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Supporting Online Material for

Human Adaptation and Plant Use in Highland New Guinea 49,000 to 44,000 Years Ago

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SUPPORTING ONLINE MATERIAL

1. Radiocarbon dating and Map of sites

Table S1. AMS determinations for archaeological sites from the Ivane Valley, PNG

Lab code	*Provenance*	*Material*	*$\delta^{13}C$*	*% Modern*	*CRA*	Calib 6.0.1. IntCal09
					uncalibrated BP	95.40% Cal BP
Layer 4						
Wk 27072	AAXF Vilakuav	Wood charcoal	-28.3+0.2	0.5 ±0.1	41951±1571	48690-42970
Wk 27074	AAXF Vilakuav	Wood charcoal	-27.3+0.2	0.6±0.1	41206±1173	46560-42950
Wk 27073	AAXF Vilakuav	Wood charcoal	-25.7+0.2	0.6±0.1	40922±1113	46180-42900
Wk 23354	AAXE South Kov	Wood charcoal	-25.8	0.7 ± 0.1	40298 ± 956	45540-42760
Wk 23356	AAXD Airport Mound	Wood charcoal	-24.9	0.7 ± 0.1	39836 ± 909	45170-42520
Wk 23355	AAXD Airport Mound	Wood charcoal	-24.9	1.1 ± 0.1	36264 ± 575	42257-40182
Wk 17900	AER Trench 2 Layer 4 upper	Wood charcoal	-23.7	1.4 ± 0.1	34531 ± 626	41110-37970
Wk 17901	AER Kosipe Trench 2, Layer 3/4 transition	Wood charcoal	-28.3	1.3 ± 0.1	35049 ± 670	41450-38700
Layer 3b						
Wk 23347	AAXC Joe's Garden	Wood charcoal	0.0 (e)	1.5 ± 0.1	33700 ± 416	39610-37060
Wk 27071	AAXF Vilakuav	Wood charcoal	-25.4+0.2	1.7+0.1	32588±392	38470-36480
Wk 17899	AER Kosipe Section 4, Layer 3, base, below lens	Wood charcoal	-24.7	2.0 ± 0.1	31620 ± 442	36850-35040
Wk 17261	AER Kosipe Section 4, Layer 3, charcoal lens	Pandanus nutshell	-23.4	2.2 ± 0.1	30575 ± 399	36280-34570
Wk 17898	AER Kosipe Section 3, Layer 3 charcoal lens	Wood charcoal	-24.7	4.3 ± 0.2	25217 ± 293	30600-29460
Layer 3a						
Wk 27080	AAXE South Kov Layer 3 spit 1	wood charcoal	-25.7+0.2	4.5±0.1	24856±153	30210-29400
Wk 27076	AAXE South Kov Layer 3 bottom spit 3	Wood charcoal	-25.1+0.2	4.8±0.1	24433+149	29570-28630
Wk 27079	AAXE South Kov Layer 3 spit 2	Wood charcoal	-25.6+0.2	5.8±0.1	22907+137	28120-26940
Wk 23352	AAXE South Kov Layer 3 lower	Wood charcoal	-23.2	6.1 ± 0.1	22414 ± 416	28060-25900
Wk 27069	AAXF Vilakuav layer 3 lower	Wood charcoal	-25.5+0.2	5.9±0.1	22802±141	28020-26910
Wk 27075	AAXE South Kov Layer 3 top spit 3	Wood charcoal	-25.1+0.2	6.2±0.1	22313±114	27620-26260
Wk 23359	AAXC Joe's Garden Layer 3 adjacent to 'in situ' stone axe	Wood charcoal	-24.5	6.2 ± 0.1	22302 ± 108	27600-26260
Wk 27077	AAXE South Kov Layer 3	Wood charcoal	-24.7+0.2	5.7±0.1	22998±125	28360-26970
Wk 27078	AAXE South Kov Layer 3 spit 2	Wood charcoal	-24.3+0.2	6.3±0.1	22155±113	27470-26120
Layer 2						
Wk 23358	AAXC Joe's garden	Wood charcoal	-32.1	39.4 ± 0.1	7489 ± 32	8380-8200
Wk 23353	AAXE south Kov	Wood charcoal	-31.6	39.7 ± 0.1	7417 ± 32	8330-8180
Wk 27070	AAXF Vilakuav	Wood charcoal	-25.9+0.2	46.0±0.1	6240±30	7250-7030
Wk 27068	AAXF Vilakuav L	Wood charcoal	-25.0+0.2	47.0 ±0.1	6070±32	7140-6800
Wk 23357	AAXC Joe's Garden Layer	Wood charcoal	-27	61.3 ± 0.2	3938 ± 34	4520-4250

