First footsteps across Lydekker's Line: behavioural plasticity in the insular and continental rainforests of western New Guinea

Report to the Royal Anthropological Institute on radiocarbon dating at archaeological sites on Waigeo Island, West Papua

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Summary

This report describes radiocarbon dating at three archaeological sites on Waigeo Island (Molol, Kapisawar, and Manwen Bokor), supported by the Horniman and Sutasoma awards. Waigeo is a key stepping-stone along the equatorial island chain of Wallacea (Indonesia) that facilitated our species migrating between mainland Southeast Asia and Australasia. Upon moving into Australasia, humans crossed the Lydekker biogeographic line, an important transitional zone that separates the placental mammal fauna of the west from the marsupial fauna of the east. The results reported here represent the most well dated archaeological sequence ever produced from West Papua. Crucially, the earliest dates are over 50,000 years old, providing the earliest known evidence for humans in the Pacific as they crossed Lydekker's Line into Australasia. Furthermore, the radiocarbon dates track repeated occupations of Waigeo from the end of the Pleistocene (c. 14,000 years ago) to the recent past (c. 1000 years ago) allowing detailed analysis of behavioural changes that took place as global climates warmed around 10,000 years ago and as Neolithic lifestyles emerged around 3000 years ago.

Introduction

The dispersal of *Homo sapiens* out of Africa and into the islands of Southeast Asia and Australasia is critical for understanding the evolution of our species and its interaction with other hominins. The timing, route, and nature of migrations into these islands remains a subject of intense scientific debate (Clarkson *et al.* 2017; O'Connell *et al.* 2018). Radiometric dating, undertaken with a joint Horniman Award and Sutasoma Award from the Royal Anthropological Institute, demonstrates that hominins, probably *Homo sapiens*, arrived on Waigeo Island in the Raja Ampat Islands of West Papua before >55–50,000. Evidence from Molol Cave on Waigeo shows that these Pleistocene people were processing plants in complex ways, using tree resin to make fires or adhesives, and visiting the forested island interior to hunt fruitbats (Gaffney 2022). This represents the earliest evidence for human migration from Eurasia into the Pacific and earliest use of small islands by our species globally. The later sequence at Molol demonstrates more widespread frequentation of the rainforests of Waigeo after the Last Glacial Maximum (LGM), about 14,000 years ago. This is supported by a small number of radiocarbon dates from Kapisawar and Manwen Bokor caves, which indicate that people were frequenting other parts of Waigeo throughout the Holocene warm period, after 10,000 years ago.

A note on redirection of funds

The Horniman and Sutasoma awards were originally intended for new archaeological excavations on Salawati Island, Raja Ampat, West Papua. Such a project would have important implications for understanding how humans moved between Waigeo and Salawati and would allow for a comparison of how humans lived in continental and island rainforests (Waigeo has always been an island but Salawati was part of continental New Guinea/Australia when sea levels were lowered in the Pleistocene). Planning was underway for these excavations to begin in April 2020. However, owing to the COVID-19 pandemic, fieldwork was postponed. At the discretion of the awards secretary and committee, the funds (£7435) were redirected to radiocarbon dating archaeological specimens from my previous field season on Waigeo Island. These results contributed to my recently submitted Cambridge PhD thesis and form the backbone for several high-impact journal publications, now in preparation.

Excavation sequences and radiocarbon dating results

Molol Cave

Molol Cave (S 0°18'21.0" E 130°55'01.4") sits on the southern bank of Rabia Strait, leading into Waigeo Island's Mayalibit Bay (Fig. 1). A transect across Rabia Strait indicates it is maximally 46 m deep and would have been a low energy valley system in the Pleistocene, becoming inundated with seawater after c.9500 years ago; 50,000 years ago, Molol was located about 15 km inland. Formed from Miocene Limestone, Molol includes an outer chamber, exposed to daylight owing to roof collapse, and a dark inner chamber, home to several bat colonies. My excavations in 2018–2019, supported by separate grants, targeted three parts of the cave system: Area 1 included Trench 1 (TR1) and Test Pit 1 (TP1) near the cave entrance; Area 2 included Trench 2 (TR2) and Test Pit 2 (TP2) on a flat, elevated space in the outer chamber; Area 3 included Test Pit 3 (TP3) at the edge of the inner chamber.

