An Indian trader in ancient Bali?

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Research

DNA analysis of a tooth found with imported pottery in Bali offers a strong possibility of the presence of a trader of Indian extraction in the late first millennium BC.

Keywords: Iron Age, first millennium AD, India, Indonesia, Bali, trade, DNA

Contacts between India and Bali

A little over a decade ago, Ardika and Bellwood (1991) reported their discovery of the first securely stratified evidence of Indian trade contact with Indonesia estimated to have occurred approximately 2000 years ago. This evidence consisted of 79 pottery sherds of rouletted and closely related ware of Arikamedu type, from excavations at Sembiran, a site on the north coast of Bali. Neutron activation analysis showed that the Sembiran specimens have identical fabrics to samples from Arikamedu (Pondicherry) and other Indian sites (Ardika *et al.* 1993). Subsequent excavations at Sembiran provided additional evidence for trading contact with India. The total quantity of known Arikamedu types is now at least 120 sherds, concentrated within an area about 130 x 100m. One sherd contained a graffito of three letters in early Indian script, Kharoshthi or Brahmi; another sherd from a large black-slipped storage jar was tempered with rice husks that were dated by AMS radiocarbon to 2660 ± 100 BP.

These discoveries significantly altered our picture of cultural contact between India and insular Southeast Asia. Before this, the earliest direct evidence for such contact consisted of stone and metal inscriptions dating from the fourth and fifth centuries AD, found in West Java and Kalimantan. However, indirect evidence, summarised by Glover (1990) and Ray (1989), suggested that contact might have begun much earlier. Miller (1969) provided detailed lists of spices and other products of presumed Indonesian origin mentioned in both Indian and Classical sources; cloves and cinnamon were known to Pliny in AD 70. Ardika and Bellwood (1991) assessed the date range for the Sembiran materials (Rouletted Ware, rice husk and Kharoshthi graffito) in order of likelihood: (1) 800 BC to AD 450 (outer possible range), (2) 150 BC to AD 450 (intermediate range), and (3) AD 1-200 (most likely date

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Received: 4 June 2003; Accepted: 4 January 2004

range in terms of the chronological overlap between use of the Kharaoshthi script and Rouletted Ware).

The site of Sembiran itself was located at the head of a small sheltered bay that no longer exists. Several inscriptions in the Old Balinese and Old Javanese languages were discovered in the vicinity. These inscriptions, written nearly a thousand years later (AD 896-1181), refer to long-distance or seafaring merchants (*banyaga; banyaga saking sabrang*); a merchant guild (*banigrama*; Sanskrit *vanigrama*); a market officer (*ser pasar*), and other aspects of sea-borne trade. Ardika and Bellwood (1991:132, 148, 265) observed that in contemporary East Java the term *banigrama* is associated with foreign traders, and further that inscription Sembiran C (#621, Old Javanese, 1181 AD) mentions that the term *juru kling* may be a specific term for Indians or the descendants of Indians. Ardika and Bellwood (1991:230) interpreted these inscriptional finds to indicate that this region of north-eastern Bali was the scene of intense maritime trading activity about 1000 years ago, with archaeological evidence pushing this activity back perhaps a millennium further. At that time, the Sembiran site likely consisted of a settlement located inside a small and shallow bay in the coastline, peopled by native Balinese who were presumably in contact with visiting traders who were able to bring in large amounts of Indian trade pottery sometime between 200 BC and AD 200 (Ardika & Bellwood 1991). However, as concluded by Ardika and Bellwood (1991: 195),"*whether these traders were ethnic Indians as opposed to Indonesians we may never know.*"

A foreign tooth?

Here we report the results of our analysis of a human tooth found in Ardika's original excavation, in the same strata in which the largest amounts of Rouletted Ware sherds were discovered (below spit 3.5 in the Pacung trench PCN III), in association with glass beads also thought to be of Indian origin (Ardika & Bellwood 1991:226). We subjected this tooth to three analyses: AMS radiocarbon dating, stable carbon isotope analysis and analysis of mitochondrial DNA.

