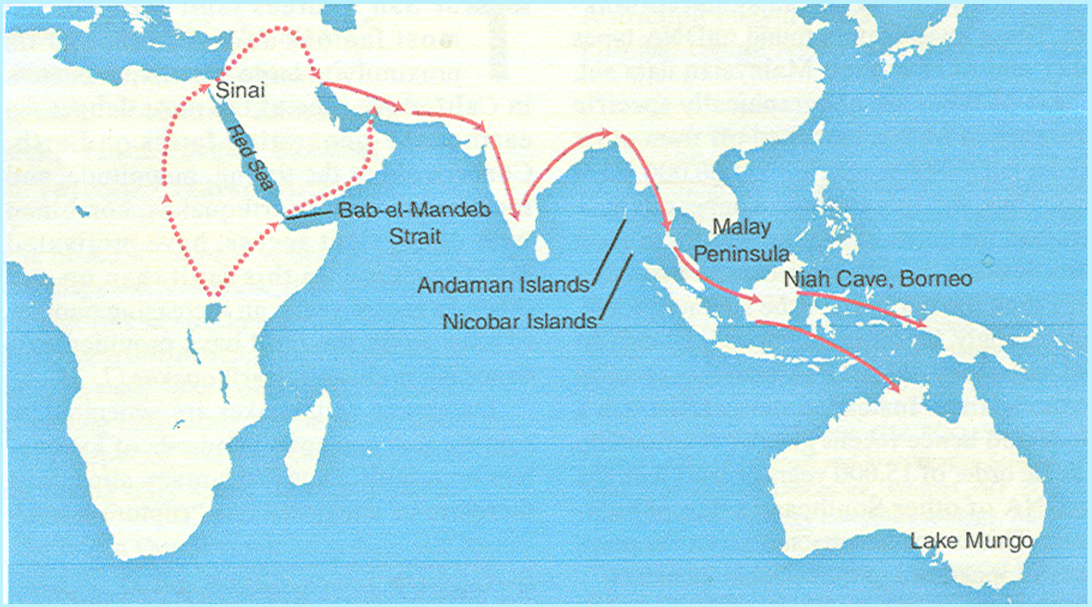
Models for the Modern Human Colonisation of South Asia: Genetic and Archaeological Perspectives

Paul Mellars

UNIVERSITY OF CAMBRIDGE



"The similarities between Africa and India are not coincidental, and fit in beautifully with the DNA evidence," says Paul Mellars, an archaeologist at the University of Oxford.

New Scientist, Oct 2007

Alternative Models for the Modern Human Colonisation of South Asia

Hypothesis A (Petraglia, Clarkson et al. 2009)

1. Dispersal of modern humans from Africa to India before 74,000 BP – associated with Middle Palaeolithic/MSA technologies.
2. Local, rapid, *in situ* evolution from ‘Middle Palaeolithic’ to ‘Microlithic’ technologies ca. 35-40,000 BP.

Hypothesis B (Mellars 2006)

1. Dispersal of modern humans from Northeast Africa to India ca. 55-60,000 BP – associated with “microlithic”/backed bladelet technologies.
2. Replacement of local Middle Palaeolithic by intrusive Microlithic technologies across India between ca. 50,000 and 35,000 BP.

Antiquity 2009

The oldest and longest enduring microlithic sequence in India: 35 000 years of modern human occupation and change at the Jwalapuram Locality 9 rockshelter

Chris Clarkson[1]*, Michael Petraglia[2], Ravi Korisettar[3], Michael Haslam[2], Nicole Boivin[4], Alison Crowther,[5] Peter Ditchfield[4], Dorian Fuller[6], Preston Miracle[7], Clair Harris[1], Kate Connell[1], Hannah James[2] & Jinu Koshy[3]

Population increase and environmental deterioration correspond with microlithic innovations in South Asia ca. 35,000 years ago

Michael Petraglia[a,b,1], Christopher Clarkson[c], Nicole Boivin[a], Michael Haslam[a], Ravi Korisettar[d], Gyaneshwer Chaubey[e,f], Peter Ditchfield[a], Dorian Fuller[g], Hannah James[h], Sacha Jones[i], Toomas Kivisild[h], Jinu Koshy[d], Marta Mirazón Lahr[h], Mait Metspalu[f], Richard Roberts[j], and Lee Arnold[j]

PNAS 2009

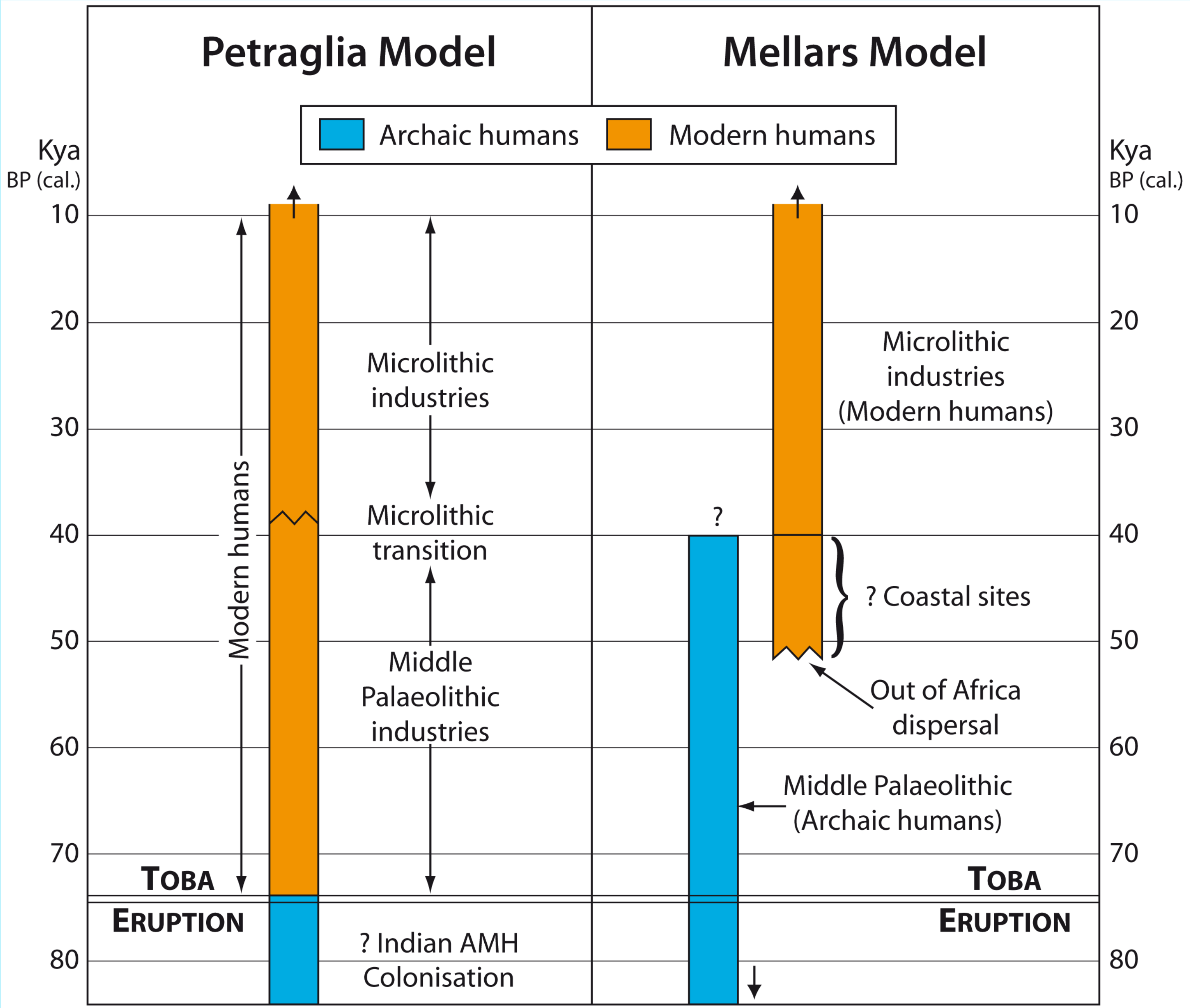
Petraglia/Clarkson Model (2009)

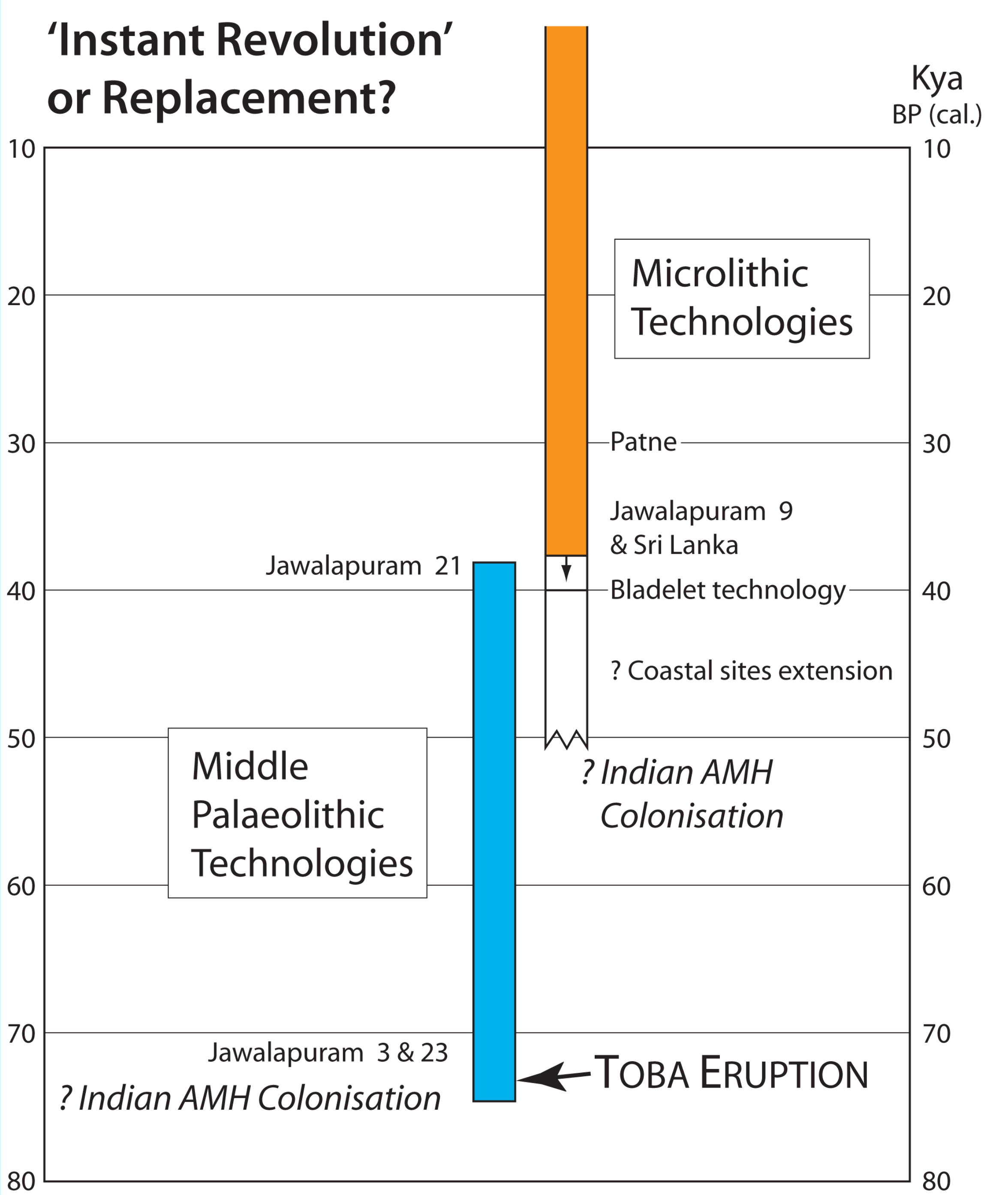
"We have argued elsewhere based on archaeological, genetic and environmental data that the appearance of microlithic technology in South Asia around 35-30,000 years ago represents a local solution to increasing aridity and population pressure in the lead up to the LGM."

"Lithic evidence from elsewhere in the Jurreru Valley demonstrates the continuance of Middle Palaeolithic assemblages until 38kya, ruling out the possibility the Indian Pleistocene microlithic was the result of the initial out of Africa spread of *Homo sapiens* (contra Mellars 2006)."

"We therefore think it likely that modern humans brought lithic technologies characteristic of the Middle Palaeolithic/ Middle Stone Age to India, rather than microlithic technology. This conclusively demonstrates that short-lived microlithic technologies such as the Howiesons Poort in South Africa are convergent and unrelated to the South Asian assemblages."


The Upper Palaeolithic Revolution in global perspective
Papers in honour of Sir Paul Mellars


Petraglia Model
Mellars Model
Archaic humans
Modern humans
Kya
BP (cal.)
10
20
30
40
50
60
70
80
Modern humans
Microlithic
industries
Microlithic
transition
Middle
Palaeolithic
industries
TOBA
ERUPTION
? Indian AMH
Colonisation
Microlithic
industries
(Modern humans)
?
? Coastal sites
Out of Africa
dispersal
Middle Palaeolithic
(Archaic humans)



'Instant Revolution' or Replacement?
Kya
BP (cal.)
10
20
30
40
50
60
70
80
Microlithic Technologies
Patne
Jawalapuram 9
& Sri Lanka
Jawalapuram 21
Bladelet technology
? Coastal sites extension
Middle Palaeolithic Technologies
? Indian AMH Colonisation
Jawalapuram 3 & 23
? Indian AMH Colonisation
TOBA ERUPTION


Ksar Akil
Boker
Tachtit
Red Sea
Bab-el-Mandeb
Strait
Patne
Jwalapuram
Malay
Peninsula
Niah Cave
Batadomba-lena
Andaman Islands
Norikiushin
Enkapune ya Muto
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Diepkloof
Klasies River
Blombos
Lake Mungo

