South Asian Archaeology 2001

Edited by

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Volume I
Prehistory

Éditions Recherche sur les Civilisations

Dung Mounds and Domesticators: Early Cultivation and Pastoralism in Karnataka

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The beginnings of settled village life in South India lie in the Southern Neolithic, known from northern Karnataka to date back to *c.* 2800 cal. BC. The origins and subsequent development of this cultural tradition have received renewed research interest in recent years (e.g. Paddayya 1993; 1998; Deveraj *et al.* 1995; DeFresne *et al.* 1998; Korisettar *et al.* 2001a; Fuller 2001), and the current contribution will explore the evidence and interpretations that have emerged from the author's study of archaeobotanical material deriving from the Southern Neolithic. In the present paper, I will move beyond the raw data to draw inferences about the organization of subsistence production in the landscape of Southern Neolithic settlement. It will provide a hypothetical framework for considering the origins of this economic system in the context of shifting vegetational patterns modelled on the basis of current understanding of the mid-Holocene decline in monsoon rainfall leading up to the beginnings of the Southern Neolithic.

The Southern Neolithic has long provided evidence for the earliest pastoralism in Peninsular India. The well-known site category of the Southern Neolithic is the ashmound, which has been shown 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). Preserved hoof-prints (at Utnur) and 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 some have interpreted all sites, including ashmounds, as sedentary sites (e.g. Paddayya 1993; Devaraj *et al.* 1995), the available field evidence, including observations of the present author, indicate differing intensities of occupation at ashmounds and non-ashmound sites which implies different occupation lengths or frequencies suggesting that many, if not all, ashmounds represent some form of seasonal encampment by a pastoral segment of society (Allchin 1963; Korisettar *et al.* 2001a; Fuller 2001; Fuller *et al.* 2001b). With the addition of archaeobotanical evidence, we can now infer seasonal patterns of plant cultivation and site use which must have been integrated with transhumant pastoral practices. The archaeobotanical evidence and its implications for understanding the settlement pattern and seasonal aspects of the economy will be discussed below. Finally a model for the emergence of this economic system in relation to changing environmental variables during the later mid-Holocene will be presented.

Staple Crops: A Native Package

A picture of staple and likely secondary crops of the Southern Neolithic has been generated by archaeobotanical evidence from a pilot study of several sites across the region. Twelve Neolithic sites across a roughly east-west transect of northern Karnataka and western Andhra Pradesh were sampled stratigraphically (Fig. 1). While analysis of samples continues, preliminary results based on 72 flotation samples from 12 sites were reported in the conference of South Asian Archaeology 1999 in Leiden (Fuller in press; also Fuller *et al.* 2004). While this includes evidence that the same basic crops were important across north-central Karnataka into western Andhra Pradesh (Fuller *et al.* 2001a), the present paper will focus