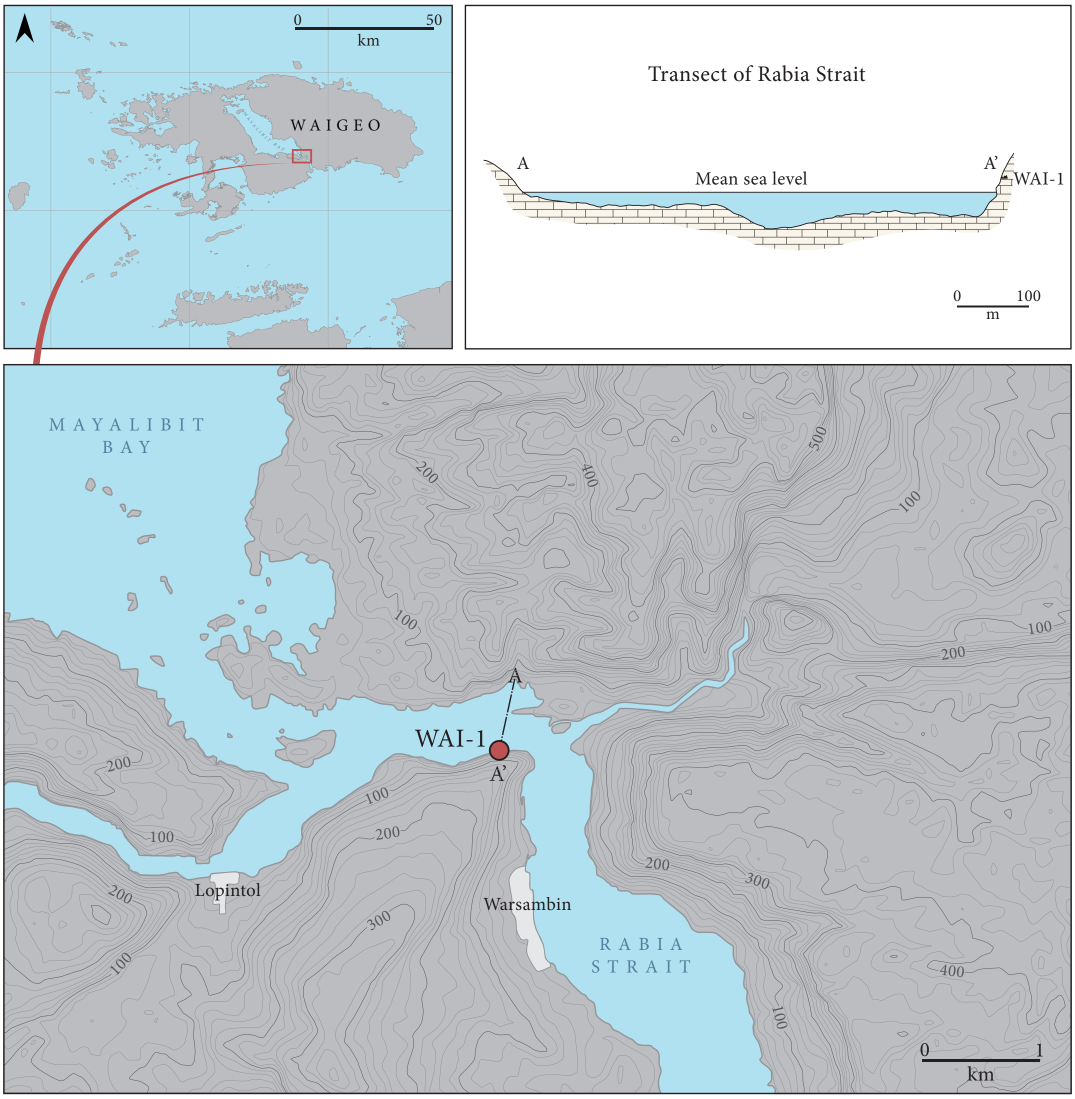


Figure 1. Waigeo Island, Raja Ampat, showing location of Molol Cave (WAI-1) where radiocarbon dating was undertaken (D. Gaffney 2021).

TR1 (2 x 2 m) was excavated to a depth of 2.57 m (Fig. 2). The upper stratigraphy was characterised by interleaved clays, midden material, and fire ash, with radiocarbon dating indicating recurring frequentation between c.15,000 and c.2100 years ago.

Below was indurated guano, probably deposited by small bats roosting on the roof above the trench. Charcoal incorporated within one indurated context (056) dates to c.44,000–43,000 years old, but it is unclear if it is anthropogenic. Owing to degradation, the charcoal was prepared with acid/base/acid (A/B/A), a pre-treatment that can produce younger-than-actual dates for material over about 20,000 years old (Higham *et al.* 2009). As such, 43,000 years old is likely a minimum possible age for these indurated contexts. These contexts overlie looser guano associated with numerous small bat bones that could not be radiocarbon dated owing to poor collagen preservation. At the base of the excavation, coral gravel overlying limestone bedrock indicates Area 1 was originally submerged and has been subsequently uplifted to its present location.