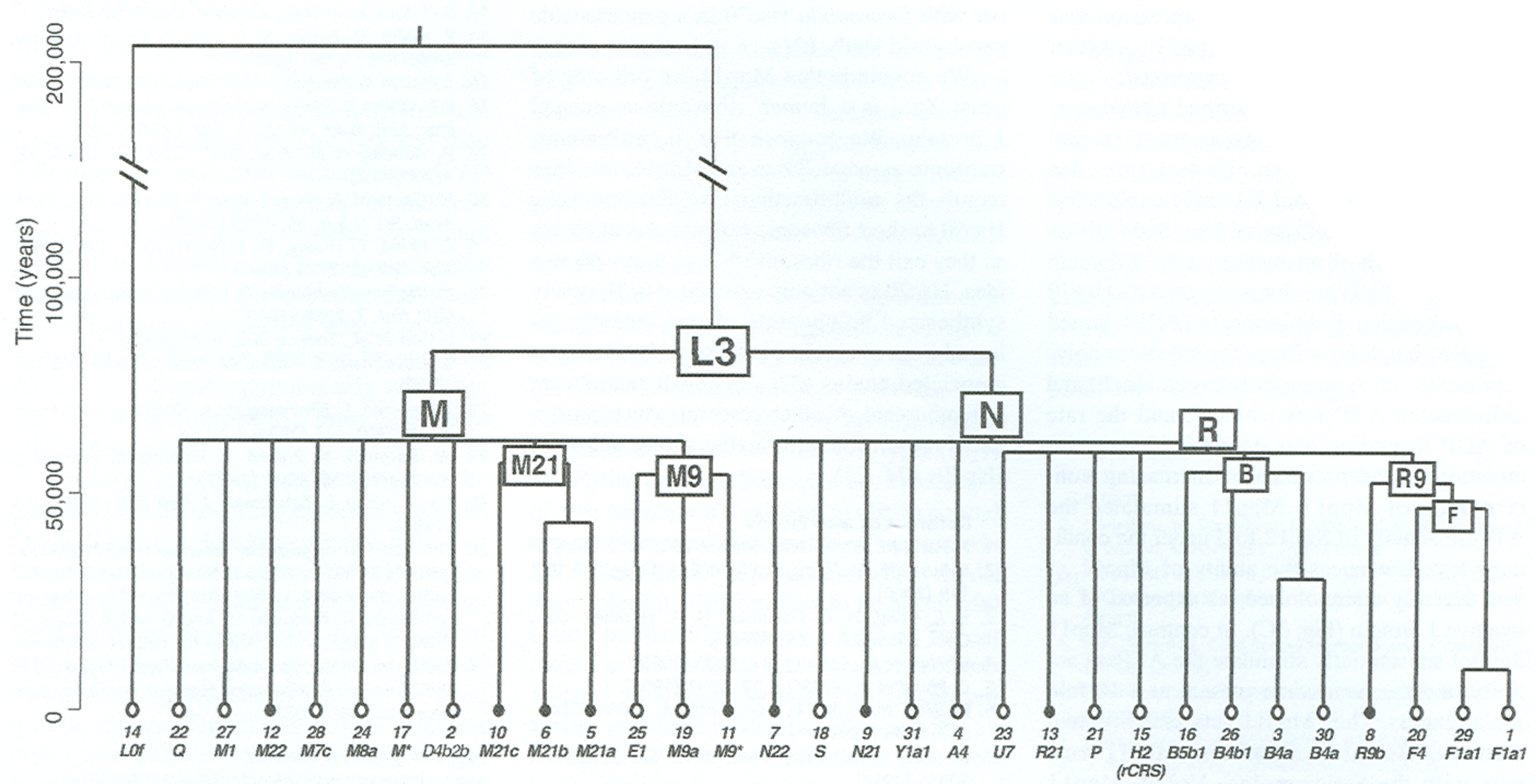
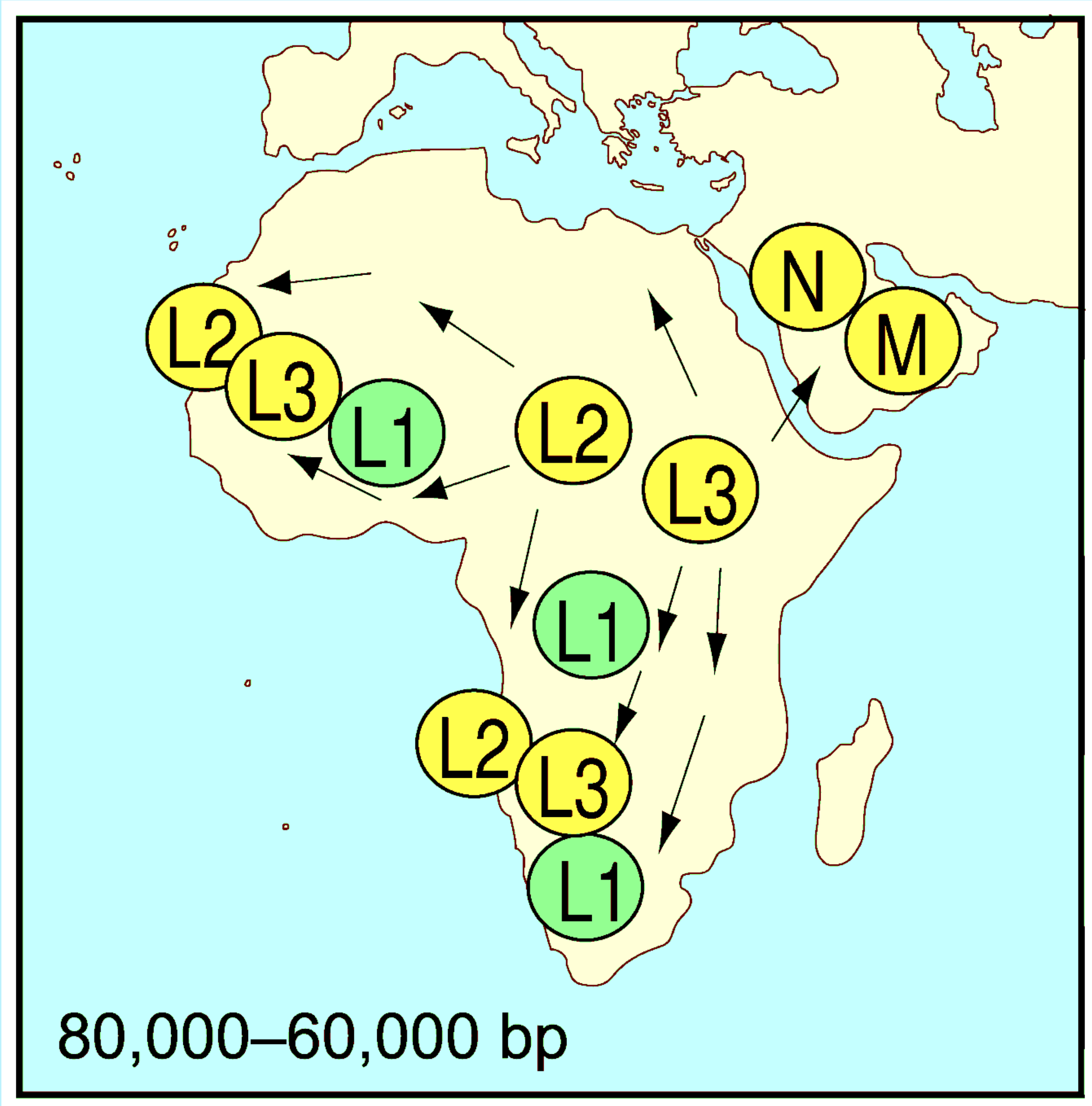
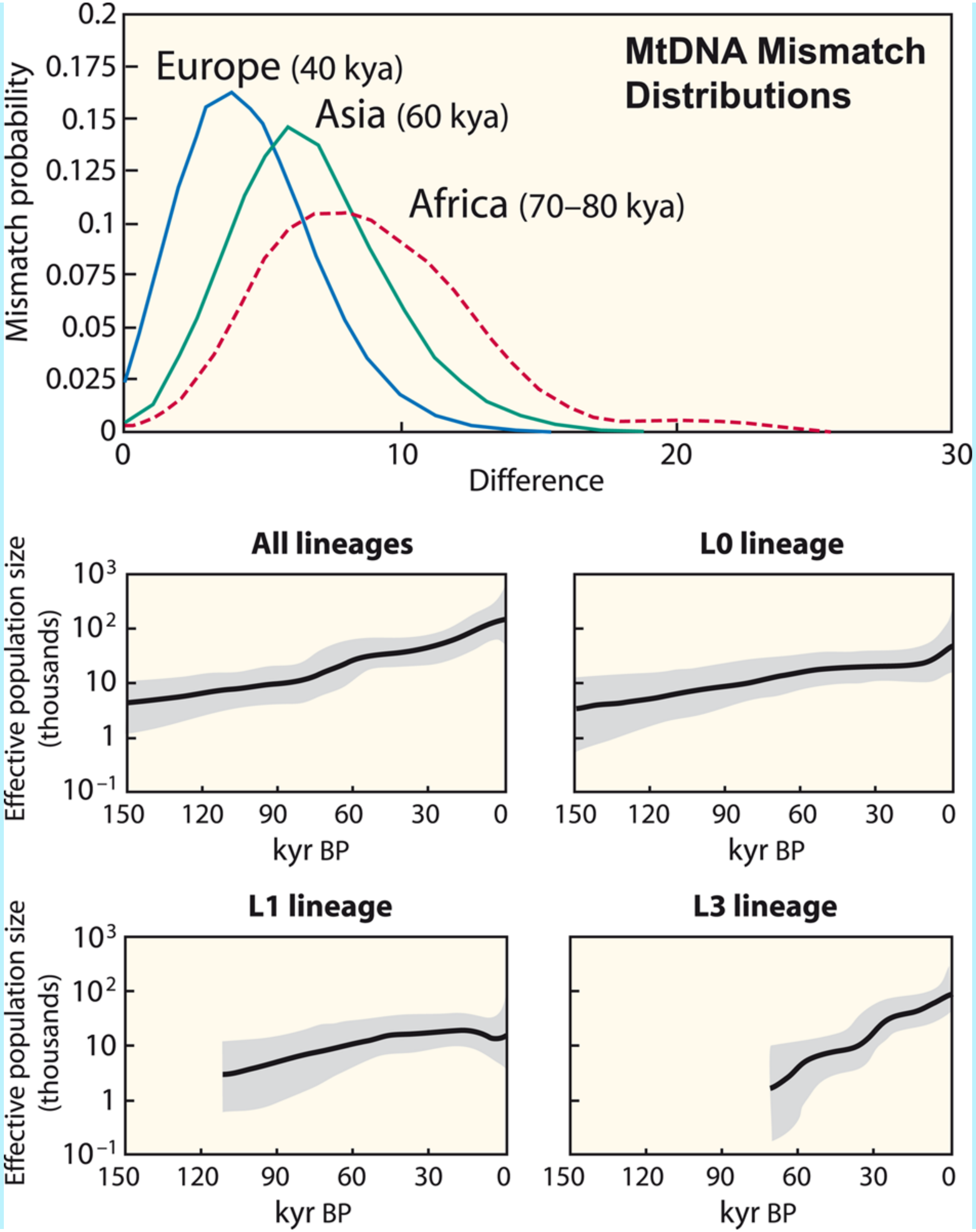


Fig. 1. Reconstructed phylogeny of 31 mtDNA coding region sequences. mtDNAs from the Malay Peninsula are indicated by solid circles at the tips of the tree.

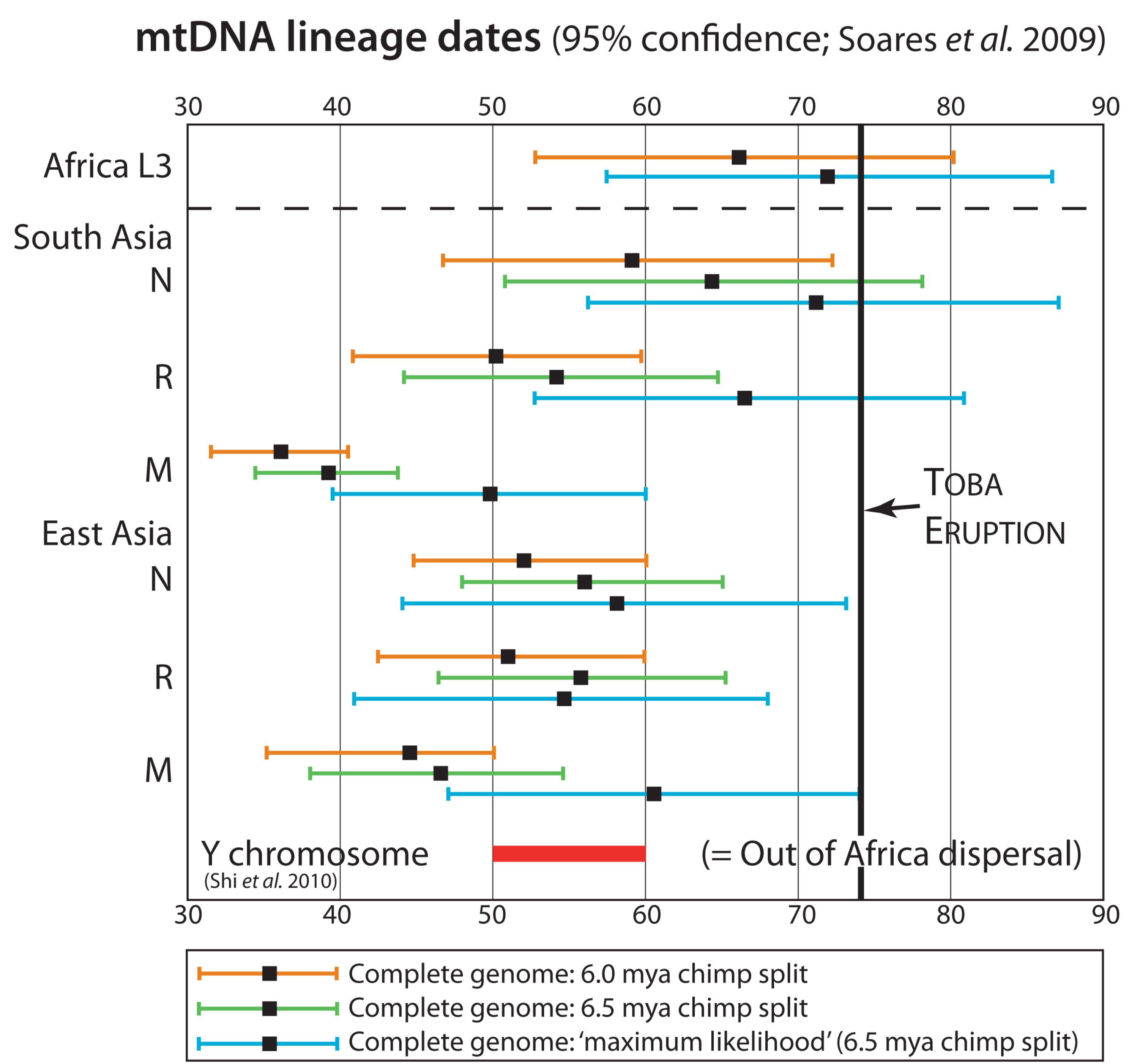
Mitochondrial DNA lineages (Kivisild / Richards)



