indicate that Indo-Aryan speakers picked up retroflexion as they moved into northwest India/Pakistan (Deshpande, 1995; Tikkanen, 1999), which might be connected with this extinct language. More recently, it has become increasingly clear that another, distinct substrate language or languages heavily influenced early Vedic Sanskrit, probably mainly in the greater Punjab region (Witzel, 1999, 2005). This has been inferred therefore to be substrate influence from the Harappan language, or the *Kubhā-Vipāś* language (to use Vedic terms) (Witzel, 1999:8–16, 2005:176–179). On the basis of prefixes and consonant clusters, Witzel suggests that this language shares phonological structure (especially prefixes) with Munda or the greater Austro-Asiatic family of languages, and thus refers to it as 'Para-Munda'. Witzel has further inferred a separate dialect or related language that seems to have been focused in the southern Indus or greater Sindh region, thus a southern Harappan language, or *Meluhhan*, to apply to an ancient Mesopotamia term for the region. Loanwords, and versions of the same word, from the Southern and Northern Harappan dialects can be shown to have regular phonological differences (Witzel,1999:30–37). Current archaeological orthodoxy implies that actual Proto-Munda was a relative latecomer to the subcontinent from the Northeast (e.g., Higham, 1998; Fuller, 2003c; Bellwood, 2005), a problem which requires reconsideration.

This range of substrate words clearly indicates indigenous agriculturalists at the time of the arrival of Indo-Aryan speakers in the subcontinent. The crop species represented point towards Indus agricultural traditions and/or that of the upper Ganges, including species of Southwest Asian origins as well as Indian species of northern origins. This also indicates that if 'Language X' is indeed to be related to a Gangetic Neolithic tradition, that this had already intermingled with the Harappan (*Kubhā-Vipāś*) tradition, presumably already by the period of urbanism. Indeed in the Eastern Harappan zone, including the upper Yamuna basin there is growing evidence for an Early Harappan tradition that incorporated the Southwest Asia crops with native rice, pulses and probably millets (cf. Saraswat, 2002, 2003, 2004), and became part of the Harappan civilization area in the later Mature period (from 2300–2200 BC). Vedic terms for singing, dancing and musical instruments also come from the *Kubhā-Vipāś* substrate source (Kuiper, 1991:19–20; Witzel; 1999:41). The loans from the *Kubhā-Vipāś* language, and probable 'Language X' is pronounced in the earliest parts of the Rig Veda, whereas plausible Dravidian loans are few and later in the Rig Veda, or post-Rig Veda (and possibly indirect through an intermediary language) as are those of the *Meluhha* language (Witzel, 1999:18–23; cf. Southworth, 2005a). Witzel (1999:24), however, has continued to accept that early Dravidian must have entered the subcontinent via Sindh as non-agricultural farmers, a view which can be contrasted with either the Proto-Dravidian farming vocabulary suggested by Southworth (1976, 1988, 2005a) or the development of agriculture early within the divergent lineages of Proto-Dravidian hunter-gatherer-herders (Fuller, 2003a). Evidence for placing early Dravidian, and perhaps Proto-Dravidian speakers needs to be considered, both through reconstructible vocabulary as well as toponyms.

Early Dravidian Ecology and Agriculture

A challenge is to untangle reliable Proto-Dravidian cultural vocabulary and to relate this to archaeology and evidence for place-names (which may relate to later dispersal of subfamilies of Dravidians). Evidence for a more widespread distribution of Dravidian cultural groups (but not necessarily Proto-Dravidian) in the past, with subsequent conversion to Indo-European languages is clear (see Figure 4; Trautman, 1979; Fairservis and Southworth, 1989; Parpola, 1994; Southworth, 2005a; 2005b). Southworth, for example has traced village place-name endings typical of South India throughout Maharashtra and the Saurashtra peninsula, and with a few in Sindh and Rajasthan (Southworth, 2005a: Chapter 9). In these regions (specifically Gujarat and Maharashtra) cross-cousin marriages are either typical or practiced by some cultural/caste groups, as discussed by Trautman (1979, 1981). There appears to be no evidence that cross-cousin marriages were ever practiced in Gangetic India (Trautman, 1981). This implies that this characteristically Dravidian cultural practice has persisted in areas where Indo-Aryan languages are now spoken. This terminology is reconstructed for Proto-Dravidian by Krishnamurti (2003:10). The practice of cross-cousin marriages within the North Dravidian subfamily remains problematic, with the practice only recorded amongst the Kurukh but neither Malto or Brahui; the absence from the latter can be explained by cultural influences due to their encapsulation. The reconstruction of this practice has potential implications for archaeology and paleodemography, as it implies a particular kind of extended kin-network and endogamy that we might expect to influence aspects of settlement pattern and perhaps genetic structure within populations.

Two difficulties face historical linguistic reconstruction: incomplete recording and anachronistic definitions. As is well-known, the better recorded languages are the large and literary languages (Tamil, Telugu, Kannada, Malayalam), whereas the word lists available for other languages are more limited (e.g., absence of data for names of many crops in North Dravidian and often Central Dravidian in Fuller, 2003a). While it is undoubtedly true that absence of a cognate word in these incompletely recorded languages is not necessarily evidence for absence, it seems methodologically flawed to reconstruct Proto-Dravidian from cognates just across the South (SDr1) and South-Central (SDr2) families, as Krishnamurti (2003) does. These larger and more widespread language subfamilies share a more recent common ancestry and as such can be expected to preserve later cultural-historical developments, such as greater social complexity. The fact that these are the most widespread and diverse subfamilies also suggests that they have expanded more recently and successfully, which may itself relate to demographic and cultural factors related to the emergence of more intensive agriculture and social complexity. There is also a danger in projecting into prehistory more modern definitions of words that have arisen metaphorically in parallel in the more recent past. Krishnamurti (2003) had reconstructed a Proto-Dravidian word for "write," but the cognates in all Central Dravidian and South-Central languages, as well as most South Dravidian languages is glossed as 'scratch' or make 'lines' and indeed only in Tamil has this meaning been extended to 'inscribe' or 'write' (Dravidian Etymologycal Dictionary [DEDR], entry number 1623, Burrow and Emeneau, 1984). He has also reconstructed 'king' from cognates found only in the four literary languages (DEDR 527), i.e. those languages which have been historically associated with states, and which derives from a compound word meaning "the high one," a fairly recurrent way to make terms for rulers (e.g., English, 'her highness'). Meanwhile his large state territory is a term (*natu* DEDR 3638) that has extended in Tamil from an original meaning of village or cultivated land (cf. Krishnamurti, 2003:7–8), and weaving (DEDR 3745) is widely glossed as 'to do matwork' or even 'thatch', and need not imply a textile industry! In other words he has inferred an essentially urban and Bronze Age (or even Iron Age, as he reconstructs iron, but from a word meaning 'black') for the Proto-Dravidians, and he cites their identification with the Harappans as possible (although the Harappans did not have iron). Nevertheless there are many things which have cognates across a large number of Dravidian languages, and many are to be found in terms of plants. While there remain gaps in recording, especially for the North Dravidian languages, these need to be filled by new linguistic field recording or use of sources beyond the Dravidian Etymological Dictionary (Burrow and Emeneau, 1984).

In terms of pinning down early Dravidians, an ecological assessment of tree names may be useful (compare with Figure 5). In Table 2 there is a selection of trees, that are found in the Dry Deciduous forests of the Peninsula and central India (Puri et al., 1989; Meher-Homji, 2001; Asouti and Fuller, 2006). Many of them also occur in Eastern India and in parts of the Himalayan foothills, but some do not, notably teak. They are entirely monsoonal, absent from the northwest, and also present in smaller patches in Saurashtra (Gir hills) and Rajasthan (Mount Abu). The fact that several of these species have good cognates across all Dravidian subfamilies strongly supports a Proto-Dravidian homeland somewhere in Peninsular India. Culturally, it is of interest that some of these species are ecological dominants in the Dry Deciduous woods of the peninsula, suggesting that this was a particularly salient environment to these people. In addition, a number of these species are useful, as sources of edible fruits, medicines or lac (used for lacquering and as dye). In the drier savannah zones, that in reality intergrade with the dry deciduous, two more fruit trees can be definitely reconstructed to proto-Dravidian, and another nearly so (Table 3). By comparison, Moist Deciduous trees in Table 4 in no cases are recorded to extend to North Dravidian, although they do consistently have cognates across the South and Central branches (absence from North Dravidian could be a limitation of recording). Of interest from this zone is the likely tuber food (perhaps cultivated), taro. Those wetter species present, both *Syzygium* and *Artocarpus* favour watercourses and along rivers extend their ranges into drier zones. Of the species on these lists, only *Ziziphus* and the date palm(s), might possibly have been known in Baluchistan/Iran, and only a few more species (toddy palm, the *Ficus* spp., *Terminalia* spp.) would have occurred in Sindh (and probably very patchily). Thus, taken together, the tree words and place-names point to a restricted peninsular zone for the early Dravidian speakers focused on the Dry Deciduous and savannah zones. If the Moist Deciduous elements are taken into account (assuming incomplete recording for North Dravidian) then even Saurashtra is less likely (although these species could be found as relicts on Mount Abu, Rajasthan). Thus the plant name evidence clearly contradicts Krishnamurti's (2003:15) claim that early Dravidians were throughout the subcontinent "even as far as Afghanistan."

From similar vegetation zones we find the wild progenitors of the crops that also have wide Dravidian cognates (included in Tables 2–4, also, Fuller, 2003a). It is not possible to know whether knowledge of these plants implies their cultivation (although that is often assumed, e.g., Southworth, 1988), if they might have been encountered wild in the environment. As previously argued (Fuller, 2003a) those species with the deepest Dravidian roots, based on recorded cognates, correspond to those with the oldest archaeological occurrences in South India, and suggest an identification with the Southern Neolithic (also concluded by Southworth, 2005a). Crops that are non-native and archaeologically turn up somewhat later, such as wheat, barley and African crops, tend to have recorded cognates only for Proto-South Dravidian, although in many cases these plants are poorly recorded in the DEDR (which calls for moving to further sources or new recording). There remain some unresolved issues. Crops such as urd and pigeonpea are not part of a widespread and early Southern Neolithic crop package. Pigeonpea arrived later, ca. 1500 BC, spreading from Orissa while urd has been found as a trace occurrence on a few sites, and is rather to be associated with cultures like the Deccan Chalcolithic and Late Harappan Gujarat. If we assume that some (like horsegram and mung) will prove to be cognate in Kurukh and Malto (once additional linguistic sources become available), while others (urd, pigeonpea) do

Table 2. Trees and shrubs of the Dry Deciduous zone cognate across Dravidian subfamilies, indicating those languages for which cognates are documented in their respective subfamilies. DEDR entry numbers indicated (Burrow and Emeneau, 1984). Protoform reconstructions from Southworth (2005). For comparison of Indo-Aryan (after Turner 1966) and Munda languages (after Zide and Zide, 1976) are included