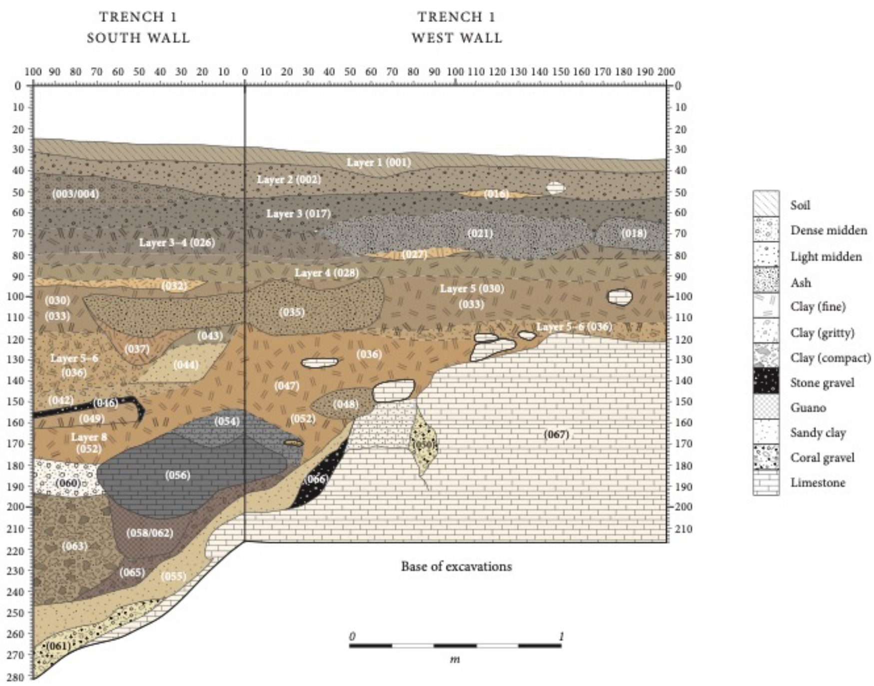


Figure 2. Trench 1 (TR1) stratigraphy, Molol Cave (D. Gaffney 2021).

TR2 (2 x 2 m) extended to 1.68 m deep, primarily comprising clays with two Late Holocene middens in the upper deposit (Fig. 3). Radiocarbon dating shows that use of Area 2 occurred repeatedly during the Holocene from c.9100 and 2100 years ago. The lower part of the excavation transitions from highly indurated clay into flowstone and limestone bedrock. In Layer 7 (Context 088; a hard, brown clay), a tree resin artefact radiocarbon dated directly to >55,000–49,620 cal. BP. Resins begin to harden upon burial and are highly resistant to post-depositional contamination; the Molol resin is exceptionally well preserved and provided a radiocarbon yield of 94.5%, meaning that the sample was pretreated with A-BOX, which provides a more accurate result than A/B/A by removing trace contamination (Bird *et al.* 1999). The date pushes the upper limit of the IntCal20 calibration curve (Reimer *et al.* 2020), and the maximum range lies sometime before 55,000 cal. BP. Fruitbat bones from Layer 7 could not be radiocarbon dated owing to a lack of collagen.

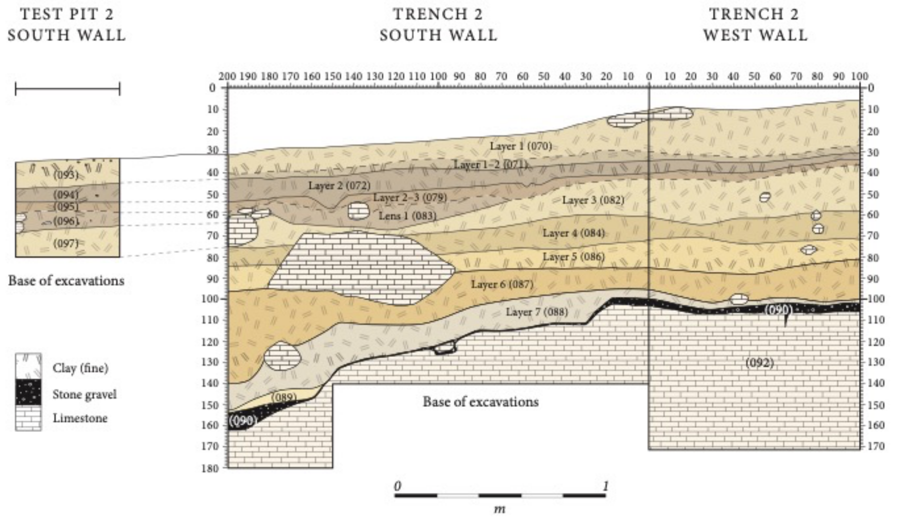


Figure 3. Trench 2 (TR2) stratigraphy, Molol Cave (D. Gaffney 2021).

TP3 (1 x 0.5 m) was excavated to 1.4 m and comprised several clay layers overlying dark clay mixed with guano (Fig. 4). Below was a soft brown clay overlying limestone bedrock. Sparse charcoal and archaeological material in the upper clay layers indicate frequentation of the dark inner chamber by at least c.8600 years ago.

Kapisawar Cave

Kapisawar Cave (S 0°31’42.8” E 130°34’29.2”) is located on the slopes of a small saltwater inlet at the entrance to Gaman Bay (Fig. 5). The cave is sited about 14 m above modern sea level, meaning that barring substantial uplift within the last 5000 years it remained above sea level during the Mid Holocene high stand, and would have been several kilometres inland during the Pleistocene period. The limestone cave system is formed of two chambers: a well-lit entrance chamber (11 m deep x 4.5 m wide) and a dark inner chamber (23 m x 12 m) that is home to swiftlet and small bat colonies.