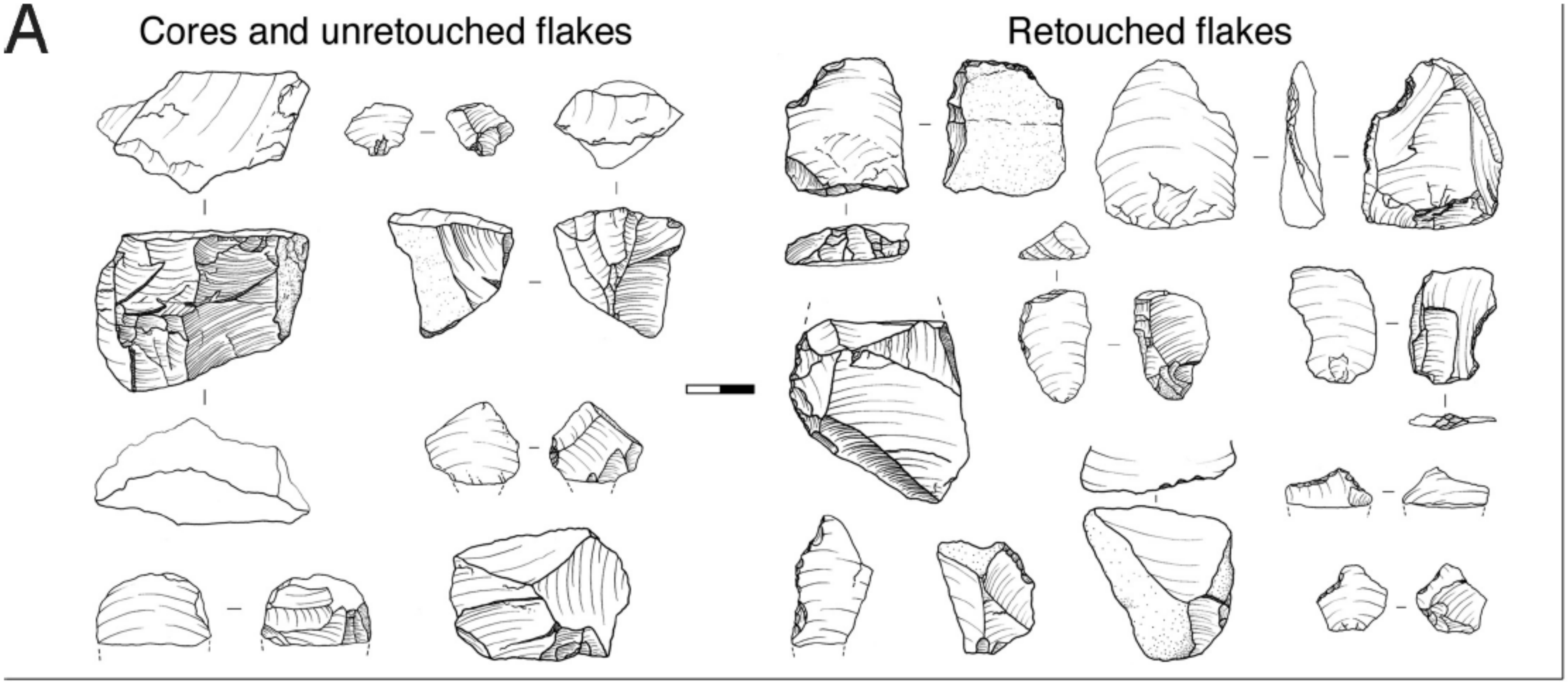
Dispersal of L2 and L3 Mitochondrial Lineages in Africa *c*. 80-60,000 BP



MtDNA Mismatch Distributions
Europe (40 kya)
Asia (60 kya)
Africa (70–80 kya)
Mismatch probability
Difference
All lineages
L0 lineage
L1 lineage
L3 lineage
Effective population size (thousands)
kyr BP



mtDNA lineage dates (95% confidence; Soares et al. 2009)
30 40 50 60 70 80 90
Africa L3
South Asia
N
R
M
East Asia
N
R
M
TOBA ERUPTION
Y chromosome
(Shi et al. 2010)
(= Out of Africa dispersal)
Complete genome: 6.0 mya chimp split
Complete genome: 6.5 mya chimp split
Complete genome: 'maximum likelihood' (6.5 mya chimp split)



Indian Middle Palaeolithic

(Jawalapuram Sites)

Indian Middle Palaeolithic

"Comprehensive technological attribute analysis of the open-air assemblages (dated to ca. 74 ka and 38 ka) demonstrates that intersite variability is minor over the period represented. Multiplatform and radial cores dominated …. In all sites flakes are small and squat … Rare production of both blades (> 4cm) and microblades (<4cm) is noted, ***although microblade cores are absent and production of these forms is considered fortuitous ….*** These assemblages fall chronologically and typologically within the Indian Middle Palaeolithic.

The first clear qualitative and quantitative shift in Jerreru Valley lithic technology occurs with the introduction of systematic microblade and backed artefact production in the lower levels of the Jawalapuram 9 rock-shelter."

(Petraglia et al 2009)

Jwalapuram 9 Rock Shelter

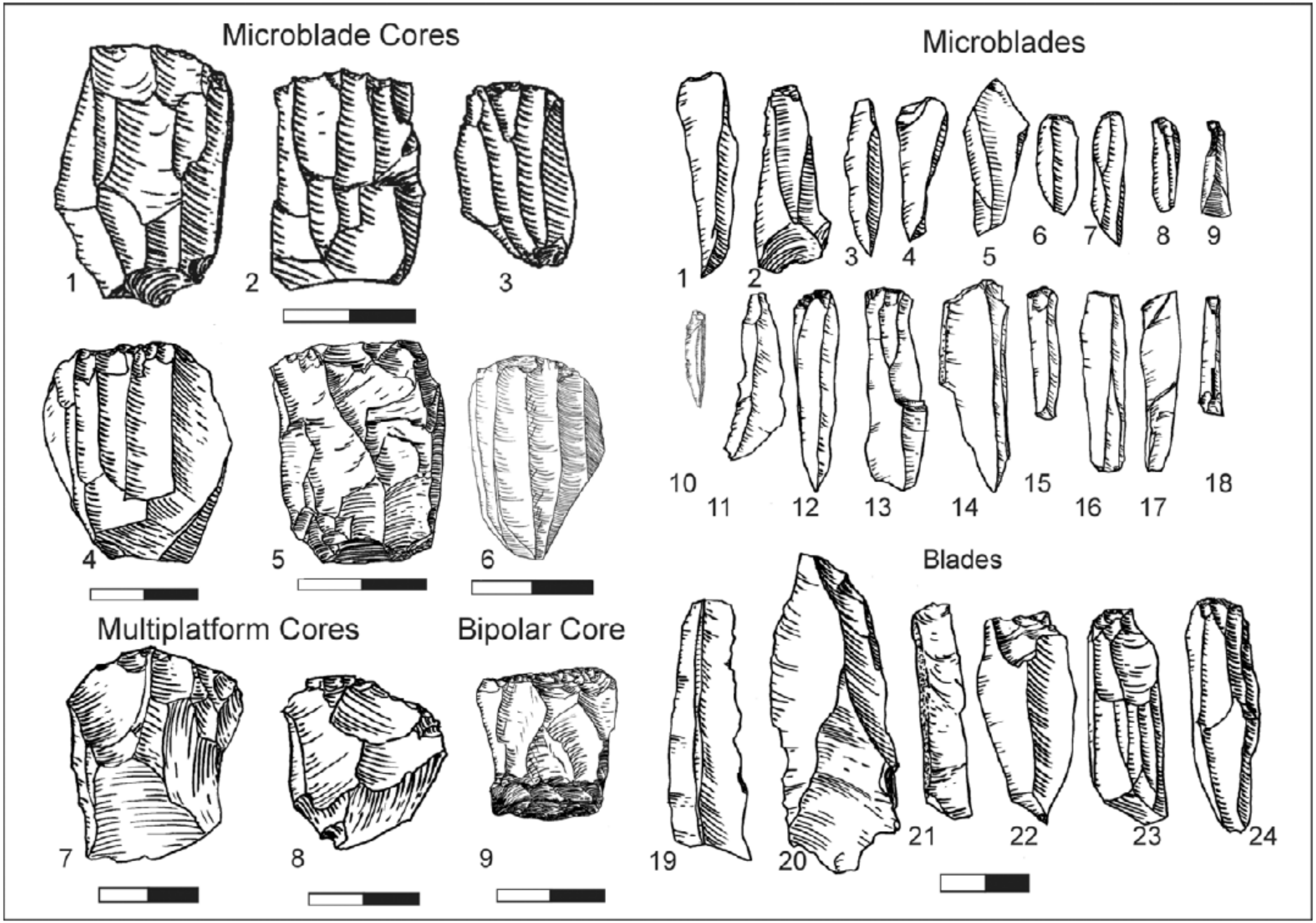


Figure 10. Blades, microblades and cores from Spits 33 and 34 of Square N3, Locality 9, during the peak of the microlithic phase.

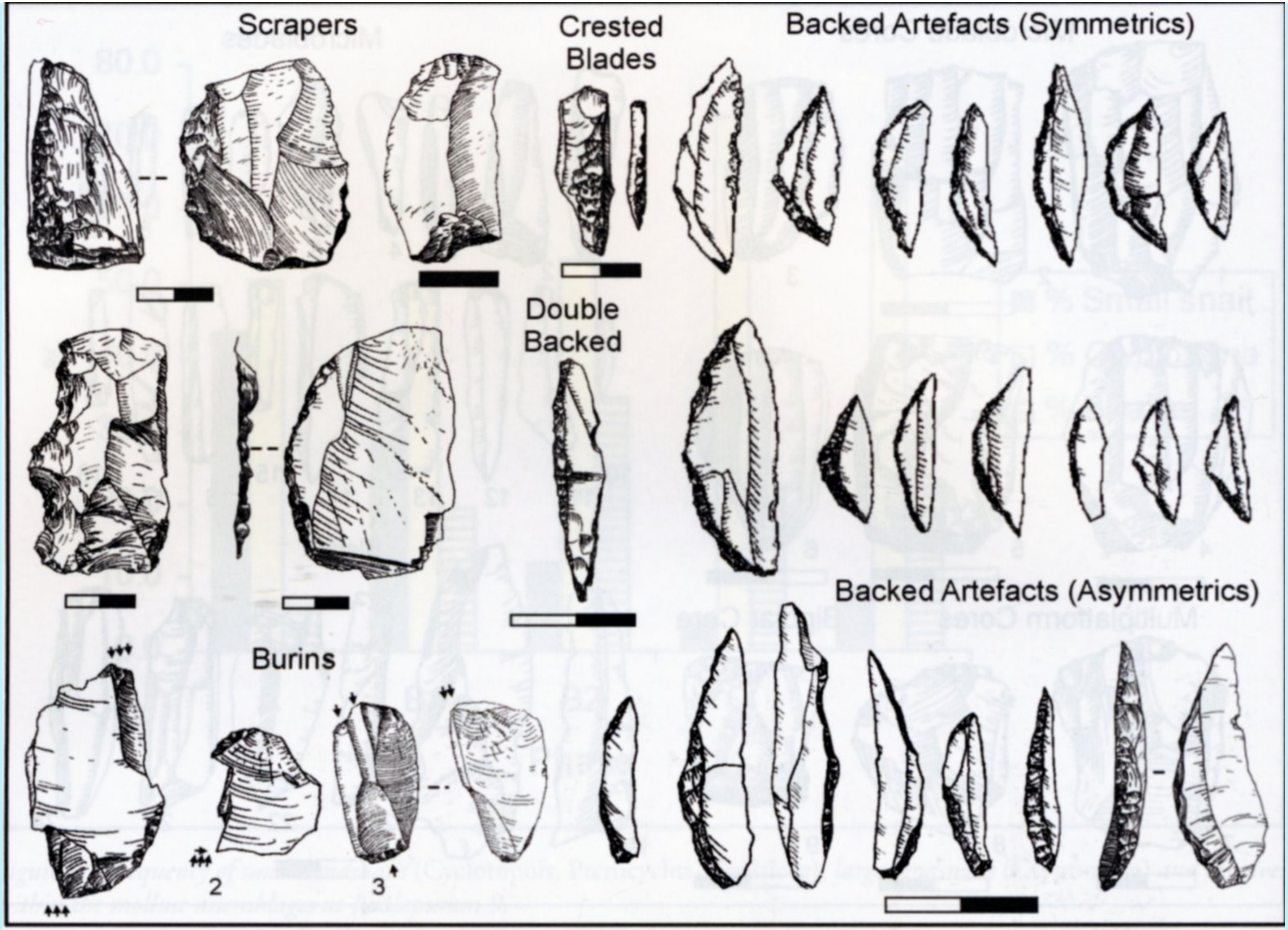


Figure 11. Retouched artefacts from Spits 33 and 34 of Square N3, Locality 9, during the peak of the microlithic phase.

