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The process, biotic impact, and global implications of the human colonization of Sahul about 47,000 years ago

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ABSTRACT

Comprehensive review of archaeological data shows that Sahul (Pleistocene Australia-New Guinea) was first occupied by humans ca. 47 ka (47,000 years ago); evidence for earlier arrival is weak. Colonizing populations remained low – perhaps two orders of magnitude below those estimated at European contact – for many millennia, and were long restricted to relatively favorable habitats. Though human arrival coincided with changes in native flora and fauna, these were mainly the products of climatic factors, not human interference. The genetic makeup of founding populations and their arrival date are consistent with the Late Dispersal Model of anatomically modern humans beyond SW Asia, beginning ca. 50 ka. Early Dispersal Models (120–70 ka) are not refuted, but draw no support from the Sahul record as currently understood.

1. Introduction

A decade ago, we presented two critical reviews of evidence for the date at which humans first occupied Sahul (Allen and O'Connell, 2003; O'Connell and Allen, 2004). Continuing dispute about this issue, recent improvements in chronometric techniques, and reports of new sites and dates led us to undertake another assessment, the details of which are presented elsewhere (Allen and O'Connell, 2014). Here we summarize key elements of that exercise and consider their implications for current ideas about the process of Sahul colonization, its impact on terrestrial habitats and resources, and the timing of anatomically modern human dispersals beyond Africa.

2. Background

In the 1980s, it was argued that anatomically modern humans had colonized Sahul by 40 ka (e.g. White with O'Connell, 1982; Flood, 1983; Allen, 1989). The coincidence with the earliest dates for the European Upper Paleolithic suggested that both developments were part of the same process: the rapid dispersal of modern humans from Africa across Eurasia and ultimately into Sahul 40–45 ka (e.g. Cann et al., 1987; Stringer and Andrews, 1988). Subsequent reports of 50–60 ka luminescence dates from two archaeological sites in Arnhem Land (Roberts et al., 1990, 1994), Malakunanja II (now called Madjedbebe) and Nauwalabila, challenged this notion. Proponents of these early dates observed that the Sahul chronology was based mainly on radiocarbon dating, that 40 ka was at or near this method's operational limit, and that small amounts of contamination could result in "old" samples yielding much younger apparent ages (Roberts et al., 1994; Chappell et al., 1996). Dates from the two Arnhem Land sites were widely viewed as important indicators of the limits of radiocarbon dating and of the more likely age of Sahul colonization. The challenge to broader arguments about ex-African human dispersal chronologies, also based on radiocarbon dating, was implicit but obvious.

Some maintained that, despite concerns about sample contamination, the date for Sahul colonization might well have been about 40–45 ka, consistent with then standard European and broader Eurasian models (e.g. O'Connell and Allen, 1998). These commentators raised crucial questions about the Arnhem Land sites, specifically about the stratigraphic relationships between dated media (energy trapped in sand grains) and archaeological phenomena (stone tools) at these two locations (e.g. Bowdler, 1990; Hiscock, 1990; O'Connell and Allen, 1998). If these relationships were not secure, any argument about the anthropological implications of the dates was meaningless.

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Our 2003/2004 reviews concluded that people had arrived and spread widely across Sahul by 43–45 ka, but found that evidence for an earlier presence, particularly one >50 ka, was weak. Our conclusion was broadly consistent with some aspects of then-current arguments about the effect of human arrival on indigenous megafauna (e.g. Roberts et al., 2001), but contradicted other ideas about a purported pre-50 ka arrival and impact, not only on native plant and animal communities but also on regional climate systems (e.g. Miller et al., 1999). Equally important, our assessment provided a basis for estimates of mitochondrial DNA (mtDNA) mutation rates, which in turn contributed to the development and critique of various Upper Pleistocene ex-African human dispersal scenarios (e.g. Endicott et al., 2009; Henn et al., 2012; cf. Oppenheimer, 2009; Petraglia et al., 2010). Nevertheless, a >50 ka arrival date is still asserted in some quarters (e.g. Cane, 2013; Hiscock, 2013; Smith, 2013; Oppenheimer, 2014). No final resolution of this issue has yet been achieved, and it remains crucial to arguments about the process of Sahul colonization and its impact on indigenous fauna and flora, as well as to ongoing disputes about the timing of Upper Pleistocene human diasporas and the identities of the populations involved.

Recent developments in dating technology provided the basis for an updated review. These include: 1) more frequent use of pretreatment methods that extend the applicability of radiocarbon dating back to ca. 50–55 ka (Bird et al., 1999); 2) widespread use of accelerator mass spectrometry (AMS) as a means of generating more precise estimates of radiocarbon content (but see Hogg et al., 2013; Allen and O'Connell, 2014:87); 3) construction of calibration curves that allow accurate calendar-age estimates from ^{14}C dates for samples much older than a previous limit of ca. 26 ka (e.g. Bronk Ramsey et al., 2012; Reimer et al., 2013), and 4) new radiocarbon and luminescence dates from sites previously described, as well as from those reported for the first time following our 2003/2004 reviews.