Consistent with dates for the Rouletted Ware and Kharaoshthi graffito (Ardika & Bellwood 1991), AMS radiocarbon analysis of the tooth indicate its age as 2050 ± 40 BP (conventional radiocarbon age 2110 ± 40 BP). Stable carbon isotope ratios can be used to interpret diet; it is estimated that ratios of –18.0 to –9.5 are characteristic of a purely marine diet and –22.5 to –18.5 indicate consumption of terrestrial herbivores (DeNiro 1985; McGovern-Wilson & Quinn, 1996). The $^{13}C/^{12}C$ ratio for the Sembiran tooth is –21.1 ‰, which suggests a primarily terrestrial diet. The indigenous Balinese at the Sembiran site probably consumed marine foods as this is typical of coastal Indonesian peoples. Thus, the stable carbon isotope ratios do not suggest that the Sembiran tooth belonged to a native Balinese, but rather to a foreigner.

Mitochondrial DNA

The most striking result comes from the analysis of ancient mitochondrial DNA. DNA was extracted from the human tooth and sequence data were obtained for a130 base-pair (bp) segment of the control region (sites 16189-16319). Compared with the human reference (Anderson *et al.* 1981) the tooth sequence contained six substitutions including: 16189 C, 16223 T, 16240 G, 16261 T, 16290 T, and 16319 A. Three of these sites (16223 T, 16290 T, 16319 A) are generally associated with haplogroup A which is defined by a non-control region site (663 G) that is detected with a restriction enzyme (*Hae*III) (Torroni *et al.* 1992). When tested with this assay, the human tooth was confirmed to belong to the haplogroup A lineage. Haplogroup A is one of nine Asian lineages (Kivisild *et al.* 2002; Schurr & Wallace 2002). Haplogroup A is present in high frequency in Native American (0-100per cent) and Siberian (0-80 per cent) populations, in appreciable frequency in Tibetan (~11per cent), Chinese (4-17 per cent), and Northeast Tribal Indian (17 per cent) populations, and at lower frequencies in other Asian populations: Koreans (8 per cent), Taiwanese Han (10 per cent), and Mongolians (4 per cent). (Ballinger *et al.* 1992; Torroni *et al.* 1992, 1994; Kolman *et al.* 1996; Merriwether *et al.* 1996; Yao *et al.* 2002; Cordaux *et al.* 2003). We then screened for the *Hae*III site at position 663 in a sample of 550 Balinese, as well as in an Asian sample consisting of 81 Indians (Andra Pradesh caste and tribal populations); 71 Tibetans, 46 Chinese Han, 23 Yao from southern China, and 34 Aboriginal Taiwanese. While haplogroup A was found in all four East Asian populations (Tibetans, Chinese Han, Yao, and Taiwanese Aboriginals), it was completely absent in our large sample of Balinese. Figure 1 shows a median-joining network (Bandelt *et al.* 1999) of haplogroup A sequences in our samples, as well as from many of the aforementioned surveys. Although the Sembiran tooth harbours