Wk 23348	AAXC Joe’s Garden Layer	Wood charcoal	-28.4	61.9 ± 0.2	3855 ± 30	4410-4160

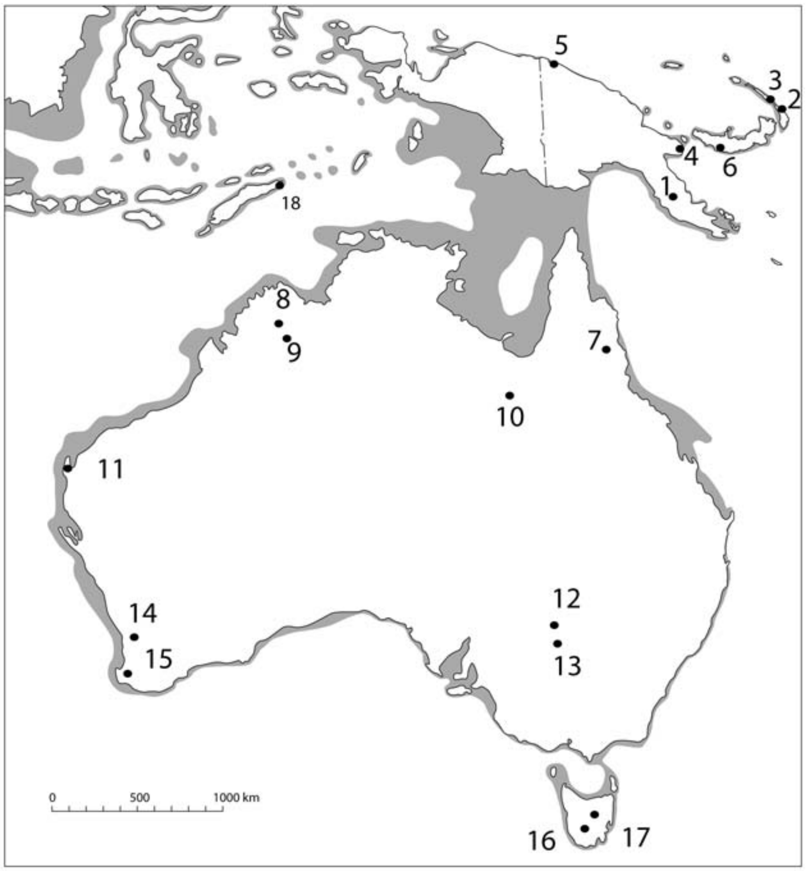
Table S2. Chronology of occupation in Sunda and Sahul

Region/site	CRA	Lab No	C14 calibrated 95.4% probability	Luminescence x 10^3	reference
Sunda					
Lang Rongrien (Thailand)	37,265±1000	SI-6216	43630-40230		(S1; S2)
Niah Cave (Borneo)	45,900±800	OxA-V-2057-31	>50000-47170		(S3)
Wallacea					
Jerimalai (Timor)	38,255±596*	Wk-17831	43290-41580		(S4)
Lene Hara (Timor)	34,650±650*	ANU-11418	40890-37430		(S5)
Sahul North					
<u>Mainland PNG</u>					
Bobongara				>38,000±600	(9)
Kosipe	34,531 ± 626	Wk 17900	41110-37970		
Vilakuav	41,951±1571	Wk-27072	48690-42970		
South Kov	40,298 ± 956	Wk 23354	45540-42760		
Airport Mound	39,836 ± 909	Wk 23356	45170-42520		
<u>Bismarck Archipelago</u>					
Kupona na dari				34-38,000	(S6)
Buang Merabak	40,090±550	ANUA-15809	44890-43100		(S7,S8)
Matenkupkum	35,410±430*	ANU-8178	41100-38950		(S9)
Yombon	35,570±480	Beta-62319	41640-39400		(S10)
Sahul Mid North					
Carpenters Gap	40,600±800	ANUA-7616	45500-43130		(S11)
GRE 8	37,110±2494	Wk-11429	45440-36600		(S12)
Janz	35,230±500*	Wk-8921	41030-38770		(S13)
Mandu Mandu	34,200+1050*	Wk-1513	41070-36470		(S14)
Ngarrabullgan	36,800±100	Beta 47849	42080-41420		(S15)
Riwi	41,300±1020	ANUA-13005	46350-43250		(S16)
Sahul Mid South					
Devils Lair	41,460±1300	ANUA-11709	47250-42870	44,400+2100	(S17)
Menindee	41,530±1630	NZA-23736	48360-42580	45,300+1500	(S18)
Upper Swan	39,500±2000		46850-40170		(S19)
Willandra Mungo	38,100+110	AA4553	42940-42217	45,400+2500	(S20)
Sahul Far South					
Parmerpar Meethaner	33,850±450	Beta-68158/CAMS-10270	40080-37280		(S21)
Warreen	34,790±510	Beta-42122B/ETH-7665B	41025-38740		(S22)

dates marked with an * - saltwater shells calibrated using marine 09. All terrestrial samples dates using IntCal09