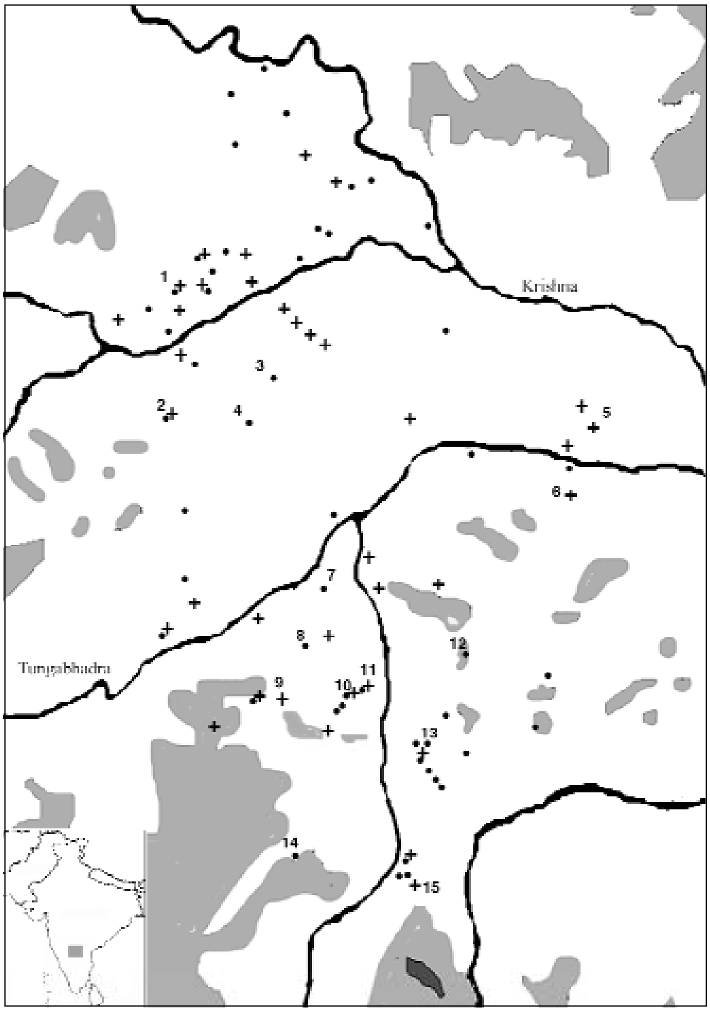

Fig. 1 – Distribution of Southern Neolithic sites in the core region of the Ashmound Tradition.

on a more restricted aspect of the Southern Neolithic, which may be termed the "Ashmound Tradition" on the basis of the distinctive site type found over a limited area of the Neolithic distribution of Karnataka. These distinctive sites derived from the periodic burning of dung accumulations at the sites of cattle pens (e.g. Allchin 1963; Paddayya 1998), are interspersed with sites of a different character, with more clear evidence for intensive human occupation, such as previously excavated sites of Sanagnakallu and Tekkalakota (Nagaraja Rao & Malhotra 1965; Ansari & Nagaraja Rao 1969). Within the Bellary District (Karnataka) and adjacent Andhra Pradesh, seven of these sites have been studied archaeobotanically in addition to field observations on five ashmounds sites (Korisettar *et al.* 2001a; 2001b; Fuller 1999, Appendix B)

The archaeobotanical material came from archaeological levels that coincide with Phases II and III in the Southern Neolithic chronology of Allchin & Allchin (1982), equivalent to 2300-1800 cal. BC and 1800-1200 cal. BC respectively (cf. Deveraj *et al.* 1995). As of yet few non-ashmound occupation sites that can be clearly referred to Phase I are known from south of the Tungabhadra, although such sites are known in the Raichur Doab, such as at Watgal (Deveraj *et al.* 1995) and Piklihal (Allchin 1960). The bulk of seed/fruit material was found to consist of pulses and millet grasses (Table 1). The millet grasses have been identified as being primarily from two species, *Brachiaria ramosa* and *Setaria verticillata*, species known to be utilized on only a small scale today (De Wet *et al.* 1983; Pandey & Chanda 1996: 26; Kimata *et al.* 2000). The consistently recovered pulses are two species native to the region, mung bean (*Vigna radiata*) and horsegram (*Macrotyloma uniflorum*) present from the earliest levels, while other pulses appear only in later levels. Other species are sporadic across the region or else present only in Phase III suggesting that these species were adopted by selected communities during the course of the Neolithic. These include non-native taxa such as wheat and barley, possibly rice (found in small quantities only at Hallur), hyacinth bean (*Lablab purpureus*, probably a native of East Africa), African pearl millet (*Pennisetum glaucum*) and pigeon pea (*Cajanus cajan*, from Orissa or adjacent parts of eastern India) (For a recent review of the regions of origins of major South Asian crops see Fuller 2002). Thus the staple taxa of the Southern Neolithic, on which the earliest agriculture in this region is likely to have been based, are native species, presumably domesticated within South India independent of the introduction of agriculture from elsewhere (Fuller 2001; Fuller *et al.* 2004).