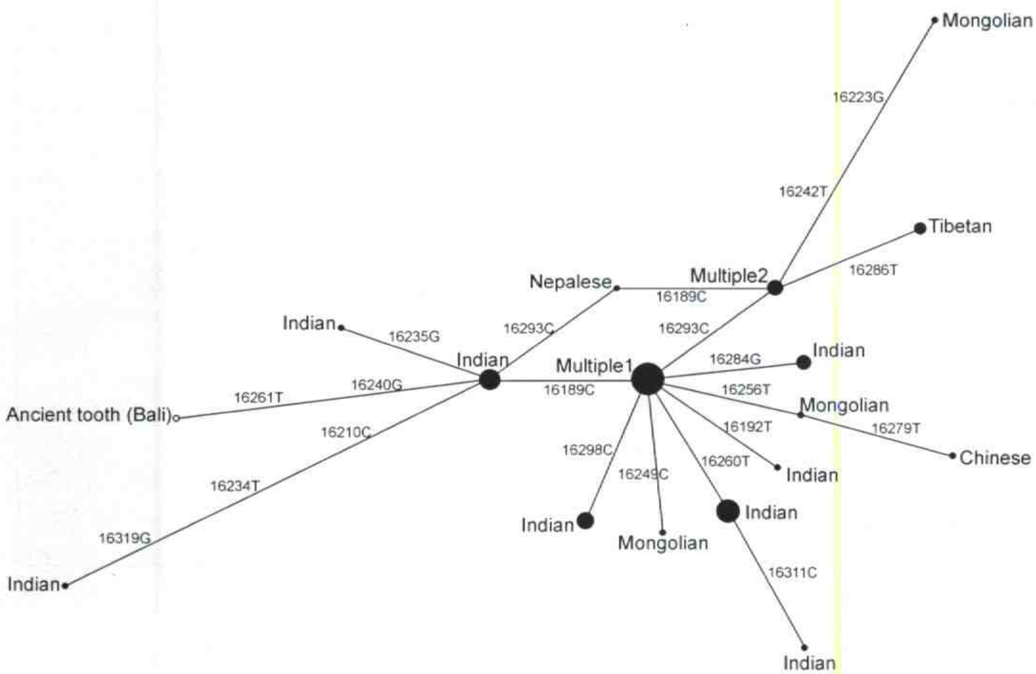
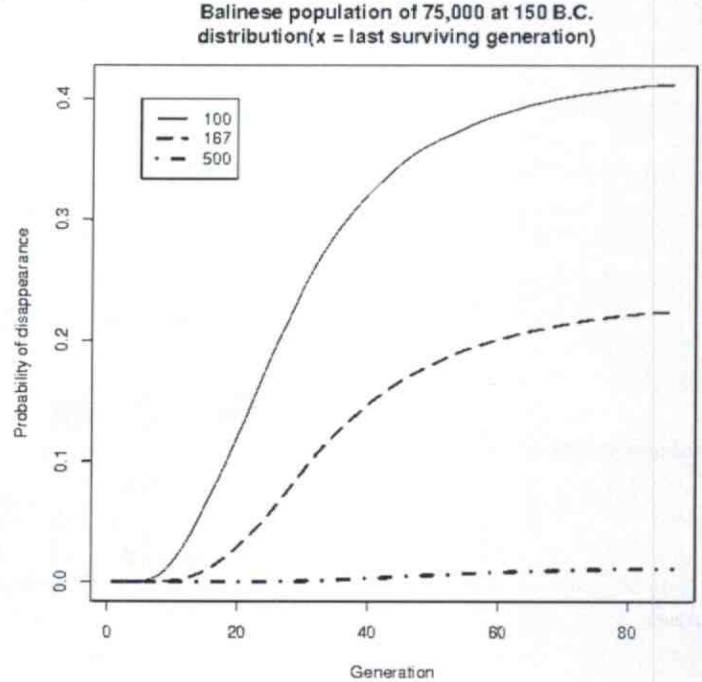


Figure 1. Median-joining network of mitochondrial DNA sequences that belong to haplogroup A. Each circle represents a unique mitochondrial type, and the size of the circle is proportional to the number of individuals sharing that type. Control region nucleotide differences from the human reference are indicated by numbers. Multiple1 is shared by 11 Nepalese; 4 Indians; 3 Tibetans; 1 Mongolian, and 1 Taiwanese; Multiple2 is shared by 1 Nepalese; 1 Tibetan; and 1 Indian. Sources for the data include the following: 29 Tribal Indians (Cordaux et al. 2003); 13 Nepalese (Tad Schurr, unpublished data); 6 Tibetans (this study); 4 Mongolians (Kolman et al. 1996); 1 Chinese Han (this study); and 1 Taiwanese (this study).

two private substitutions (16240 C and 16261 T), this ancient specimen clearly clustered closest to Indian sequences followed by most of the Nepalese and Tibetan sequences (i.e., 16240 G, 16261 T). Assuming a similar geographic distribution of haplogroup A approximately 2000 years ago, these mtDNA data strongly support the hypothesis that the Sembiran tooth belonged to an individual of north-east Indian ancestry.