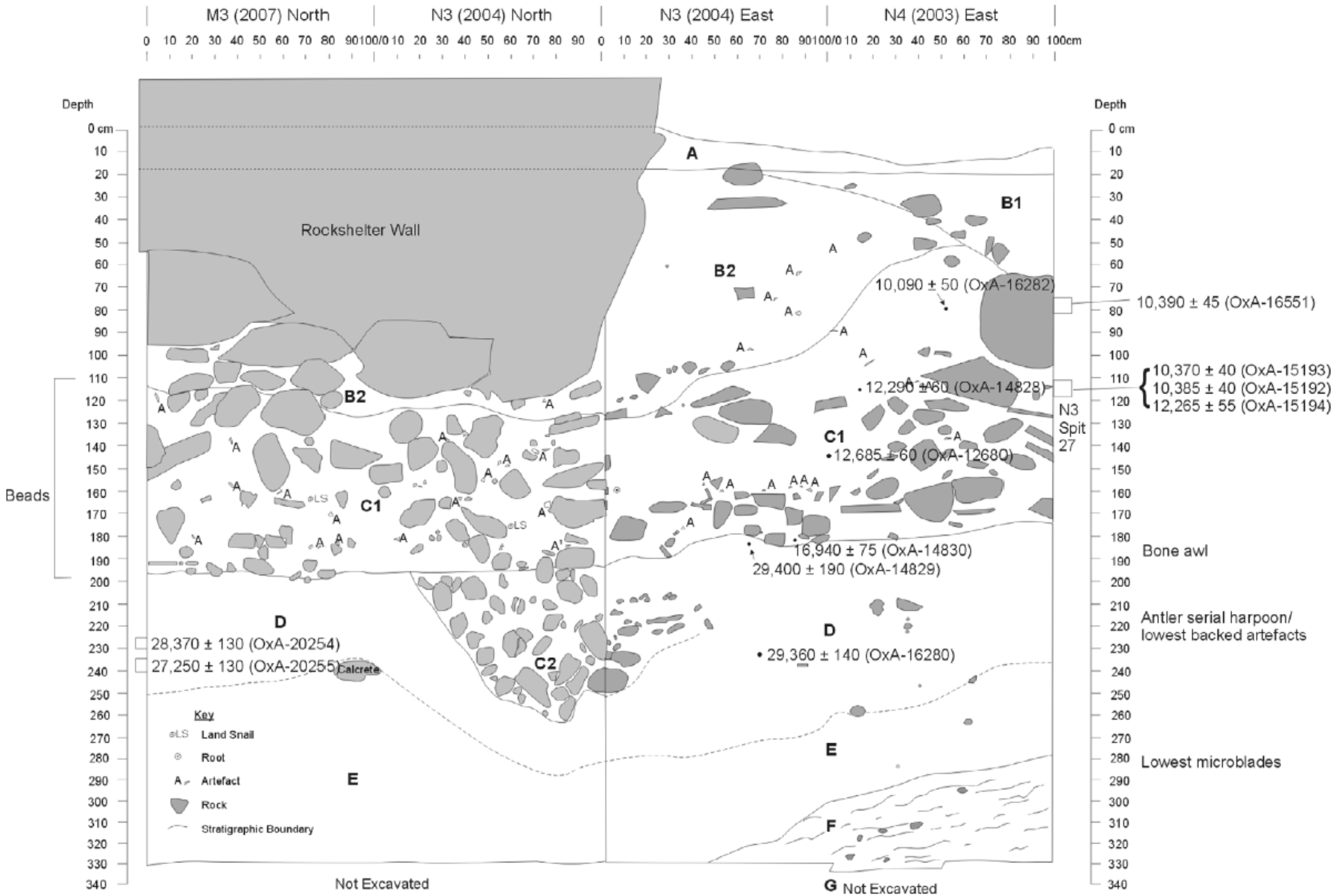
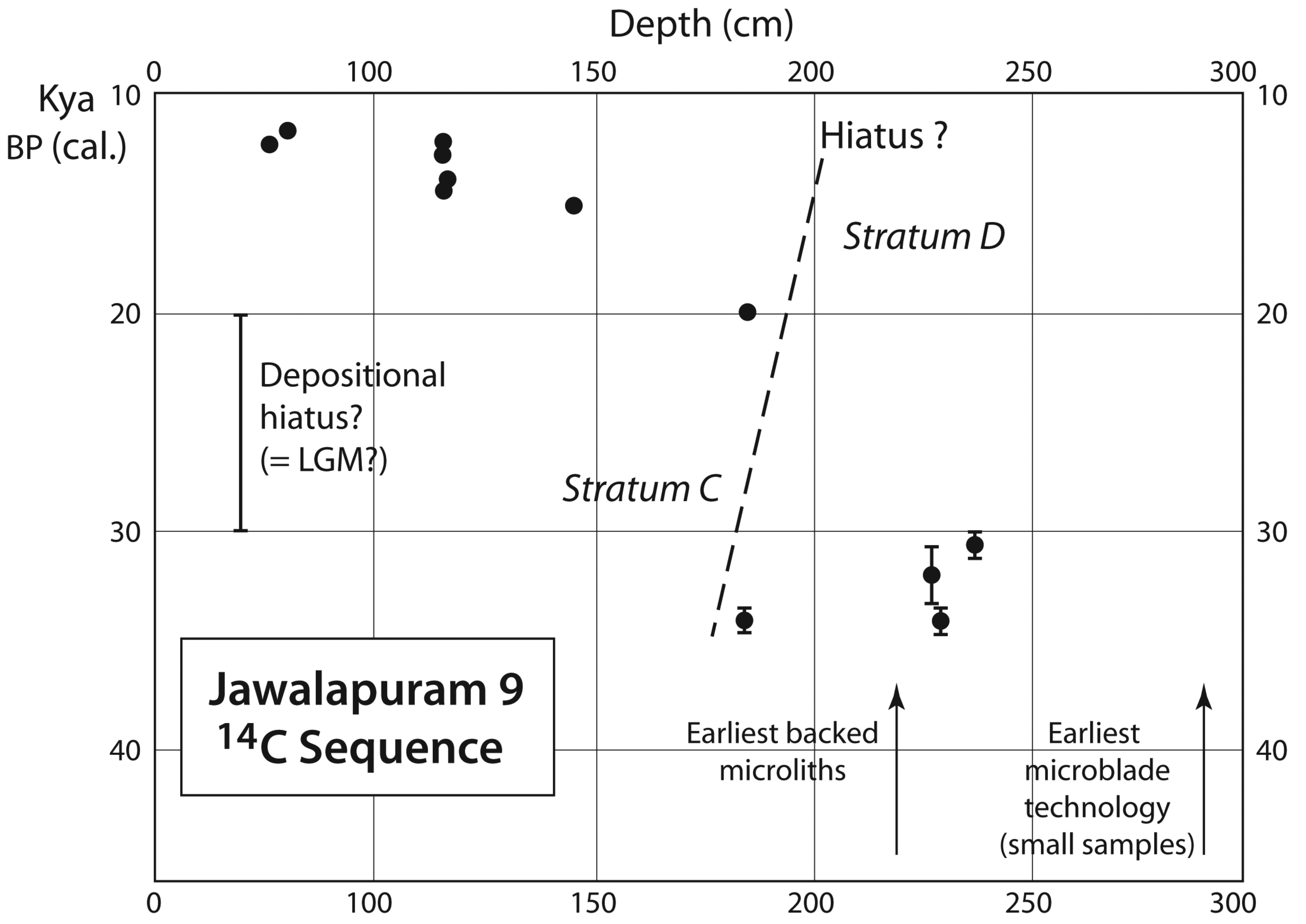


Figure 4. Section drawing of the north and east walls of the Locality 9 rockshelter excavations.



Depth (cm)
0
100
150
200
250
300
Kya
BP (cal.)
10
20
30
40
Hiatus ?
Stratum D
Stratum C
Depositional
hiatus?
(= LGM?)
Jawalapuram 9
14C Sequence
Earliest backed
microliths
Earliest
microblade
technology
(small samples)

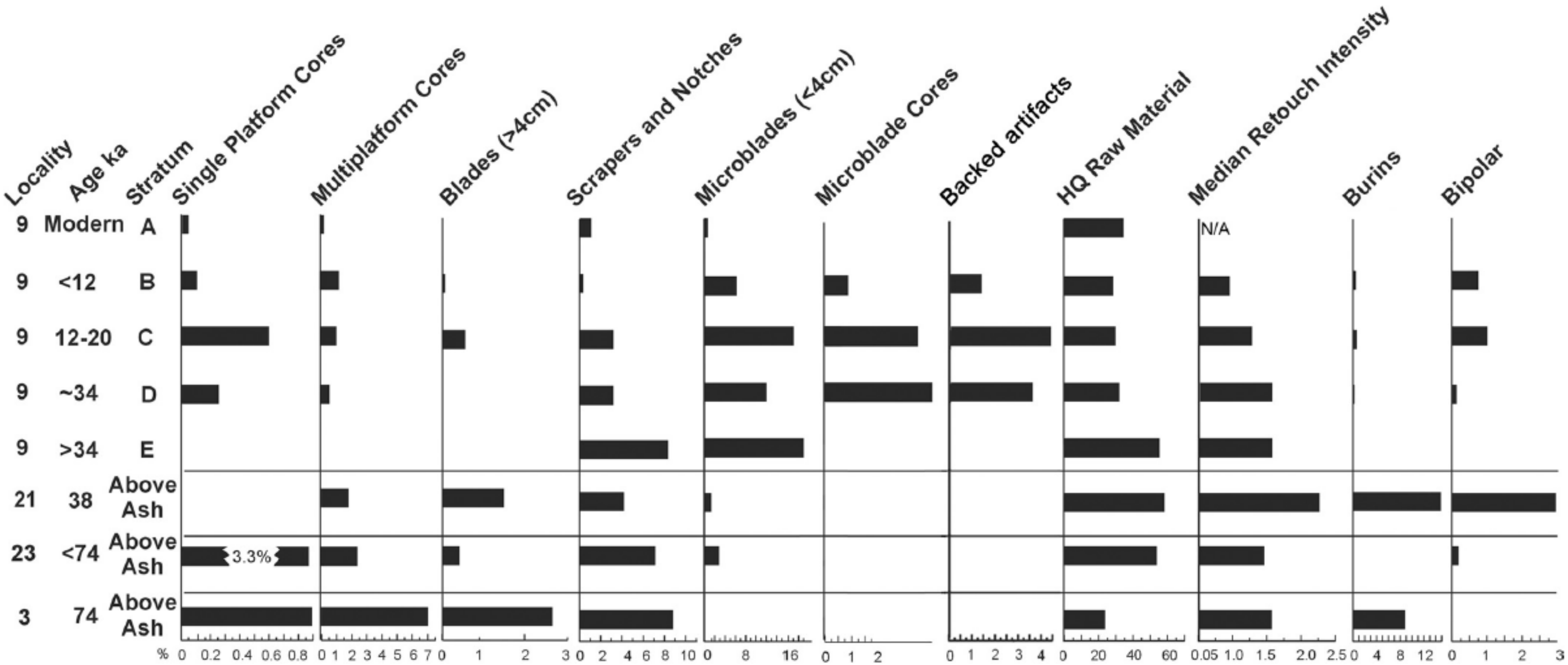


Fig. 3. Lithic technology in the Jurreru Valley. Note the major technological change between 38 and 34 ka from single and multiplatform cores with scrapers, blades, and burins to an assemblage dominated by microblades, microblade cores, and backed artifacts (indicating systematic microlith production). Percentages are proportions in relation to the total artifact assemblage in strata (Locality 9) or in above-ash contexts (Localities 3, 21, and 23).

Jawalapuram Site Industrial Sequence

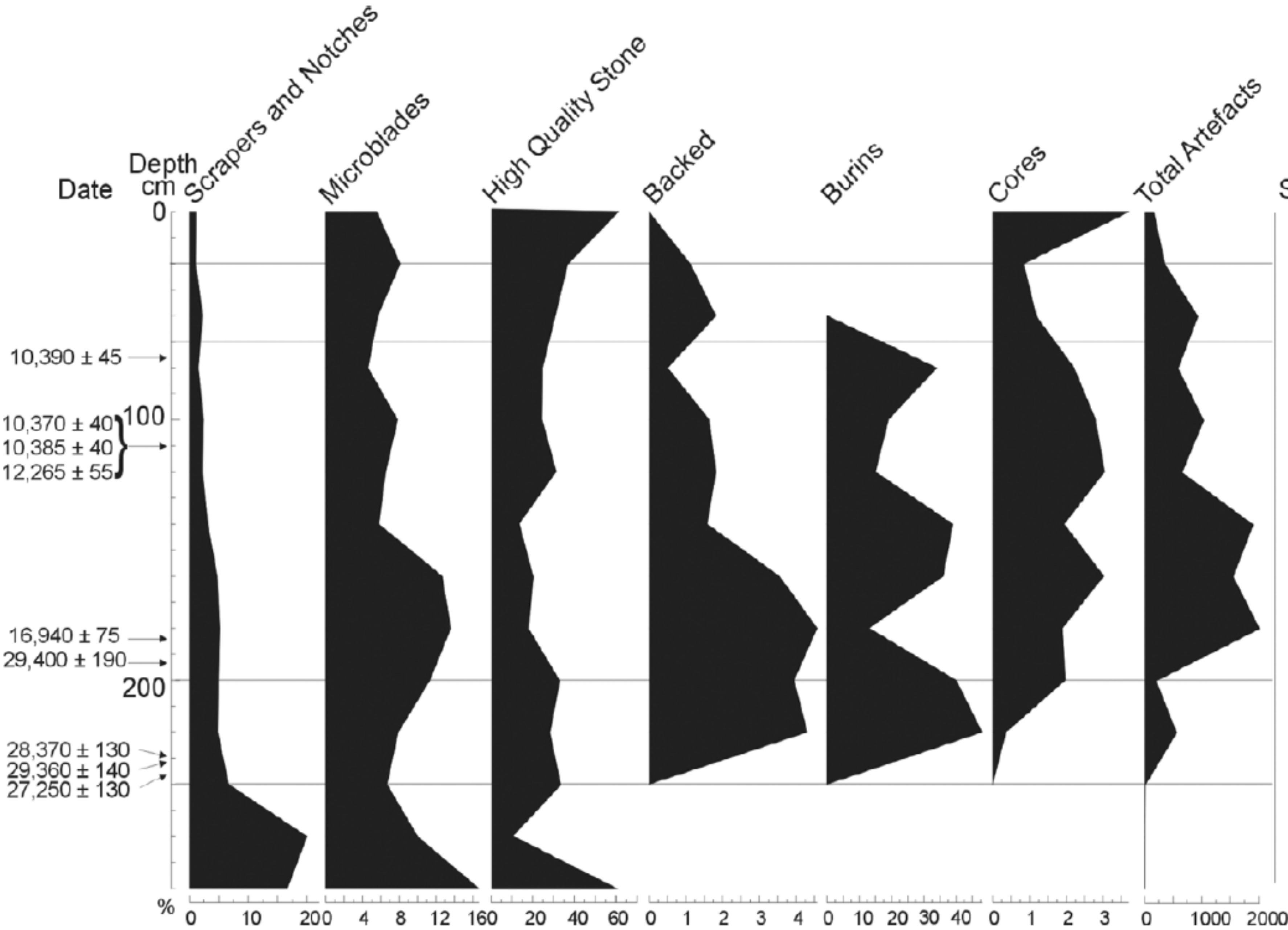


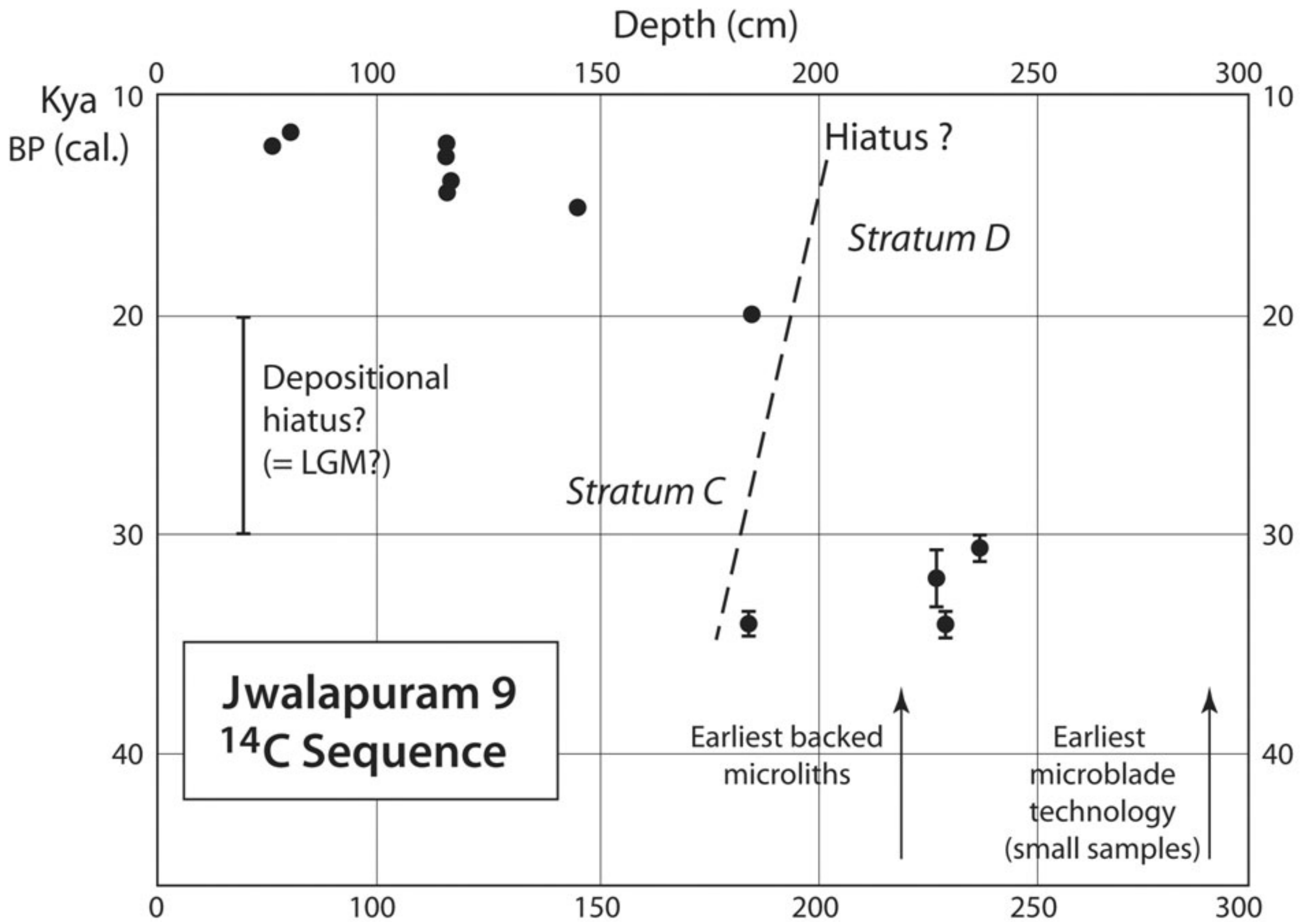
Figure 9. Technological sequence for Locality 9 showing major technological and typological classes.