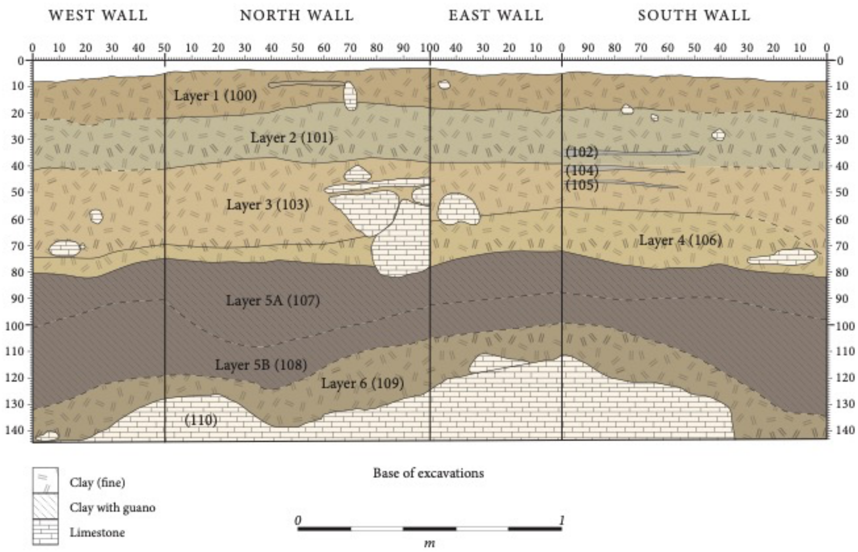


Figure 4. Test pit 3 (TP3) stratigraphy, Molol Cave (D. Gaffney 2021).

A 1 x 1 m excavation (Unit 1) was undertaken in Kapisawar's entrance chamber and extended 1.61 m deep, revealing a complex stratigraphy of interleaved soils, ashes, guanos, and clays (Fig. 6). Wood charcoal fragments from Unit 1 indicate the cave was frequented several times throughout the Holocene. The most recent determination in Layer 3 (012) derives from the Late Holocene, sometime between 3060–2760 years ago. The date of 6530–6320 years old from Layer 5 (053) suggests the cave remained above sea level even during the Mid Holocene sea level high stand. The deepest determination from a dense white sediment (072) derives from 117 cm below the datum line, and no organic remains were encountered in the basal half of the deposit. This may be due to poor preservation or may reflect the fact that people did not use the cave until the Early Holocene, about 9260– 9000 years ago, following marine transgression that brought the coastline close to the cave.