Species	*Uses*	*SD1*	*SD2*	*CDr*	*ND*	*DEDR*	*CDIAL nos.*	*PMunda*
Butea monosperma, flame of the forest	Lac host, resin: Bengal kino, 'holi powder' yellow pigment, medicinal uses	X	X	X	X	4981 **mur-ukk-*	3149 *su-kimśu-ka* (from Witzel's K-V language)	
Pterocarpus marsupium, Malabar kino tree	resin: Malabar kino,	X	X	X		5520 Ta. *venkai*		
Moringa sp., Drumstick tree, horseradish tree	*M. oleifera* wild in W. Himalayan foothills, but similar *M. concanensis* in Nallamalais, Conkan, inner Western Ghats	X	X	X	X	4982 **murum-*	> 10209 *murangi* (H., Or.). 12437 *sigru*	
Schleichera oleosa, Ceylon oak	Lac host (true shellac), edible leaves, fruits and seeds	X	X	X	X	4348 **puc-*/**puy-*		
Ficus religiosa, Pipal	One of the Sacred figs. Introduced to peninsula?	X	X			202 PSDr **ar-ac-al*	8205 *pippala*	
		X	X	X		2697 **cuw-*		
Ficus benghalensis, banyan	One of the sacred figs, introduced to peninsula??	X	X	X		382 **āl*	7610 *nyagrodha*	
Phyllanthus emblica, emblic myrobalan	Edible fruit, medicinal	X	X	X		3755 **nelli-*	1247 *amalaka*	
			X	X		574 Te. *usirika*		
Feronia limonia, wood apple	Edible fruit	X	X	X		(?) 5509 **wel-V-*	2749 *kapittha*	
Bombax ceiba, silk-cotton tree	Source of fibre	X	X	X		495 & 5539	12351 *Śalmali, Śimbala*	
Gmelina arborea	Edible fruit, medicinal root and bark	X	X	X		1743 Ta. *kumiṟ*	3082 *karsmarya*[kv] 4030 *gambhari*	
Tectona grandis, teak	Medicinal uses	X	X	X		3452 **tēnkk-*	? >12369 *saka*	
Terminalia tomentosa	Dominant peninsular deciduous tree	X	X	X		4718 **mar-Vt-*	963 *asana*	
Terminalia bellerica	Medicinal uses	X	X	X		3198 **tānṯ-i*	11817 *vibhidakā*	

Table 2. Continued

Species	*Uses*	*SD1*	*SD2*	*CDr*	*ND*	*DEDR*	*CDIAL nos.*	*PMunda*
Phoenix sylvestris/ dactylifera, wild forest date, domestic date	Edible fruit	X	X	X	X	2617 **cĭnt(t)-*	*Khajúra*	**Vn-deñ*, **raloXg*
Borassus flabellifer, toddy palm (may also mean *Caryota urens*, the west coast's toddy palm)	Sweet fruit, edible, generally fermented	X	X	X	X	3180 **tāZ*	>Skt. *Tāla* CDIAL 5750	
Cordia myxa, sebestan plum	Edible fruit		X	X		3627 5408	1990 *uddala* 12610 *selu*	
Azadirachta indica, neem	Medicinal uses, sacred	X	X			5531 **wē-mpu*	7245 *nimba*	

Table 3. Trees and shrubs of the dry evergreen scrub and zone cognate across Dravidian subfamilies, indicating those languages for which cognates are documented in their respective subfamilies. DEDR entry numbers indicated (Burrow and Emeneau, 1984). Protoform reconstructions from Southworth (2005). For comparison words Indo-Aryan (after Turner, 1966) and Munda languages (after Zide and Zide, 1976) are included

Species	*Uses*	*SD1*	*SD2*	*CDr*	*ND*	*DEDR*	*CDIAL nos.*	*PMunda*
Diopsyros melanoxylon	Edible berry, a kind of ebony wood, used in tanning	X	X	X		3329	>5872 *tumburu-*. 3464 *kendu*	
Tamarindus indica, tamarind	Edible fruits, native(?) to India as well as Africa	X	X	X	X	2529 **cin-tta*	1280 *amla*	**R-tiXn* also(?) **(ro)joXd*
Ziziphus mauritania, Indian jujube	Edible fruit	X	X	X	X	475	Skt. *badara-*	
Macrotyloma uniflorum, horsegram	Edible pulse, crop	X	X	X		2153 **koL*	>Skt. *kulattha*, or from PM (?)	**kodaXj* <?>Skt./PDr. Dr. source more likely

not, then we would have clear linguistic stratification that reflects that of archaeobotany, and implies that indigenous peninsular agriculture (perhaps focused on the Eastern Ghats Dry Deciduous zones north of the Krishna River) can be associated with Proto-Dravidians. The Southern Neolithic, as it is currently known, would then reflect one of the cultural offshoots as this early Dravidian agriculture expanded. While the status of plant cultivation amongst Proto-Dravidians remains unresolved, the herding of animals seems clear with reconstructed words for cow **ām* (DEDR 334), bull **erum-* (DEDR 815), two probable sheep/goat terms (one for each species, or female and male?) **yātu-* (DEDR 5153), **kat-ā-* (DEDR 1123) (Southworth, 2005a: Chapter 8, Appendix A).

Table 4. Trees and shrubs of the Moist Deciduous zone cognate across Dravidian subfamilies, indicating those languages for which cognates are documented in their respective subfamilies. DEDR entry numbers indicated (Burrow and Emeneau, 1984). Protoform reconstructions from Southworth (2005). For comparison words from Indo-Aryan (after Turner, 1966) and Munda languages (after Zide and Zide, 1976) are included

Species	*Uses*	*SD1*	*SD2*	*CDr*	*ND*	*DEDR*	*CDIAL nos.*	*PMunda*
Artocarpus integrifolia	Edible fruit	X	X	X		3988 **pal-ac*/ **pan-ac*	7781	
Syzygium cumini, Indian jambos or java plum	Edible fruit	X	X	X		2917 Ga. Nendi **ñānṯ-Vl* also SDr 2914 Ta. *naval*	*Jambu*	NM **koXda* SM **ko?-deX*
Vigna radiata, mung bean	Edible pulse, crop	X	X	X		3941 **payaru* (S) **pac-Vṯ*/**pac-Vl*	10198 *mudgà*, *khálva*	
Vigna mungo, urd bean	Edible pulse, crop	X	X	X		690 **uZ-untu*	>1693 **uddida* 10097 *mása*	**rVm*
			X	X		4862 **minimu*	>Skt. *malada*	
Cajanus cajan, pigeon pea	Edible pulse, crop	X	X	X		3353 **tu-var-*	>Skt. *tubarika*	**sVr/d – u/aj* **sVr/d – oXm*
		X	X			1213 **kar-Vnti*		
Colocasia esculentum, taro	Edible, tuber crop	X	X	X	X	2004 **kic-ampu*	?> Skt. *Kemuka, kacu, kacvi*	
Sesame (wild?), *Sesamum indicum/ malabaricum*	Edible oil seed	X	X	X		3720 **nuv-*	Skt. *tila, jar-tila* (wild sesame); cf *ellu* in SDr, and similar in ancient Sumer and Akkad.	

Some challenges for further investigation remain. First, it should be noted that tables used here have excluded the native millets and rice. As discussed in Fuller (2003a), millet terms that can be extracted from botanical sources are often unrepresented in the DEDR, and key millet species that occur archaeologically, especially *Brachiaria ramosa*, are not recorded at all. Between (some) millet species we might expect a substantial degree of semantic shift, as these species have many superficial similarities. Thus, it is of interest that Southworth (2005a) has reconstructed two millet terms to Proto-Dravidian, with another four added at the Proto-South Dravidian stage, and two more to the proto-language of Tamil and Kannada (Southworth, 2005a:247–248). From southern Neolithic sites there are two predominant millet crops (Fuller et al., 2001, 2004), whereas by the early historic period as documented on archaeological sites in Tamil Nadu seven millets have been identified archaeologically (but not including Sorghum) (Cooke et al., 2005). I have also omitted rice, for which Southworth (2005a: Chapter 7, B8) reconstructs 3 possible early Dravidian terms, although glosses in some languages suggest that these might originally have been more general terms for ears of grain, crops, cooked grain (and I would suggest perhaps some other crop, such as a millet). While South and North Munda each have a reconstructible terms for rice, with apparent cognates in other Austroasiatic languages, there is not one coherent rice etymology for the whole family, and etymologies like those in Mahdi (1998) and Witzel (1999:30–33) also use proto-forms for millet terms. In general, I would regard such a semantic shift as more likely to have occurred in the other direction, from older millet terms to rice (which is everywhere a more productive and increasingly widespread crop in historical times). Horse terms, which include those for donkeys and probably wild hemiones, are also problematic with three possible terms reconstructed to Proto-Dravidian or Proto-S/C Dravidian (Southworth, 2005a, Chapter 8, Appendix A; cf. Witzel, 2005:103–104). One problem is that the archaeozoology of the equid species in peninsular India is still poorly documented and the actual semantic categories of the proto-words may not be clearly fixed. Southworth expresses the most confidence in a Proto-South/Central Dravidian term for donkeys (DEDR 1364, **kaz-ut-ay*), which might plausibly have spread to South India by the third millennium BC (from ultimate origins in Egypt or the Sahara). Sesame also raises questions, as linguistic data suggest a reconstruction for one term back to Proto-South/Central Dravidian, although there is no archaeobotanical evidence yet for its early use, as early as native pulse (and millet) crops which we know were being cultivated in Neolithic South India. While I previously suggested that this species may have been encountered by early Dravidians in wild form (Fuller, 2003a), since it is native to South Asia, further consideration makes this less likely. The habitats on the peninsula where sesame occurs are restricted to the wet west coast near sea-level, including coastal sand dunes (personal botanical field observation), and such an ecology is incompatible with the deciduous woodland species that readily reconstruct to Proto-Dravidian or Proto-South/Central Dravidian. Sesame is likely to have been domesticated prior to the Mature Harappan period somewhere in the greater Indus region (Fuller, 2003d; Bedigian, 2004), in line with its Para-Munda etymology. There is no evidence to suggest dispersal to the peninsula prior to the Late Neolithic/Chalcolithic period, i.e. the same time horizon as wheat, barley and some African crops, which would be in line with the northwestern *tila* loanword in Proto-South Dravidian.

Archaeological evidence can make a significant contribution to dating the antiquity of languages. While one might suggest correlation between a reconstructed proto-language vocabulary and an archaeological culture horizon, it is easy for dating to be wrong, since technologies and crops will have continued in use. On the other hand, when different language sub-families have distinct words for items of culture, we may hypothesize that such technologies (or domesticates) entered the cultural repertoire independently in each of the language/culture sub-families, and archaeological evidence for the adoption of such technologies might be used to place a general minimal age for the separation of these branches. Evidence for a number of items which have distinct roots across the South, Central and North Dravidian language groups, suggest a mid-second millennium BC minimal divergence for the Central and South Dravidian languages on the basis of archaeological dates. This includes domesticates that have distinct etyma across these three language subfamilies, including several tree-fruit cultivars (mangoes, *Citrus* spp., bael fruits), as well as chickens (see Table 5). In addition, adopted tree crops from Southeast Asia can be reconstructed only for Proto-South Dravidian, *Areca* nuts, coconuts and sandalwood. Wood charcoal evidence for sandalwood indicates its establishment in South India by ca. 1300 BC, with probable *Citrus* tree cultivation from the same period (Asouti and Fuller, 2006). Bananas may have been introduced even later since the two South Dravidian branches have different roots. In the future we may expect archaeological phytolith evidence to be able to pin down the date of introduction of Bananas to this region; it now appears that some banana cultivar was established in the lower Indus region already in Harappan times (Madella, 2003). These data suggest therefore that Proto-South Dravidian might be identified with the latest phase of the Southern Neolithic and the transition to

Table 5. Selected plants and livestock with separate linguistic roots from different Dravidian subfamilies, indicating those languages for which cognates are documented in their respective subfamilies. DEDR entry numbers indicated (Burrow and Emeneau, 1984). Protoform reconstructions from Southworth (2005). This list included introduced crops. For comparison words from Indo-Aryan (after Turner, 1966) and Munda languages (after Zide and Zide, 1976) are included

