PALAEOANTHROPOLOGY

Of humans, dogs and tiny tools

Genomic data hint at the possibility of human migration from India to Australia 4,230 years ago. However, the inference that these humans took along their dogs and tools is difficult to reconcile with previous reports.

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Reporting in *Proceedings of the National Academy of Sciences*, Pugach and colleagues[1] provide genetic evidence of a possible mid-Holocene (4,230 years ago) link between human populations in India and Australia. Their data confirm the results of some genetic studies[2], but contradict others[3]. Intriguingly, the authors also link this evidence to the arrival of the dingo and the appearance of microlithic stone tools, which appeared in India as early as 34,000 years ago[4], but much more recently in Australia.

The fascination with human migration to Australia began in the eighteenth century, when European explorers reached its coastline. They were surprised to find indigenous human inhabitants and dogs on a continent that was otherwise filled by alien flora and fauna. Australia was separated from both the Asian mainland and the Indonesian archipelago by sea, so where had Aboriginal Australians and dogs come from, and when?

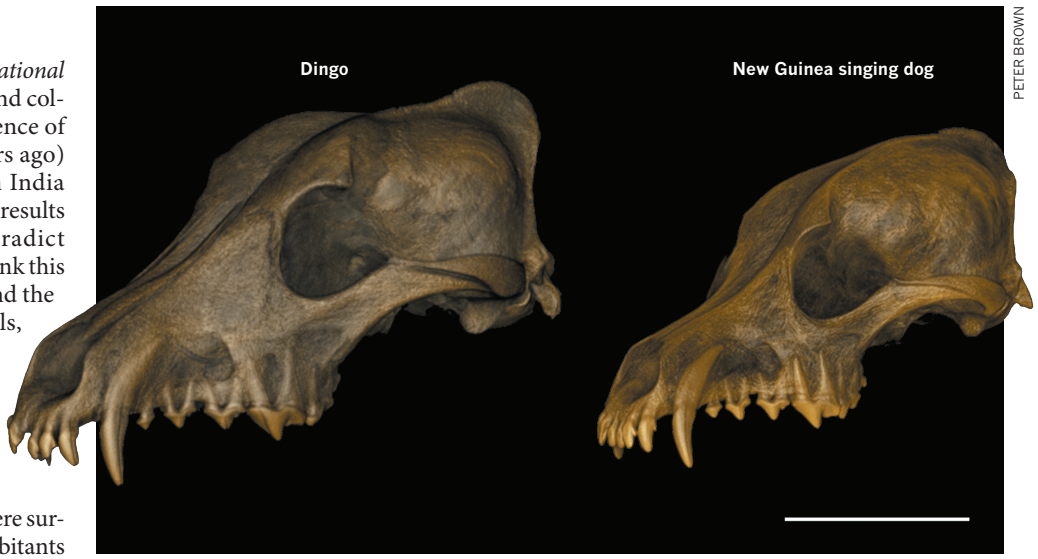

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Figure 1 | Sahul Shelf cousins. Three-dimensional reconstructions from microtomography scans of the crania of a female dingo and New Guinea singing dog. Although different in size, the two species are genetically closely related and exhibit similar behavioural and anatomical features. In contrast to Pugach and colleagues' suggestion[1], dingo ancestors probably arrived in Australia from Papua New Guinea. Scale bar, 50 millimetres. (Scans by Richard Flavel, Univ. New England.)

Unfortunately, for succeeding generations of anthropologists and archaeologists, determining the origins of these early navigators remained a vexatious issue. Until recently, all that could be said with confidence was that by 45,000 years ago modern humans had occupied large tracts of Australia[5], that water craft were required to reach the Sahul Shelf from Asia, and that for most of its human history Australia was a relatively isolated place[3,6]. Issues relating to the dispersion or the independent invention of aspects of material culture (rock art, ground-edge axe and microlithic tools), as well as to the spread of dingoes, which could shed light on human origins and cultural development, remained unresolved.