Seasonality

The important contrast between the winter seasonality of crops of Southwest Asian origin and the summer/monsoon seasonality of many other crops in India has been widely discussed (e.g. Allchin & Allchin 1968; Hutchinson 1976; Possehl 1986; Kajale 1988; Weber 1991; Meadow 1996). To some extent these seasons are determined by growth and fruiting mechanisms in the

Neolithic sub-phas	**Phase II**					**Phase III**						
Site	SGK	HGD	VPM	HBG	HLR	SGK	HGD	KRG	HLR	HRP	RPG	PDM
Pulses												
Macrotyloma uniflorum	X	X		X	X	X	X	X	X	X		X
Vigna radiata	X	X		X	X	X	X		X	X	X	X
Vigna cf. mungo					o				o	o		o
Vigna trilobata					o				o	o		
Lablab purpureus					+	+			+			
Cajanus cajan						+						*
millets (and related grasses)												
Brachiaria ramosa	X	X	X	X	X	X	X	X	X	X	X?	X?
Setaria verticillata	X	X	X	X	X	X	X	X	X	X	X	X
Echinochloa cf. colona							o		o	o		
Setaria pumila	o					o						
Panicum sumatrense					o			o	o			
Paspalum scrobiculatum									o			
Pennisetum glaucum					+							
Eleusine coracana									+			
large cereals												
Hordeum vulgare	+	+		+		+		+				
Triticum sp.	+	+				+		+				
Triticum diococcum		+				+						
Triticum durum/aesitvum	+	+				+						
Oryza sp.					o/ +				o/ +			
misc. food/crop plants												
Ziziphus sp.	o	o			o	o		o				
Ficus sp.								o	o	o		
cf. Syzigium cumini					o					o		
Cucumis cf. prophetarum					o				o	o		
cf. Luffa cylindrica									+			
Linum usitatissimum									+			
Gossypium sp.									X/ +			
parenchyma fragments	X/o	X/o		X/o	X/o	X/o	X/o	X/o	X/o	X/o	X/o	X/o

X = Presence of inferred crop, possibly derived from domestication in Southern India.

.+ = Present as crop, introduced from another region

o = Present in limited quantity, possibly gathered from wild

* = Presence reported by Venkatasubbaiah and Kajale 1991

Table 1 – Presence of crops and other food plants identified from Southern Neolithic sites in the present study. For site abbreviations and locations, see Fig. 1.

plants, i.e. whether flowering is triggered by lengthening or shortening day length (Willcox 1992), although for most crops there exist modern varieties which are photoperiod neutral. In cases where modern experimental work on seasonality has not been done, it will be assumed that traditional cultivation reflects the optimal or inherent seasonality of a plant (for details see Fuller *et al.* 2001b).

The suite of Southern Neolithic crops had a monsoonal (*kharif*) seasonality, i.e. flowering after summer. The period of growth varies between species with the