Species	*Uses, comments on*	*Dravidian Languages (DEDR entry nos.)*				*Indo-Aryan*	*Munda*
	Origins (in relation to South India)	PSDr [PDr.3]					
		SDr1 [SDr]	SDr2 [SCDr]	CDr	NDr		
Mango *Mangifera indica*	Edible fruit, wet Western Ghats forests and introduced cultivars from northeast India (Assam)	4782 PSDr **mām*		4772 **mat-kāy* (>Go., Kui, Kon., Kuwi)	2943		**uXli*/ **uXla* SM **kaj'-er*/ **kag'-er* (green mango)
Bael *Aegle marmelos*	Edible fruit, introduced as cultivar from central/north India(?)	1910 Ta. *Kuvilam*, cf. Skt.	4821 Te. *maredu*	4821 SDr2>Nk	2072 Kur. *Xotta*	[p.457] Skt. *bailvam*, Pkt. *Billa-*	
Mast tree *Calophyllum inophyllum*	Restricted distribution: Western Ghats wet forests, west and east coast pockets	4343 PSDr **pun-ay*					
Coconut *Cocos nucifera*	Introduced from Malaysia/ Indonesia, via Sri Lanka(?)	3408 PSDr **ten-kāy* "southern-fruit" 1254 PSDr **kairu* (coconutfibre)				*Nārikela* Ramayana Skt.	
Citron, *Citrus medica*	Introduced to south by 1300 BCE from central-eastern Himalayas	4808 Ta. *Matalai*, PSDr. *Māt-al*				Cf. 10013 Skt. *Matu-lunga-*	
Orange, *Citrus aurantium*	Introduced from SE Asia via NE India(?)	552 PSDr **ize*					
Sandalwood, *Santalum album*	Introduced from Indonesia by 1300 BCE	2448 PSDr **cāntu*					
Banana, Musa paradisiaca	Introduced from Malaysia/ Indonesia, via Sri Lanka(?). In Sindhi Harappan Kot Diji by 2000 BCE	5373 PSDr1 **wāz-a-*	205 PSDr2 **ar-Vṇṭṭi*	754 Pa., Ga.			
Areca nut, *Areca catechu*	Introduced from Southeast Asia	88 PSDr **at-ay-kkāy*					
Mustard, *Brassica* sp., probably *B. juncea*	In northwestern subcontinent by the Harappan civilization. Native there(?)	921 PSDr **ay-a-*					

(Continued)

Table 5. (Continued)

Species	*Uses, comments on*	*Dravidian Languages (DEDR entry nos.)*				*Indo- Aryan*	*Munda*
Barley *Hordeum vulgare*	Introduced crop (Near Eastern). In Southern Neolithic by 1900 BC	1106 PSDr1 **koc-/Kac-*					
Wheat *Triticum* spp. Mainly *T. aestivum* words	Introduced crop (Near Eastern). In Southern Neolithic by 1900 BC	PSDr **koo-tumpai*					
		1906 PDr. *kāl-i* ('rice/wheat')					
Pearl millet *Pennisetum glaucum*	Introduced crop (African). In Southern Neolithic by 1500 BC	1242 PSDr **kampu*				Skt. *kambu*	
Sorghum *Sorghum bicolour*	Introduced crop (African)	2896 PDr-2 **connel*				Pkt. *Gajja* >Dr. Skt. *yavanala* (from IE)	
Hyacinth bean *Lablab purpureus*	Introduced crop (African). In Southern Neolithic by 1500 BC	? 2496 PSDr **cikk-Vt*; Also, 262.					
Peas *Pisum sativum*	Introduced crop (Near Eastern)	Probable cognates with Guj, Mah.				9724 NIA **mattara*	
Lentils *Lens culinaris*	Introduced crop (Near Eastern)	Probable cognates, <Skt.				Skt. *masúra*	
Chickpea *Cicer arientinum*	Introduced crop (Near Eastern)	1120 PSDr1 **kaḇalai*	Te.'sana-galu'	Cf. Mah. 'harbara'		4579 *Caṇaka*	
Fenugreek *Trigonella fenugraecum*	Introduced crop (Near Eastern). Finds Harappan and Late Harappan Punjab/Haryana	5072 PSDr **mentt-i*				10313 **mētthī*. <? >PSDr	
Flax *Linum ussitatissimum*	Introduced crop (Near Eastern)	3 PSDr **ak-V-ce* (**akace*)				OIA **atasi-* <? >PSDr	
Cotton *Gossypium arboretum* (>*Gossypium* spp.)	Introduced crop (from Pakistan)	3393 PSDr **tuu* (but='feather') 3976 PSDr **par-utti* 3726 PSDr **nāl* (cotton thread)				5904 Skt. *tula-* <? >SDr Skt. *karpāsa-* (Table 1)	
Chicken *Gallus gallus*	Introduced domestic animal	2248 PSDr **kōz-i* (>Nk.)		2160 (>Go.)	2013	**kukhro*, Skt. *kukkutah*	**si(X)m*
Pig, domestic	Introduced/local ?	4039 PS/CDr **pan-ti*					
Water buffalo (female)	Introduced from NW(?)/local ?	816 PSDr **erum-*					Kharia *Bontel* Sant. *bitkel* **oreXj* ('draft animal')

the Megalithic period in South India, in the time horizon 1500–1300 BC, and certainly no earlier than 1800–1700 BC. Central Dravidian is likely to have diverged prior to this date (by ca. 2000 BC, before the introduction of wheat and barley), and North Dravidian even earlier (but further linguistic clarification is needed on native crop words before a date can be assigned). Further support comes from other technologies such as those of metal working. Terms for gold and smelting can be reconstructed from Proto-South Dravidian only (Southworth, 2005a). Archaeological evidence for metals is restricted to Phase III of the Southern Neolithic (i.e., 1800–1400 BC), including gold objects from Tekkalakota (1700–1400 BC) (Nagaraja Rao and Malhotra, 1965, Korisettar et al., 2001a). It is also at the Proto-South Dravidian level that a number of terms that suggest incipient social hierarchy (and political economy) are found (e.g., chiefs or lords, tribute, commodity/ware, 'money' [some standard of exchange value], battle/army, a range of buildings and settlement types) (Southworth, 2005a: Chapter 8, Appendix B), which is congruent with the evidence for the evolution towards social complexity from Neolithic Phase III towards the Megalithic (Fuller and Boivin, 2005; Fuller et al., 2006).

Early Munda agriculture and Austroasiatic Dispersals

New linguistic research suggests that Munda ancestry, and the larger Austroasiatic family, should be placed in South Asia. In recent discussions archaeologists have assumed that Munda was a relative late-comer to the subcontinent, coming from Southeast Asia/Southwest China (e.g., Higham, 1998, 2003; Bellwood, 2001, 2005; Bellwood and Diamond, 2003; Fuller, 2003c). This has also tended to be the assumption of linguists, since the Southeast Asian Mon-Khmer languages form the sister group to Munda languages (e.g., Zide and Zide, 1976; Diffloth, 2005; see also, Blench, 1999, 2005). Implicit in most of this literature is the assumption that rice has a single origin to be located in South China. For reasons already reviewed above, this assumption is in error. It is contradicted by genetic evidence from rice, and is inconsistent with currently available archaeobotanical evidence, which instead indicates that Chinese *japonica* rice domestication is distinct from *indica* rice domestication, probably in the Ganges and perhaps an additional locus. Since Mon-Khmer and Munda share (some) agricultural vocabulary (Zide and Zide, 1976; Blench, 2005), including terms for rice, but not a strongly rice-focused vocabulary (Fuller, 2003a; Blench, 2005) this was taken to imply dispersal from the Chinese centre of rice domestication. The archaeobotanical case negates this, leaving it an open question whether Mon-Khmer or Proto-Munda should be seen as dispersing.

The evidence of an Austroasiatic substrate in the Indus valley and new linguistic research on comparative phonology and syntax both support an indigenous development for Proto-Munda and a dispersal eastwards for Mon-Khmer. If the Austroasiatic affiliation of the inferred *Kubhā-Vipāś* and *Melluha* languages ('Para-Munda') are correct then this would imply a much earlier and more widespread distribution of pre-Munda/Austro-Asiatic. As already noted, the reconstructed vocabulary (e.g., Sal trees) and modern linguistic geography suggest an Eastern Indian (Orissan) homeland for Proto-Munda, which would suggest that these language substrates, as well as Munda-like placenames in the Gangetic zone (Witzel, 1999:15, 2005:179–180) come from an earlier pre-Proto-Munda branch of Austro-Asiatic. This is also suggested by the phonological structure of Para-Munda vis-à-vis modern Austro-Asiatic languages. As discussed by Witzel (2005:178–179), these substrate loanwords have active prefixing, a small number of possible infixes and no clear suffixes. This is typical of the eastern Austro-Asiatic languages of the Mon-Khmer family (Diffloth, 2005; Donegan and Stampe, 2004), whereas Munda tends to be suffixing (with other infixes). As explored in detail by Donegan and Stampe (2004:20) proto-Austroasiatic is inferred to have had a 'rising rhythm' with one or two syllable words stressed on the second syllable, prefixing and analytic grammar (i.e., without complex declensions and conjugations) based on subject-verb-object ordering. This rhythm has been retained in Mon-Khmer, whereas in Munda it has evolved in an opposite direction, to a 'falling rhythm' in which grammar became synthetic based on subject-object-verb ordering in which suffixes became necessary for marking gender, tense, etc. for subordinate clauses. While falling rhythm is typical across language families in South Asia, the Munda suffixes do not appear to be either borrowings or calques (translations) from Dravidian (Donegan and Stampe, 2004:19), but instead they evolved for reasons of simplifying speech rhythm (a 'trochaic bias') (ibid.:25–26). This falling rhythm is an important trait uniting Munda languages (*sensu stricto*), and thus the lack of clear suffixing in Witzel's 'Para-Munda' would place this language lineage prior to, or separate from, the Proto-Munda lineage. Donegan and Stampe (2004:27) conclude that the diversity of Munda structures and low level of Munda cognates, in contrast to Mon-Khmer, argues that this is the older branch of this language family, thus suggesting a South Asian Austroasiatic homeland. Similarly, acceptance of 'Para-Munda' as a branch prior to the diversification of Proto-Munda (and presumably Mon-Khmer) also argues for greater antiquity of Austroasiatic in South Asia than in Southeast Asia. This further implies that if the Austric hypothesis, which links Austronesian languages of island Southeast Asia with Austroasiatic, is accepted (cf. Blust, 1996b; Higham, 2003) then this divergence must be placed in deeply, pre-agricultural times and related probably to a Pleistocene demographic process (see also, Blench, 1999, 2005).

In terms of agricultural history, we probably need to assume at least two origins (or adoptions) of agriculture within Austroasiatic, as indicated by the label "A" on Figure 8. In the history of the 'Para-Munda' lineage Near Eastern wheat-barley agriculture was adopted, as documented archaeologically in Baluchistan and the Indus valley. Note that neither of these cereals or the winter pulses or flax have 'Para-Munda' etymologies. Additional local domesticates were added, such as cotton, sesame and some fruits (*Phoenix sylvestris*, jujube and Indian jambos), all with 'Para-Munda' etymologies. Some species from the Gangetic basin were also adopted, carrying with them loanword names and perhaps accompanying some immigrant farmers (of Language X), such as rice, cucumbers (and other gourds) and native *Panicum* and *Setaria* millets (which would have been subsequently replaced by larger grained *P. miliaceum* and *S. italica*), and native Indian pulses (horsegram, mung and urd).

By contrast the (pre-)Proto-Munda lineage somewhere in Eastern India followed a different trajectory to agriculture. These people adopted (or domesticated) two or three small millets, rice, probably pigeon pea and mungbean, while adopting horsegram and perhaps a small millet from early Dravidian groups or some intermediary, extinct group. It may be that during this process of agricultural beginnings in Eastern India that demographic expansion and cultural differentiation led some offshoot group to move eastwards towards Southeast Asia retaining some tradition of shifting cultivation that involved rice and/or millets (ancestral to Mon-Khmer) (labelled 'B'). If this group had an economic emphasis on shifting cultivation in hilly zones then we might tentatively identify them with the Neolithic of the Orissa hills which produced some shouldered celts, which have long been taken to indicate connections with Southeast Asia (e.g., Wheeler, 1959), but the arrow of dispersal needs to now be reversed to an out-of-India dispersal. Proto-Munda agriculture should perhaps be placed in the Orissan lowlands. The reconstructed rice and millet terms in Proto-Munda all show evidence of having suffered semantic shift between species (including between rice and millets) and often plausible connections with other language families as loanwords in one direction or another (cf. Zide and Zide, 1976:1311; Mahdi, 1998; Witzel, 1999: 30–33). Words for goat, chicken, and draught cattle (zebu?) suggest that the Proto-Munda speech community existed at the time these taxa were dispersed as domesticates across northern India, i.e., in the mid to late third millennium BC. The reconstructed word for water buffalo is perhaps more likely to imply a separate domestication in eastern India, as there is no archaeological basis to infer that the domesticated water buffalos of the Sindhi Harappan (e.g., Dholavira) dispersed widely. It is of note that the water buffalo is symbolically significant amongst ethnographic Munda-speaking peoples (Zide and Zide, 1976:1319). It would be within the cultural context of these emergent agriculturalists of eastern India, that key linguistic changes occurred (marked as “C” in Figure 8, such as the rhythmic and word order changes). Then one cultural lineage (North Munda) must have been more prone to dispersal, perhaps with more of an ancestral emphasis on shifting cultivation (a second wave of hill cultivators), while the other (South Munda) was more prone to sedentarisation and increasing population density. It was within this more sedentary group that pigs were domesticated or adopted and became culturally salient (Figure 8, “D”).

