LETTER

Interpreting the evidence for middle Holocene gene flow from India to Australia

In an important recent study, Pugach et al. (1) identify substantial human gene flow from India to Australia, which they estimate occurred about 4,230 y ago based on an admixture model. Their study improves on previous ones by using a larger sample size, incorporating an expanded range of comparison populations, and using SNPs rather than mitochondrial or Y-chromosome DNA. They link the middle Holocene gene flow to roughly coincident changes that occur in the Australian archaeological record, including the appearance of microliths, innovations in plant processing techniques, and introduction of the dingo. They imply that these innovations arrived in Australia along with the carriers of Indian genes. Like Brown (2), we have misgivings with this inference. We briefly summarize contradicting evidence and then discuss the possibility that the migration that ultimately brought people from India to Australia occurred through Island Southeast Asia (ISEA) early during (or before) the Austronesian expansion into ISEA.

The "magic bullet" explanation of middle Holocene archaeological change in Australia, whereby the introduction of external technology explains complex middle Holocene archaeological changes, is difficult to sustain given present archaeological and genetic data (3). Microliths have been identified in late Pleistocene deposits in northern Australia and early Holocene deposits in southern Australia and merely show a florescence beginning about 4,500 y ago; grindstones, widely seen as vital to the occupation of arid regions during the late Holocene, have been identified in late Pleistocene deposits; and detoxification of Macrozamia plants, once considered an exclusively late Holocene innovation, has been identified in terminal Pleistocene deposits (4). As for the dingo, work linking dingoes to Indian canids on morphological grounds has been overturned by substantial consistent genetic data tying dingo mDNA and Y-chromosome–DNA lineages to source populations in ISEA and New Guinea, with an ultimate origin in East Asia (5). If India-to-Australia gene flow and archaeological change are connected, the link is not one of simple technological transfer concomitant with migration. Rather, we must envision more complex scenarios, including scenarios in which external innovations or ideas accompanied or precipitated autochthonous change.

Pugach et al. (1) also suggest that the "scenario of Indian ancestry via SE Asia [is] unlikely" because ISEA populations in their sample lacked Indian genes. This creates a puzzle because we consider direct voyaging from India to Australia unlikely. In historic times, most voyaging between India and ISEA and within ISEA occurred on an east-west axis in tune with the seasonal trade winds, and lengthy voyages occurred in steps to allow reprovisioning. So why the lack of Indian genes in the sample of ISEA individuals in Pugach et al.? If the migration occurred early during (or before) the Austronesian expansion into ISEA circa 4,000 y ago, the signal could easily have been swamped by later population growth and intermixing. Therefore, we suggest that future archaeological and genetic work will uncover material and genetic exchange between India and ISEA dating to circa 4,000 y ago or before.

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2 Brown P (2013) Palaeoanthropology: Of humans, dogs and tiny tools. *Nature* 494(7437):316–317.
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5 Ardalan A, et al. (2012) Narrow genetic basis for the Australian dingo confirmed through analysis of paternal ancestry. *Genetica* 140(1-3):65–73.

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