Table adapted from (S23)

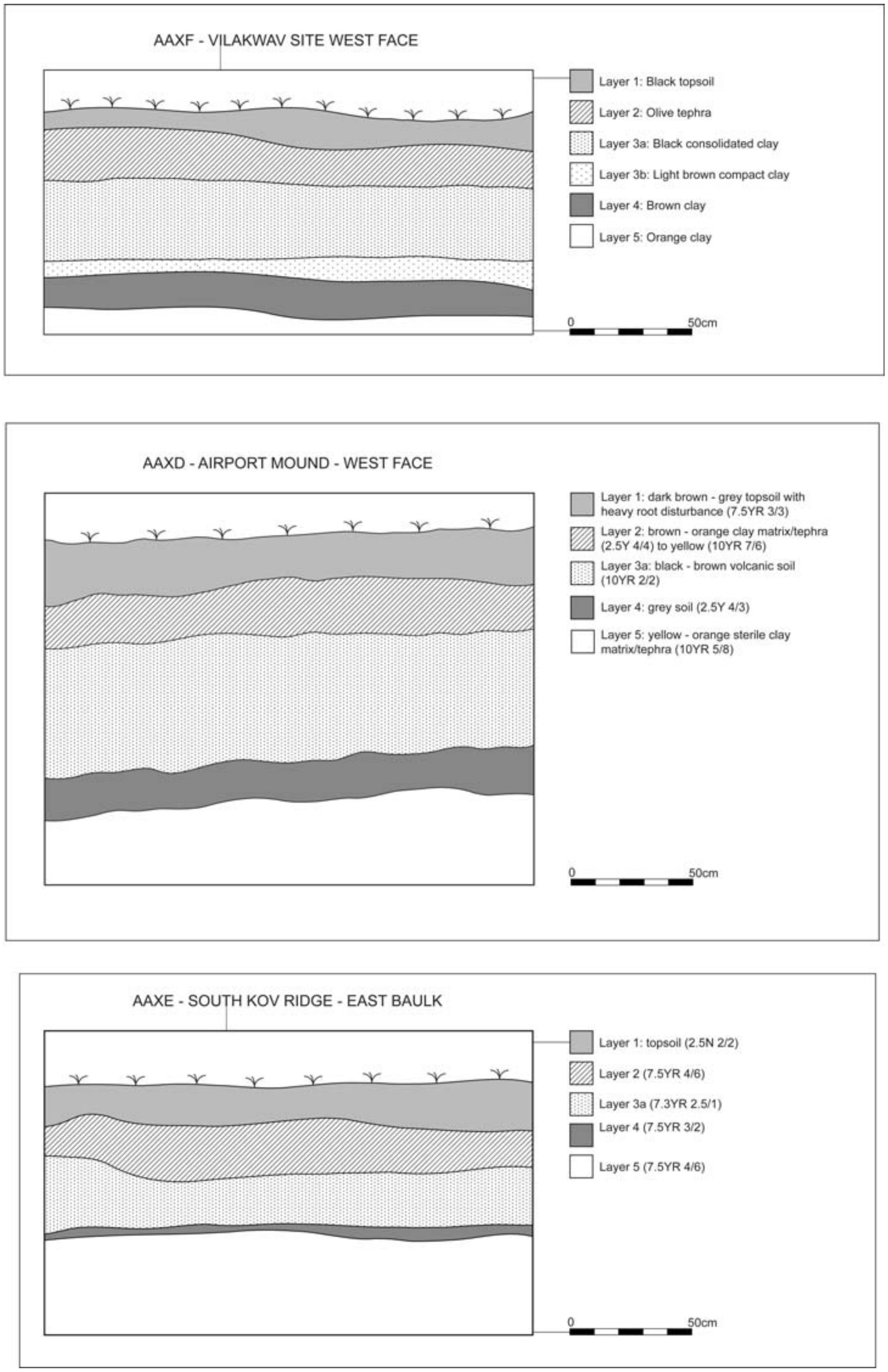
Figure S1. Sahul - Late Pleistocene sites



1. Ivane Valley
2. Matenkupkum
3. Buang Merabak
4. Bobongara
5. Lachitu
6. Yombon
7. Nagarrabullgan
8. Carpenter's Gap
9. Riwi
10. GRE 8
11. Jansz/mandu Mandu
12. Menindee
13. Willandra
14. Upper Swan
15. Devils Lair
16. Warreen
17. Parmerpar Meethaner
18. Jerimalai/Lene Hara

2. Stratigraphy of selected sites

Figure S2. Stratigraphy of Ivane archaeological sites showing Layer 4 (Vilakuav, Airport Mound and South Kov.)