Jawalapurum 9 sequence

"Backed artefacts and burins make their first appearance at a depth of 2.20m, about 100mm above the date of 34kya, and remain at high frequency until just before the peak in total artefact discard rates approximately 20,000 years ago. ***Their absence below 2.20m may simply reflect small sample size.***"

"Scrapers take a range of forms, including side and end scrapers as well as end scrapers on blades and carinated end scrapers."

(Clarkson et al 2009)



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Depositional
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(= LGM?)
Jwalapuram 9
14C Sequence
Earliest backed
microliths
Earliest
microblade
technology
(small samples)

Sri Lanka

“Fa Hien is the is the earliest dated Sri Lankan cave site, with radiocarbon ages on charcoal documenting occupation from ca. 38-36 to 28.5 ka…. The Pleistocene levels are characterized by microblades as well as larger flakes, and contain the earliest skeletal evidence for anatomically modern *Homo sapiens* in South Asia. Technology at Batadomba-lena consists of geometric backed microliths and rare small blades in all levels, with their initial appearance occurring somewhere between 39 and 30 ka and continuing through to the terminal Pleistocene. *H. sapiens* remains are associated with the early age range. Beli-lena Kitulgala records a sequence dating from 32-27 ka to the Holocene … with geometric backed microliths from the lowest levels.”

(Petraglia et al 2009)

Jawalapuram 9 (c. 30,000 BP)

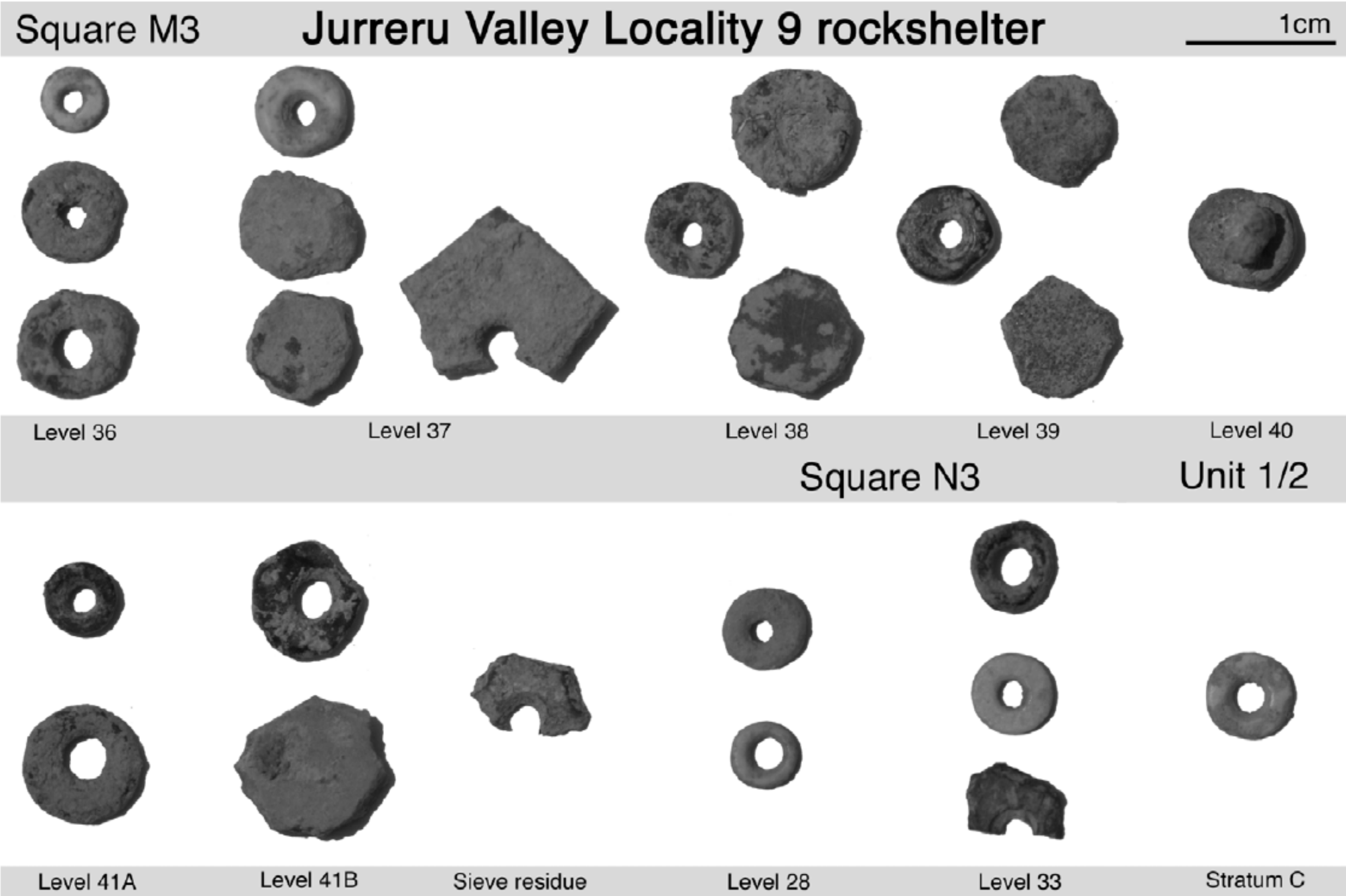


Figure 6. Bead assemblage from Stratum C (1.10–2.00m below surface).

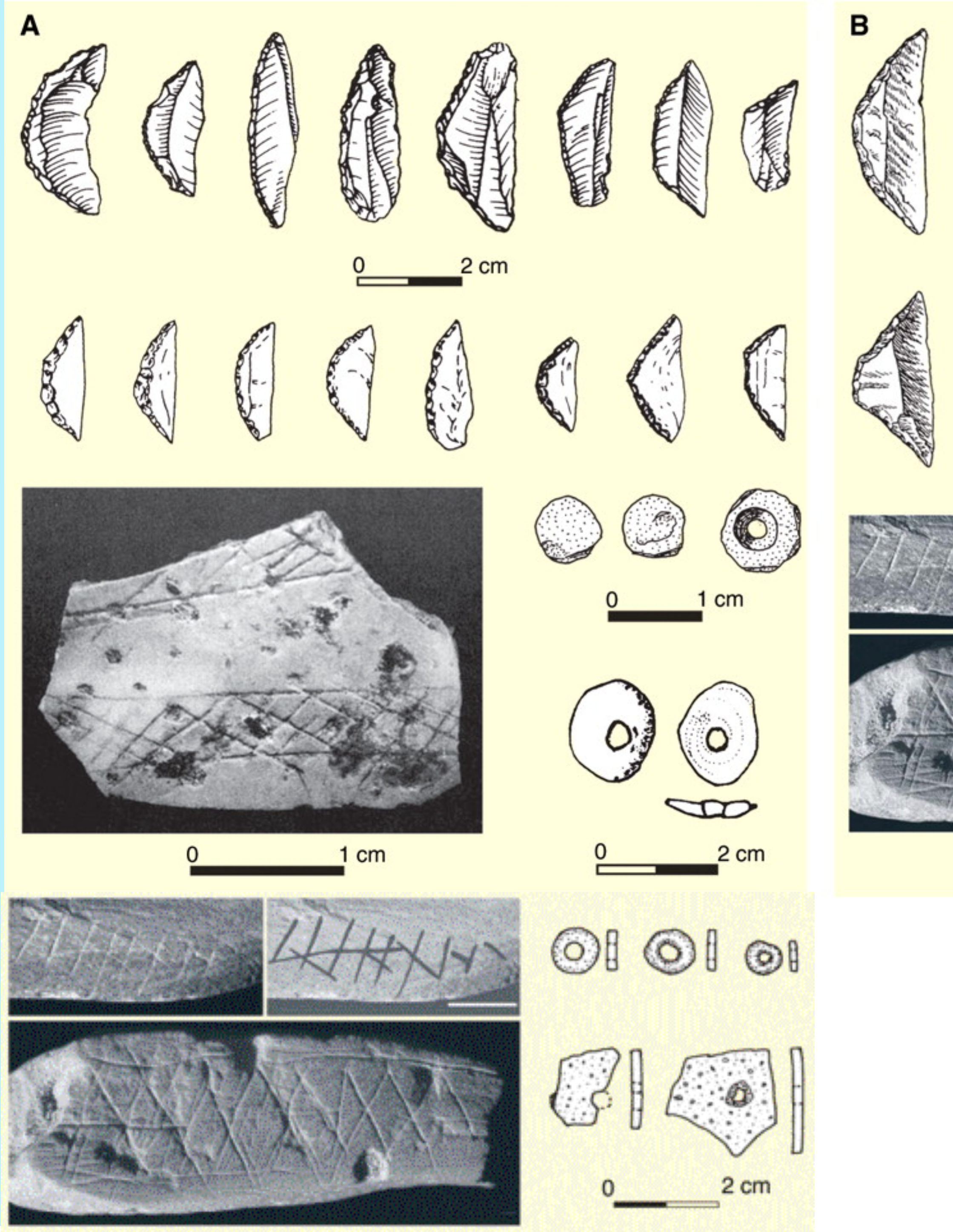
Patne (India)

Batadomba-lena (Sri Lanka)

Patne (India) : ostrich egg shell c. 30,000 BP

Blombos Cave (South Africa) : ochre c. 75,000 BP

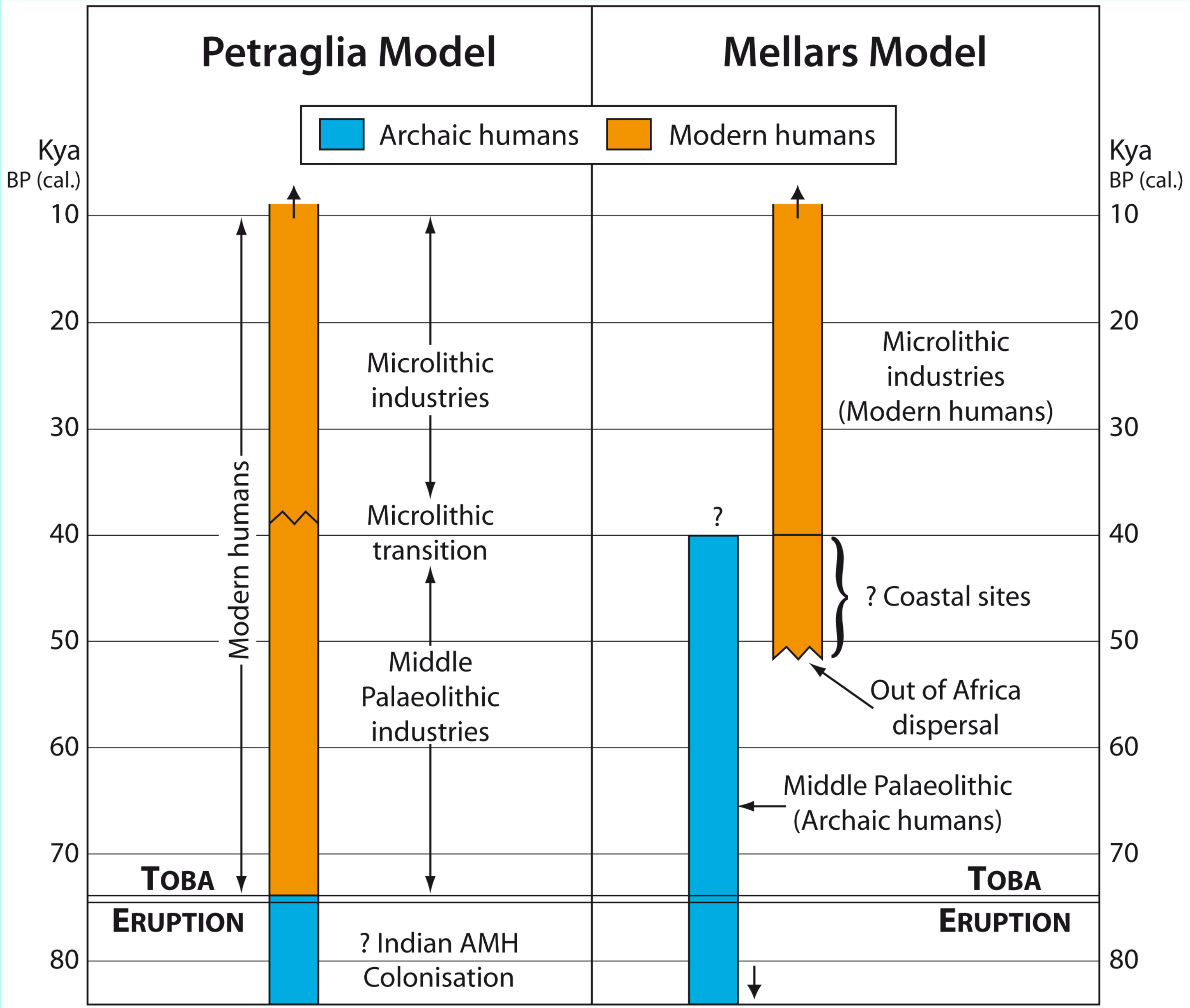
Enkapune-ya-Muto (Kenya) : Ostrich eggshell beads > 40,000BP



Cultural features present in the early Microlithic technologies in India (ca. 30-40,000 BP) which are not present in the preceding Middle Palaeolithic technologies.

1. Fully developed blade and bladelet technology.
2. Typical end-scrapers
3. Carefully shaped, complex, backed microliths and micro-blade forms.
4. Shaped bone artefacts.
5. Perforated beads and other ‘personal ornaments’.
6. Symbolic “design” / “art” motifs on organic materials.

- All these features are characteristic of the early Upper Palaeolithic industries in Europe and western Asia – and form the diagnostic hall-marks of the classic “Upper Palaeolithic Revolution”.
- Why does this “Upper Palaeolithic Revolution” occur at a closely similar time in both India and western Eurasia?
- If these cultural developments are viewed as totally independent – and convergent – developments in both India and Eurasia, could this fairly be described as an “Impossible Coincidence”?