An obvious question arising from this new evidence is whether the owner of the tooth was a native Balinese or a foreign visitor; perhaps a member of a foreign community resident on Bali as later inscriptions appear to suggest (Lansing 1983). While we cannot provide a definitive answer to this question, it is possible to estimate the chances of finding this particular mtDNA sequence in the present population of Bali, given the assumption that haplotype A was initially present at low frequency. We present the results of a simulation experiment designed to estimate this probability with the following assumptions concerning the population of Bali 2150 years ago. Following Lodewycksz (1597), Reid (1988:13-14; 1999: 199) accepts a population for Bali of 600 000 in 1600 AD. A growth rate of 0.12 per cent p.a. from 150 BC is consistent with this estimate. This would produce a population density for the contemporary agricultural regions of Bali (3266 km^2 of sawah and dry lands agriculture) of 13.5 persons /km^2, slightly higher than Kirch's (1984:98) estimate of 12 persons/km^2 for the Hawaiian population at the time of contact. We assumed (1) a population size of 75 000 (with a minimum of 44 000 and a maximum of 220 000) (2) a population of individuals with haplotype A between 100 and 500 and (3) random mating. We simulated a Wright-Fisher model with maternal inheritance assuming an effective population size of 45 per cent of the total female population size. We assume that the total population of Bali remained constant from 2150 BP until the introduction of irrigated rice around 600 AD, and then rose exponentially to the present population of three million. A total of 450 000 simulations were run in order to assess the likelihood that our sample of 550 modern Balinese should have turned up one or more persons with haplogroup A. The results are shown in Table 1 and in Figure 2.



Figures 2. Estimates of the expected frequency of Haplogroup A individuals in the modern population of Bali based on demographic simulations. The figure graphs the probability of disappearance of Haplogroup A as a function of generation. These values are based on 50 000 simulations of the Wright-Fisher model described in the text, an ancient Balinese population of 75 000 and ancient Haplogroup A populations of 100, 167, and 500 in ca. 150 B.C. Simulations based on ancient Balinese populations of 44 000 and 220 000 yield similar graphs and are not displayed here.

Table 1. Probability that Haplogroup A escapes detection in a sample of 550 present day Balinese based on estimated sizes for the populations of Bali and Haplogroup A at 2150 BP.

Number of individuals with haplogroup A		100	167	500
Bali	44 000	58.3%	40.8%	6.5%
Population	75 000	67.1%	51.1%	13.2%
Size	220 000	83.1%	73.2%	39.0%

Note: Each table entry is computed from 50 000 simulations of the Wright-Fisher model described in the text.

In the most restrictive case (a Balinese population of 222 000 in 2150 BP, of whom only 100 carried haplogroup A), there is a strong likelihood (83.1 per cent) that our study of 550 modern Balinese individuals would have been too small to detect this marker. But if the population carrying the haplogroup A marker were as large as 500, our study should have turned up a few modern descendants. It is important to note that this does not prove that the owner of the tooth was a foreigner; it is possible that haplogroup A was present at very low frequency in the indigenous Balinese population of 2150 BP and subsequently vanished due to genetic drift. But the simulation does provide evidence that this haplotype was extremely rare on Bali in 2150 BP.

Conclusion

These results have important implications for our picture of prehistoric maritime contacts between India and Bali. Ray (1989) suggests that the earliest Indian contacts with South-east Asia were not entirely from the emporia of the south, but from various parts of the east coast, perhaps linked by a single trade network. Ardika and Bellwood (1991:227) carried this idea further by asking whether the two aspects of ancient trade through the Sunda islands – that with early historical India and that involving the Vietnamese Heger I drums – were not in some way linked. They observed that copper and tin, used for casting bronze drums in Bali in the early first millennium AD, had to be imported because these metals are not found in Bali. In this context it is highly suggestive that a volcanic tuff stamp or mould that was probably used to impress a decorative pattern into the wax used to mould bronze drums was discovered at a depth of 3.4 metres in association with Rouletted Ware sherds (Ardika & Bellwood 1991:226). Ardika and Bellwood (1991:231) concluded that this evidence points to the possible existence of a widespread network of international trade before the period of the Rouletted Ware (cf. Bellina 2003). The mtDNA analysis of the Sembiran tooth is particularly intriguing in light of our recent discovery of an apparent connection between the populations of ancient Bali and India based on evidence from the Y chromosome. We are presently analysing mtDNA and Y chromosome data from our sample of 551 modern Balinese men and preliminary results indicate significant prehistoric contact between India and Bali. These results will be discussed in a forthcoming publication (Karafet *et al,* submitted).

Acknowledgements

This work was supported by grant #BCS-0083524 from the National Science Foundation (to JSL and MFH), and sponsored by the Balai Penelitian dan Pengkajian Teknologi Pertanian, Denpasar Bali and its Director, Dr. Suprapto. We are grateful to the Director of the Balai Purbakala Bali, Dra. Ayu Kusumawati, and the Lembaga Ilmu Pengetahuan Indonesia for continuing support. We thank Laura Mayer and Veronica Contreras for laboratory assistance.

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