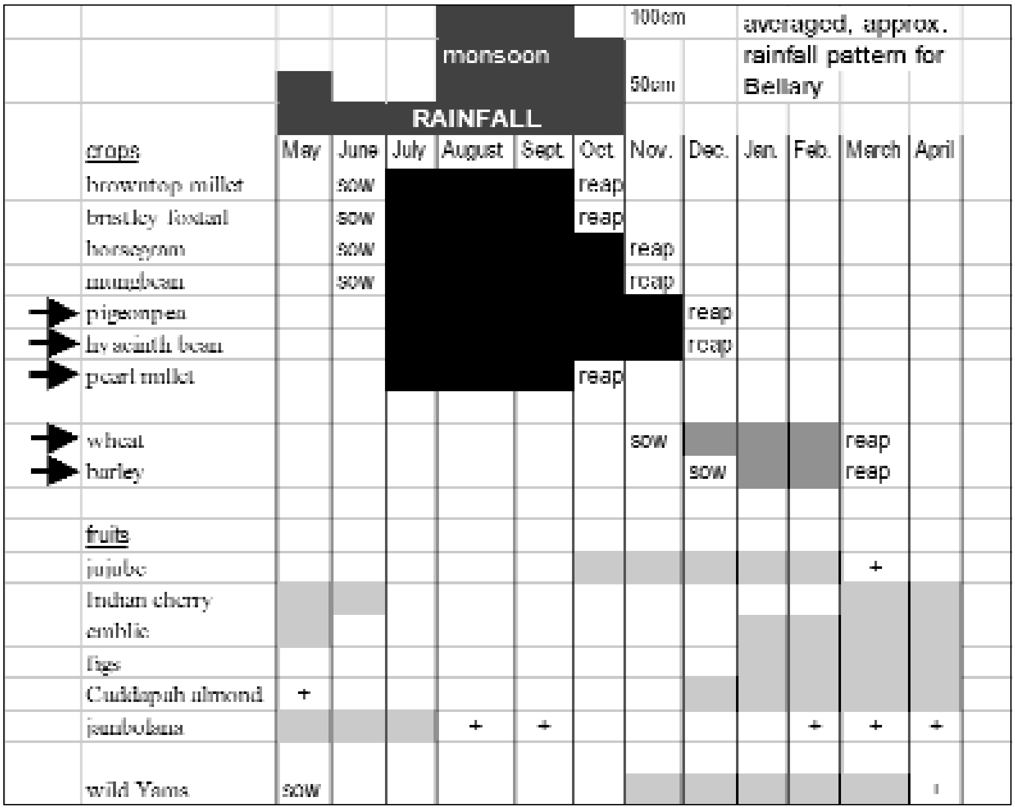

Fig. 2 – Inferred basic seasonality of Southern Neolithic cultivation and foraging.

small millets and some crops of mung bean maturing in 3-4 months while horsegram may take as long as 6 months. It is likely that when cultivated, harvest would have occurred prior to natural seed set in order to reduce loss of shattering spikelets, which would have been more prevalent amongst morphological wild or early domesticated forms of these species. This suggests that the main Neolithic harvest would have been during September and October. It should also be noted that wild millet-grasses, and presumably early cultivars, may have been prone to asynchronous ripening, and thus have required several harvests over a period of several weeks (see, for example, Lu's (1998) harvesting experiments with *Setaria viridis*).

Most additional species would have also been monsoon crops. Other millet species, including African pearl millet would have had the same seasonality. Introduced species, including hyacinth bean, pigeonpea and rice, would have had this seasonality, although many of these species probably had longer maturation time close to 6 months. Therefore these species were well-suited to incorporation in South India cultivation systems. That some of the adopted species are evident in only small quantities, including Pearl millet and Finger millet at Hallur, raises the question as to what factors, such as cultural traditions may have delayed their widespread adoption. Taxa that that are likely to have been gathered or grown on a small scale in garden plots, including cucurbits (*Cucumis, Luffa*), are likely to have shared the same seasonality as the millets and pulses with harvesting during the post-monsoon period, October to December. Cotton (*Gossypium arboreum*) was probably grown as a bushy perennial and harvested after the monsoon at the start of the dry season, like long-duration *kharif* crops. In addition to periods of agricultural activity, such as planting and harvesting, it is necessary to consider periods of availability of fruits that would have been gathered from the wild. Although there is likely to have been some localized variation in the timing of fruitset, most of the fruits can be generalised to dry season availability, as is also the case with several other gathered fruits of the Deccan for which there is as yet no archaeobotanical evidence.

At some sites this basic scheduling was augmented by the adoption of additional crops, made available from other regions (Fig. 2). The first and most widespread crops to be adopted in the Bellary region were winter cereals, wheat and barley, which added a new cropping season to the calendar. As noted above, these crops are not well-suited to the rainfall regime of monsoonal India and are likely to have required some form of irrigation, as Kajale (1988) has suggested for Malwa phase Inamgaon. Thus it seems likely that the South Indian tradition of tank irrigation or the damming of water near the bases of local hills may have begun already before *c.* 2000 BC, although the start of this tradition is usually attributed to later periods, especially the Early Historic Period or perhaps the Iron Age (Wheeler 1959: 163; Gurukal 1989; Champakalakshmi 1996: 36, 82-83). This then represents the first form of agricultural intensification in this region through irrigation and through adding additional seasons of tilling, sowing and harvesting. The apparent absence of winter pulses here, which were important in contemporary Maharashtra, is curious and suggests that there may have been particular cultural factors promoting the selective adoption of wheat and barley.