Conclusion: A Mosaic of Origins, Expansions and Interactions

Currently we are on the brink of being able to produce a new synthesis of early agriculture and later Holocene population history in South Asia. Both the archaeology of early agriculture and the historical linguistics of South Asia have undergone major advances in data collection and analysis in recent years. Nevertheless there remain major gaps in the evidence. In archaeology, there are major regional biases in Neolithic excavation and in systematic archaeobotany. Key regions such as central India (Madhya Pradesh) and Eastern India (Jarkhand, Chattisgarh, Orissa, northern Andhra) are still largely unknown and we are forced into speculative scenarios. In the Gangetic basin and South India we face the archaeological challenge that our better documented Neolithic sites are already fully agricultural and more or less sedentary. Their less sedentary, more archaeologically ephemeral predecessors await discovery, although the new research findings at Lahuradewa (Uttar Pradesh) hint at some of the insights such sites may soon yield. As some have long-maintained (e.g., Possehl and Rissman, 1992; Possehl, 1999) there may be a stage during which animal herding spread prior to the beginnings of plant cultivation, but which parts of South Asia and which cultural traditions participated in this remains to be clearly documented through archaeology, in which modern archaeozoology is critical. In the northwest of India and Pakistan a research focus on the Harappan civilization has left Neolithic developments poorly understood.

In terms of linguistics, further collection of data from small languages and relating to ‘minor’ crops is needed. As noted, millets are poorly represented in linguistic sources, both because the botany of linguistic sources is not always clear (and always poorly documented in botanical terms) and because these crops are often not of great subsistence significance in the modern day. Similar problems surround certain vegetable crops, such as the numerous indigenous gourd (cucurbitaceae) crops of northern India. In addition, a more realistic and botanically informed assessment of semantic shift between millets, rice and other cereal crops is needed. As recent research indicates (e.g., Witzel, 1999, 2005; Southworth, 2005a), there is much to gained by further assessment of substrate loanwords and ancient borrowing between languages. The integration of such linguistic findings with an archaeological framework of cultural complexes and chronology offers the greatest promise for an integrated long-term cultural history of South Asian populations. Some working hypotheses in this direction have been offered in the present chapter. Once such a framework is in place, historical linguistics potentially offers archaeologists access to less material aspects of culture, such as concepts of kinship and the supernatural.

The Neolithic revolution fuelled a major demographic expansion. While population density can be theorized to have promoted sedentism (e.g., Rosenberg, 1998), this in turn helped to accelerate population growth. Archaeology indicates a number of distinct Neolithic cultural traditions likely to be based on separate transitions from hunting-and-gathering that involved domestication. This is likely to have occurred at least in South India, Western India (Gujarat), the middle Ganges and probably the Orissan region, as well as distinctive developments in the Indus basin and hill regions to its west. These, and possibly other, Neolithic beginnings must have involved population expansions of culturally distinct groups, presumably with different languages. In addition, the spread of farming through the incorporation of hunter-gatherers might also be expected to have involved language shift to established farmer languages, presumably through high degrees of bilingualism that can account for some of the varied substrates detectable in South Asian languages. As suggested above, the Neolithic languages that underwent expansion, and subsequent diversification, include Proto-Munda (in Eastern India), Proto-Dravidian (or an early derivative) in South India, 'Para-Munda' in the Greater Indus region, and perhaps 'Language X' in the Ganges basin. In Gujarat or south Rajasthan we might perhaps think in terms of a proto-Nahali agricultural language or a second early branch of Dravidian. All of this implies that a large degree of cultural (and linguistic) diversity was already established in South Asia prior to the Neolithic, and this must be accounted for by population expansions during an era of hunter-gatherers, such as during the Pleistocene.

The language history of South Asia extends back to the entry of modern humans, and must be complicated by processes of internal expansion and differentiation and further influxes. In general terms such population processes are indicated in the genetic diversity of modern populations in South Asia, which points to a substantial proportion of human biological diversity as developing within South Asia since the Pleistocene (e.g., Su et al., 1999; Kumar and Mohan Reddy, 2003; Kivisild et al., 2003; see Endicott et al., Stock et al., this volume). Technological innovations and climatic changes must have contributed to these processes (James and Petraglia, 2005). Oxygen Isotope Stage 3 saw the expansion of wet forests as well as grass-dominated savannas, especially after ca. 50,000 years ago (Prabhu et al., 2004), and this presumably promoted the expansion of human groups and facilitated migrations between South Asia and areas to the west. Subsequent dry climate of the last glaciation may have forced population distributions to adjust and separated lineages on either side of the greater Thar Desert. The wetter conditions of the terminal Pleistocene and early Holocene, provided a context that would have encouraged expansion and migration again. It is presumably to such processes, and numerous still imperceptible local processes, that language dispersals into South Asia and deep separations with related cultural lineages must be attributed. Linguistic macro-phyla hypotheses need to be considered against such a backdrop, including the proposed links between Nahali and Ainu (perhaps at the earliest stage), links between Austroasiatic and Austronesian (and perhaps Sumerian, see Witzel, 1999:15–16) or Dravidian and Elamite (and perhaps Afro-asiatic or Sumerian, see Blazek 1999) (at a later stage, but probably still Pleistocene). It is within these earlier stages in which Austroasiatic became widespread across northern South Asia, from the Para-Munda Indus region to the Proto-Munda Orissan region, and during which the ancestors of Proto-Dravidian became established on the Peninsula. The Neolithic revolution then provided a major demographic transition through which established languages expanded and diversified in parallel in several areas of the subcontinent. Subsequently language changes occurred through processes of social interactions that were political as much as demographic, reflected in the extensive evidence for substrates and loanwords (e.g., in Indo-Aryan), and contextualized by the increasing social complexity of the Chalcolithic and Iron Age societies of South Asia. Further research in linguistics, archaeology and their integration has much to reveal about the dynamics of these cultural histories.

Acknowledgments

I would like to acknowledge my debt to several friends and collaborators who have introduced me to the Neolithic archaeology of various parts of India, including Ravi Korisettar, P. C. Venkatasubbaiah, J. N. Pal, M. C. Gupta, Rabi Mohanty, Kishor Basa, Basanta Mohanta, and K. Rajan. My ideas have also developed through ongoing discussions with Nicole Boivin, Emma Harvey, Michael Petraglia, Eleni Asouti and Marco Madella. I have benefited from several discussions and arguments with my archaeobotanist colleagues, Mukund Kajale, K.S. Saraswat and Steve Weber in recent years, which have helped to me to clarify my thinking on our present state of knowledge with regards to early plant cultivars, and I accept responsibility for my differences of opinion. My avocational thinking on Indian linguistics has benefited from recent discussions and correspondence with Frank Southworth, although any mistakes are likely my own. I must thank Qin Ling for introducing me to aspects of the Chinese Neolithic, including material published in the Chinese language. This paper has been improved by those who took time to read and comment on various drafts, including Emma Harvey, Edgar Samarasundara, Archana Verma, Mary Anne Murray and three anonymous peer-reviewers.

References

Allchin, B., Allchin, F.R., 1982. The Rise of Civilization in India and Pakistan. Cambridge University Press, Cambridge.

Allchin, B., Allchin, F.R., 1995. Rock art of north Karnataka. Bulletin of the Deccan College Post-Graduate and Research Institute 54–55, 313–339.

Allchin, F.R., 1963. Neolithic Cattle Keepers of South India. A Case Study of the Deccan Ashmounds. Cambridge University Press, Cambridge.

Allchin, F.R., Allchin, B., 1974. Some new thoughts on Indian cattle. In: van Lohuizen-de Leeuw, J.E., Ubaghs, J.N. (Eds.), South Asian Archaeology 1973. E.J. Brill, Leiden, pp. 71–77.

Ammerman, A.J., Cavalli-Sfroza, L., 1971. Measuring the rate of spread of early farming in Europe. Man (n.s.) 76, 674–688.

Asouti, E., Fuller, D.Q., 2006. Trees and Woodlands in South India: An Archaeological Perspective. UCL Press, London.

Asouti, E., Fuller, D.Q., Korisettar, R., 2005. Vegetation context and wood exploitation in the southern Neolithic: preliminary evidence from wood charcoals. In: Franke-Vogt, U., Weisshaar, J. (Eds.), South Asian Archaeology 2003. Proceedings of the European Association for South Asian Archaeology Conference, Bonn, Germany, 7th - 11th July 2003. Linden Soft, Aachen, pp. 336–340.

Bedigian, D., 2004. History and lore of sesame in southwest Asia. Economic Botany 58(3), 330–353.

Behera, P.K., 2002. Khameswaripali: a protohistoric site in the middle Mahanadi Valley, Orissa: results of first season (1996–97) excavation. In: Sengupta, G., Panja, S. (Eds.), Archaeology of Eastern India: New Perspectives. Jayasree Press, Kolkata, pp. 487–514.

Bellwood, P., 1996. The origins and spread of agriculture in the Indo-Pacific region: gradualism, diffusion or revolution and colonization. In: Harris, D.R. (Ed.), The Origins and Spread of Agriculture and Pastoralism in Eurasia. UCL Press, London, pp. 465–498.

Bellwood, P., 1997. Prehistory of the Indo-Malaysian archipelago. University of Hawaii Press, Honolulu.

Bellwood, P., 2001. Early agriculturalist population diasporas? Farming, languages and genes. Annual Review of Anthropology 30, 181–207.

Bellwood, P., 2005. First Farmers: The Origins of Agricultural Societies. Blackwell, Oxford.

Bhattacharya, S., 1975. Studies in Comparative Munda Linguistics. Indian Institute for Advanced Study, Simla.

Blazek, V., 1999. Elam: abridge between Ancient Near East and Dravidian India? In: Blench, R., Spriggs, M. (Eds.), Archaeology and Language IV. Routledge, London, pp. 48–78.

Blench, R., 1999. Language phyla of the Indo-Pacific region: recent research and classification. Bulletin of the Indo-Pacific Prehistory Association 18, 59–76.

Blench, R., MacDonald, K.C., 2000. Chickens (II.G.6). In: Kiple, K.F., Ornelas, K.C. (Eds.), The Cambridge World History of Food. Cambridge University Press, Cambridge, pp. 496–499.

Blench, R.M., 2004. Archaeology and language: methods and issues. In: Bintliff, J. (Ed.), Blackwell's Companion to Archaeology. Blackwell, Oxford, 52–74.

Blench, R.M., 2005. From the mountains to the valleys: understanding ethnoliguistic geography in Southeast Asia. In: Blench, R.M., Sagart, L., Sanchez-Mazas, A. (Eds.), Perspectives in the Phylogeny of East Asian Languages. Curzon Press, London, pp. 31–50.

Blench, R.M., Spriggs, M., 1999. General introduction. In: Blench, R.M., Spriggs, M. (Eds.), Archaeology and Language IV. Routledge, London, pp. 1–20.

Blust, R., 1996a. Austronesian culture history: the windows of language. In: Goodenough, W. H.(Ed.), Prehistoric Settlement of the Pacific. American Philosophical Society, Philadephia, pp. 28–35.

Blust, R., 1996b. Beyond the Austronesian homeland: the Austric hypothesis and its implications for archaeology. In: Goodenough, W.H. (Ed.), Prehistoric Settlement of the Pacific. American Philosophical Society, Philadelphia, pp. 117–160.

Bogaard, A., 2004. Neolithic Farming in Central Europe. Routledge, London.

