further west, together with livestock, rather than indigenous crops. These crops were then taken up further east in Central India and on the northern Peninsula in the second half of the third millennium BC. On the northern peninsula the winter cereals and pulses were markedly important but they seem to have been part of a mixed cultivation strategy which included significant frequencies of the native species, including the pulses and millets that featured prominently in the Southern Neolithic.

From Ashmounds to Villages in South India

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 2003d; Asouti et al 2005). 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.

The centrality of cattle in this symbolic aspect of life is also suggested by a rich rock art corpus associated with some Neolithic sites in the region, which is dominated by pecked images of cattle. While these sites were seasonal encampments, in many cases they developed over time into village settlements. This is indicated by ashmound deposits buried under village occupation at sites such as Sanganakallu, and by the development of a village adjacent to the ashmound at Budihal. These transitions are part of a protracted regional process of increasing sedentism between 2200 and 1800 BC. After 1800 BC the distribution of ashmound sites had reached their maximal extent in northwestern Karnataka, and other traditions of village settlement began to be established in adjacent regions, of West and South Karnataka, Andhra Pradesh and northwest Tamil Nadu.

Recent archaeobotanical research has provided a picture of recurrent staples and occasional secondary crops of the Southern Neolithic (Fuller 2003d; Fuller et al. 2001a; 2001b; 2004). The staples include two native species of millets (*Brachiaria ramosa* and *Setaria verticillata*) and two pulses (*Vigna radiata* and *Macrotyloma uniflorum*). 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 2003d: 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).

What is known of the ecology of the native crop species suggests that domestication occurred in a Dry Deciduous woodland zone that inter-fingered 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), I now favour patches along the Eastern Ghats between the Krishna and the Godavari river on the basis of recently gathered data on wild progenitors of the *Vigna* pulses (Figure 2; Fuller and Harvey, in press).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 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. These dates have been updated since earlier publications (e.g. Fuller et al. 2001; 2004), on the basis of a recent radiocarbon dating program, including direct AMS dates on hyacinth bean of ca. 1500 BC (Fuller et al., in press B). These introductions from the north, in the period around 1500 BC, may also have included the African crops, since earlier finds put them in northwest India. At around the same time, chickens are likely to have come to South India based on the still rather limited faunal record (Fuller 2003a: Table 16.4). In general the revised chronology makes these introductions 200-300 years later than earlier suggestions. Subsequent crop adoptions, or at least species that are not documented until later, include the fibre crops (cotton and flax), finger millet (*Eleusine coracana*), as well as perennial tree fruits, such as *Citrus* spp and mangos. Also of note is evidence from wood charcoal from sandal wood by ca. 1300 BC (Asouti and Fuller, in press), since this species is likely to have been introduced to the Indian peninsula from Indonesia (Fischer 1938; see further discussion in Asouti and Fuller, in press).

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 to 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; Meher-Homji 1996). 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 Ash Mound 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; in press). 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 (Korisettar, Petraglia and the author, unpublished data). 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 distinctions 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 (the author and Venkatasubbaiah, unpublished 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 become 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 has 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 or Mount Abu).

Agriculture further South, throughout Tamil Nadu for example, appears to have only become established during the Iron Age and in some regions of Southwest Tamil Nadu as late at the end of the First Millennium BC. Here agriculture included rice which had diffused from northern India, perhaps along the eastern coast, early in the first millennium BC. Similarly, rice based agriculture came to Sri Lanka, perhaps as early as 900 BC. This long regional transition from hunter-gatherer societies to agriculturalists is also characteristic of the hill tracts of Peninsular India, where in some areas hunter-gatherers became specialized forager-traders tied to agricultural societies in the plains, and some of these forager-trader communities persisted into the ethnographic present as 'professional primitives' (Fox 1969; Morrison 2002).