2. **Ivane Valley Late Pleistocene stone tools**

Figure S3. Top, Middle and Lower - South Kov AAXE Layer 4.

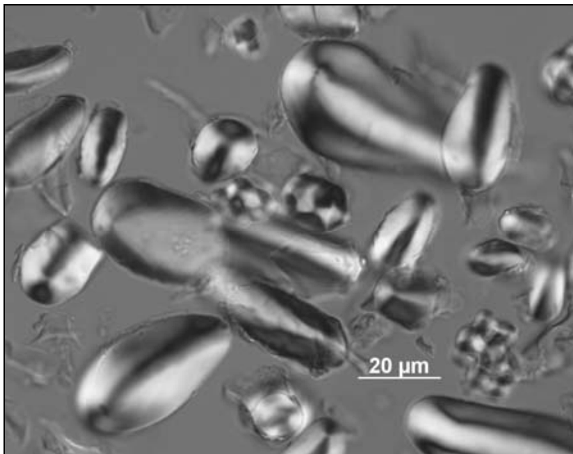
Figure S4. Ivane Valley Late Pleistocene stone tools: Top - Joe's Garden AAXC Layer 3b; Middle - Airstrip Mound AAXD Layer 4; Lower - South Kov AAXE Layer 3a.

3. Methods for starch analysis:

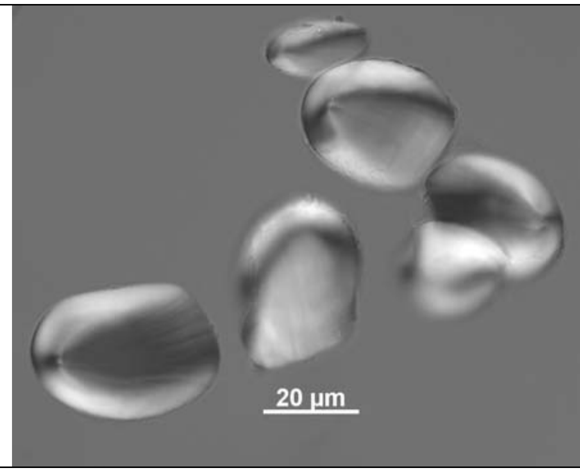
Samples were collected from the used edges of artefacts by placing a portion of the edge into an ultrsonnicator bath for 1 minute. The sample plus water was transferred to a 10ml centrifuge tube and spun for 5 minutes at 1500RPM. Supernatant was decanted and the starch/phytoliths fractions were separated using heavy liquid (Sodium polytungstate, S.G. 2.3.). The sample was rinsed in water by centrifugation and mounted in 50% Glycerol. Slides were scanned with 20× and 63× objectives using a Zeiss Axioskop 2 brightfield microscope with polarizing filters and Differential Interference Contrast (DIC) optics. Image capture was achieved using a Zeiss Axiocam (HRc) digital camera and Zeiss AxiovisionTM software.

Note also that the comparative reference material compiled by the Australian Museum, from which these images were obtained were mounted in Euparol. The Euparol mountant masks surface features of starch such as fissures at the hilum and is a function of the refractive index of the mountant. When starch preparations are mounted in water or glycerol, as is the case in this study, surface features are clearly visible

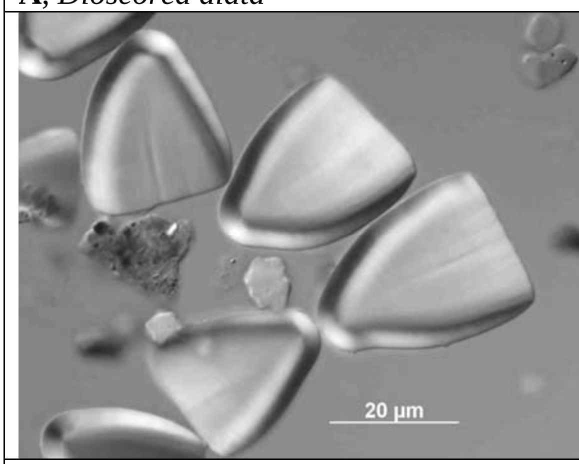
Figure S5. Representative images of the Australian Museum comparative reference material from which the data for Figure 1 was collected. Samples were mounted in Euparol. Fissures apparent in material mounted in water or glycerol preparations are not always visible in material mounted in Euparol or Permount.