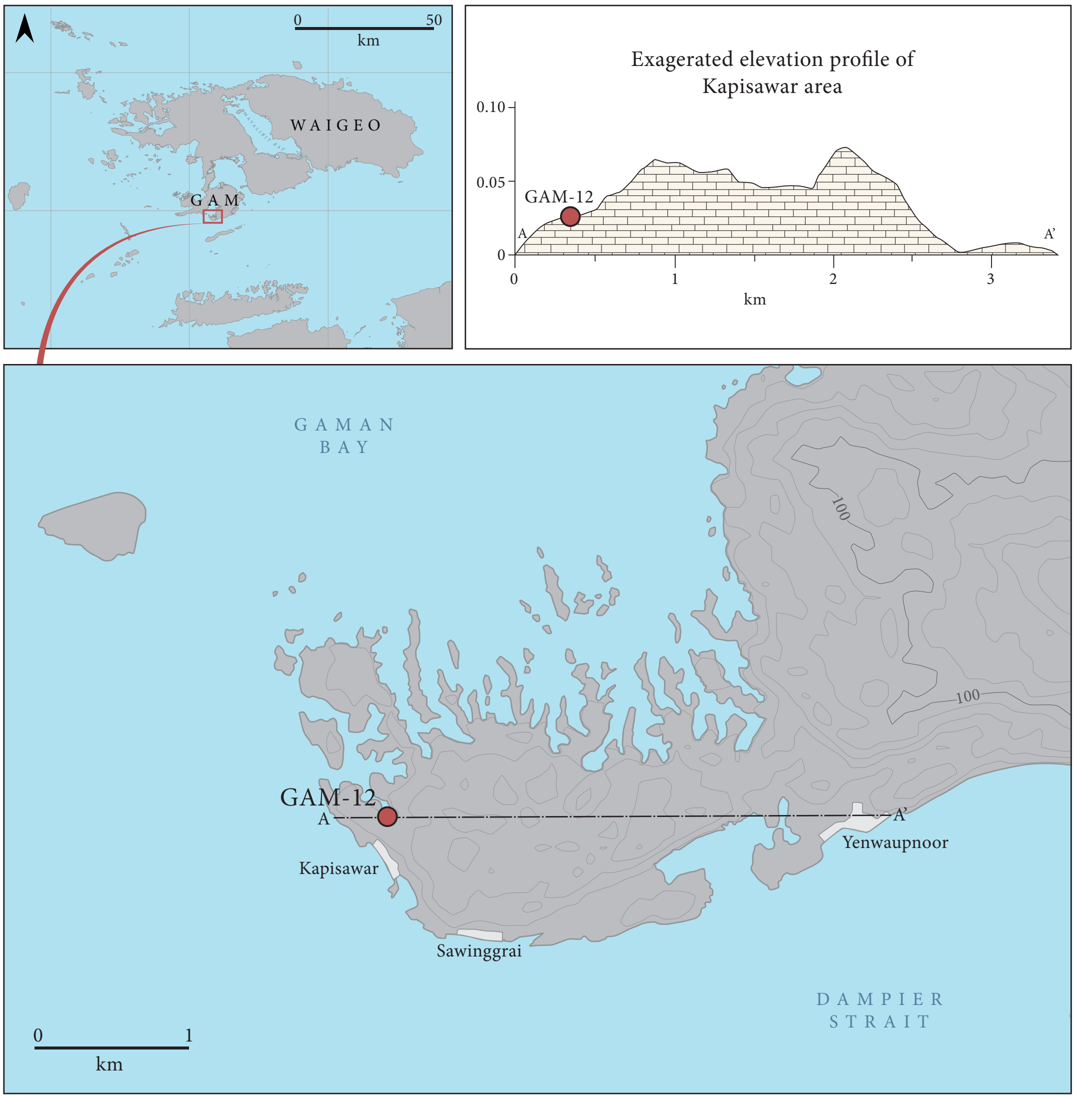


Figure 5. Kapisawar Cave (GAM-12) at entrance to Gaman Bay (D. Gaffney 2021).

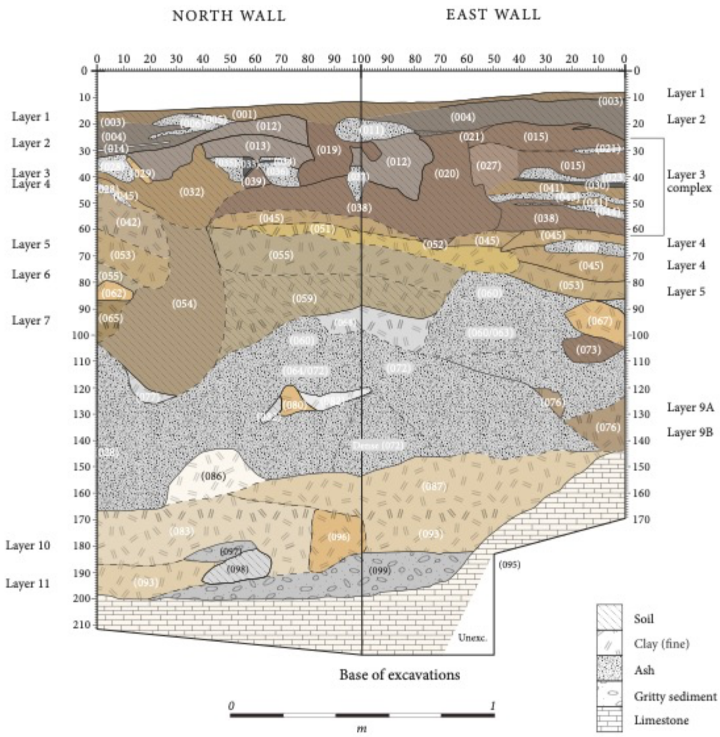


Figure 6. Kapisawar Unit 1 excavation stratigraphy (D. Gaffney 2021).

Manwen Bokor Cave

Manwen Bokor (S 00° 02'47.3" E 131° 00'49.4") is a large rockshelter and cave (c. 30 m high, 30 x 40 m wide) formed by an escarpment of Waigeo Limestone, located 600 m downstream along the Rainkan River on the north coast of Waigeo Island (Fig. 7). A single 1 x 1 m excavation unit (Unit 1) was placed in a dry and elevated eastern part of the site (Fig. 8). To assess the spatial distribution of material culture at the site we also excavated two small test pits: Test Pit 1 (TP1) was a 0.5 x 0.5 m pit at the northern entrance to the shelter, and Test Pit 2 (TP2) was a 1 x 0.5 m pit closer to Unit 1.

Manwen Bokor's formation history seems to be rapid and recent, meaning that the stratigraphy is relatively simple. The Unit 1 stratigraphy consisted of two layers. Layer 1 (001) was a black sand that was consistent from the surface down to about 900 mm. This layer dated to about 1300–1000 years old. Layer 2 (002) was associated with water-rolled limestone and stretched below the water table. In TP2, Layer 3 (005) connected with Unit 1's Layer 1 (001), formed from the same black sand. A date on wood charcoal from TP2, Layer 3 (005) confirmed the Unit 1 date of about 1300–1000 BP for the timing of occupation associated with shell and fish bone as well as pottery fragments.