Early Dravidian and the Southern Neolithic

Recent assessments of Dravidian historical linguistics which have emphasized reconstructible terms for crop species have suggested an identification with the archaeological Southern Neolithic. The linguistic details are provided by Southworth (2005; this volume; some also in Fuller 2003a). There is clearly a strong correlation between crops that are documented archaeologically and species that have cognates across the South and Central Dravidian subfamilies, which Southworth (this volume) reconstructs as a Late Proto-Dravidian stage (Pdr-2 or Proto-South/Central Dravidian in earlier treatments, e.g. Fuller 2003a). One potential limitation on correlating archaeology with historical linguistics, however, is gaps in the available linguistic data. When the Dravidian Etymological Dictionary lacks a word from a plant species in the North Dravidian languages, can we be sure that this indicates that these languages do not have a cognate term or could this be a product of incomplete recording in available linguistic sources? Previously, I have tried to highlight these limitations (Fuller 2003a, tables). Given that there appears to be differences in the antiquity of mungbean and horsegram versus urd and pigeonpea, but no differences in the level to which they reconstruct linguistically, there is ground to question whether absence of recorded evidence is really evidence for absence at an early Proto-Dravidian stage. Further linguistic evidence is needed, a problem which is particularly the case for several native Indian millets.

Nevertheless, another set of botanical data, tree names, may shed light on correlating Dravidian historical linguistics with archaeology. The ecological constraints on the crop origins of the Southern Neolithic provide a significant means for assessing historical linguistic data. Early agriculturalists and their hunter-gatherer precursors must have been familiar with the peninsular Dry Deciduous forests and savannah zones in particular, with wild horsegram and millet-grasses, as well as wet deciduous forests whence the mungbean was domesticated (Fuller and Korisettar 2004; Asouti et al. 2005; but especially Asouti and Fuller, in press). Indeed, a number of key tree species in these peninsular vegetation zones can be inferred to have significant antiquity in the Dravidian languages. Trees with cognate names across all the Dravidian subfamilies (entry numbers from Burrow and Emeneau 1984; proto-form reconstructions from Southworth 2005: Ch. 7; but taking into account botanical synonymy), include *Butea monosperma* (**mur-ukk-*, DEDR 4981). *Moringa* sp. (**murum-kāy,* DEDR 4982), *Schleichera oleosa* (**puc,* DEDR 4348), *Phoenix* sp., probably *P. sylvestris(*cīnt(t)-, DEDR 2617),* and the Toddy Palm, *Borassus flabellifer* (**tāz,* DEDR 3180), all of which are predominantly part of the peninsular Dry Deciduous woodlands but might range into savannahs and patches of moist deciduous forests. With an absence of cognates recorded for North Dravidian, an even wider range of Dry Deciduous trees can be inferred for Late Proto-Dravidian: *Pterocarpus marsupium* (**vēn-kay,* DEDR 5520), *Ficus religiosa* (**ar-ac,* DEDR 2697), *Ficus benghalensis* (**āl-*, DEDR 382), *Feronia limonia* (**vel-*, DEDR 5509), *Bombax ceiba* (DEDR 495 and 5539), *Tectona grandis* (**tēnkk-*, DEDR 3452), *Terminalia tomentosa* (**mat-Vt-*, DEDR 4718), *Terminalia bellerica* (DEDR 3452) and *Gmelina arborea* (**kūm(p)-iz,* DEDR 1743). A couple of moist deciduous fruit-bearing trees, that range along rivers into drier zones, can also be reconstructed to this level, such as the jackfruit, *Artocarpus integrifolia* (**pal-ac,* DEDR 3989) and the jambos, *Syzygium cumini* (DEDR 2917). Taken together this suggests a familiarity with peninsular Indian woodlands at an Early Proto-Dravidian level and an even greater familiarity at the level of Late Proto-Dravidian in which evidence for pulse and cereal crops is also found. This might then suggest more of a forager lifestyle at the Earlier stage, together with livestock and perhaps some garden cultivation, such as of taro, *Colocasia esculenta* (**kic-ampu,* DEDR 2004; I regard *Colocasia* as the most reasonable gloss) and aubergines (see Southworth, this volume). While serious field crop cultivation of grains had become well-established by the stage of Late Proto-Dravidian which might therefore be equated with the Southern Neolithic in its classic manifestation as the Ashmound Tradition, especially during Phase 2 (2200 -1800 BC) (cf. Southworth, this volume; Fuller 2003a).

Towards Political economies in South India: South Dravidian diversification?

