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Searching for the origins of African rice domestication

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Until recently, African rice (*Oryza glaberrima*) was an important staple for peoples across much of West Africa. Favoured for its resistance to drought, disease, and pests, its cultivation has spread during the past 1000 years and more, over broad regions of western Africa, ranging from the Atlantic coast of sahelian Mauritania to Lake Chad, south to the Bight of Benin, and west along the coast to Senegal (Pearson *et al.*; 1981, Portères 1976). Its nutty flavour and ability to "fill one up properly" has led many societies of West Africa to consider African rice so important that without it, a meal is simply not a meal (Harlan 1995b).

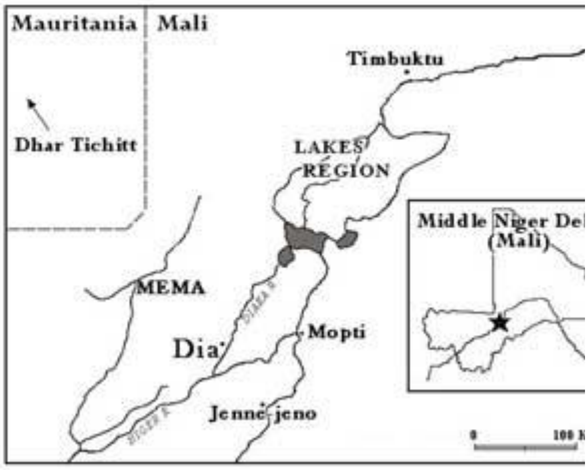

Figure 1: Map of the Middle Niger Delta, Mali. Click to enlarge

Archaeological data on the place and timing of African rice domestication remain virtually non-existent. It has been recovered in less than a handful of early sites, such as at Gajiganna and Kursakata in the Chad Basin of north-eastern Nigeria, and at Jenné-jeno in the Middle Niger Delta (MND), Mali (McIntosh 1995, Zach & Klee 2003). Nevertheless, when it has been found, there has been immense difficulty in distinguishing the ancient grains to wild or domestic status. In 1998-2001 however, a large quantity (n=1376) of rice grains was recovered from the site of Dia (Fig 1), in the MND (Bedaux *et al.* 2001; Bedaux *et al.* n.d.). AMS dates on three grains indicate that rice was present from the earliest occupation (799-413 BC, 785-411 BC, 791-413 BC, 2 sigma), and dates on another seven grains place it in secure contexts through to the mid-first millennium AD.

Figure 2: Spikelets and naked grains of *Oryza glaberrima* and *O. barthii*.
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Many researchers (Andah 1993; Clark 1976; Harlan 1971; Harlan 1995a; Harris 1976; Portères 1970, 1976; Shaw 1976) consider the MND a primary centre for African rice domestication. Portères (1976: 442-443) defined it as such because in modern domestic varieties he recognised genetically dominant traits (large, thick and rigid panicles, spikelets loosely attached to pedicels, and red pigmentation) as analogous to traits in the MND. Varieties with recessive characters were more similar to those in the Sene-Gambia and Guinea, suggesting African rice more likely derived from the former area than the latter.

Determining the specific status of the ancient grains from Dia was difficult. Virtually all of the grains were recovered naked - without the paleas and lemmas necessary for distinguishing African rice to wild or domestic species. Typically, spikelets of the wild ancestor (*Oryza barthii*) have hairs and awns (Fig 2), while the domesticate (*O. glaberrima*) is smooth and without awns, though hispid forms occur, as do brittle rachii (Ogbe & Williams 1978; Portères 1976).

An examination of the literature indicates that grain dimension (length, width, thickness) in wild and domestic rice species overlaps extensively, and most interestingly, that length is greater in the wild species. This suggests that unlike the domestication process in many other cereals, African rice domestication apparently did not involve selection for larger grains (Katayama 1992; Katayama & Sumi 1995; Ogbe & Williams 1978). Moreover, Katayama (1992, 1994, Katayama & Sumi 1995) found that ratios of these dimensions (length/width, length/thickness, width/thickness) show differences between Asian (*Oryza sativa*) and African species (*O. glaberrima* and *O. barthii, O. longistaminata*). Although much variability exists, these ratios point to an evolutionary trend towards *thicker* grains in *O. glaberrima* and *O. barthii*, compared to Asian and other wild African species. Comparing ratios of *O. glaberrima* and *O. barthii*, these species are often distinguishable by the manner in which volume becomes larger: *O. glaberrima* adds to overall volume by increasing thickness, while *O.*