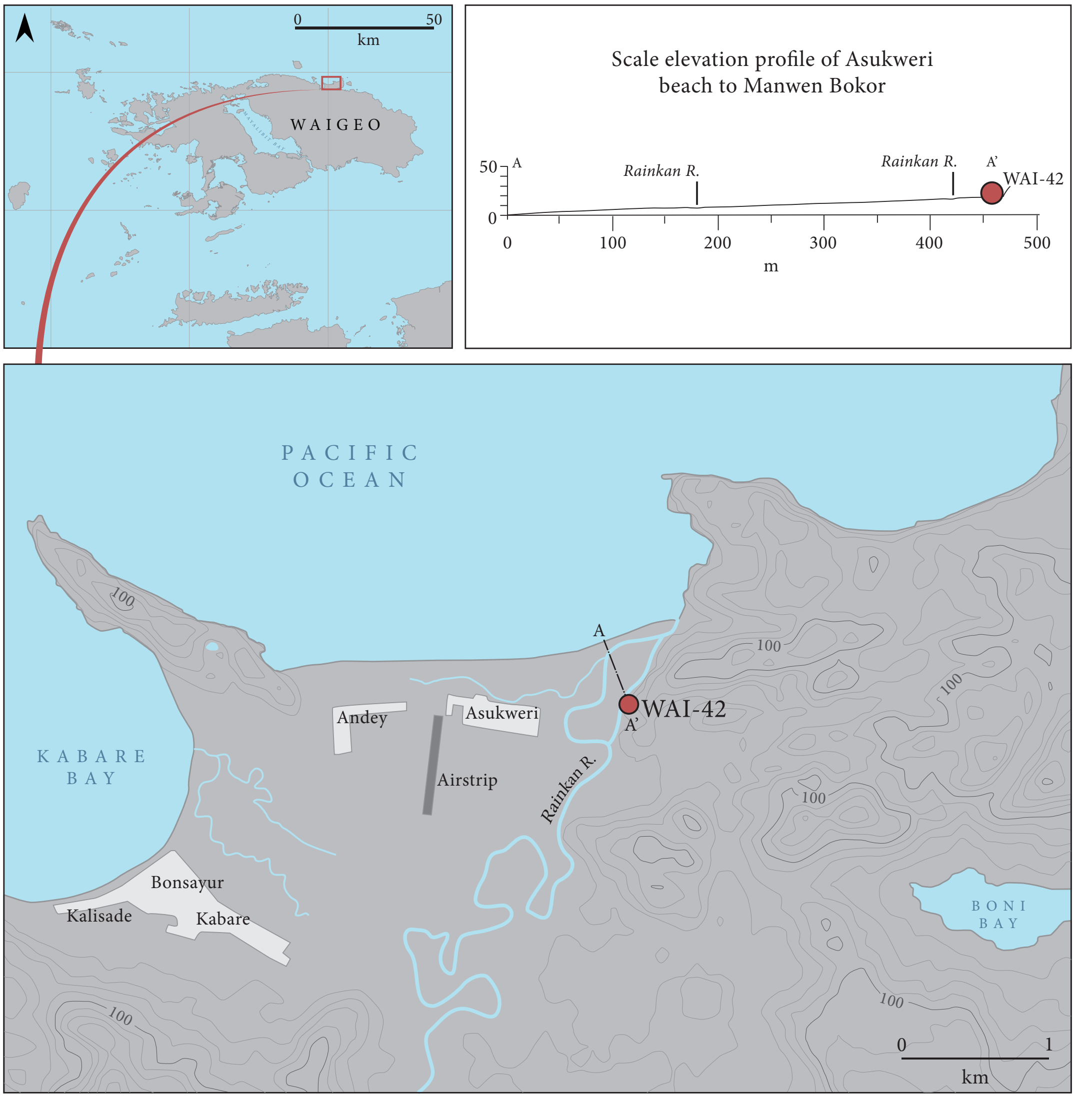


Figure 7. Manwen Bokor (WAI-42) on the north coast of Waigeo Island (D. Gaffney 2021).