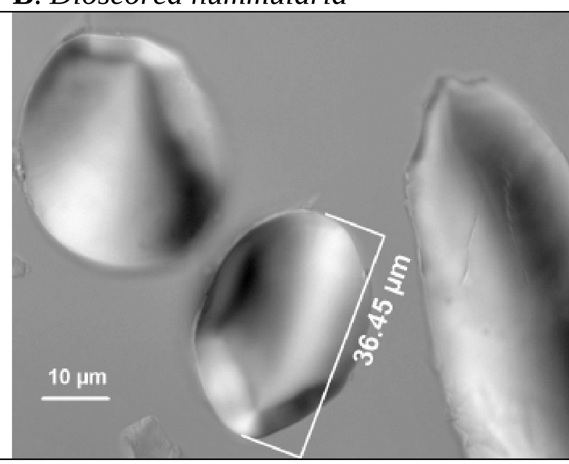
A, *Dioscorea alata*



B. *Dioscorea nummularia*

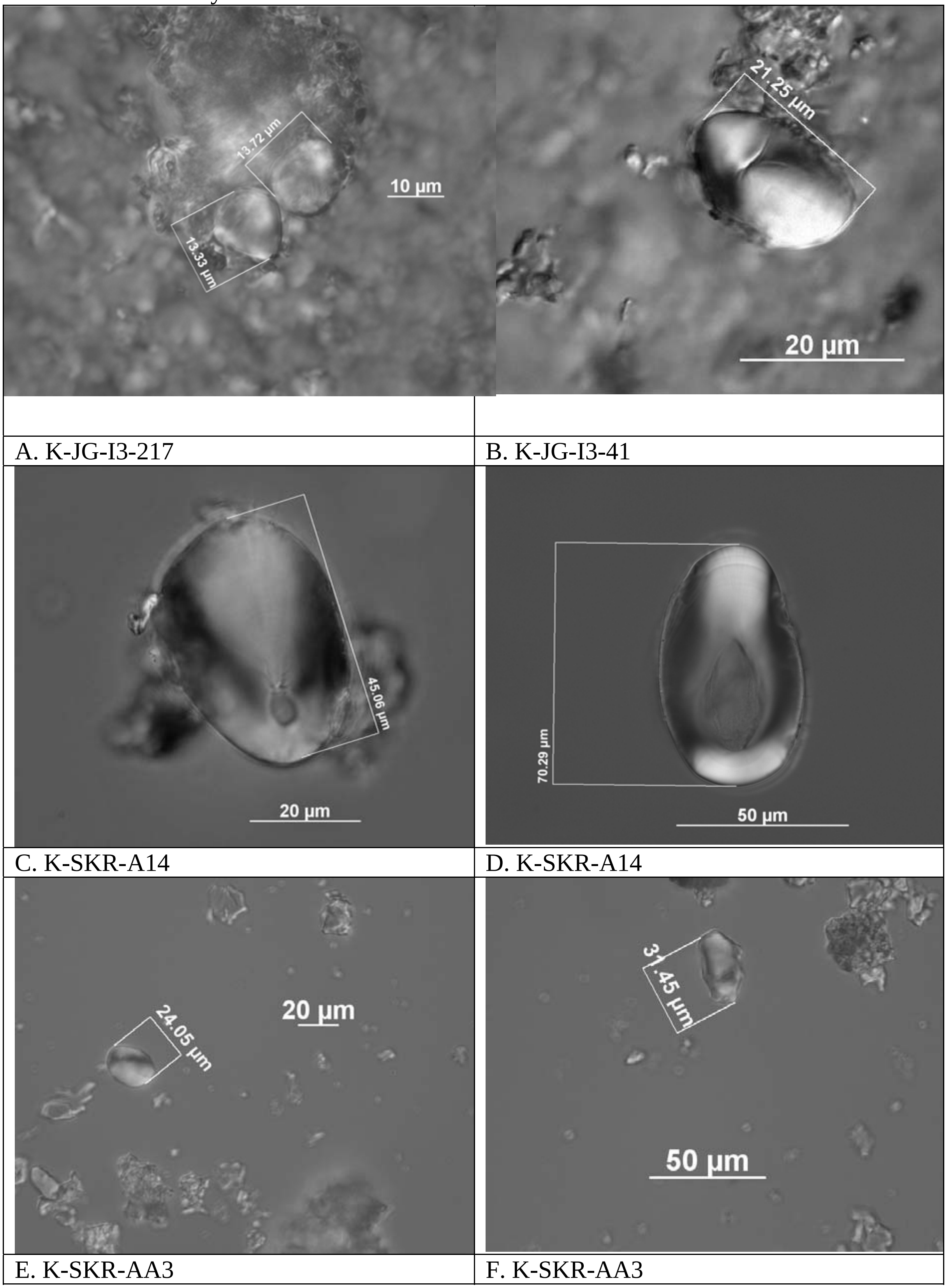


C. *Dioscorea bulbifera*



D. *Dioscorea pentaphylla*

Figure S6. Starch grains in extractions from archaeological preparations. Samples were mounted in 50% Glycerol in water.