Bradley, D.G., Loftus, R., Cunningham, P., MacHugh, D.E., 1998. Genetics and domestic cattle origins. Evolutionary Anthropology 6, 79–86.

Burrow, T., Emeneau, M.B., 1984. A Dravidian Etymological Dictionary. Clarendon Press, Oxford.

Chang, K.-C., 1986. The Archaeology of China. Yale University Press, New Haven.

Chang, T.T., 1989. Domestication and spread of the cultivated rices. In: Harris, D.R., Hillman, G.C. (Eds.), Foraging and Farming: The Evolution of Plant Exploitation. Unwin, London, pp. 408–417.

Chang, T.T., 1995. Rice. In: Smartt, J., Simmonds, N.W. (Eds), Evolution of Crop Plants. Longman Scientific, Essex, pp. 147–155.

Chang, T.T., 2000. Rice (II.A.7). In: Kiple, K.F., Ornelas, K.C. (Eds.), The Cambridge World History of Food. Cambridge University Press, Cambridge, pp. 132–149.

Charles, M.P., 2006. East of Eden? A consideration of the Neolithic crop spectra in the eastern Fertile Crescent and beyond. In: Colledge, S., Conolly, J. (Eds.), The Origins and Spread of Domestic Plants in Southwest Asia and Europe. UCL Press, London.

Chattopadyaya, U.C., 1996. Settlement pattern and the spatial organization of subsistence and mortuary practices in the Mesolithic Ganges Valley, North-Central India. World Archaeology 27, 461–476.

Chattopadyaya, U.C., 2002. Researches in archaeozoology of the Holocene period (including the Harappan Tradition in India and Pakistan). In: Settar, S., Korisettar, R. (Eds.), Indian Archaeology in Retrospect, Volume III. Archaeology and Interactive Disciplines. Manohar, New Delhi, pp. 365–422.

Chen, W.-B., Nakamura, I., Sato, Y.-I., Nakai, H., 1993a. Distribution of deletion type in cpDNA of cultivated and wild rice. Japanese Journal of Genetics 68, 597–603.

Chen, W.-B., Nakamura, I., Sato, Y.-I., Nakai, H., 1993b. Indica and Japonica differentiation in Chinese landraces. Euphytica 74(3), 195–201

Cheng, C., Motohashi, R., Tchuchimoto, S., Fukuta, Y., Ohtsubo, H., Ohtsubo, E., 2003. Polyphyletic origin of cultivated rice: based on the interspersion patterns of SINEs. Molecular Biology and Evolution 20, 67–75.

Clarke, G.D., Khanna, G.S., 1989. The site of Kunjhun II, Middle Son Valley, and its relevance for the Neolithic of Central India. In: Kenoyer, J.M. (Ed.), Old Problems and New Perspectives in the Archaeology of South Asia. Department of Anthropology, University of Wisconsin, Madison, pp. 29–46.

Cohen, D.J., 1998. The origins of domesticated cereals and the Pleistocene-Holocene transition in East Asia. The Review of Archaeology 19, 22–29.

Cohen, D.J., 2002. New perspectives on the transition to agriculture in China. In: Yasuda, Y. (Ed.), The Origins of Pottery and Agriculture. Lustre Press and Roli Books, New Delhi, pp. 217–227.

Cohen, M.N., 1991. Health and the Rise of Civilization. Yale University Press, New Haven.

Colledge, S., Conolly, J., 2002. Early Neolithic agriculture in Southwest Asia and Europe: re-examining the archaeobotanical evidence. Archaeology International 5, 44–46.

Committee, S., C.R.P. 1962. The test excavation of Guang Fu Lin Neolithic site at Songjia county of Shanghai. Kao Gu (archaeology), 9.

Conningham, R., Sutherland, 1998. Dwellings or granaries? The pit phenomenon of the Kashmir-Swat Neolithic. Man and Environment 22, 29–34.

Cooke, M., Fuller, D.Q., Rajan, K., 2005. Early Historic agriculture in southern Tamil Nadu: archaeobotanical research at Mangudi, Kodumanal and Perur. In: Franke-Vogt, U., Weisshaar, J. (Eds.), South Asian Archaeology 2003. Proceedings of the European Association for South Asian Archaeology Conference, Bonn, Germany, 7th – 11th July 2003. Linden Soft, Aachen, pp. 341–350.

Costantini, L., 1979. Plant remains at Pirak. In: Jarrige, J.-F., Saontoni, M. (Eds.), Fouilles de Pirak, Volume 1. Difussion de Boccard, Paris, pp. 326–333.

Costantini, L., 1983. The beginning of agriculture in the Kachi Plain: the evidence of Mehrgarh. In Allchin, B. (Ed.), South Asian Archaeology 1981. Cambridge University Press, Cambridge, pp. 29–33.

Costantini, L., 1987. Appendix B. Vegetal remains. In: Stacul, G. (Ed.), Prehistoric and Protohistoric Swat, Pakistan. Instituto Italiano per il Medio ed Estremo Orientale, Rome, pp. 155–165.

Costantini, L., Biasini, L.C., 1985. Agriculture in Baluchistan between the 7th and 3rd Millenium B.C. Newsletter of Baluchistan Studies 2, 16–37.

Crawford, G., Shen, C., 1998. The origins of rice agriculture: recent progress in East Asia, Antiquity 72, 858–866.

Crawford, G., 2006. East Asian plant domestication. In: Stark, M. (Ed.) Archaeology of Asia. Blackwell, Oxford, pp. 77–95.

Crowley, T., 1997. An Introduction to Historical Linguistics. Oxford University Press, Oxford.

Decker-Walters, D.S., 1999. Cucurbits, Sanskrit, and the Indo-Aryans. Economic Botany 53(1), 98–112.

Deshpande, M.M., 1995. Vedic aryans, non-Vedic aryans, and non-Aryans: judging the linguistics evidence of the Veda. In: Erdosy, G. (Ed.), The Indo-Aryans of Ancient South Asia. Language Material Culture and Ethnicity. Walter de Gruyte, Berlin, pp. 67–84.

Diamond, J., Bellwood, P., 2003. Farmers and their languages: the first expansions. Science 300, 597–603.

Diffloth, G., 2005. Austroasiatic languages. In Encyclopedia Britannica, 2005 online edition, retrieved from 10 July 2005 from http://www.britannica.com/eb/article-9109792.

Donegan, P., Stampe, D., 2004. Rhythm and the synthetic drift of Munda. In: Singh, R. (Ed.), The Yearbook of South Asian Languages and Linguistics 2004. Mouton de Gruyter, Berlin, pp. 3–36.

Ehret, C., 1988. Language change and the material correlates of language and ethnic shift. Antiquity 62, 564–74.

Elfenbein, J., 1987. A periplus of the 'Brahui Problem'. Studia Iranica 16, 215–233.

Elfenbein, J., 1998. Brahui. In: Steever, S.B. (Ed.), The Dravidian Languages. Routledge, London, pp. 388–414.

Emeneau, M.B., 1997. Linguistics and botany in the Nilgiris. In: Hoskins, P. (Ed.), Blue Mountains Revisited: Cultural Studies on the

Nilgiri Hills. Oxford University Press, New Delhi, pp. 74–105.

Endicott, P., Metspalu, M., Kivisild, T., 2006. Genetic evidence on modern human dispersals in South Asia: Y chromosome and mitochondrial DNA perspectives. In: Petraglia, M.D., Allchin, B. (Eds.), The Evolution and History of Human Populations in South Asia: Interdisciplinary Studies in Archaeology, Biological Anthropology, Linguistics and Genetics. Springer, Netherlands, pp. 227–242.

Fairservis, W.A., Southworth, F., 1989. Linguistic archaeology and the Indus Valley Culture. In: Kenoyer, J.M. (Ed.), Old Problems and New Perspectives in the Archaeology of South Asia. Department of Anthropology, University of Wisconsin, Madison, pp. 133–141.

Fuchs, S., 1973. The Aboriginal Tribes of India. Macmillan Press, Madras/London.

Fuller, D.Q., 2001. Harappan seeds and agriculture: some considerations. Antiquity 75, 410–413.

Fuller, D.Q., 2002. Fifty years of archaeobotanical studies in India: laying a solid foundation, In: Settar, S., Korisettar, R. (Eds.), Indian Archaeology in Retrospect, Volume III. Archaeology and Interactive Disciplines. Manohar, Delhi, pp. 247–363.

Fuller, D.Q., 2003a. An agricultural perspective on Dravidian historical linguistics: archaeological crop packages, livestock and Dravidian crop vocabulary. In: Bellwood, P., Renfrew, C. (Eds.), Examining the Farming/Language Dispersal Hypothesis. McDonald Institute for Archaeological Research, Cambridge, pp. 191–213.

Fuller, D.Q., 2003b. Indus and non-Indus agricultural traditions: local developments and crop adoptions on the Indian peninsula. In: Weber, S.A., Belcher, W.R. (Eds.), Indus Ethnobiology. New Perspectives from the Field. Lexington Books, Lanham, pp. 343–396.

Fuller, D.Q., 2003c. African crops in prehistoric South Asia: a critical review. In: Neumann, K., Butler, A., Kahlheber, S. (Eds.), Food, Fuel and Fields: Progress in African Archaeobotany. Heinrich-Barth Institut, Köln, pp. 239–271.

Fuller, D.Q., 2003d. Further evidence on the prehistory of sesame. Asian Agri-History 7(2), 127–137.

Fuller, D.Q., 2006. Dung mounds and domesticators: early cultivation and pastoralism in Karnataka. In: Jarrige, C., Lefèvre, V. (Eds.), South Asian Archaeology 2001, Volume I. Prehistory. Éditions Recherche sur les Civilisations, Paris, pp. 117–127.

Fuller, D.Q., Boivin, N.L., 2005. From domestic economy to political economy: a framework for thinking about changes in artefacts and agriculture in prehistoric South India. Paper presented at the Bienneal Conference of the European Association of South Asian Archaeology, London, July, 2005.

Fuller, D.Q., Boivin, N.L., Korisettar, R., 2006. Dating the Neolithic of south India: new radiometirc evidence for key economic, social and ritual transformations. Antiquity, in press.

Fuller, D.Q., Harvey, E.L., 2006. The archaeobotany of Indian pulses: identification, processing and evidence for domestication. Environmental Archaeology, in press.

Fuller, D.Q., Korisettar, R., 2004. The vegetational context of early agriculture in South India. Man and Environment 29, 7–27.

Fuller, D.Q., Korisettar, R., Venkatasubbaiah, P.C., Jones, M.K., 2004. Early plant domestications in southern India: some preliminary archaeobotanical results. Vegetation History and Archaeobotany 13, 115–129.

Fuller, D.Q., Madella, M., 2001. Issues in Harappan archaeobotany: retrospect and prospect. In: Settar, S., Korisettar, R. (Eds.), Indian Archaeology in Retrospect, Vol. II. Protohistory. Manohar, New Delhi, 317–390.

Fuller, D.Q., Korisettar, R., Venkatasubbaiah, P.C., 2001a. Southern Neolithic cultivation systems: a reconstruction based on archaeobotanical evidence. South Asian Studies 17, 171–187.

Fuller, D.Q., Venkatasubbaiah, P.C., Korisettar, R., 2001b. The beginnings of agriculture in the Kunderu River Basin: evidence from archaeological survey and archaeobotany. Puratattva 31, 1–8.

Thompson, G.B.T., 1996. The Excavations of Khok Phanom Di: A Prehistoric Site in Central Thailand. Volume IV: Subsistence and Environment: The Botanical Evidence. Oxbow Books, Oxford.

Gadgil, M., Joshi, N.V., Shambu Prasad, U.V., Manoharan, S., Patil, S. 1998. Peopling of India. In: Balasubramanian, D., Appaji Rao, N. (Eds.), The Indian Human Heritage. Universities Press, Hyderabad, pp. 100–129.

Garrard, A., 2000. Charting the emergence of cereal and pulse domestication in South-West Asia. Environmental Archaeology 4, 67–86.