Settlement System

The seasonal patterns of crop production can be placed into a settlement system model by considering the likely role played by different categories of sites (Fuller 2001). Sites of the Ashmound Tradition in the Bellary district can be divided into three categories (Table 2). First there are well-stratified settlement sites that have yielded abundant evidence for crops. Although beyond the scope of this paper, our general understanding of the formation processes of charred seed assemblages suggests that they derive primarily from the incidental waste of crop processing, which we would expect to have been more extensive and more routine on permanent sites near which cultivation was carried out and on which crops were stored (Fuller 1999). In contrast, ashmound sites generate few archaeobotanical remains, with the exception of very limited finds from Budihal (see Paddayya

Site type, Archaeological characters	Examples	Botanical preservation	Social/ economic Interpretation
Settlements, Deep, stratified deposits, evidence for structures, usually on hilltops	Sanganakallu, Tekkalakota, Velpumadugu, HattiBelagallu, Kurugodu,	consistent recovery of seed assemblages	Permanent settlement Above agricultural plains (occasional sites near base of hills such as Kurugodu, Bellary Face Hill, Watgal)
Ashmounds, with no stratified deposits around them	Kudatini, Godekal Utnur, Chopadamagudda	no sediments to float	Seasonal, short-stay(?) encampments of single pastoral groups
Ashmounds, with some habitation deposits around them	Kupgal, Palavoy, also Budihal (Paddayya 1993; 1998)	very poor recovery of seeds	Seasonal, long-stay encampments of pastoral groups, in dry season. Often multiple ashmounds (perhaps from several pastoral social groups). Often near sources of lithic raw materials

Table 2 – Tabular summary of the three main site types of the Ashmound Tradition of the Bellary region, including notes on the extent of preservation of archaeobotanical material.

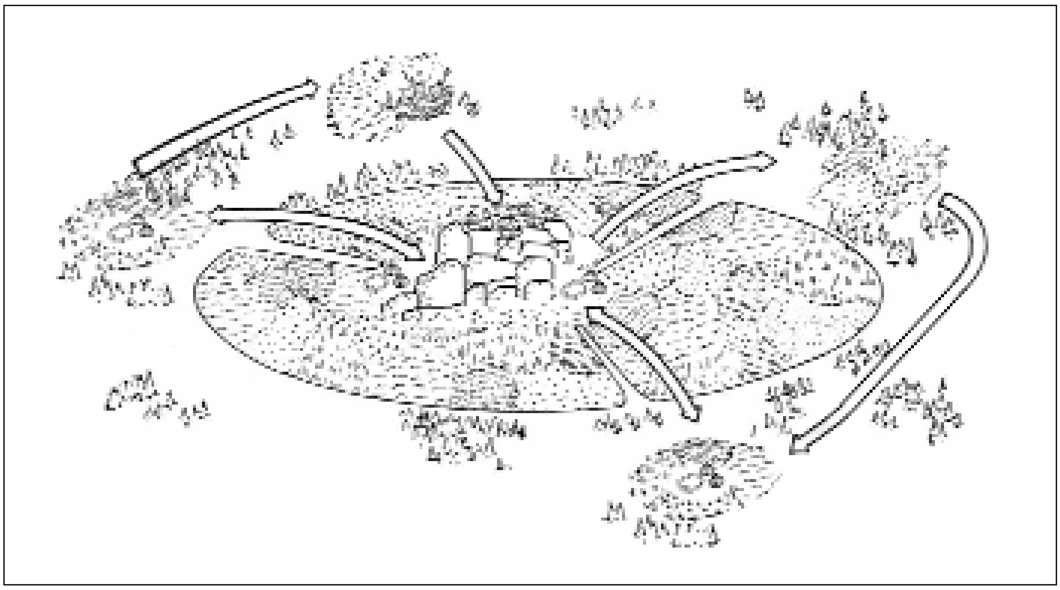

Fig. 3 – Idealized model of the settlement pattern of the South-Indian Ashmound Tradition.

1993; Kajale & Eksambekar 1997). Ashmound sites can be divided into two main groups: those with evidence for extremely limited habitational refuse, such as Kudatini, Godekal or Utnur, that are considered short-stay encampments, and those with some limited stratigraphy of habitational refuse were prolonged encampments, such as Budihal, Palavoy or the ashmounds of Kupgal (Korisettar *et al.* 2001a; see also Allchin 1963). The significant role of ashmound sites in pastoralism is clear from evidence for penning, dung accumulation and animal bones, predominantly cattle (Allchin 1963; Paddayya 1998). The paucity of archaeobotanical remains suggests not that plants formed an inconsequential part of the diet, but rather that these sites supported little processing, such as de-husking and winnowing that produce archaeobotanical remains. Instead only the final food preparation stages would have been carried out on these sites, and on a more restricted scale. When considered on a general regional scale it can be seen that groups of permanent village sites and ashmound encampments form geographical clusters that might represent networks of agricultural villages with associated hinterlands of pastoral transhumance (Fig. 3). Similar patterns may have held in regions adjacent to the ashmound tradition. In the region of Hallur, insufficient survey data are available to suggest similar site-type divisions. In the Cuddapah district further analysis is necessary but provisionally at least two broad division can be drawn, perhaps equivalent to permanent agricultural sites and seasonal, pastoral encampments, albeit without any evidence for ashmound formation (Fuller *et al.* 2001a).