Petraglia Model
Mellars Model
Archaic humans
Modern humans
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Modern humans
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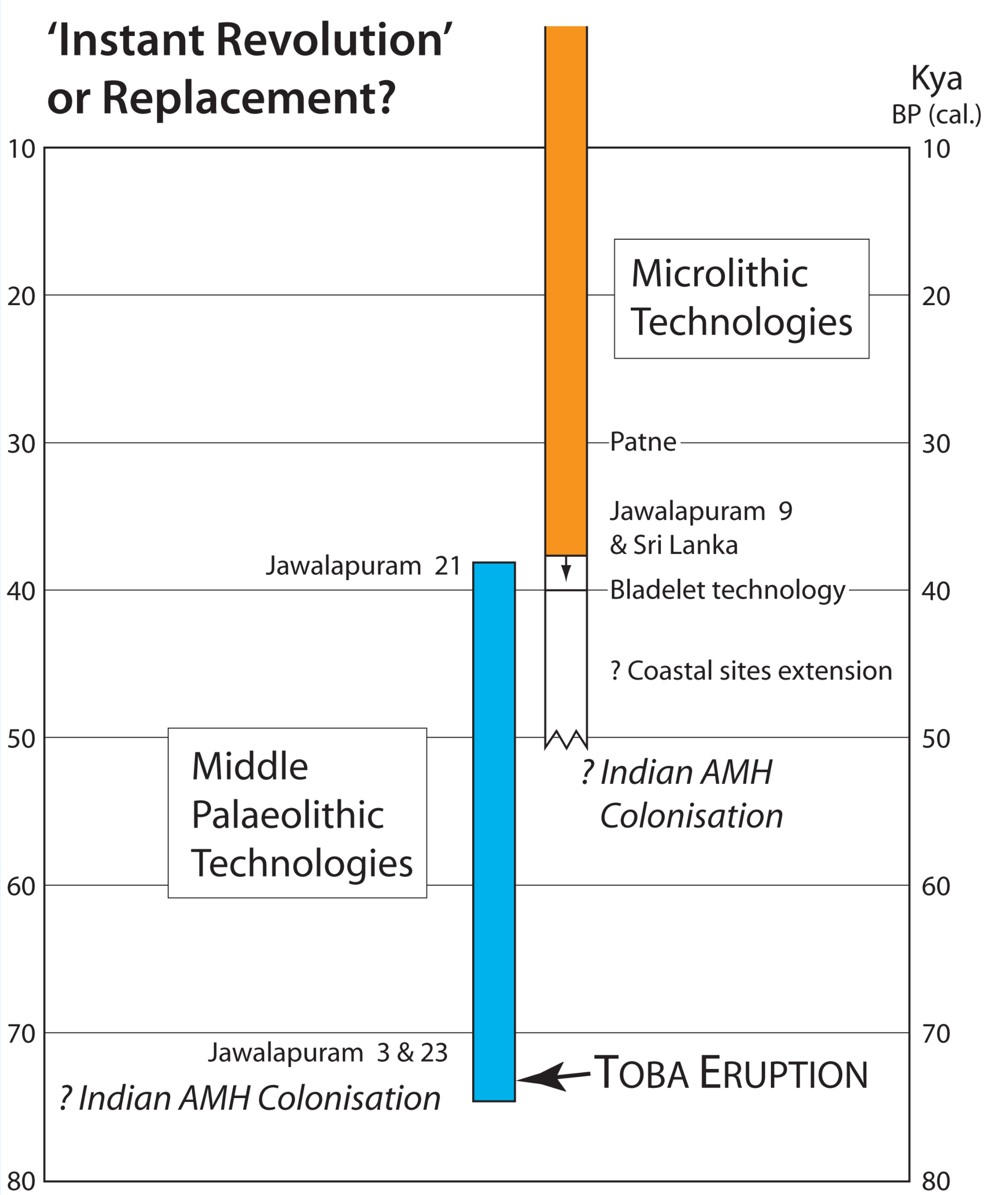
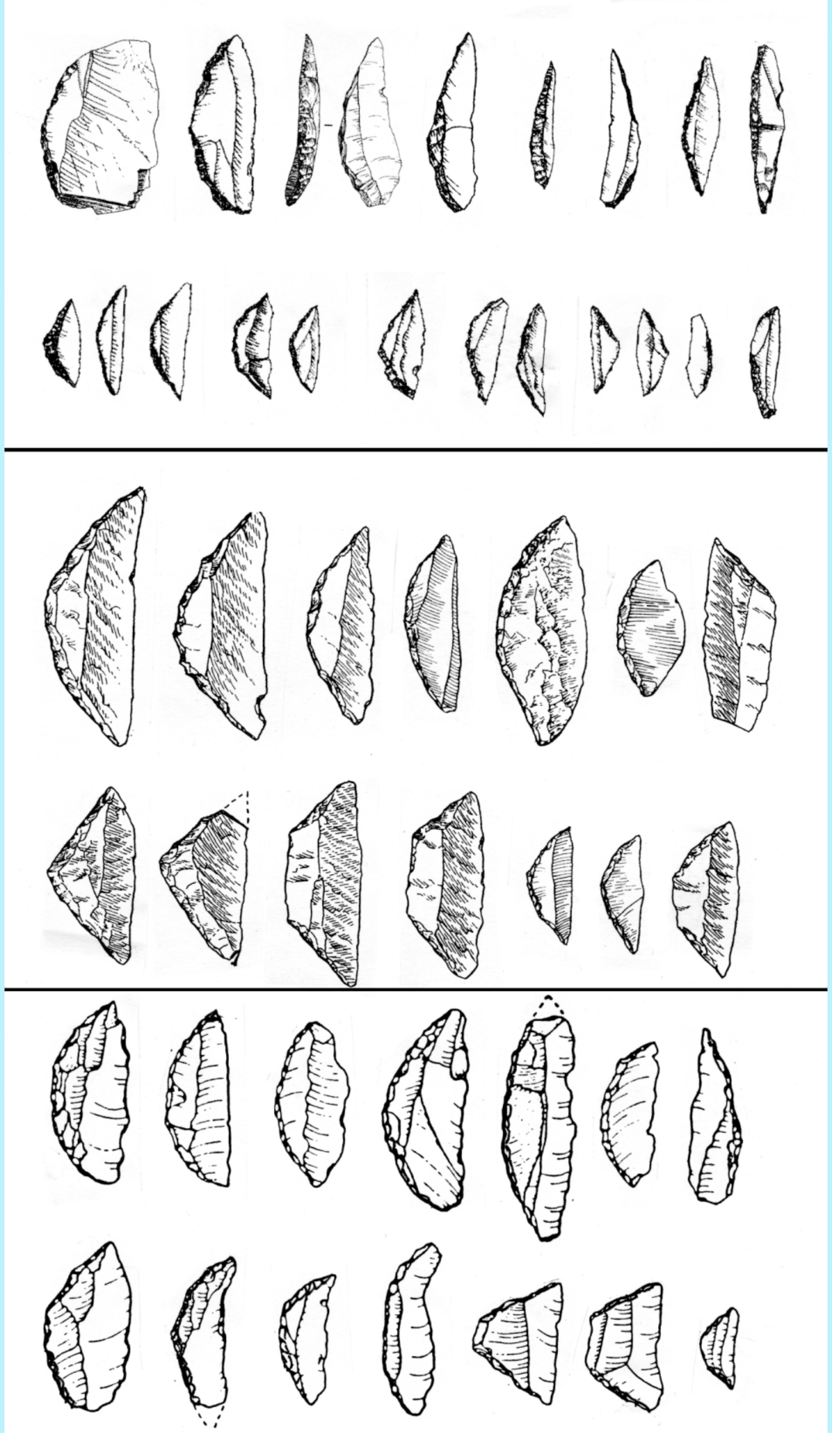
Palaeolithic
industries
TOBA
ERUPTION
? Indian AMH
Colonisation
Microlithic
industries
(Modern humans)
?
? Coastal sites
Out of Africa
dispersal
Middle Palaeolithic
(Archaic humans)
TOBA
ERUPTION
Kya
BP (cal.)
10
20
30
40
50
60
70
80


'Instant Revolution'
or Replacement?
Kya
BP (cal.)
10
20
30
40
50
60
70
80
Microlithic
Technologies
Patne
Jawalapuram 9
& Sri Lanka
Jawalapuram 21
Bladelet technology
? Coastal sites extension
Middle
Palaeolithic
Technologies
? Indian AMH
Colonisation
Jawalapuram 3 & 23
? Indian AMH Colonisation
TOBA ERUPTION

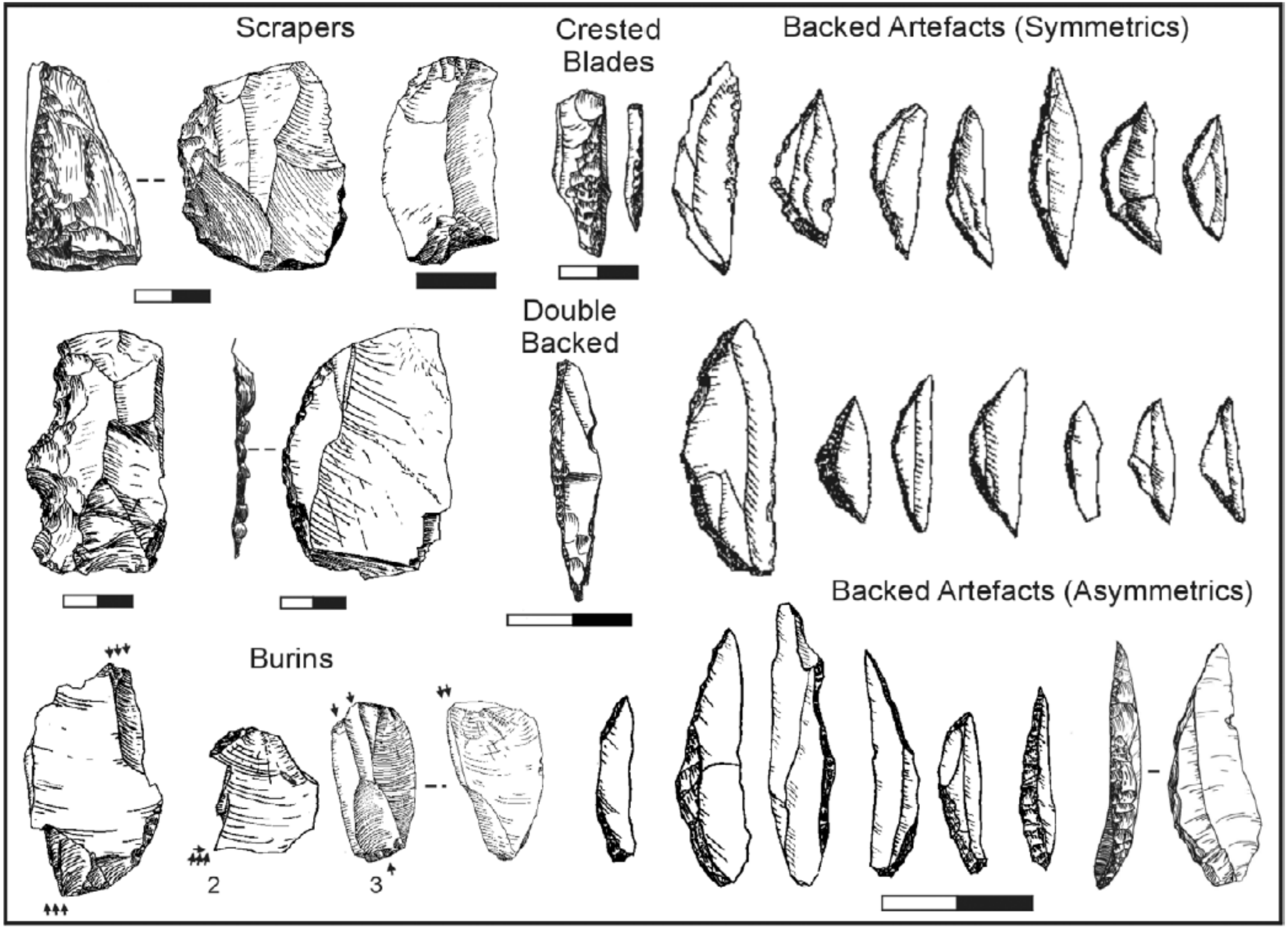

High marine productivity
Howiesons Poort sites
Red Sea
SAUDI ARABIA
AFRICA
Bab el Mandeb Strait
Norikiushin
Enkapune ya Muto
Mumba
Atlantic Ocean
Indian Ocean
Pomongwe
Apollo II
Border Cave
N
Sibudu
Diepkloof
Howiesons Poort
Klasies River
0
1000 km
Blombos Cave



Jwalapuram 9
(India)

Klasies River
Mouth (South
Africa)

Mumba,
(Tanzania)