Glover, I.C., Higham, C.F.W., 1996. New evidence for early rice cultivation in South, Southeast and East Asia. In: Harris, D.R. (Ed.), The Origins and Spread of Agriculture and Pastoralism in Eurasia. UCL Press, London, pp. 413–441.

Grove, C.P., 1985. On the agriotypes of domestic cattle and pigs in the Indo-Pacific region. In: Misra, V.N., Bellwood, P. (Eds.) Recent Advances in Indo-Pacific Prehistory. Oxford and IBH, New Delhi, pp. 429–438.

Harlan, J.R., 1971. Agricultural origins: centers and noncenters. Science 174, 468–474. Harlan, J.R., 1992. Crops and Ancient Man. American Society for Agronomy, Madison.

Harris, D.R., 1998a. The origins of agriculture in Southwest Asia. The Review of Archaeology 19, 5–11.

Harris, D.R., 1998b. The spread of Neolithic agriculture from the Levant to Western Central Asia, In: Damania, A.D., Valkoun, J., Willcox, G., Qualset, C.O. (Eds.), The Origins of Agriculture and Crop Domestication. Proceedings of the Harlan Symposium 10–14 May 1997, Aleppo, Syria. International Center for Agricultural Research in the Dry Areas, Alllepo, pp. 65–82

Harvey, E., Fuller, D.Q., 2005. Investigating crop processing through phytolith analysis: the case of rice and millets. Journal of Archaeological Science 32, 739–752.

Harvey, E., Fuller, D.Q., Basa, K.K., Mohanty, R., Mohanta, B., 2006. Early agriculture in Orissa: some archaeobotanical results and field observations on the Neolithic. Man and Environment, 30, in press.

Harvey, E., Fuller, D.Q., Pal, J.N., Gupta, M.C., 2005. Early agriculture of Neolithic Vindyhas (North-Central India). In: Franke-Vogt, U., Weisshaar, J. (Eds.), South Asian Archaeology 2003. Proceedings of the European Association for South Asian Archaeology Conference, Bonn, Germany, 7th - 11th July 2003. Lindin Soft, Aachen, pp. 329–334.

Hiendleder, S., Kaupe, B., Wassmuth, R., Janke, A., 2002. Molecular analysis of wild and domestic sheep questions current nomenclature and provides evidence for domestication from two different subspecies. Proceedings of the Royal Society of London B 269, 893–904.

Higham, C.F.W., 1998. Archaeology, linguistics and the expansion of the Southeast Asian Neolithic. In: Blench, R., Spriggs, M. (Eds.), Archaeology and Language II. Routledge, London, pp. 103–114.

Higham, C.F.W., 2003. Languages and farming dispersals: Austroasiatic languages and rice cultivation. In: Renfrew, C., Bellwood, P. (Eds.) Examining the Farming/Language Dispersal Hypothesis. McDonald Institute for Archaeological Research, Cambridge, pp. 223–232.

Higham, C.F.W., Thosarat, R., 1998. Prehistoric Thailand: From early settlement to Sukothai. River Books, Bangkok.

Hillman, G.C., 2000. Abu Hireyra 1: The Epipalaeolithic. In: Moore, A.M.T., Hillman, G.C., Legge, A.J. (Eds.), Village on the Euphrates: From Foraging to Farming at Abu Hureyra. Oxford University Press, New York, pp. 327–398.

Hillman, G.C., Hedges, R., Moore, A.M.T., Colledge, S., Pettitt, P., 2001. New evidence of Late Glacial cereal cultivation at Abu Hureyra on the Euphrates. The Holocene 11, 383–393.

Hillman, G.C., Mason, S., de Moulins, D., Nesbitt, M., 1996. Identification of archaeological remains of wheat: the 1992 London Workshop. Circaea 12, 195–209.

Hoffpauir, R., 2000. Water Buffalo, (II.G.23). In: Kiple, K. F. and Ornelas, K. C. (Eds.), The Cambridge world history of food. Cambridge University Press, Cambridge, pp. 583–607.

James, H.V.A., Petraglia, M.D., 2005. Modern human origins and the evolution of behavior in the Later Pleistocene record of South Asia. Current Anthropology 46(S5), S3–S28.

Jarrige, J.-F., 1985. Continuity and change in the North Kachi Plain (Baluchistan, Pakistan) at the beginning of the second millennium BC. In: Schotmans, J., M. Taddei, M. (Eds.), South Asian Archaeology 1983. Instituto Universitario Orientale, Dipartimento di Studi Asicatici, Naples, pp. 35–68.

Jarrige, J.-F., 1987. Problèmes de datation du site néolithique de Mehrgarh, Baluchistan, Pakistan. In: Aurenche, O., Evin, J., Hours, F. (Eds.), Chronologies du Proche Orient/Chronologies in the Near East: Relative Chronologies and Absolute Chronology 16,000–4,000 B.P. British Archaeological Reports International Series 379, Oxford, pp. 381–386.

Jarrige, J.-F., 1997. From Nausharo to Pirak: continuity and change in the Kachi/Bolan region from 3rd to 2nd Millennium BC. In: Allchin, R., Allchin, B. (Eds.), South Asian Archaeology 1995. Oxford-IBH, New Delhi, pp. 35–68.

Jarrige, J.-F., Jarrige, C., Quivron, G., 2006. Mehrgarh Neolithic: the updated sequence. In: Jarrige, C., Lefèvre, V. (Eds.), South Asian Archaeology 2001. Éditions Recherche sur les Civilisations, Paris, pp. 129–142.

Joglekar, P.P., 2004. Animal economy at Lahuradewa, preliminary results. Paper presented at the Indian Archaeological Society and Indian Society for

Quaternary Science and Preshitoric Studies annual conference, Lucknow, December 2004.

Joglekar, P.P., Thomas, P.K., 1993. Faunal diversity at Walki: a small Chalcolithic settlement in western Maharashtra. Bulletin of the Deccan College Post-Graduate and Research Institute 53, 75–94.

Kajale, M.D., 1979. On the occurrence of ancient agricultural patterns during the Chalcolithic periods (c. 1600–1000 BC) at Apegaon, District Aurangabad in central Godavari valley, Maharashtra. In: Deo, S.B., Dhavalikar, M.K., Ansari, Z.D. (Eds.), Apegaon Excavations. Deccan College, Pune, pp. 50–56.

Kajale, M.D., 1988. Plant economy. In: Dhavalikar, M.K., Sankalia, H.D., Ansari, Z.D. (Eds.), Excavations at Inamgaon. Deccan College Postgraduate and Research Institute, Pune, pp. 727–821.

Kajale, M.D., 1989. Archaeobotanical investigation on Megalithic Bhagimohari, and its significance. Man and Environment 13, 87–96.

Kajale, M.D., 1990. Observations on the plant remains from excavation at Chalcolithic Kaothe, District Dhule, Maharashtra with cautionary remarks on their interpretations. In: Dhavalikar, M.K., Shinde, V.S., Atre, S.M. (Eds.), Excavations at Kaothe. Deccan College, Pune, pp. 265–280.

Kajale, M.D., 1991. Current status of Indian palaeoethnobotany: introduced and indigenous food plants with a discussion of the historical and evolutionary development of Indian agriculture and agricultural systems in general. In: Renfrew, C. (Ed.), New Light on Early Farming – Recent Developments in Palaeoethnobotany. Edinburgh University Press., Edinburgh, pp. 155–189.

Kajale, M.D., 1994. Archaeobotanical investigations on a multicultural site at Adam, Maharashtra, with special reference to the development of tropical agriculture in arts of India. In: Hather, J. (Ed.), Tropical Archaeobotany: Applications and New Developments. Routledge, London, pp. 34–50.

Kajale, M.D., 1996. Palaeobotanical investigations at Balathal: preliminary results. Man and Environment 21, 98–102.

Kar, S.K., 1995. Further exploration at Golpalpur, Orissa. Puratattva 26, 105–106.

Kar, S.K., 2000. Gopalpur; A Neolithic-Chalcolithic site in coastal Orissa. In: Basa, K.K., Mohanty, P. (Eds.), Archaeology of Orissa. Pratibha Prakashan, Delhi, pp. 368–391.

Kar, S. K., Basa, K.K., Joglekar, P.P., 1998. Explorations at Gopalpur, District Nayagarh, Coastal Orissa. Man and Environment 23, 107–114.

Kennedy, K.A.R., 2000. God-Apes and Fossil Men: Paleoanthropology in South Asia. University of Michigan Press, Ann Arbor.

Kharrakwal, J.S., Yano, A., Yasuda, Y., Shinde, V.S., Osada, T., 2004. Cord impressed ware and rice cultivation in South Asia, China and Japan: possibilities of inter-links, Quaternary International 123–125, 105–115.

Kivisild, T., Rootsi, S., Metspalu, M., Mastana, S., Kaldma, K., Parik, J., Metspalu, E., Adojaan, M., Tolk, H.-V., Stepanov, V., Goge, M., Usanga, E., Papiha, S.S., Cinniogu, C., King, R., Cavalli-Sforza, L., Underhill, P.A., Villems, R., 2003. The genetic heritage of the earliest settlers persists both in Indian tribal and caste populations. American Journal of Human Genetics 72, 313–332.

Korisettar, R., Joglekar, P.P., Fuller, D.Q., Venkatasubbaiah, P.C., 2001b. Archaeological re-investigation and archaeozoology of seven southern Neolithic sites in Karnataka and Andhra Pradesh. Man and Environment 26, 47–66.

Korisettar, R., Venkatasubbaiah, P.C., Fuller, D.Q., 2001a. Brahmagiri and beyond: the archaeology of the southern Neolithic. In: Korisettar, R., Settar, S. (Eds.), Indian Archaeology in Retrospect, Volume I. Prehistory. Manohar, New Delhi, pp. 151–238.

Krishnamurti, B., 2003. The Dravidian Languages. Cambridge University Press, Cambridge.

Kuiper, F.B.J., 1991. Aryans in the Rig Veda. Rodopi, Amsterdam/Atlanta.

Kumar, P., Freeman, A.R., Loftus, R.T., Gaillard, C., Fuller, D.Q., Bradley, D.G., 2003. Admixture analysis of South Asian cattle. Heredity 91, 43–50.

Kumar, V., Mohan Reddy, B., 2003. Status of Austro-Asiatic groups in the peopling of India: an exploratory study based on the available prehistoric, linguistic and biological evidence. Journal of Bioscience 28, 507–522.

Larsen, C.S., 1997. Biological changes in human populations with agriculture. Annual Review of Anthropology 24, 185–213.

Leshnik, L.S., 1973. Land use and ecological factors in prehistoric north-west India. In: Hammond, N. (Ed.), South Asian Archaeology. Duckworth, London, pp. 67–84.

Liu, L., Chen, X., 2004. The measurement and primary analysis of the buffalo bones from the Kua Hu Qiao site. In: Zhejian Provincial Institute of Archaeology and Cultural Relics, Kua Hu Qiao: A Neolithic Site Excavation Report. Wenwu Press, Beijing. [In Chinese]

Lone, Farooq A., Maqsooda Khan, Buth, G.M., 1993. Palaeoethnobotany – Plants and Ancient Man in Kashmir. A.A. Balkema, Rotterdam.

Lu, T.L.D., 1999. The Transition from Foraging to Farming and the Origin of Agriculture in China. British Archaeological Reports, Oxford.

Lu, T.L.D., 2006. The origin and dispersal of agriculture and human diaspora in East Asia. In: Sagart, L., Blench, R., Sanchez-Mazas, A. (Eds.), The Peopling of East Asia: Putting Together Archaeology, Linguistics and Genetics. Routledge Curzon, London, pp. 51–62.

Luikart, G., Gielly, L., Excoffier, L., Vigne, J.-D., Bouvet, J., Taberlet, P., 2001. Multiple maternal origins and weak phylogeographic structure in domestic goats. Proceedings of the National Academy of Sciences (USA) 98, 5927–5932.

Lukacs, J.R., 2002. Hunting and gathering strategies in prehistoric India: a biocultural perspective on trade and subsistence. In: Morrison, K.D., Junker, L.L. (Eds.), Forager-Traders in South and Southeast Asia. Cambridge University Press, Cambridge, pp. 41–61.