An important set of transformations occurred during the course of each regional Neolithic sequence as long-distance trade increased, local craft-production developed and social hierarchy emerged. During this process, forms of non-subsistence agriculture emerged, focused on 'cash-crops' like cotton and flax, or perennial fruits trees and vines. In South India, evidence for cotton and flax, together with spindle whorls indicate the emergence of textile production during Phase 3 of the Southern Neolithic. While the earliest spindle whorls may be at ca. 1700 BC, larger quantities of them appear after ca. 1500 BC. The first attested seeds of cotton and flax are ca. 900 BC (Fuller et al. 2004; in press B), although they are likely to have arrived earlier like the spindle whorls. Numerous biases act against their preservation. It is also from these later period (perhaps ca. 1400-1300 BC) that evidence for mango, sandalwood and probable *Citrus* occur in the wood charcoal evidence (Asouti and Fuller, in press). These species, as well as flax and cotton, seem to reconstruct back to

Proto-south-Dravidian (Southworth 2005) only and in the case of mango unrelated words are found in Central and in Northern Dravidian (DEDR 4772, 4782, 2943). Their presence archaeologically might be used to suggest a minimum age for separation of South from Central Dravidian, i.e. by 1400/1300 BC.

This same general period shows trends towards social complexity and the emergence of commodities of wealth and power. There are trends towards increasing trade, such as in chert, increased finds of beads, and from ca. 1400 BC wheelmade ceramics and megalithic burials, which imply individuals with exalted social status.

In considering linguistic reconstructions, this transformation might be suggested to correlate in broad terms with two successive stages of linguistic reconstruction. As already indicated there is much to suggest an identification between Late Proto-Dravidian (reconstructions form the cognates of Central and South Dravidian) and the Southern Neolithic in its classic ashmound periods. By contrast, reconstructions for Proto-South Dravidian (Southworth 2005) include concepts for planted fruit trees, such as *Citrus* (**māt-al-,* DEDR 4808), and mango (**mām-*, DEDR 4782); weavers (**cāl-*, DEDR 2475; **cēnt-ir* DEDR 2809), flax (**ak-V-ce,* DEDR 3: PSD1) and cotton (**par-utti,* DEDR 3393; **nūl,* DEDR 3726); battle/army (**pat-ay,* DEDR 3860), metallurgy (**patt-at-ay,* DEDR 3865; **kol-,* DEDR 2133; **tak-a-r,* DEDR 3001), as well as a concepts of commodity (**car-a-kk-,* DEDR 2353) and exchange value (**kāc-u,* DEDR 1431, eventually 'money'), amongst many other concepts appropriate to this period (see Southworth 2005, Chapter 8, Appendix B). The subsequent spread and diversification of Southern Dravidian languages might be related to the much wider distribution of the latest phase of the Southern Neolithic and particularly with the South Indian megalithic. It is during the megalithic and Early Historic period when agricultural settlements became widespread in Tamil Nadu (Cooke et al 2005). The megalithic period provides clear indications of social hierarchy and emergent social complexity (Moorti 1994; Brubaker 2001).

Rice, cucurbits and more millets from the Ganges and the East

The Ganges basin, the adjacent Himalayan foothills to the north and the hill zones of Bihar and Orissa taken together delimit an important zone of probable plant domestications. Evidence has long been clear that a number of cucurbit crops originate in this general area, including cucumbers, luffas and various 'gourds' (see Table 1). In addition the wild distribution of some Indian pulses definitely occurs here, especially mung bean in the Western Himalayas and pigeonpea (red gram) in the South Orissa/Bastar hills. Other pulses, urd bean and horsegram, might have or have had in the past wild distributions here, but we still lack adequate records from modern botanical studies of their wild forms. This is also the probable zone for the origin of okra (Lady's finger) which is a domesticate of hybrid origin (Hamon and van Sloten 1995). It is possible that either parent species was first cultivated and then after spreading improved hybrids evolved where it came to overlap in range with the other species. In general we would expect that to have occurred in northwestern South Asia or central India. Of special interest is, of course, the predominant staple today rice, which is also a plausible native domesticate of this region.