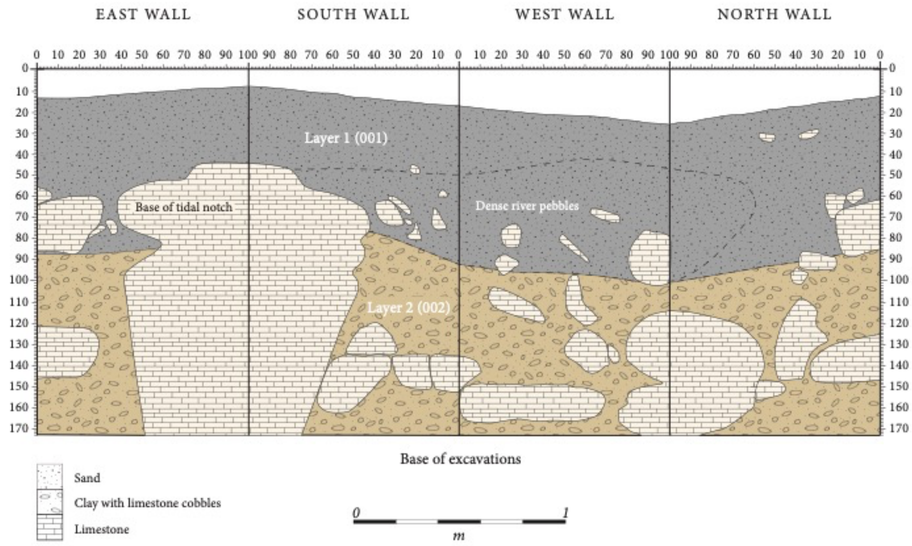
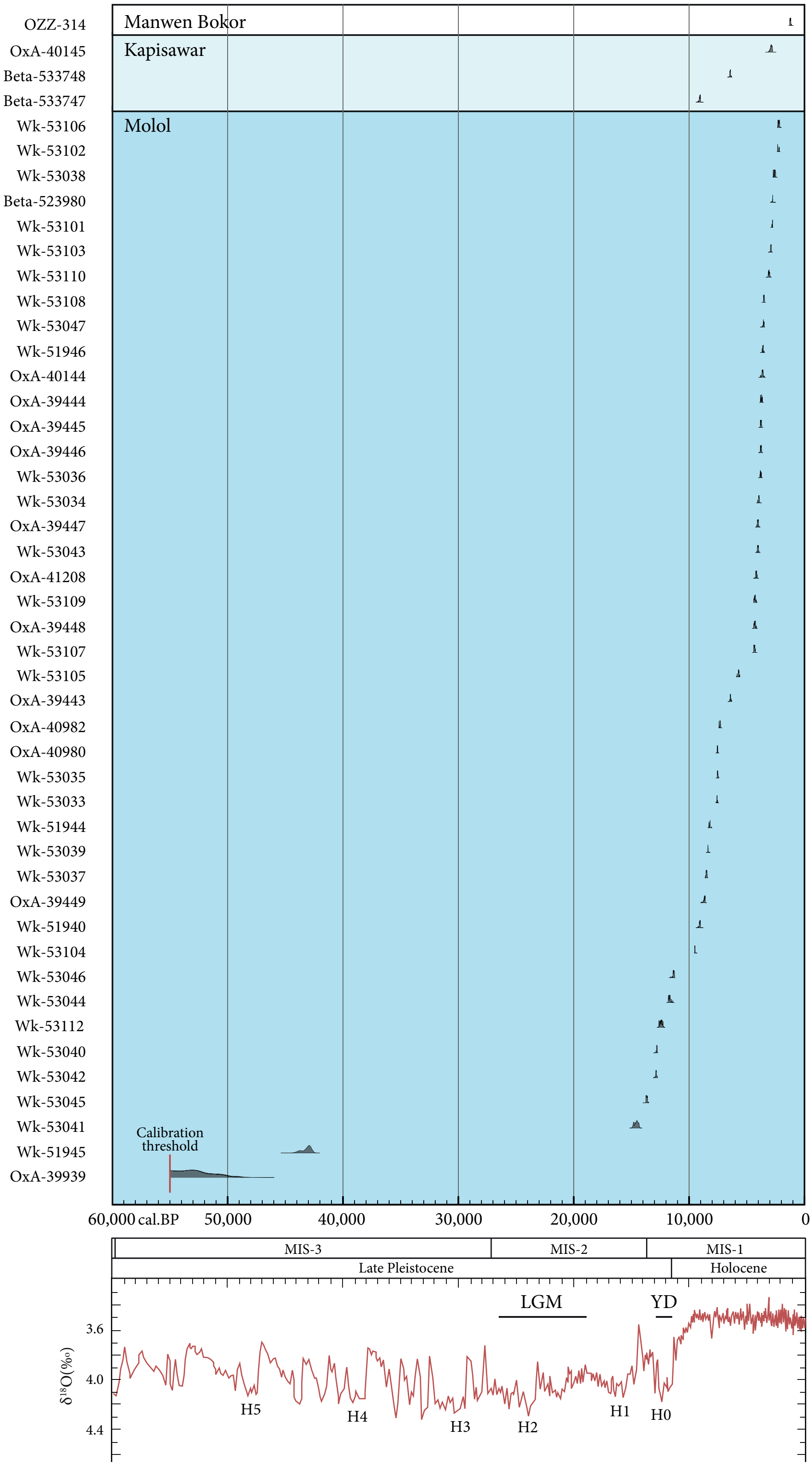


Figure 8. Manwen Bokor, Unit 1 stratigraphy (D. Gaffney 2021).

Summary

The radiocarbon sequences produced for the excavations at Molol, Kapisawar, and Manwen Bokor now include close to 50 dates and make Waigeo Island — formerly an archaeological enigma —the best dated place in West Papua (Fig. 9). There is sparse but reliable evidence for Late Pleistocene (c. >55,000–50,000 cal. BP) occupation, making the Raja Ampat Islands a viable thoroughfare of dispersal between mainland Southeast Asia and Australasia. The earliest dates are followed by an absence of evidence for human settlement until the terminal Pleistocene (c.14,000 years ago), after which there is a relatively continuous sequence of occupation until the present. The isotope plot at the bottom of Figure 9 shows corresponding periods of warmer (high) and colder (low) conditions. More regular occupation corresponds with climatic amelioration following the LGM during the Holocene warm period. These sequences now provide the framework for ongoing research into how human behaviour and culture transformed throughout the millennia, as environments changed and different groups of people moved around, and settled in, the islands.