Earlier studies[2,3] have highlighted the ancient roots of the first Australians, but have disagreed over the evidence of Indian contact. In one case, Y-chromosome analysis[2] indicated tight links to Indian and Sri Lankan lineages in the mid-Holocene, but another[3] study of Y chromosomes and DNA from cellular organelles called mitochondria found no evidence of a specific relationship with South Asian lineages.

Pugach *et al.* approached these issues by analysing single nucleotide polymorphisms (SNPs) across autosomal (non-sex) chromosomes of 344 individuals, including Aboriginal Australians, New Guineans, island Southeast Asians and Indians, as well as those of European and Chinese origin. SNPs describe DNA-sequence variations that are present in at least 1% of members of a species[7].

In agreement with previous studies[2,3], the authors report a close genetic relationship between Aboriginal Australians and both highlanders of New Guinea (who are known to have an ancient common origin) and the Mamanwa — a Negrito group from the Philippines. The authors estimate the divergence time between these three groups to be 36,000 years ago, which is too recent to tally with the archaeological evidence of dispersal onto the Sahul Shelf about 45,000 years ago. The authors acknowledge that the method they used to estimate divergence times may have produced an underestimate.

What makes this research contentious is that it indicates mid-Holocene gene flow from India to Australia. Pugach *et al.* rule out the possibility that this signal in their Aboriginal sample is a result of the recent European genetic admixture. Instead, using simulations, they pinpoint the Indian admixture time to 141 generations ago, which — with a generation time of 30 years — dates the gene flow to 4,230 years ago.

The genetic evidence of a possible prehistoric link between Australia and India is intriguing, particularly given the previously accepted genetic and archaeological evidence for isolation[3,8]. Until now, the most substantial evidence of pre-European contact was with Macassan trepang (sea cucumber) fishermen, who sailed to northern Australia from around 1640. Indeed, the significant cultural impact of these long-term contacts on Aboriginal Australians is evident in language, art and material culture. Surely, a substantial genetic signal from presumably Neolithic navigators should be similarly reflected in evidence of cultural transmission. So I imagine that many archaeologists and biologists who work in the Australasian region would dispute Pugach and colleagues' suggestion

that this possible India-to-Australia gene flow is connected with the spread of the dingo and microlith use.

The dingo has only ever been found on the Australian mainland, presumably arriving some time after post-glacial flooding of the Bass Strait around 12,000 years ago. The earliest reliably dated evidence of the dingo is about 3,450 years old from Madura Cave — roughly 800 years after the suggested Indian contact. As the introduced European fox crossed the continent in only 80 years, you might expect closer correspondence between the inferred dates of introduction and the palaeontological and archaeological evidence.

As for the origin of these animals, when mitochondrial DNA from 211 dingoes was compared with that of 676 dogs from all continents[9], dingoes were shown to originate from domesticated East Asian — not Indian — dogs, and may have been part of the Austronesian expansion into Southeast Asia around 4,500 years ago. Specifically, dingoes were found to be closely related to the much smaller New Guinea singing dog (Fig. 1), and both species were shown to have descended from an early East Asian domesticated dog. The ancestors of living dingoes, therefore, may have been introduced across the Torres Strait, which separates Papua New Guinea from Australia, at some point after it flooded 8,000 years ago.

The arrival of microlithic tools in Australia as part of a package with the dingo and contact with Indian populations may be equally unlikely. Although it was once thought that the large-scale production of microliths dated to the period after 4,000 years ago, corresponding with the earliest evidence of the dingo, there is strong evidence that microliths were in use many millennia before the dingo appeared[8] — for instance, 6,000 years ago at Capertee 3 rockshelter and possibly as early as 15,500 years ago at Walkunder Arch.

Unfortunately, there is almost no archaeological evidence that modern humans were in Asia before their first appearance in Australia. Ultimately, the resolution of questions that surround the origins of Australia's first human colonists — and any subsequent contact with maritime peoples to the north — will come from a synthesis of genetic, archaeological and palaeoanthropological data, which have been used to estimate the time taken for the expansion of Austronesian speakers from Asia into the Pacific. ■

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