The origins of rice have remained somewhat problematic and have been prone to mis-understanding. A single origin has tended to be assumed in archaeological syntheses (e.g. Glover and Higham 1996; Higham 1998; Bellwood 1996; 2005; Bellwood and Diamond 2003), perhaps largely due to the influence of T. T.

Chang (1989; 1995; 2000). A single origin for Asian rice, however, can be falsified on the grounds of current genetics as well as archaeological evidence. 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 1993; 1994; Cheng et al. 2003; Sato 2002). 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. 1993; Cheng et al. 2003; for current rice taxonomy see Vaughan 1989; 1994). Meanwhile, there are some seven nuclear genetic markers called SINEs that separate the *nivara-indica* group from the *rufipogon-japonica* (Cheng et al. 2003). The most recent phylogenetic hypothesis (Cheng et al. 2003) supports one origin of japonica in China, and perhaps two of *indica* in South Asia. The implications of the genetics deserves stressing, as it means that claims for a solitary origin of rice (in South China) from which it spread to all other countries are *false.* This has been a widespread assumption amongst archaeologists and linguists (e.g. Higham 1995; 2003; Bellwood 1996; 2003; Luce 1985; Pejros and Schnirelman 1998; Van Driem 1998), but it is now contradicted by phylogenetic data. In addition the archaeology of early rice agriculture in China (Yan 2002) and India(Fuller 2002) indicates two discrete and widely separated zones of early rice agriculture by the third millennium BC (Figure 5).

Rice is consistently present at Neolithic sites in the Ganges basin, from the earliest phases with archaeobotanical samples. It is often found together with various small millets (*Brachiaria ramosa*, *Setaria vertcillata*, and *Setaria pumila*). Native Indian pulses are also present but only from later phases, which could indicate dispersal of native pulses from elsewhere prior to 2000 BC. 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. Within the Gangetic region three subregional trajectories towards agriculture can be identified.

First there is a tradition located in the eastern part of this region, represented by Lahuradewa and Senuwar. Its earliest stage, represented by lake edge occupation at Lahuradewa shows ceramic production by sometime in the fifth millennium, and rice was part of the diet, although clarification is needed on its cultivation status (Tewari et al 2003; 2004; Saraswat and Pokharia 2004). Later levels at Lahuradewa and at Senuwar indicate more sedentary settlement and clear rice cultivation after 2500 BC (Saraswat and Pokharia 2004; Saraswat 2004a). Some winter crops, especially wheat and barley, were added to the agricultural system by 2200 BC, and pulses from elsewhere in India were added shortly thereafter. Livestock were also adopted beginning perhaps as early as 2500 BC and certainly by ca. 2000 BC (Joglekar 2004). A second tradition that shows parallel economic developments was in northern Vindhyan hills and the Son and Belan river valleys, represented by sites like Mahagara, Koldihwa and Tokwa, although here the founding of sedentary villages with mixed agro-pastoralism occurred mainly after ca. 2000 BC (Harvey et al 2005; Misra et al. 2001). Once again the initial agriculture was rice and millets, with winter crops and pulses adopted shortly thereafter. Earlier evidence in the region suggests seasonal settlement, rice use and probably some production of ceramics amongst hunter-gatherers. A third distinct cultural tradition to take up agriculture was the Mesolithic of central Ganges plains, represented by the site of Damdama. Here there has been a long tradition of semi-sedentary hunting and fishing focused on the oxbow ponds and former meanders of the Ganges plain (Chattopoadyaya 1996; 2002). Despite the absence of pottery, crops, including rice and barley, were adopted after 2500 BC (Saraswat 2004b), but this distinct aceramic tradition ceases to be recognizable by the early second millennium BC.

After 2000 BC agricultural villages become more widespread in the Gangetic region. These seem to have consisted of small villages of round huts and possible communal animal pens. While it is not year clear that these sites were truly year-round sedentism, it is clear that they were much more permanent and long-lasting than anything that had been before. It is also clear that cultivation was established before this phase of sedentarization. Indeed, finds of probable Gangetic domestics in the Eastern Harappan zone suggests that the beginnings of cultivation date to before 3000 BC. The recent discovery of Lahuradewa dating back to before 4000 BC suggests that future work may indeed be able to elucidate the plant economies of less settled societies that saw through the transition from foraging to food production.