The functional distinction between hilltop settlement sites and the ashmounds may also be reflected in artefactual evidence for seed-food processing, namely in grinding stones (Fuller *et al.* 2001b). Although grinding stones have numerous potential uses, their use for the de-husking or grinding of seed foods is well documented ethnographically and archaeologically. While stone artefacts are not necessary for de-husking or grinding (Kraybill 1977; Cane 1989; Anderson 1992), and indeed wooden pestles are often preferred (whether with a stone, wooden, or earthen pit mortar), the presence of grinding stones during the Southern Neolithic implies that these did serve an important function, probably to do with seed grinding and/or crop-processing. These are ubiquitous finds at Neolithic sites, but our field observations indicate that their concentration is considerably higher at permanent (hilltop) settlements such as Sanganakallu, Kurugodu and Tekkalakota. Free-standing grinding stones were often large and would have been difficult to move very far, although in other cases they were small enough to be locally portable. At some sites, such as Sanganakallu, it appears that the local granite hill itself was often used for grinding, and numerous grinding hollows are located in the boulders at the edges of the site. These ovoid hollows are distinct from the grooves thought to have been used from grinding the edges of stone axes (cf. Subbarao 1948). The grinding impressions on the natural granite boulders were often quite large and many were somewhat rounder and deeper than free-standing querns. This morphology might have been produced by pounding, as in preparing cracked grain, or perhaps de-husking, and not merely grinding. The querns and grinding impressions indicate that much of the grinding of grains was done outside rather than inside dwellings, and also suggests that pounding/de-husking may have been carried out on the hillsides immediately around the site.

No examples of pounding/grinding impressions in the natural rock were noted at solitary ashmound sites, such as Godekal or Palavoy, although ashmounds sites do have querns (e.g. Allchin 1963; Rami Reddy 1978: 26; Paddayya 1993; Fuller *et al.* 2001b). Quernstones are likely to have been used to make flour. This suggests that some food processing, namely grinding, was not seasonally restricted, although pounding/de-husking was. While the presence of some querns at ashmound sites indicates that plant seed processing was also carried out at these sites, the small quantity and size of these implements argues against intense grain processing or grinding at these sites. On the other hand the presence of grinding/pounding impressions at permanent hilltop sites and associated ashmound/encampments suggests that more intensive processing activities, probably including de-husking, took place only in the vicinity of the permanent habitation sites that were presumably associated with the areas of cultivation. The encampments near these sites may have been seasonal occupations for mobile segments of the society (Korisettar *et al.* 2001a), at which post-harvest processing activities were carried out. This fits the ethnographic generalisation that grinding equipment is often cached at repeatedly occupied sites near the actual living stands of the food stuffs (Harris 1984; Wright 1994).

Thus the evidence from the Southern Neolithic, at least from the start of its second phase, indicates a well-integrated agro-pastoral system. This included transhumant pastoral social groups, as well as sedentary or near-sedentary settlements in areas where cultivation and intensive crop-processing activities were carried out. In terms of understanding the origins of this cultural tradition, it becomes necessary to ask how these different economic strands, seasonally-mobile pastoralism and cultivation each began in the region and came to be integrated. Taking a comparative perspective, it is clear that the earliest stages of food production focus on either plants or animals with integration at a later stage. Thus in Southwest Asia, especially the Levant where evidence is clear, plant cultivation began perhaps 2000 years before domestic herd animals were integrated into the subsistence system (see Harris 1998; Moore *et al.* 2000), and these animals were apparently domesticated in some adjacent region that may or may not have had cultivation. By contrast in Saharan and sub-Saharan Africa pastoralism appears to have developed and spread prior to the beginnings of plant cultivation (Marshall 1998; MacDonald 2000; Wendorf & Schild 2001). What the case may have been in peninsular India remains obscure. Sheep and goat at least, perhaps cattle as well, must have spread as domesticates from the northwestern subcontinent to have reached South India during the Phase I of the Southern Neolithic (first half of the 3rd millennium BC), a period for which there is no evidence for sedentary villages with cultivation in intervening Maharashtra. Thus our current evidence suggests the presence of forager-herders in parts of mid-Holocene India. When and where these traditions were integrated with crops remains to be determined.