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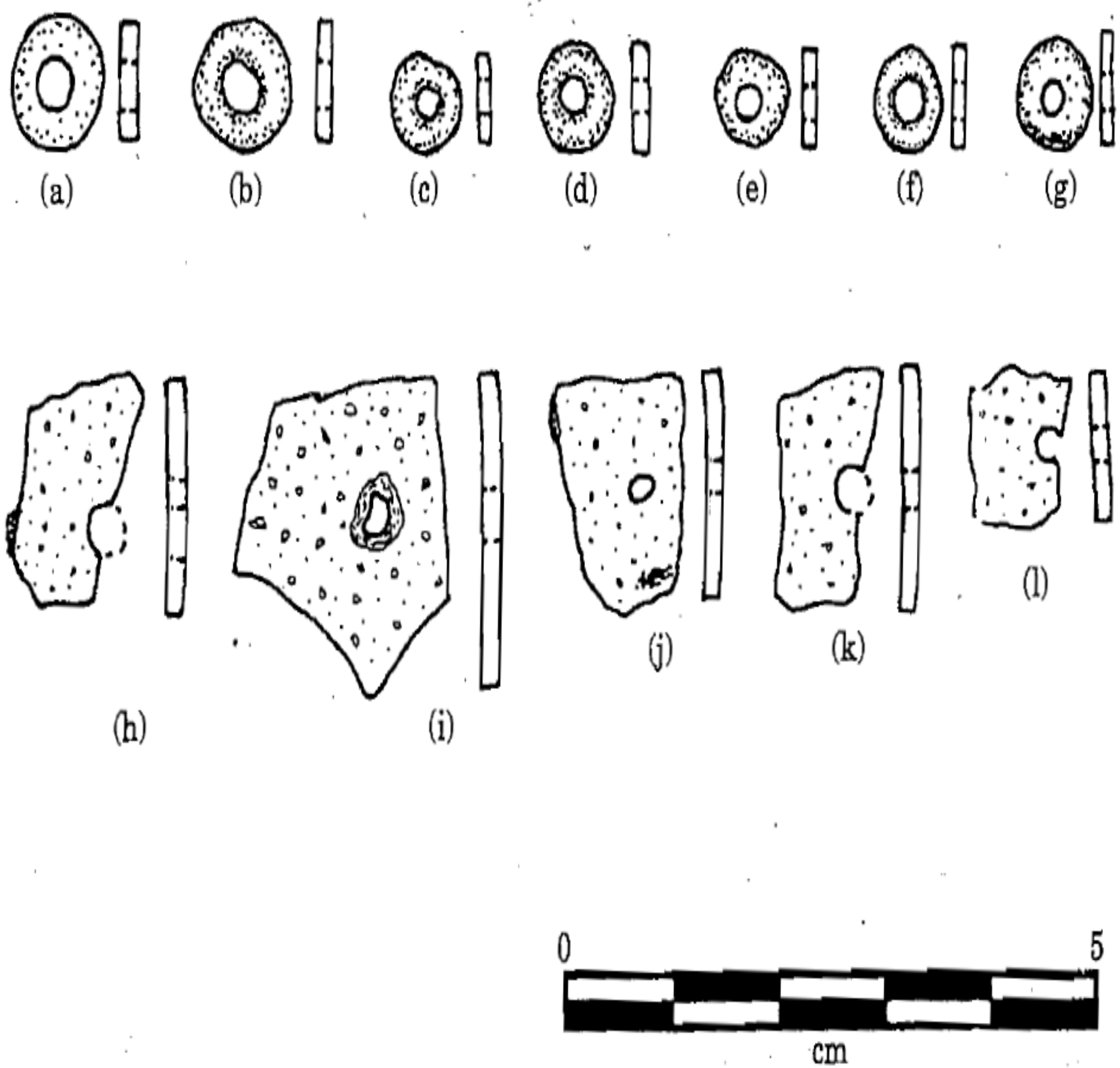
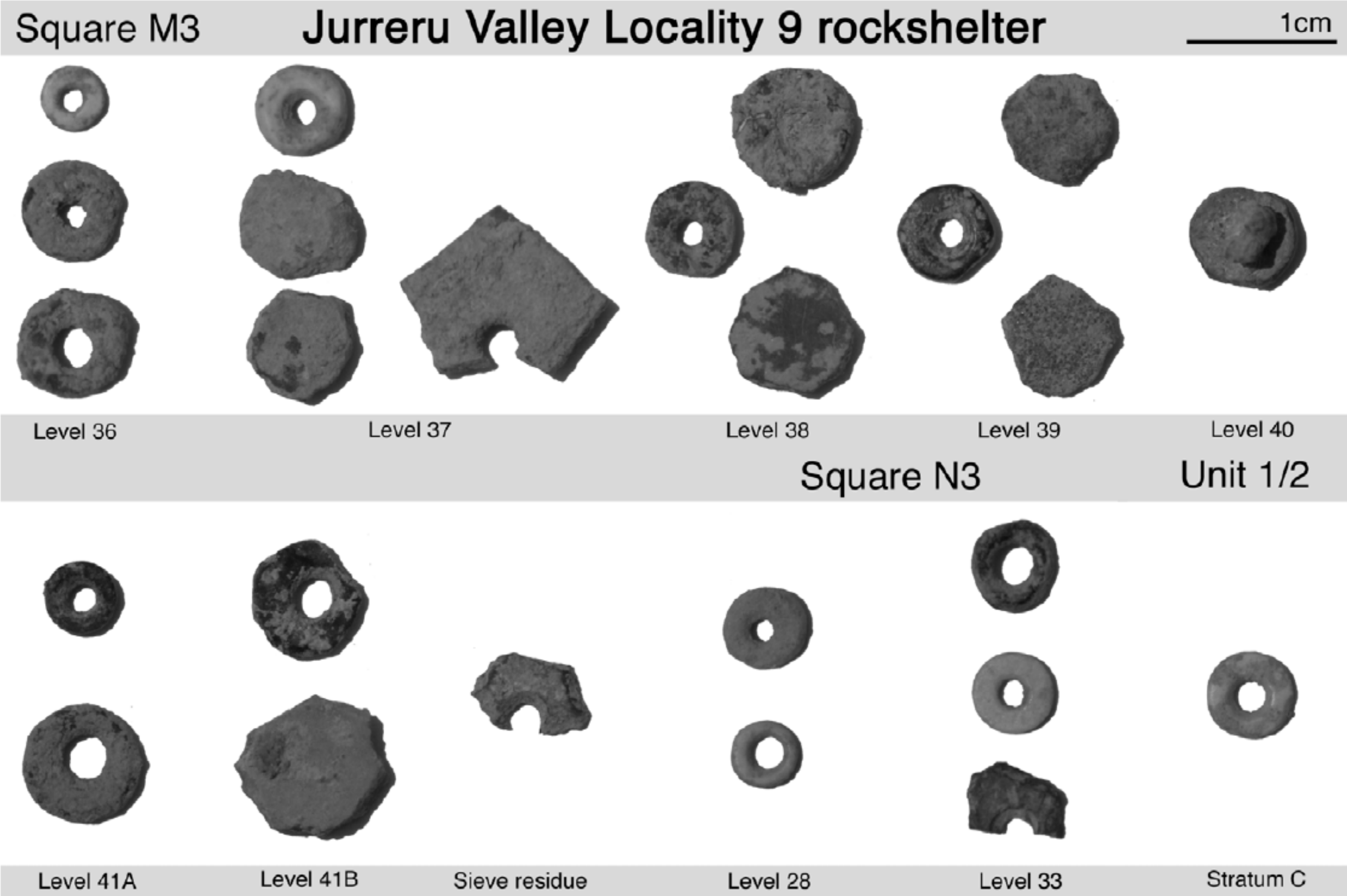


Figure 3. Ostrich eggshell beads from the base of Stratum DBL1, associated with the Sakutiek lithic industry. (a–g) complete beads; (h–l) beads and shell fragments broken during manufacture.



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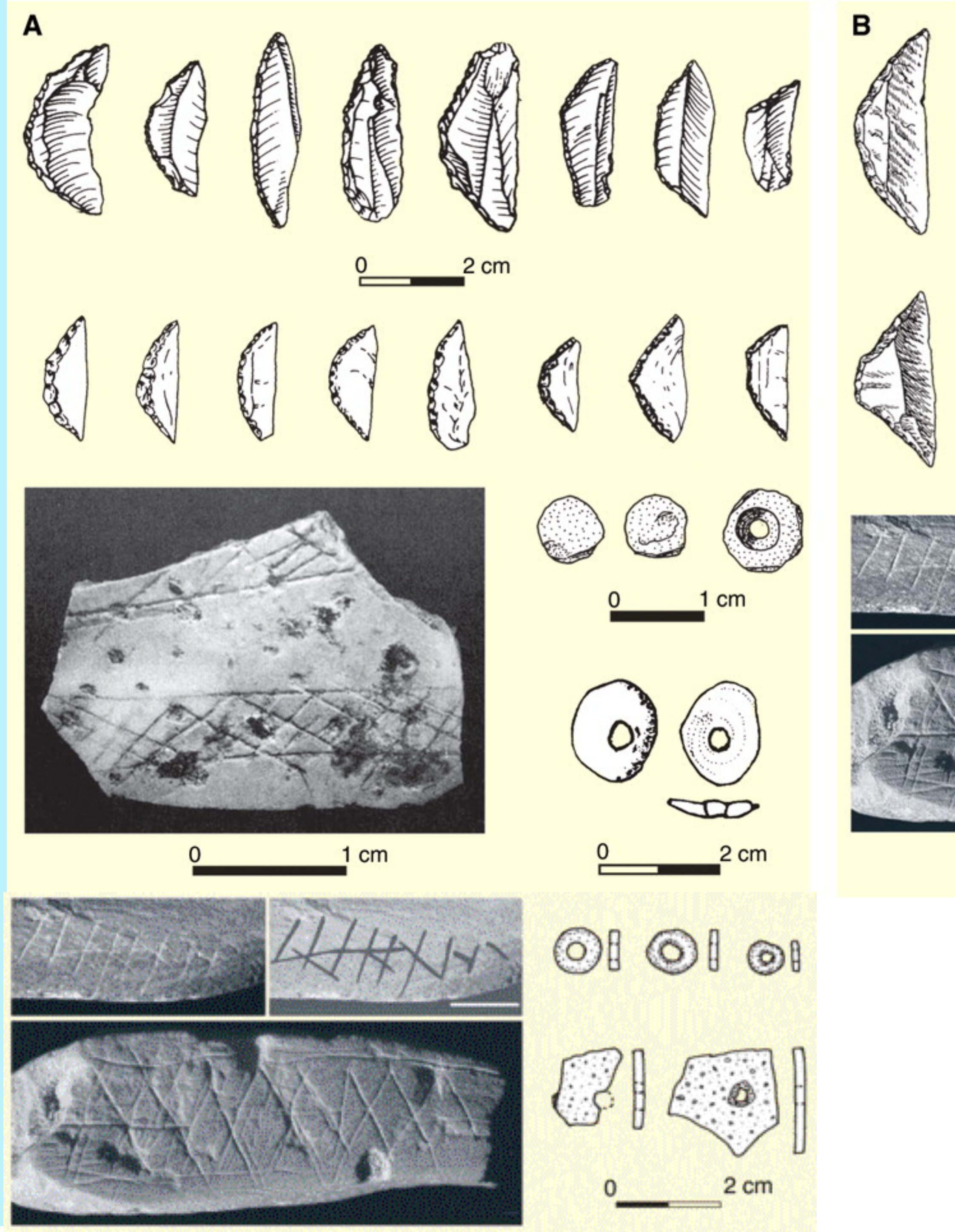
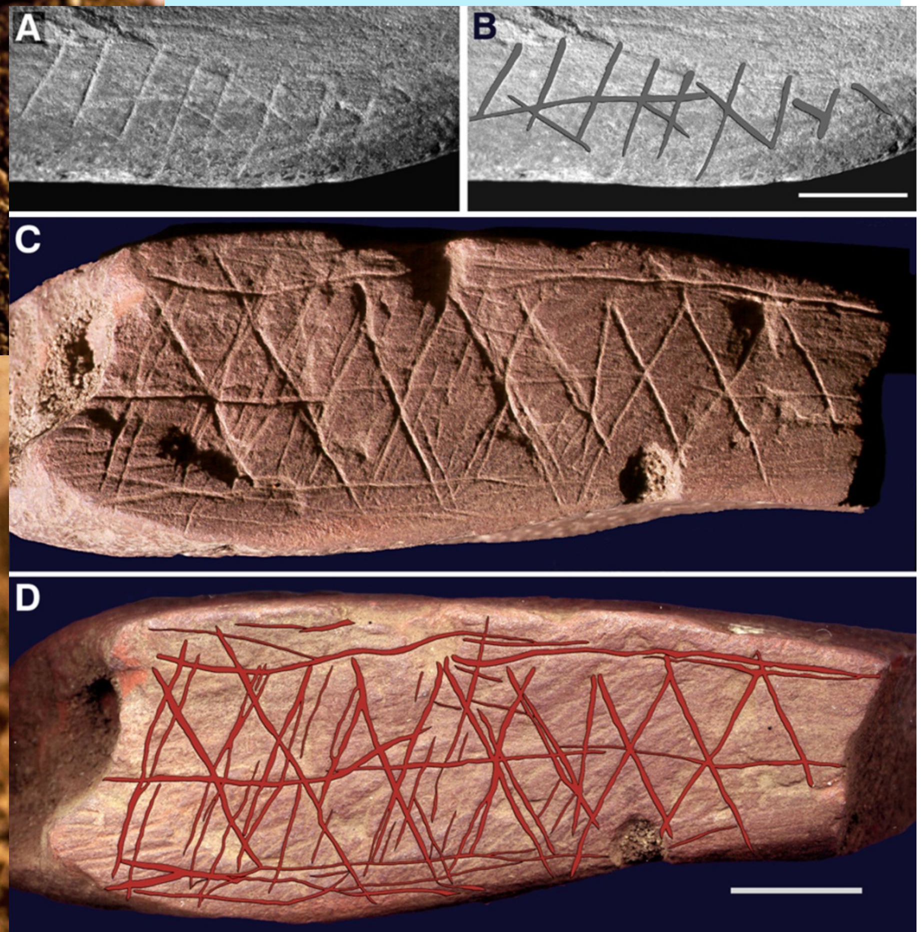
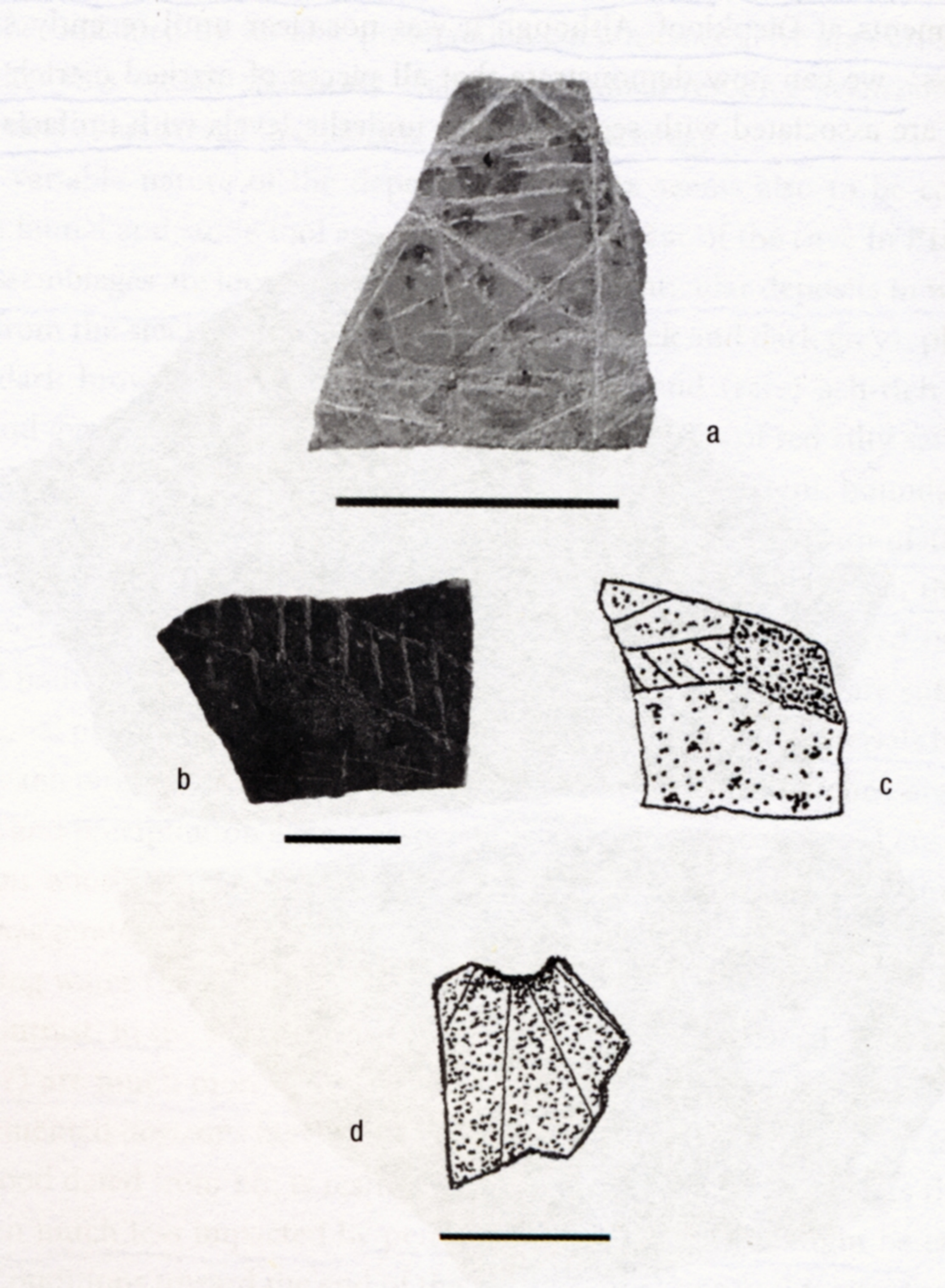
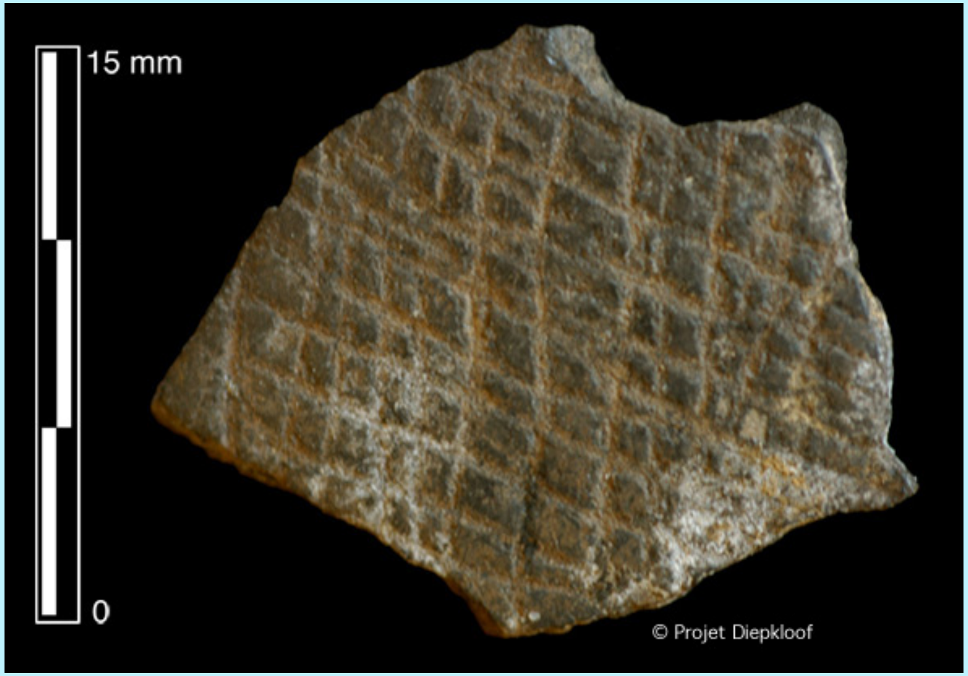