During the course of the second millennium BC agriculture diversified as did other aspects of the society (cf. P. Singh 2001: 144-146; B. P. Singh 2004: 608-612). It is during this period that the first evidence for aboriculture of native tropical trees occurs (Saraswat 2004a; Saraswat et al. 1994). This includes evidence from wood charcoal suggesting the planting of trees in the Gangetic Plains such as jackfruit (*Artocarpus heterophyllus*), mango (*Mangifera indica*), bael fruit (*Aegle marmelos*), the citron (*Citrus medica*), and tamarind (*Tamarindus indicus*). Fruit tree cultivation may have begun early in the second millennium BC but was widespread by the second half of the millennium (Saraswat et al. 1994; Saraswat 2004a; cf. Fuller and Madella 2001: 339-342). It is also during this period when the first finds of possible fibre crops, including flax and hemp, occur together with probable spindle whorls, suggesting the beginnings of textile production. The emergence of social hierarchy is suggested by the still poorly-studied Chalcolithic megalithic burials of the Vindhyan regions (Dhavalikar 1997: 231-235; V. D. Misra 1988; B. Misra 2000).

African additions

In addition to the many native crops and the important species from Southwest Asia, modern Indian agriculture includes major contribution from African domesticates. In the dry-cropping regions of India, sorghum *(Sorghum bicolor)*, pearl millet (*Pennisetum glaucum*) and finger millet (*Eleusine coracana*) are traditionally the most productive grains, while numerous varieties of cowpea (*Vigna unguiculata*) and hyacinth bean (*Lablab purpureus*) are important pulses. All five of these species have their wild progenitors in different parts of sub-Saharan African and archaeological evidence places them in South Asia in prehistory. Due to concerns with dating, and with correct archaeobotanical identification of these species, caution is warranted in taking some reports, and much secondary literature at face value. Recently, the author has published a comprehensive review, with particular attention paid to morphological identification criteria and supporting illustrations, of primary reports of African crops (Fuller 2003b). Taking a very cautious view of dating evidence, as direct radiocarbon dates are few and associated dating evidence is often limited or has wide error margins, it is nevertheless clear that most of these species were present by the first few centuries in the second millennium BC. Recently the author has had a series of direct AMS dates run on hyacinth bean from South India, confirming presence in the South at ca. 1500 BC (Fuller et al., in press). The earliest occurrences, however, appear to be on the eastern periphery of the Harappan civilization in Saurashtra and the Ganges-Yamuna region, and some finds from the latter might even date back into the third millennium and the Mature

Harappan period, as at the site if Kunal (Saraswat and Pokharia 2003), although some caution is warranted until the excavation context and associated dating evidence is published. As my previous assessment indicates the introduction of African crops to South Asia was not revolutionary but contributed to the increasingly diverse array of agricultural options:

> the spread of African crops was more piece-meal and selective.
> While a number of authors have in the past suggested that the adoption of African millets may have been an agricultural 'revolution' of the Late Harappan period or a critical factor in the spread of agriculture into monsoonal environments of India (e.g. Hutchinson 1976; Possehl 1986; Jarrige 1985; Meadow 1989; 1996), the available evidence indicates that these taxa were not adopted on a large scale on individual sites nor are they consistently in evidence over particular regions. Rather each of the African species appears to be locally important, or supplemental, to agricultural economies based primarily on other species. As already noted by Weber (1993; 1998) the African millets appear largely to have been adopted on sites where there was already ample evidence for the cultivation of other summer crops, including millets and pulses of South Asian origin' (Fuller 2003b: 263-264)