A. K-JG-I3-217
B. K-JG-I3-41
C. K-SKR-A14
D. K-SKR-A14
E. K-SKR-AA3
F. K-SKR-AA3

Table S3: Archaeological and Comparative Reference Samples for *Dioscorea*. Measurements are in microns.

Sample	**Total Grains (n)**	**Yam (n)**	**Min**	**Max**	**Mean**	**S.D.**	**Median**
K-JG-I3	321	16	11.71	26.8	19.66	4.27	19.69
K-SKR-A14	234	8	18.51	70.29	33.74	18.05	26
K-SKR-AA3	198	7	22.66	32.15	24.05	4.0	24.05
D. alata	-	143	7.97	66.69	22.47	8.89	21.17
D. bulbifera	-	106	22.75	82.19	44.68	11.26	36.98
D. nummularia	-	84	15.46	55.86	32.05	7.23	32.62
D. pentaphylla	-	243	5.63	112.88	37.42	22.95	34.56

4. Identification of *Pandanus* fruits

Charred nutshell fragments were identified using both anatomy and morphology in comparison to reference specimens collected by the authors and in the Queensland Herbarium, Brisbane. Nutshells were 1-2mm thick (Fig S7a) with external longitudinal ridges and conspicuous thick vascular bundles (Fig S7b), whose structure was visible under scanning electron microscopy (Fig S7c,d). All specimens were from large single-seeded drupes characteristic of a complex of species endemic to the high altitude regions of New Guinea classified in *Pandanus* subgenus Lophostigma, section Karuka (S24). These include the large-fruited, economically important species *P. julianettii* and *P.brosimos* and a wild species *P.iwen*, but it is clear that this group is currently inadequately described and both the domestic status and taxonomic relationships of the named species are uncertain (S25).

The anatomy of these species was identical and morphometric analysis was used to attempt higher level identification. Previous research suggested single measurements were an inadequate means of distinguishing drupes from different species (S26), so an exploratory analysis used a combination of length and breadth (Figs S8 and S9), measured using high-precision calipers. Morphometric analysis indicated that four complete drupes recovered from South Kov Layers 3 & 4 were similar in size (indicated by length and breadth – Fig S8) and shape (indicated by a length/breadth index – Fig S9) to a wild species known in the Tavade language as *Taip*, which does not match scientific descriptions of any other *Pandanus* species. *Taip* grows at 2300->2800 m asl and is eaten on hunting trips to high altitude. The archaeological specimens were quite unlike *P. brosimos* and *P.julianettii* and a cultivar source is untenable.

Figure S7 *Pandanus* specimens: a) Transverse section (TS) of Kosipe specimen (scale bar 10mm); b) external view of fragment showing longitudinal ridging and robust vascular bundle (VB); c) TS of Kosipe *Pandanus* specimen – VB = vascular bundle & G = ground tissue; d) TS of modern *P. jiulianettii* specimen; a), b) & c) are photos of the same specimen from Kosipe dated by AMS to 36,280-34590 cal BP (Wk17261) See Table S1.