Environmental Context of South Indian Plant Domestication

In terms of Indian plant domesticates like those of South India, it is possible to model the regions in which they were likely to have been first cultivated on the basis of modern ecological/floristic data and palaeo-environmental inferences. The four key staples identified archaeobotanically from the Southern Neolithic presently grow wild in Southern India and by understanding their modern ecological distributions it becomes possible to model their likely distributions during the mid-Holocene prior to the emergence of Southern Neolithic cultivation. The wild progenitor of mung bean is known to occur in the wet and dry deciduous forests on the eastern edge of the Western Ghats in clearings and forest edge habitats (Saldanha 1984), while horsegram is native to *Acacia*

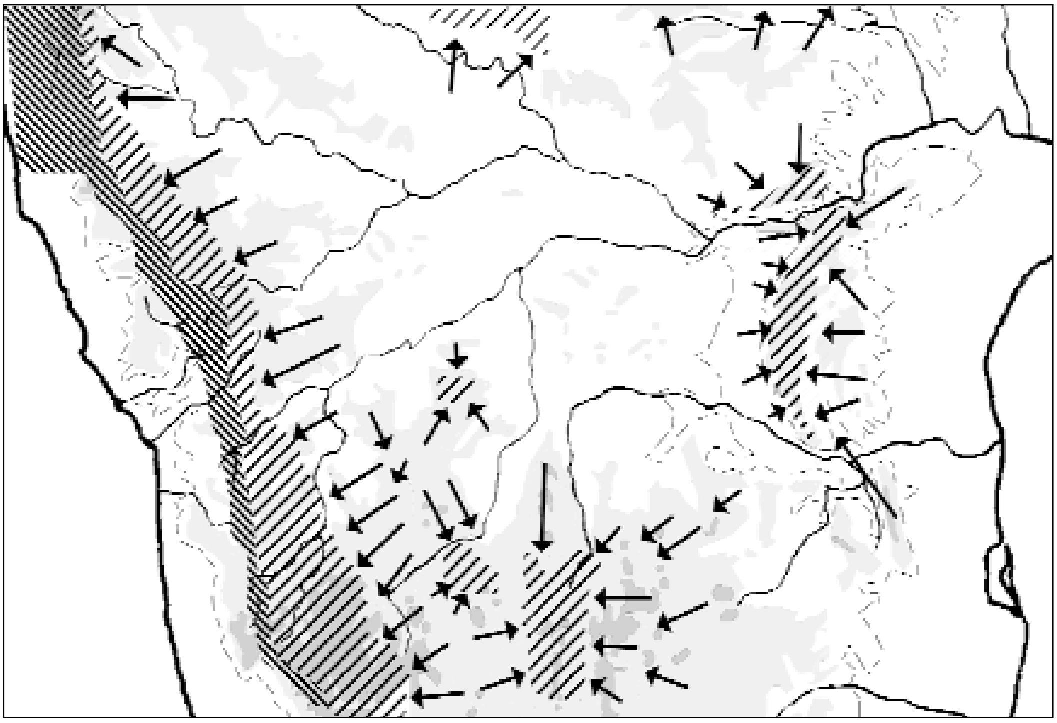

Fig. 4 – A provisional model of the retreat of wet deciduous forest element associated with the aridification at the end of the Mid-Holocene Wet Phase.

thickets on the peninsula (Jansen 1989) which are more prevalent in the dry deciduous and thorn-scrub savannah zones. It is within the dry deciduous zone, and to some extent the thorn-scrub, where the wild millet-grasses would have been available as resources before they were cultivated. In general these species prefer somewhat damper soils and occur in localized stands but are not among the more common or widespread grass taxa of the region (cf. Whyte 1964; Dabadghao & Shankarnarayan 1973). These species are apparently absent from the wet deciduous zone (Saldanha & Nicolson 1976).