Excursus: the linguistic challenge of millets and rices

I would like to highlight one persistent challenge for historical linguistic approaches to early agriculture: semantic shift amongst millet crops and rice. Linguists are well aware that semantic shift occurs, and the problems of semantic broadening and narrowing which may contribute to this in the long term are explored by Southworth (this volume). A group of crops which is particularly prone to semantic shift would appear to be millets, in the broad general sense, together with rice. Attempts to reconstruct early proto-forms for rice terms, like those of Mahdi (1998) and Witzel (1999: 30-33), often take into account names for millets. Problematic assumptions in such reconstructions are twofold, first that a single origin of domesticated Asian rice is assumed (normally in China), and second that terms for rice are likely to have been broadened (and then shifted) to indicate a particular millet. The first assumption is contradicted by available archaeology and falsified by recent genetic evidence on rice and wild rice (see above). The second assumption seems backwards to the present author. There are clear morphological reasons why rice plants and some millet plants might be associated, namely the production of loose panicles of hulled grains, which must be similarly harvested, dehusked, and potentially cooked in similar fashion. The wide diversity of native millets of Asia (see De Wet 1992; Fuller 2002: Tables 5, 8, 9; 2003d), has been largely overlooked in syntheses of early agriculture, which normally have an anachronistic bias towards modern 'world' crops like rice, wheat and sorghum. There has also been a severe shortage of well-documented archaeobotanical millet identifications, with a result that there is a great deal mis-identification reported in the archaeological literature, with an example exposed by Hilu, De Wet and Harlan (1979) and numerous instances explored in morphological detail previously by this author (Fuller 2002: 277-282; 2003b; Fuller et al. 2004: 120-122). In addition, within millets, there is a range of variation in terms of the structure of the panicle, or ear, the presence or absence of bristles and free-threshing (unhulled) forms, that might predispose certain groups of millets to semantic confusion, or semantic shifts.

While a full exploration of likely semantic shifts in past Indian or other languages remains to written, what I would like to do is highlight likely confusion groups starting from basic botanical morphology, with reference to a few documented cases of linguistic confusion. Drawing inspiration of the linguists' isogloss chart, I have prepared a representative millet 'isomorphism' chart, in which rice is also included (Figure 6). It should go without saying that species in the same genus have a great deal of similarity. Thus proposed shifts from native Indian *Setaria* spp. to the introduced *Setaria italica* (cf. Southworth, this volume; Fuller 2003a), or from native *Panicum sumatrense* to introduced *Panicum miliaceum* should come as no surprise.

Certain millets have obvious similarities by having dense ears, including the foxtail millets (*Setaria* spp.), pearl millet and some races of sorghum, especially the more 'advanced' *durra* race. Within this group, *Setaria* spp. and *Pennisetum* share bristly awns. Meanwhile both *Sorghum* and *Pennisetum* have larger grains and may be free-threshing (some sorghum varieties like *durra*). Semantic shift between sorghum and pearl millet, and from either of these to maize, is clearly documented in Africa, amongst Bantu languages and other groups (see Philipson and Bahuchet 1996; Blench et al. 1994). This appears also to be the case with Proto-Munda **gan-gay* (Zide and Zide 1976), which has derivative words in modern languages ranging across maize, sorghum and pearl millet. The proto-form is suggested to be related to a widespread South Asian millet term which may even be related to Indo-Aryan **kankunī* (Witzel 1999: 35-36; CDIAL 2606), referring to *Setaria italica.* The proposed relationship with the early Munda word implies semantic shift, while the alternative modern Indo-Aryan *bājrā* is only documented from more recent Indo-Aryan (Southworth 2005: 204). This same etymon and semantic confusion is present in Dravidian prehistory, as indicated by Proto-South Dravidian**kam-pu,* referring to *Setaria italica* in modern Tamil and Malayalam but *Pennisetum glaucum* in Kannada and Telugu (Southworth 2005: 248). On biogeographic grounds we should expect the original referent to have been a native foxtail millet (*Setaria* spp.), which are widely documented across early agricultural systems, including *S. verticillata* in South India, the Ganges and Gujarat, *S. pumila* in the Ganges (Saraswat 2004b) and another *Setaria* (but not *italica*) in Harappan Baluchistan (Benecke and Neef 2005). This would have readily broadened to include variously *Setaria italica* or *Pennisetum glaucum,* which entered South Asia in Late/Post-Harappan times (see Fuller 2003b; 2003d). In ancient Chinese there appears to have been a broadening from *liang* (native *Setaria italica*) to *gao-liang,* 'big liang' for the introduced Sorghum, which subsequently came also be called simply *liang* (Chang 1983; see Table 2).