Lukacs, J.R., 2006. Interpreting biological diversity in South Asian prehistory: Early Holocene population affinities and subsistence adaptations. In: Petraglia, M.D., Allchin, B. (Eds.), The Evolution and History of Human Populations in South Asia: Interdisciplinary Studies in Archaeology, Biological Anthropology, Linguistics and Genetics. Springer, Netherlands, pp. 271–295.

Lukacs, J.R., Pal, J.N., 1993. Mesolithic subsistence in north India: Inferences from dental attributes. Current Anthropology, 34(5), 745–765.

MacHugh, D.E., Shriver, M.D., Loftus, R.T., Cunningham, P., Bradley, D.G., 1997. Microsatellite DNA variation and the evolution, domestication and phylogeography of taurine and zebu cattle (*Bos taurus* and *Bos indicus*). Genetics 146, 1071–1086.

MacNeish, R.S., 1992. The Origins of Agriculture. University of Oklahoma Press, Norman, Oklahoma.

Madella, M., 2003. Investigating agriculture and environment in South Asia: present and future considerations of opal phytoliths. In: Weber, S.A., Belcher, W.R. (Eds.), Indus Ethnobiology: New Perspectives from the Field. Lexington Books, Lanham, pp. 199–250.

Magee, D.A., Mannen, H., Bradley, D., 2006. Duality in *Bos indicus* mtDNA diversity: support for geographical complexity in zebu domestication. In: Petraglia, M.D., Allchin, B. (Eds.), The Evolution and History of Human Populations in South Asia: Interdisciplinary Studies in Archaeology, Biological Anthropology, Linguistics and Genetics. Springer, Netherlands, pp. 381–387.

Mahdi, W., 1998. Transmission of southeast Asian cultigens to India and Sri Lanka. In: Blench, R., Spriggs, M. (Eds.), Archaeology and Language II: Archaeological Data and Linguistic Hypotheses. Routledge, London, pp. 390–415.

Mani, B.R., 2004. Further evidence on Kashmir Neolithic in light of recent excavations at Kanishkapura. Journal of Interdisciplinary Studies in History and Archaeology 1(1), 137–142.

Masica, C.P., 1979. Aryan and non-Aryan elements in north Indian agriculture. In: Deshpande, M.M., Hook, P.E. (Eds.), Aryan and Non-Aryan in India. Center for South and Southeast Asian Studies, University of Michigan, Ann Arbor, pp. 55–151.

Masica, C.P., 1991. The Indo-Aryan Languages. Cambridge University Press, Cambridge.

McAlpin, D.W., 1981. Proto-Elamo-Dravidian: The Evidence and its Implications. American Philosophical Society, Philadelphia.

Meadow, R., 1984. Animal Domestication in the Middle East: A View from the Eastern Margin. In: Clutton-Brock, J., Grigson, C. (Eds.), Animals in Archaeology 3. Early Herders and their Flocks. British Archaeological Reports, Oxford, pp. 309–337.

Meadow, R., 1993. Animal domestication in the Middle East: a revised view from the eastern Margin. In: Possehl, G.L. (Ed.), Harappan Civilization: A Recent Perspective. Oxford and IBH, New Delhi, pp. 295–320.

Meadow, R., 1996. The origins and spread of agriculture and pastoralism in northwestern South Asia In: Harris, D.R. (Ed.), The Origins and Spread of Agriculture and Pastoralism in Eurasia. UCL Press, London, pp. 390–412.

Meadow, R., 1998. Pre- and Proto-Historic agricultural and pastoral transformations in northwestern South Asia. The Review of Archaeology 19, 12–21.

Meadow, R., Patel, A.K., 2003. Prehistoric pastoralism in northwestern South Asia from the Neolithic through the Harappan Period. In: Weber, S.A., Belcher, W.R. (Eds.), Indus Ethnobiology: New Perspectives from the Field. Lexington Books, Lanham, pp. 65–94.

Meher-Homji, V.M., 2001. Bioclimatology and Plant Geography of Peninsular India. Scientific Publishers, Jodhpur.

Misra, V.D., 1999. Agriculture, domestication of animals and ceramic and other industries in prehistoric India: Mesolithic and Neolithic. In: Pande, G.C. (Ed.), The Dawn of Civilization up to 600 BC. Centre for Studies in Civilization, Delhi, pp. 233–266.

Misra, V.D., Pal, J.N., Gupta, M.C., 2001. Excavation at Tokwa: a Neolithic-Chalcolithic settlement. Pragdhara 11, 59–72.

Misra, V.D., Pal, J.N., Gupta, M.C., 2004. Significance of recent excavations at Tokwa in the Vindhyas and Jhusi in the Gangetic Plains. Journal of Interdisciplinary Studies in History and Archaeology 1(1), 120–126.

Mohanty, B., 1994. Golbai: a new horizon in Orissan archaeology. Orissa Historical Research Journal 39, 30–32.

Moore, A.M.T., Hillman, G.C., Legge, A.T., 2000. Village on the Euphrates: From Foraging to Farming at Abu Hureyra. Oxford University Press, New York.

Moulherat, C., Tengberg, M., Haquet, J.-F., Mille, B., 2002. First evidence of cotton at Neolithic Mehrgarh, Pakistan: analysis of mineralized fibres from a copper bead. Journal of Archaeological Science 29, 1393–1401.

Mufwene, S.S., 2001. The Ecology of Language Evolution. Cambridge University Press, Cambridge.

Nagaraja Rao, M.S., Malhotra, K.C., 1965. Stone Age Hill Dwellers of Tekkalakota. Deccan College, Pune.

Neumann, K., 2004. The romance of farming: plant cultivation and domestication in Africa. In: Stahl, A.B. (Ed.), African Archaeology: A Critical Introduction. Blackwell, Oxford, pp. 249–275.

Oka, H. I., 1988. Origin of Cultivated Rice. Japan Science Society Press, Tokyo.

Paddayya, K., 1998. Evidence of Neolithic cattle-penning at Budihal, Gulbarga District, Karnataka. South Asian Studies 14, 141–153.

Paddayya, K., 2001. The problem of ashmounds of Southern Deccan in the light of the Budihal excavations, Karnataka. Bulletin of the Deccan College Post-Graduate and Research Institute 60–61, 189–225.

Pandey, J.N., 1990. Mesolithic in the Middle Ganga Valley. Bulletin of the Deccan College Post-Graduate and Research Institute 49, 311–316.

Panja, S., 1999. Mobility and subsistence strategies: a case study of Inamgaon, a Chalcolithic sites in western India. Asian Perspectives 38, 154–185.

Panja, S., 2001. Research on the Deccan, Chalcolithic. In: Settar, S., Korisettar, R. (Eds.), Indian Archaeology in Retrospect, Volume I. Prehistory. Manohar, New Delhi, pp. 263–276.

Parpola, A., 1994. Deciphering the Indus Script. Cambridge University Press, Cambridge.

Parpola, A., 1988. The coming of the Aryans to Iran and India and the cultural and ethnic identity of the Dasas. Studia Orientalia (Helsinki) 64, 195–302.

Patel, A.K., 1997. The pastoral economy of Dholavira: a first look at animals and urban life in third millennium Kutch. In: R. Allchin, Allchin, B. (Eds.), South Asian Archaeology 1995. Oxford-IBH, New Delhi, pp. 101–114.

Patel, A.K., 1999. Paper presented at Fifteenth International Conference on South Asian Archaeology, Leiden Univerisy, July 5–9, 1999.

Patel, A.K., Meadow, R., 1998. The exploitation of wild and domestic water buffalo in prehistoric northwestern South Asia. In: Buitenhuis, H., Bartosiewicz, L., Choyke, A. M. (Eds.), Archaeozoology of the Near East III. Centre for Archaeological Research and Consultancy, Rijksuniversiteit Groningen, Groningen, pp. 180–199.

Pejros, I., Snirelman, V., 1998. Rice in Southeast Asia: a regional interdisciplinary approach. In: Blench, R., Spriggs, M. (Eds.), Archaeology and Language II: Archaeological Data and Linguistic Hypotheses. Routledge, London, pp. 379–389.

Pokharia, A.K., Saraswat, K.S., 2004. Plant resources in the Neolithic Economy at Kanishpur, Kashmir. Paper presented at National Seminar on the Archaeology of the Gange Plain, Joint Annual Conference of the Indian Archaeological Society, Indian Society of Prehistoric and Quaternary Studies, Indian History and Culture Society, December 2004, Lucknow.

Possehl, G.L., 1999. Indus Age: The Beginnings. University of Pennsylvania Press, Philadephia.

Possehl, G.L., 2002. The Indus Civilization: A Contemporary Perspective. Alta Mira, Walnut Creek.

Possehl, G.L., Rissman, P., 1992. The chronology of prehistoric India from earliest times to the Iron Age. In: Ehrich, R.W. (Ed.), Chronologies in Old World Archaeology. University of Chicago Press, Chicago, vol. 1, pp. 465–490, vol. 2, pp. 447–474.

Prabhu, C.N., Shankar, R., Anupama, A., Taieb, M., Bonnefille, R., Vidal, L., Prasad, S., 2004. A 200-ka pollen and oxygen-isotopic record from two sediment cores from the eastern Arabian Sea. Palaeogeography, Palaeoclimatology, Palaeoecology 214, 309–321.

Puri, G. S., Gupta, R.K., Meher-Homji, V.M., Puri, S., 1989. Forest Ecology (second edition), Volume II. Plant Form, Diversity, Communities and Succession. Oxford and IBH, New Delhi.

Puri, G.S., Meher-Homji, V.M., Gupta, R.K., Puri, S., 1983. Forest Ecology (second edition), Volume I. Phytogeography and Forest Conservation. Oxford and IBH, New Delhi.

Reddy, S.N., 2003. Discerning Palates of the Past: An Ethnoarchaeological Study of Crop Cultivation and Plant Usage in India. Prehistory Press, Ann Arbor.

Renfrew, C., 1987. Archaeology and Language: The Puzzle of Indo-European Origins. Cambridge University Press, Cambridge.

Renfrew, C., 1996. Language families and the spread of farming. In: Harris, D.R. (Ed.), The Origins and Spread of Agriculture and Pastoralism in Eurasia. UCL Press, London, pp. 70–92.

Renfrew, C., 2000. At the edge of knowability: towards a prehistory of languages. Cambridge Archaeological Journal 10, 7–34.

Rosenberg, M., 1998. Cheating at musical chairs: territoriality and sedentism in an evolutionary context. Current Anthropology 39, 653–681.

Rouse, I., 1986. Migrations in Prehistory. Yale University Press, New Haven.

Sano, R., Morishima, H., 1992. Indica-Japonica differentiation of rice cultivars viewed from variations in key characters of isozyme, with species reference to Himilayan hilly areas. Theoretical and Applied Genetics 84, 266–274.

Saraswat, K.S., 1991. Crop economy at ancient Mahorana, Punjab (c. 2100–1900 B.C.). Pragdhara 1, 83–88.

Saraswat, K.S., 1993. Plant economy of Late Harappans at Hulas. Purattatva 23, 1–12.

Saraswat, K.S., 2002. Banawali (29′37′5″N; 75′23′6″E), District Hissar. Indian Archaeology 1996–97- A Review, 203.

Saraswat, K.S., 2004a. Plant economy of early farming communities at Senuwar, Bihar. In: Singh, B.P. (Ed.), Senuwar Excavations. Banares Hindu University, Varanasi.

Saraswat, K.S., 2004b. Plant economy of Damdama. Paper presented at Indian Archaeological Society and Indian Society for Quaternary Science and Preshitoric Studies, Lucknow, December 2004.

Saraswat, K.S., 2005. Agricultural background of the early farming communities in the Middle Ganga Plain. Pragdhara 15, 145–178.

Saraswat, K.S., Chanchala, 1995. Palaeobotanical and pollen analytical investigations. Indian Archaeology 1990–91 - A Review, 103–104.

Saraswat, K.S., Pokharia, A.K., 2002. Harappan plant economy at ancient Balu, Haryana. Pragdhara 12, 153–172.