Sources for mid to late Holocene palaeo-enviromental data in the south-central Deccan are lacking but general inferences about climatic and vegetational change can be inferred from other datasets in South Asia and the wider Indian Monsoon system (Fuller & Korisettar 2004; see Fuller & Madella 2001; Schulderein 2001). On the whole datasets from East Africa (e.g. Gasse 2000), the Arabian peninsula (e.g. Lezine *et al.* 1998), the Thar Desert (e.g. Enzel *et al.* 1999) and the Himalayas (e.g. Wei & Gasse 1999) all indicate increased precipitation and stronger monsoons in the mid-Holocene which peaked in the 5th to early 4th millennium BC, with evidence for the beginnings of aridification trends in the second half of the 4th millennium BC. Precipitation and moisture levels decreased during the 3rd millennium BC towards minimum at *c.* 2200 cal.BC. In South India this same sequence of change is indicated by a few datasets, including Nilgiri peat (Sukumar *et al.* 1993), Tamil Nadu groundwater isotopes (Sukhija *et al.* 1998) and the earliest pollen zone in a core off the Karnataka coast at Karwar (Caratini *et al.* 1994). Therefore the era during which the Ashmound tradition of South India emerged was one of declining monsoon levels.

The region would have been wetter, i.e. having a somewhat stronger and longer-lasting monsoon at the beginning of, and just prior to, the Neolithic, *c.* 3000 BC. Significant differences may have existed in the distribution of the wetter vegetation zones and therefore the wild pulse (especially mung bean) progenitors (Fig. 4). The Evergreen zone is likely to have remained confined to the Western Ghats corridor, with some latitudinal shifts in its composition. The Wet Evergreen forests and the transitional Dry Deciduous teak-*Terminalia-Anogeissus* woodlands may have extended marginally further eastwards but are also likely to have encroached into the Deccan along hill ranges, especially those of the Dharwar schists with their loamy soils. The wild millet populations are likely to have been somewhat more widespread in the central Deccan but less so towards to wetter hill ranges, including the western Ghats, the Nalamallais and perhaps parts of the Sandur hills. Nevertheless they would have still been locally restricted in terms of their availability as wild food resources, and most frequent along watercourses, seasonal watercourses and hill slopes. The region around Bellary would still have received less rainfall than would regions further west and east. As this region also has less water-retentive soils, it is likely to still have been dominated by dry shrubby vegetation, although the less thorny *Albizia-Chloroxylon-Anogeissus* type is likely to have encroached significantly into areas where *Acacia* is now important. This region is likely to have had a more open savannah habitat than other regions. It is intriguing that this vegetational area corresponds fairly closely to the distribution of the Ashmound Tradition and it is tempting to see a correlation between the importance of cattle in the more open habitats of the granitic northern Maidan.

Taken as a whole the early Holocene and mid-Holocene saw more rainfall and expansion of forested environments in the south Deccan. Unfortunately, given the low level of Mesolithic archaeological evidence, it is not possible to address subsistence practices during these periods. While drier periods would have encouraged the spread of grasslands, the Neolithic evidence indicates that only particular millet species, probably rare in the landscape as a whole, came to be relied upon as important foods. These species may have been more widespread in the dry zones during wetter epochs. The extent to which the wild pulses, especially *Vigna radiata* and *Macrotyloma uniflorum,* might have extended their ranges during the wetter period is unclear and requires more detailed ecological studies of these crops. Potential root crops almost certainly would have been more widespread during the wetter phases. Nevertheless, it is tempting to suggest that expanding wild millet availability, coincident with contracting pulses and perhaps tubers in the environments east of the Western Ghats and perhaps around the Sandur hills may have fostered the beginnings of intensive exploitation of these species. There is no palaeo-ecological evidence that connects the emergence of cultivation with a harsh or sudden climatic change, but it is plausible that environmental changes were contributing factors in the creation of a food-producing economy in South India.

Acknowledgements: I would like to thank my principle collaborators, Professor Ravi Korisettar and Dr. Venkatasubbaiah for their hard work and coordination in the field and their useful discussions and input. I would also like to thank Sarah Walshaw for her constructive comments on an earlier draft of this paper.

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