Amongst looser panicled species, we can place *Panicum, Echinochloa, Paspalum, Digitaria,* and *Brachiaria* together with rice and primitive lax-eared sorghum, like the ubiquitous race *bicolor*. Cases of confusion between *Echinochloa colona* and *Panicum sumatrense* have apparently even been made by modern agronomists who were not millet experts, as collection histories of specimens in the USDA Agricultural Research Service seed banks indicate (e.g. Germplasm accession PI 463619, see database at http://www.ars-grin.gov/cgi-bin/npgs/html/queries.pl). A similar confusion seems to have occurred in a recent ethnoarchaeological study (cf. Reddy 2003, figs 3-21, 4-10). Thus it should be no surprise that names like *shame, samai, sawa* seem to be rather unstable in their attribution to these species, as appears also the case with Proto-Munda **iri/ *e-rig* (Zide and Zide 1976). Once again a Proto-South Dravidian word's history illustrates semantic confusion in this group: **var-ak* has derivatives meaning *Panicum miliaceum* (Telugu) and *Paspalum scrobiculatum* (Tamil/Malayalam/Kannada). Amongst colloquial names from botanical sources this same root may have contributed modern words for *Eleusine coracana* and *Brachiaria ramosa* in some *geographic regions (see Fuller 2003a: Table 16.6).*

Within this group there are some species that tend to have finger-like lateral branches of grain, including *Echinochloa* but especially *Digitaria, Paspalum* and *Eleusine.* Semantic shift between *Paspalum* and *Eleusine* seems clear in the case of 'kodo', used today in Garhwal to refer to *Eleusine coracana* (personal observation), a dominant crop, whereas in many other parts of the India 'kodo' is *Paspalum scrobiculatum,* presumably from Old Indo-Aryan *kodrava* (Southworth 2005: 207). In samples from an early medieval site in Garhwal, Ufalda, *Eleusine* is absent but *Paspalum* is present suggesting a more recent introduction of *Eleusine* (author's unpublished archaeobotanical data). The widespread name 'ragi', is suggested to be derived from a more general ancient 'millet' or grain term, such as Proto-Munda **e-rig,* or Proto-Dravidian **iraki* (see Southworth, this volume; also, Fuller 2003a; cf. Southworth 2005: 247-248).

Semantic shift from any of these millets to rice should be considered plausible, especially in contexts in which labour intensive but highly productive (and taxable) rice cultivation has been introduced and supplants the less-productive millet cultivation. The general similarities between millets and rice is recognized linguistically in Chinese, as these hulled, panicled cereals are all kinds of *mi*, and can be opposed to the eared, free-threshing cereals of the *mai* group, which includes wheat, barley, rye and oats (Table 2). What all this means, is that systematic efforts need to be made by linguists to "excavate" the layers of semantic history of millet/rice words with a more nuanced appreciation of some of the morphological similarities between species that are likely to have been salient to farmers and consumers in the past. I suspect that much is to be gained by further millet-savvy linguistic fieldwork, and ethnographic explorations of how folk taxonomies divide up the spectrum of millets/grasses.

The challenge of silent beginnings (and tubers)

In no region of South Asia do we yet have clear evidence for the transition from hunting-and-gathering to food production. What we know in most cases is fully established crop cultivation, and often agro-pastoralism, in the context of village settlements. While biogeographic evidence, of modern wild progenitors, combined with the available archaeobotanical data, suggests at least three and perhaps more centres of indigenous crop domestication: the middle Ganges, South India, Gujarat, and perhaps Orissa and even the upper Ganges/Indian Punjab region; the archaeological evidence documenting any of these transitions is lacking. This limitation can be attributed to the likelihood that these earlier stages were less sedentary, i.e. they were closer towards to lower left hand portion of the mobility/sedentism graph (Figure 1). Sites were occupied for shorter portions or the year, or perhaps quite likely, sites were less permanent due to traditions of shifting cultivation (on the archaeological challenge of shifting cultivation, cf. Pratap 2001). We are seeing from archaeology the processes of settling down, as sites become more permanent and occupations become more sedentary. By this time agriculture in each of it distinctive regional manifestations is already developed. While in the northwest region (Baluchistan) this settling phase could represent immigration of populations from the west (or northwest) with wheats, barley and goats, in other regions it is likely to be due to internal processes of settling down or some kind of small scale immigration from an adjacent region. For example, in the case of the Southern Neolithic ashmound tradition I would now favour immigration of people from the Eastern Ghats north of the Krishna and south of the Godavari, and what is now the western Andhra borderlands with north-east Karnataka.