3. Sahul sites dated 40–47 ka

Table 1 lists the 26 archaeological sites or localities that offer relatively reliable, relatively well-published evidence of an anatomically modern human presence in Sahul, Wallacea and the Bismarck Archipelago by about 40,000 years ago. The two oldest dates for the occupation of Tasmania (ca. 38–39 ka) are also noted. Fig. 1 provides a graphic summary of this information; Fig. 2 shows the distribution of all sites listed in Table 1. All radiocarbon dates were calibrated by reference to OxCal 4.2, using the IntCal 13 curve. The Southern Hemisphere offset SHCal 13 was not applied since dates derived from that routine in this age range fall within the standard deviations of unadjusted determinations. A further seven recently reported sites with claimed archaeological dates 40–47 ka are not referenced here because of incomplete information on stratigraphic provenience, relationships with evidence of human presence, or the dates themselves (Allen and O'Connell, 2014). Their inclusion would have no significant effect on this discussion.

Early dates from 21 sites were determined solely by radiocarbon, those from another three by a combination of radiocarbon and luminescence, and those from the remaining four by luminescence or U-series analyses. Most radiocarbon samples were subjected to acid-base-acid or acid-base-oxidation-stepped combustion (ABOX-SC) pretreatment; all but three (from GRE 8, Matenkupkum, Upper Swan) were analyzed by accelerator mass spectrometry. All carbon dates were derived from charcoal or shell collected from sedimentary strata containing evidence of human activity. The oldest dates from four sites (Devil's Lair, Menindee, Riwi, PACD H1) pertain to samples retrieved from anthropogenic thermal features (probably hearths or roasting pits) and are regarded as especially secure with respect to their implications for the date of human presence. Luminescence and U-series age estimates were derived from sediment samples and are generally marked by much wider confidence intervals (Fig. 1).

4. What about Nauwalabila and Madjedbebe?

As indicated above, excavations at Nauwalabila and Madjedbebe (both located north of Nawarla Gabarnmang, Fig. 2) yielded stone tools in association with sediments dated by luminescence at 50–60 ka (Roberts et al., 1990, 1994). Detailed re-analysis of data from Nauwalabila showed that the relationship between artifacts and dated sediments was probably the result of post-depositional disturbance, and that claims for human presence at this location greater than about 40 ka were unsupportable (Allen and O'Connell, 2003; cf. Bird et al., 2002). The sedimentary situation at Madjedbebe is similar to that at Nauwalabila but has been much less fully reported, making any serious evaluation of a proposed 50–60 ka human presence there difficult. The results of renewed excavations undertaken at Madjedbebe in 2012 may change matters once they are made public (see also below).

5. Discussion

Data presented in Table 1 show that humans reached Sahul by 47 ka. The difference from our 2003/2004 estimate of 43–45 ka is mainly a function of more precise radiocarbon date calibration at greater time depth than was possible when we wrote. That, combined with more effective sample pretreatment, allows the technique to generate accurate dates of 50–55 ka. With that in mind, we take the absence of reliable archaeological dates greater than 47 ka to indicate an outer bound for continental colonization. Contrary to claims made in the 1990s, and continuing in the recent literature (e.g. Oppenheimer, 2012; Cane, 2013; Hiscock, 2013; Smith, 2013), this is not a function of methodological constraints on radiocarbon dating. We discount claims for earlier age estimates based on luminescence and U-series analyses, not because of concerns about the dates themselves (although that issue certainly merits critical attention, as is the case with any dating technique), but because of uncertainties about the evidence of human presence and its relationship with the dates. On current evidence, an age estimate >50 ka from a new or already known site would be a definite outlier in the early continental chronology (more on this below).

5.1. Site distribution and process of colonization

Though still small, the sample of sites listed in Table 1 is sufficient to support speculative comment on the pattern and process of initial colonization. Analysts mostly agree that founding populations arrived in Sahul along Birdsell's (1977) northern and/or southern routes across Wallacea, via Sulawesi and/or Timor, respectively (Fig. 2). As argued elsewhere (O'Connell et al., 2010), travel east of Sunda probably involved hundreds of individuals and was almost certainly deliberate, if not always unidirectional. It required the use of well-made watercraft, some large enough to carry perhaps as many as a dozen people as well as several days' supply of food and water. Paddle-powered (possibly even sail-driven), such craft must have been capable of maintaining headway under a wide range of conditions, including moderately contrary currents.

Although the southern route is widely identified as the main avenue of access to Sahul, we think the northern route was more likely because of the consistent island inter-visibility and shorter voyaging distances it offered (Irwin, 1992; Allen and O'Connell,