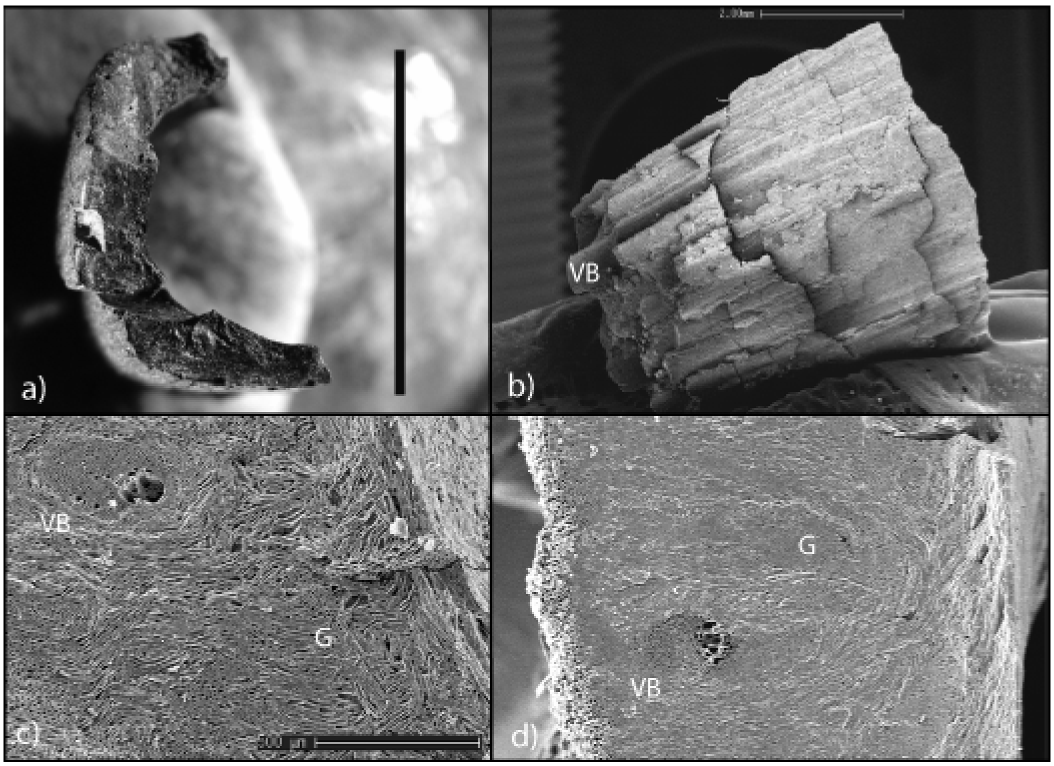


Figure S8 Scatter plot comparing the length and breadth measurements from 534 modern drupes from *Pandanus brosimos*, *P. julianettii*, *Pandanus* Taip and 4 archaeological specimens from South Kov Layers 3 and 4 (symbols explained in key)