Saraswat, K.S., Pokharia, A.K., 2003. Palaeoethnobotanical investigations at Early Harappan Kunal. Pragdhara 13, 105–140.

Saraswat, K.S., Pokharia, A.K., 2004. Archaeological studies in the Lahuradewa Area 2. Plant economy at Lahuradewa: a preliminary contemplation. Paper presented at National Seminar on the Archaeology of the Ganga Plain, Joint Annual Conference of the Indian Archaeological Society, Indian Society of Prehistoric and Quaternary Studies, Indian History and Culture Society, December 2004, Lucknow.

Saraswat, K.S., Sharma, N.K., Saini, D C., 1994. Plant economy at ancient Narhan (Ca. 1,300 B.C. - 300/400 A.D.). In: Singh, P. (Ed.), Excavations at Narhan (1984–1989). Banaras Hindu University, Varanasi, pp. 255–346.

Sato, Y.-I., 2002. Origin of rice cultivation in the Yangtze River Basin. In: Yasuda, Y. (Ed.), The Origins of Pottery and Agriculture. Lustre Press and Roli Books, New Delhi, pp. 143–150.

Sato, Y.I., 2005. Rice and Indus civilization. In: Osada, T. (Ed.), Linguistics, Archaeology and Human Past. Research Institute for Humanity and Nature, Kyoto, pp. 213–214.

Sato, Y.-I., Ishikawa, R., Morishima, H. 1990. Nonrandom association of genes and characters found in indica x japonica hybrids of rice. Heredity 65, 75–79.

Shanghai Cultural Relics Protection Committee, 1962. The Test Excavation of Guang Fu Lin Neolithic Site at Songjia County of Shanghai, Kao Gu (archaeology), 9. [in Chinese]

Sharma, A.K., 1982 Excavations at Gufkral, 1981. Purattatva 11, 19–25.

Sharma, A.K., 1986 Neolithic Gufkral. In: Buth, G.M. (Ed.), Central Asia and Western Himalaya – A Forgotten Link. Scientific Publishers, Jodhpur, pp. 13–18.

Sharma, G.R., Misra, V.D., Mandal, D., Misra, B.B., Pal, J.N., 1980. Beginnings of Agriculture (Epi-Palaeolithic to Neolithic: Excavations at Chopani-Mando, Mahadaha, and Mahagara). Abinash Prakashan, Allahabad.

Shinde, V., 1998a. Pre-Harappan Padri culture in Saurashtra: the recent discovery. South Asian Studies 14, 173–182.

Shinde, V.S., 1998b. Early Settlements in the Central Tapi Basin. Munshiram Manoharlal, New Delhi.

Shinde, V.S., 2002. The emergence, development and spread of agricultural communities in South Asia. In: Yasuda, Y. (Ed.), The Origins of Pottery and Agriculture. Lustre Press and Roli Books, New Delhi, pp. 89–115.

Simoons, F.J., 1991. Food in China. A Cultural and Historical Inquiry. CRC Press, Boca Raton.

Singh, I.B., 2005. Landform development and palaeovegetation in Late Quaternary of the Ganga Plain: implications for anthropogenic activity. Pragdhara 15, 5–31.

Sinha, B.K., 1993. Excavations at Golbai Sasan, District Puri, Orissa. Puratattva 23, 48–50.

Sinha, B.K., 2000. Golbai: a protohistoric site on the coast of Orissa. In: Basa, K.K., Mohanty, P. (Eds.), Archaeology of Orissa. Pratibha Prakashan, Delhi, pp. 322–355.

Southworth, F.C., 1976. Cereals in South Asian prehistory: the linguistic evidence. In: Kennedy, K.A.R., Possehl, G.L. (Eds.), Ecological Backgrounds of South Asian Prehistory. South Asia Program, Cornell University, Ithaca, New York, pp. 52–75.

Southworth, F.C., 1979. Lexical evidence for early contacts between Indo-Aryan and Dravidian. In: Deshpande, M.M., Hook, P.E. (Eds.), Aryan and Non-Aryan in India. Center for South and Southeast Asian Studies, University of Michigan, Ann Arbor, pp. 191–233.

Southworth, F.C., 1988. Ancient economic plants of South Asia: linguistic archaeology and early agriculture. In: Jazayery, M.A., Winter, W. (Ed.), Languages and Cultures: Studies in Honor of Edgar C. Polome. Mouton de Gruyter, Amsetrdam, pp. 649–688.

Southworth, F.C., 1992. Linguistics and archaeology: prehistoric implications of some South Asian plant names. In: Possehl, G.L. (Ed.), South Asian Archaeology Studies. Oxford and IBH, New Delhi, pp. 81–85.

Southworth, F.C., 2005a. The Linguistic Archaeology of South Asia. Routledge, London.

Southworth, F. C. 2005b. Prehistoric implications of the Dravidian element in the NIA lexicon with special reference to Marathi. International Journal of Dravidian Linguistics 34(1), 17–28.

Southworth, F.C., Witzel, M., 2006. The SARVA (South Asia Residual Vocabulary Assemblage) Poject Website (http://www.aa.tufs.ac.jp/sarva/).

Stock, J., Lahr, M.M., Warusawithana-Kulatilake, S., 2006. Human dispersals and cranial diversity in South Asia relative to global patterns of human variation. In: Petraglia, M.D., Allchin, B. (Eds.), The Evolution and History of Human Populations in South Asia: Interdisciplinary Studies in Archaeology, Biological Anthropology, Linguistics and Genetics. Springer, Netherlands, pp. 243–266.

Su, B., Xiao, J., Underhill, P., Deka, R., Zhang, W., Akey, J., Huang, W., Shen, D., Lu, D., Luo, J., Chu, J., Tan, J., Shen, P., Davis, R., Cavalli-Sforza, L. L., Chakraborty, R., Xiong, M., Du, R., Oefner, P., Chen, Z., Jin, L., 1999. Y-Chromosome evidence for a northward migration of modern humans into Eastern Asia during the last Ice Age. American Journal of Human Genetics 65, 1718–1724.

Tengberg, M., 1999. Crop husbandry at Miri Qalat, Makran, SW Pakistan (4000–2000 B.C.). Vegetation History and Archaeobotany 8, 3–12.

Tengberg, M., 2005. Exploitation and use of plants in the Halil Valley during the Bronze Age: first results from the archaeobotanical analysis at Kunar Sandal A and B, Southeast Iran. Paper presented at the 15th Conference of the European Association of South Asian Archaeologists, London.

Tewari, R., Srivastava, R.K., Singh, K.K., Saraswat, K.S., Singh, I.B., 2003. Preliminary report of the excavation at Lahuradewa, District Sant Kabir Nagar, U.P. 2001–2002: wider archaeological implications. Pragdhara 13, 37–68.

Tewari, R., Srivastava, R.K., Singh, K.K., Vinay, R., Trivedi, R.K., Singh, G.C., 2005. Recently excavated sites in the Ganga Plain and North Vindhyas: some observations regarding the pre-urban context. Pragdhara 15, 39–49.

Thapar, B.K., 1978. Early farming communities in India. Journal of Human Evolution 7, 11–22.

Thomas, P.K., Joglekar, P.P., Mishra, V.D., Pandey, J.N., Pal, J.N., 1995. A preliminary report of the faunal remains from Damdama. Man and Environment 20, 29–36.

Tikkanen, B., 1999. Archaeological-linguistic correlations in the formation of retroflex typologies and correlating areal features in South Asia. In: Blench, R., Spriggs, M. (Eds.), Archaeology and Language IV: Language Change and Cultural Transformation. Routeledge, London, pp. 138–148.

Trautman, T.R., 1979. The study of Dravidian kinship. In: Deshpande, M.M., Hook, P.E. (Eds.), Aryan and Non-Aryan in India. Center for South and

Southeast Asian Studies, University of Michigan, Ann Arbor, pp. 153–173.

Trautman, T.R., 1981. Dravidian Kinship. Cambridge University Press, Cambridge.

Turner, R.L., 1966. A Comparative Dictionary of the Indo-Aryan Languages. Oxford University Press, Oxford.

Van Driem, G., 1998. Neolithic correlates of ancient Tibeto-Burman migrations. In: Blench, R., Spriggs, M. (Eds.), Archaeology and Language II: Archaeological Data and Linguistic Hypotheses. Routledge, London, pp. 67–102.

Vaughan, D.A., 1989. The Genus *Oryza L.*: Current Status of Taxonomy. International Rice Research Institute, Los Banos, Philippines.

Vaughan, D.A., 1994. The wild relatives of rice: a genetic resources handbook. International Rice Research Institute, Los Banos, Philippines.

Vishnu-Mittre, 1976. The archaeobotanical and palynological evidence for the early origin of agriculture in South and Southeast Asia. In: Arnott, M.I. (Ed.), Gastronomy. Mouton and Co., The Hague, pp. 13–21.

Wan, J., Ikehashi, H., 1997. Identification of two types of differentiation in cultivated rice (*Oryza sativa L.*) detected by polymorphism of isozymes and hybrid sterility. Euphytica 94, 151–161.z

Weber, S.A., 1991. Plants and Harappan Subsistence: An Example of Stability and Change from Rojdi. Oxford and IBH., New Delhi.

West, B., B.-X., Z., 1988. Did chickens go north? New evidence for domestication. Journal of Archaeological Science 15, 515–533.

Wheeler, R.E.M., 1959. Early India and Pakistan. Thames and Hudson, London.

Willcox, G., 1992. Some differences between crops of Near Eastern origin and those from the tropics. In: Jarrige, C. (Ed.), South Asian Archaeology 1989. Prehistory Press, Madison, pp. 291–299.

Willcox, G., 1999. Agrarian change and the beginnings of cultivation in the Near East: evidence from wild progenitors, experimental cultivation and archaeobotanical data. In: Gosden, C., Hather, J. (Eds.), The Prehistory of Food: Appetites for Change. Routledge, London, pp. 478–500.

Willcox, G., 2002. Geographical variation in major cereal components and evidence for independent domestication events in Western Asia. In: Cappers, R.T.J., Bottema, S. (Eds.), The Dawn of Farming in the Near East. Ex Oriente, Berlin, pp. 133–140.

Willcox, G., 2005. The distribution, natural habitats and availability of wild cereals in relation to their domestication in the Near East: multiple events, multiple centres. Vegetation History and Archaeobotany 14(4), 534–541.

Witzel, M., 1999. Early sources for South Asian substrate languages. Mother Tongue Special Issue, 1–76.

Witzel, M., 2005. Central Asian roots and acculturation in South Asia: linguistic and archaeological evidence from Western Central Asia, the Hindukush and northwestern South Asia for early Indo-Aryan language and religion. In: Osada, T. (Ed.), Liguistics, Archaeology and the Human Past. Research Institute for Humanity and Nature, Kyoto, pp. 87–211.

Witzel, M., 2006. South Asian agricultural terms in Indo-Aryan. In: Osada, T., Sato, Y.-I., Witzel, M. (Eds,), Ethnogenesis in South and Central Asia. Harvard-Kyoto Roundtable (7th ESCA), Research Institute for Humanities and Nature, Kyoto.

Yan, W., 2002. The origins of rice agriculture, pottery and cities. In: Yasuda, Y. (Ed.), The Origins of Pottery and Agriculture. Lustre Press and Roli Books, New Delhi.

Zeuner, F.E., 1963. A History of Domesticated Animals. Hutchinson, London.

Zide, A.R.K., Zide, N.H., 1976. Proto-Munda cultural vocabulary: evidence for early agriculture. In: Jenner, P.N., Thompson, L.C., Starosta, S. (Eds.), Austroasiatic Studies, Part II. University of Hawaii Press, Honolulu, pp. 1295–1334.

Zohary, D., 1996. The mode of domestication of the founder crops of Southwest Asian agriculture, In: Harris, D.R. (Ed.), The Origins and Spread of Agriculture and Pastoralism in Eurasia. UCL Press, London, pp. 142–158.

Zohary, D., Hopf, M., 2000. Domestication of Plants in the Old World. Oxford University Press, Oxford.