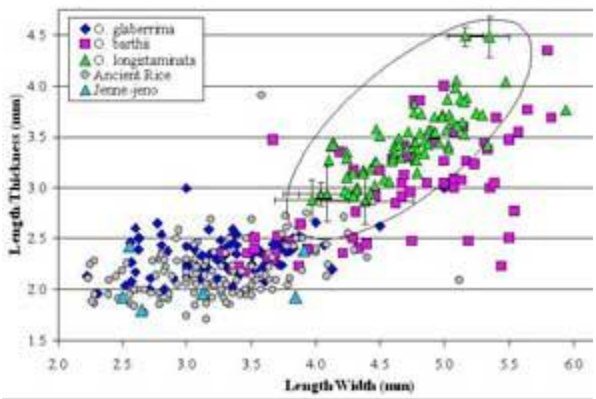

Figure 3: Scatterplot of modern and ancient African rice. Note: the Jenne-jeno samples date Phase I/II to Phase IV (250BC-AD1400) .
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barthii increases volume more through length.

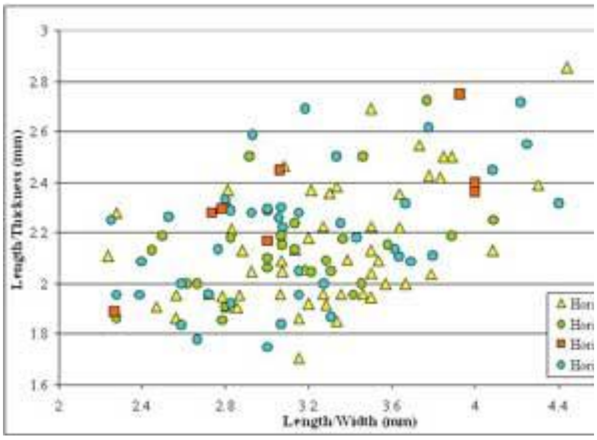

Figure 4: Scatterplot of the ancient African rice grains from Dia. (Horizon 1 = 800-400 BC - AD 0; Horizon 2 = AD 0-500; Horizon 3 = AD 500-1000; Horizon 4 = AD 1000-1600)
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To identify the rice grains from Dia to wild or domestic species, the grains were measured and compared to ratios of modern African rice. Only whole, undistorted ancient grains were measured (n = 134), as were modern dehulled grains of *Oryza glaberrima* (n=91) and *O. barthii* (n=68) obtained from Niger, Nigeria, and Mali by the International Rice Research Institute. The ancient grains also were compared to another wild species, *O. longistaminata*. As the United States Department of Agriculture considers this species a weedy pest, it was impossible to import it into the U.S. Instead, the ancient grains were compared to averages and standard deviations of 83 accessions (30 grains each) of *O. longistaminata* collected in Nigeria, Ivory Coast, and Senegal (Katayama 1992, 1994).

Figure 3 shows ratios of length/width and length/thickness of the modern species and the ancient grains from Dia and Jenné-jeno. The majority of ancient grains appear to resemble more closely the modern domestic African rice than they resemble the wild species. A few grains resemble those of the wild species however, which is expected, as today wild rice grows along the margins of domestic fields, is harvested, and sold at market for consumption (Harlan 1989).

Interestingly, the ancient grains show little change in size through time (Figure 4). This lack of change supports the idea that rice at Dia was fully domesticated from the earliest occupation, as some change in size or shape should be evident if it had undergone *in situ* domestication, or if early rice at Dia was wild and domestic rice was introduced during occupation. *If* domestication occurred in the MND, it might have resulted from long years of cultivation by local fisher-foragers, perhaps the proto-Bozo or Nono. Alternatively, perhaps it was introduced into the upper MND from elsewhere, such as from the Méma to the west, or the Lakes Region to the north (Gallais 1967:102).

Sadly, recent decades have witnessed the rapid replacement of African rice by its Asian relative (*O. sativa*). Asian rice generates higher yields, possesses a tougher rachis (making it easier to harvest), and produces a grain less conducive to shattering, but it also matures later and is more susceptible to drought and pests, compared to the native rice (Nyanteng *et al.* 1986). Fortunately, recent attempts by the West Africa Rice Development Association (WARDA) have successfully crossed *O. glaberrima* and *O. sativa*, producing a natural hybrid known as "nerica" (New Rice for Africa). Nerica combines the advantages of its parent species, creating a variety that has shown since 1997 to be a sort of "miracle" rice for West Africa, producing food security (through higher yields and earlier harvests) for peoples often plagued by famine and drought (Harsch 2004, WARDA 2004, http://www.warda.org).

This study forms part of a PhD dissertation project on the rise of African rice farming in the MND, in collaboration with the Dia Archaeological Project. For forthcoming publications or questions, email:

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