Figure 9 (next page). Compilation of non-marine radiocarbon dates from excavations at Molol (WAI-1), Kapisawar (GAM-12), and Manwen Bokor (WAI-42). Radiocarbon distributions are calibrated and in chronological (rather than stratigraphic) order to show periods of probable human occupation. Plotted in OxCal 4.4 using IntCal20 calibration (D. Gaffney 2021).



OZZ-314
OxA-40145
Beta-533748
Beta-533747
Wk-53106
Wk-53102
Wk-53038
Beta-523980
Wk-53101
Wk-53103
Wk-53110
Wk-53108
Wk-53047
Wk-51946
OxA-40144
OxA-39444
OxA-39445
OxA-39446
Wk-53036
Wk-53034
OxA-39447
Wk-53043
OxA-41208
Wk-53109
OxA-39448
Wk-53107
Wk-53105
OxA-39443
OxA-40982
OxA-40980
Wk-53035
Wk-53033
Wk-51944
Wk-53039
Wk-53037
OxA-39449
Wk-51940
Wk-53104
Wk-53046
Wk-53044
Wk-53112
Wk-53040
Wk-53042
Wk-53045
Wk-53041
Wk-51945
OxA-39939
Manwen Bokor
Kapisawar
Molol
Calibration threshold
60,000 cal.BP
50,000
40,000
30,000
20,000
10,000
0
MIS-3
MIS-2
MIS-1
Late Pleistocene
Holocene
LGM
YD
3.6
4.0
4.4
δ18O(‰)
H5
H4
H3
H2
H1
H0

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References

Bird, M.I., L.K. Ayliffe, L.K. Fifield, C.S.M. Tumey, R.G. Cresswell, T.T. Barrows & B. David, 1999. Radiocarbon dating of “old” charcoal using a wet oxidation, stepped-combustion procedure, *Radiocarbon* 41(2), 127–40.

Clarkson, C., Z. Jacobs, B. Marwick, R. Fullagar, L. Wallis, M. Smith, R.G. Roberts, E. Hayes, K. Lowe, X. Carah, S.A. Florin, J. McNeil, D. Cox, L.J. Arnold, Q. Hua, J. Huntley, H.E.A. Brand, T. Manne, A. Fairbairn, J. Shulmeister, L. Lyle, M. Salinas, M. Page, K. Connell, G. Park, K. Norman, T. Murphy & C. Pardoe, 2017. Human occupation of northern Australia by 65,000 years ago, *Nature* 547(7663), 306–10.

Gaffney, D., 2022. *Human Behvaioural Dynamics in Island Rainforests: Evidence from the Raja Ampat Islands, West Papua*, PhD thesis, University of Cambridge.

Higham, T.F.G., H. Barton, C.S.M. Turney, G. Barker, C.B. Ramsey, F. Brock, T.F.G. Higham, H. Barton, C.S.M. Turney, G. Barker, C.B. Ramsey & F. Brock, 2009. Radiocarbon dating of charcoal from tropical sequences: results from the Niah Great Cave, Sarawak, and their broader implications, *Journal of Quaternary Science* 24(2), 189–97.

O’Connell, J.F., J. Allen, M.A.J. Williams, A.N. Williams, C.S.M. Turney, N.A. Spooner, J. Kamminga, G. Brown & A. Cooper, 2018. When did Homo sapiens first reach Southeast Asia and Sahul?, *Proceedings of the National Academy of Sciences* 115(34), 8482–90.

Reimer, P.J., W.E.N. Austin, E. Bard, A. Bayliss, P.G. Blackwell, C. Bronk Ramsey, M. Butzin, H. Cheng, R.L. Edwards, M. Friedrich, P.M. Grootes, T.P. Guilderson, I. Hajdas, T.J. Heaton, A.G. Hogg, K.A. Hughen, B. Kromer, S.W. Manning, R. Muscheler, J.G. Palmer, C. Pearson, J. Van Der Plicht, R.W. Reimer, D.A. Richards, E.M. Scott, J.R. Southon, C.S.M. Turney, L. Wacker, F. Adolphi, U. Büntgen, M. Capano, S.M. Fahrni, A. Fogtmann-Schulz, R. Friedrich, P. Köhler, S. Kudsk, F. Miyake, J. Olsen, F. Reinig, M. Sakamoto, A. Sookdeo & S. Talamo, 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP), *Radiocarbon* 62(4), 725–57.

Table. Itemised account of expenditure.

Cost incurred for Waigeo radiocarbon dating (2021)	*Price GBP*
20 radiocarbon dates (University of Waikato AMS lab – 725 New Zealand dollars per sample)	7450.00
Ministry of Primary Industries import charge	18.00
DHL shipping to radiocarbon laboratory	40.00
TOTAL	7508.00