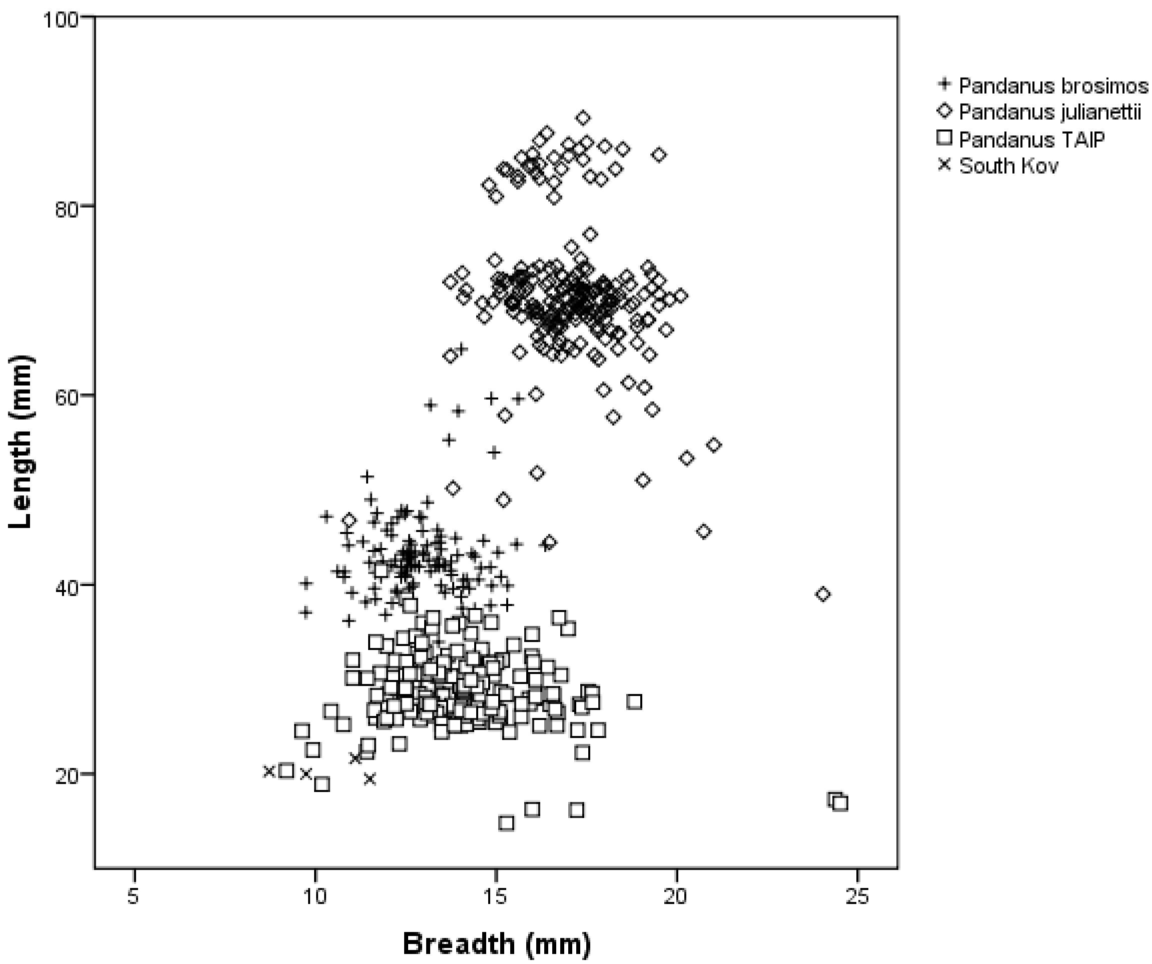
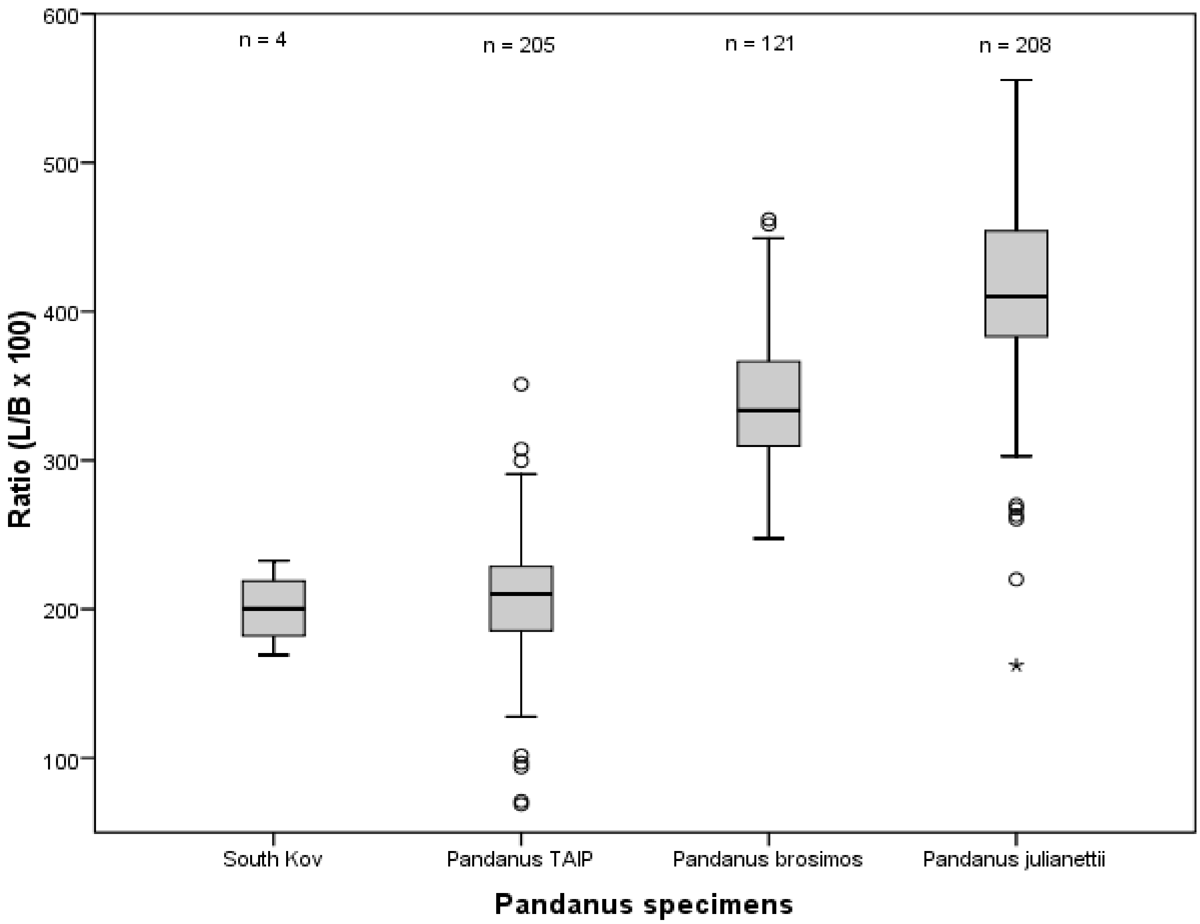


Figure S9 Boxplots of length/breadth index (length/breadth x 100) values from 534 modern drupes from *Pandanus brosimos*, *P. julianettii*, *Pandanus* Taip and 4 archaeological specimens from South Kov Layers 3 and 4



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