Another issue about which the archaeological record remains silent is tuber cultivation. Archaeobotanical evidence is highly biased towards cereal grains and pulses, both of which have hard dry seeds that are more likely to survive fires which are essential for their archaeological preservation (cf. Fuller 2002: 262-264; Weber 1992). While fragments of starchy roots and tubers can also survive charring, they are recovered as non-descript and non-distinctive parenchyma fragments (Hather 1999; Fuller 2002: 322-324). These can sometimes be identified with aid of scanning electron microscopy and extensive study of anatomical features in modern reference material (e.g. Hather 1994; 1999), but the development of suitable reference collections and the time consuming study of this material has not yet begun in South Asia. Thus it could be that any of the Neolithic traditions discussed above was also cultivating such crops as yams or taro, and we just do not know it yet. Indeed, in the case of South India, parenchyma is a frequent part of archaeobotanical samples (Fuller 1999; Fuller et al. 2001a; 2004), and at least some of these fragments appear to be yam-like, but further work is needed. Tubers, as had been stressed by comparative approaches to early agriculture developed from ethnographic perspectives (e.g. Sauer 1952; Harris 1969; 1972; 1973), could have been very important food sources for early cultivators in tropical regions, especially in the woodland savannah boundaries (Harris 1972; 1973). Indeed, recent work in South America integrating landscape approaches (palynological evidence for vegetation change), with newer archaeobotanical techniques such as identification of starch grains preserved on stone tools suggests primacy of tuber cultivation in the lowland tropics of central and South America (Piperno and Pearsall 1998; Piperno et al. 2000). Thus we should be open to the possibility that more mobile forms of tuber cultivation, presumably with some accompanying vegetable crops, was of greater antiquity than the grain-based systems of rice, millets and pulses. As highlighted by Harris (1969; 1972; 2003), it is these grain-based agricultural systems that tend to be more intensive and intensifiable, support denser populations and might be expected to displace and largely replace tuber-based systems. Most expansive appear to have been systems of cultivated cereals and pulses together with livestock (Harris 2003). The Neolithic evidence we have at present for the settling down of grain farmers, might therefore be the end of a much longer process of the development of food production.

There is much to be done on the origins, settling and spread of agricultural societies in South Asia. While recent years have seen a great increase in hard evidence from archaeobotany, there are still massive gaps in knowledge. These gaps are even more massive for the pre-settled Neolithic and the preceramic (Mesolithic) societies which must be understood if agricultural origins are too be traced in South Asia. The theoretical possibility that some of these groups cultivated tubers together with some vegetables, as might be suggested by proto-Dravidian reconstruction for a tuber term (probably taro; DEDR 2004, see Southworth, this volume; 2005: Appendix A) at the same level as eggplant (DEDR 5301) and some sort of onion/garlic (DEDR 705), requires further investigation. There is also much more work of a botanical and biogeographic nature that is needed, as some of the author's recent revisions of wild progenitor distributions (see above), suggest. Problem-oriented botanical fieldwork, backed up by genetics, and problem-oriented archaeological fieldwork in some of the indicated, but under-explored, regions is needed. Similarly, recent advances in historical linguistic information (e.g. Southworth 2005; Witzel 1999; 2005) are reaching limits in what has been published in the main etymological dictionaries. The DEDR is incomplete with plant names, especially for indigenous millets, and it is unclear whether absence of evidence, e.g. for mungbean in North Dravidian, is evidence for absence or incomplete recording. Similarly CDIAL lacks clear vocabulary for cucurbit crops which were important in the prehistory or northern India and both sources have limitations with regards to tuber crops and various trees. Some directed linguistic fieldwork, which would be best if accompanied by botanical expertise (especially for the problematic millets and tubers), seems needed. Nevertheless, the patterns that can be discerned at present from recent research indicate growing consilience between linguistic, botanical and archaeological research.

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