Blombos Cave *c.* 75,000 BP





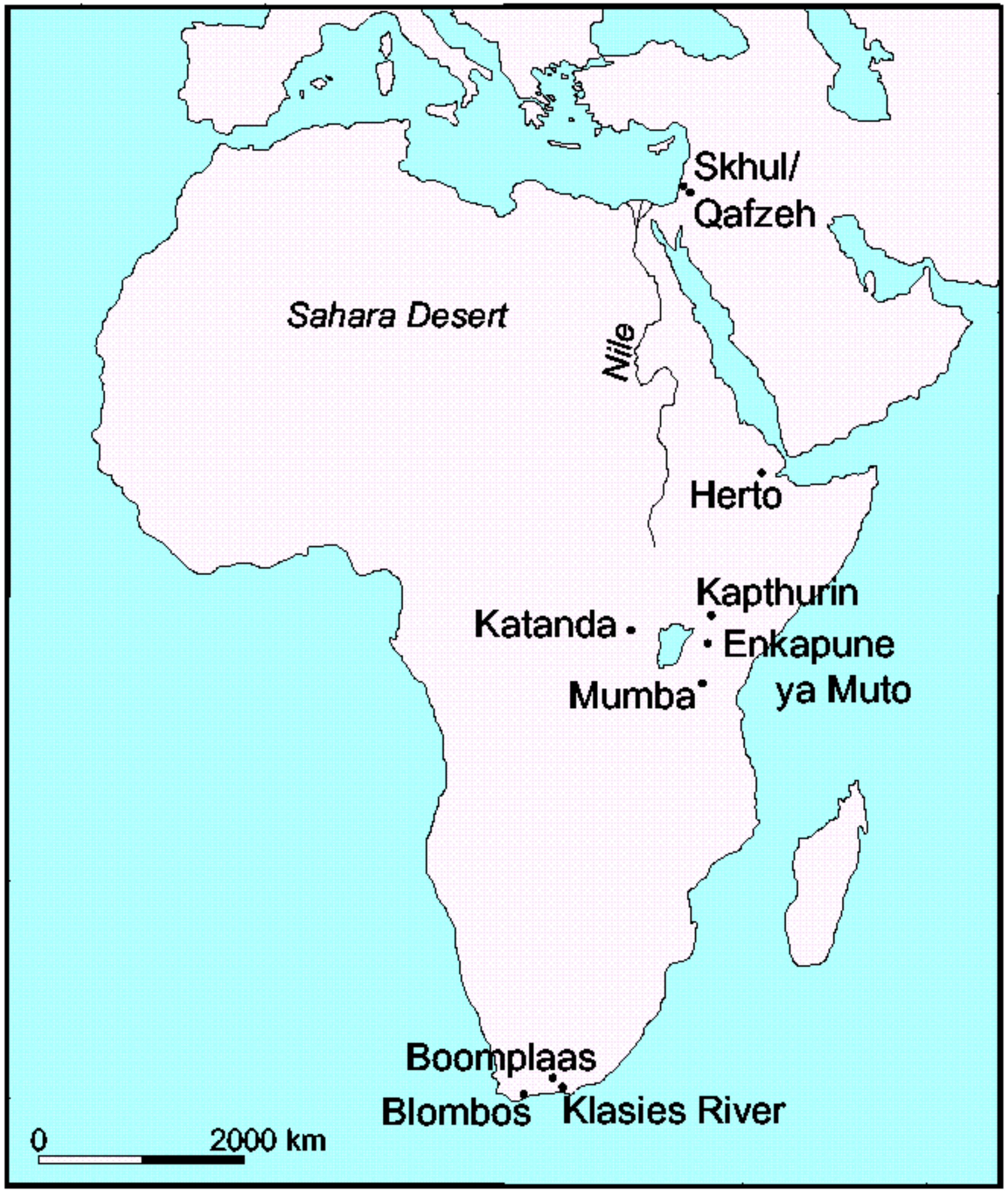
Diepkloof ostrich egg-shell engravings c. 65,000 BP



Diepkloof (South Africa)

Engraved ostrich eggshell c. 60,000 BP (Howiesons Poort)

(From P-J. Texier & J. Parkington, in press)


Skhul/
Qafzeh
Sahara Desert
Nile
Herto
Kapthurin
Katanda
Enkapune
ya Muto
Mumba
Boomplaas
Blombos
Klasies River
0
2000 km

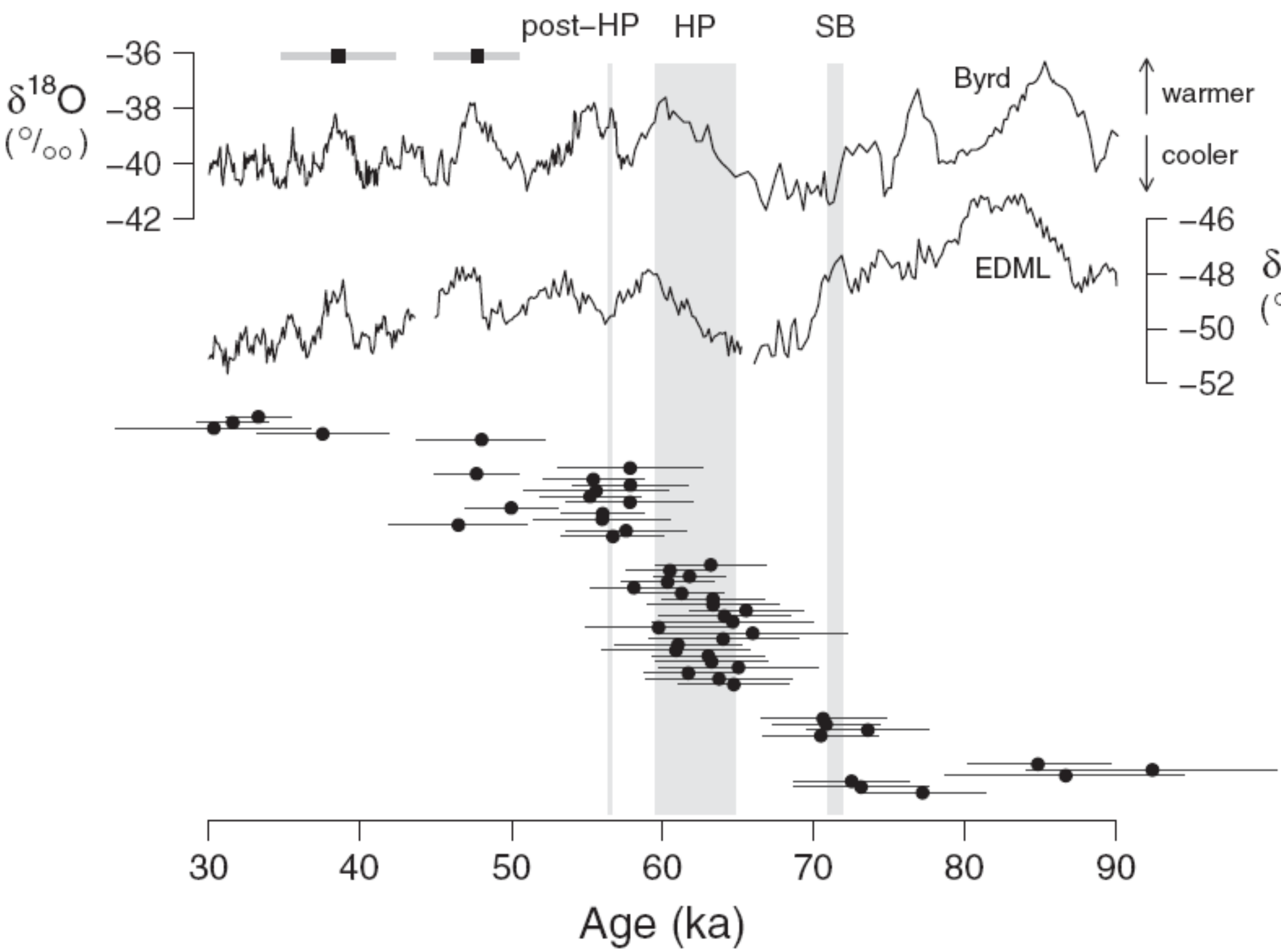


Fig. 4. Age estimates (with 95% CIs) from Fig. 2 plotted alongside oxygen isotope data (‰, per mil) from the Byrd and European Project for Ice Coring in Antarctica (EPICA) Dronning Maud Land (EDML) ice cores from Antarctica (*23*, *24*). Both records are plotted on a common time scale, achieved by synchronization with Greenland ice core data (*24*), and the EDML data are lowess-smoothed to 100-year resolution. Ages labeled "pre-HP" in Fig. 2 are omitted here, as they cannot be identified with a specific period. Vertical gray bands show our estimates of the HP and SB periods as well as the pulse immediately post-HP. The gray horizontal bars show mean age estimates and 95% CIs for the late and final MSA periods obtained in (*26*).

(Jacobs et al, 2008, Science)

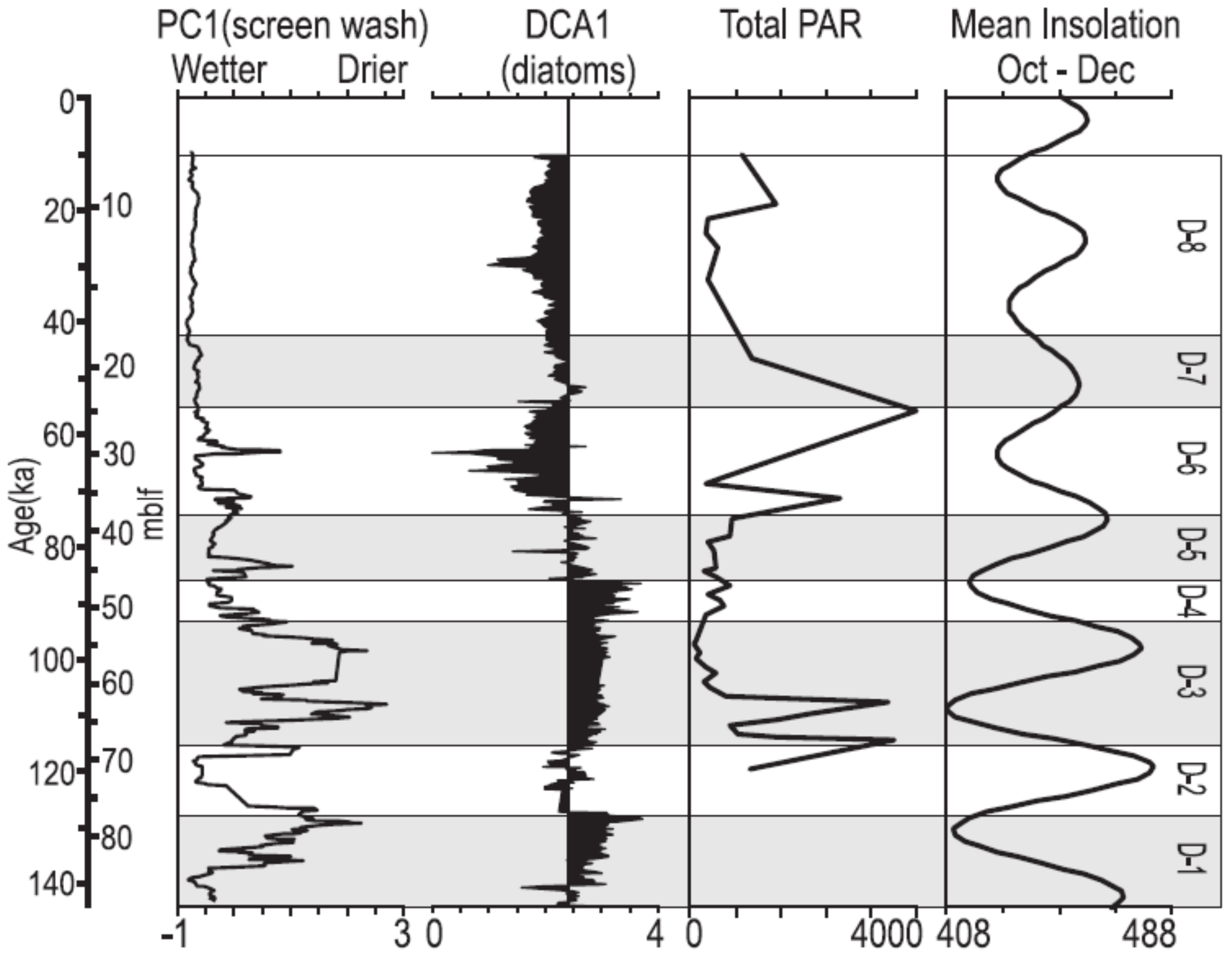


Fig. 4. Comparison of major summary paleoecological records for core 1C. From left to right: PC1 for screen-wash data, DCA1 for diatom data, total PARs, and rainy season solar insolation (W/m^2) for the drill site.

Lake Malawi

(Cohen et al PNAS 2007)

Specific similarities between the Indian Microlithic and African "Late MSA" technologies

- Microblade technology
- Specific range and shapes of backed microblade forms:

  Crescents / segments

  Triangles

  Trapezes
- Circular, rotary-perforated ostrich-eggshell beads – and 'pre-forms'

  (Patne, Enkapune-ya-Muto etc.)
- "Bounded criss-cross" motifs engraved on ochre and ostrich-eggshell

  (Patne, Blombos, Diepkloof etc.)

The Impossible Convergence?

- Most if not all of the features which define the early microlithic / microblade technologies of South Asia correspond closely with those documented in the 'Later MSA' (Howiesons Poort-like) technologies in both southern and eastern Africa between ca. 60,000 and 50,000 BP.

- These are therefore the features which one would expect to disperse from north-east Africa to India in direct association with the 'Out of Africa' dispersal of the L3 mitochondrial lineage at ca. 50-60,000 BP.

- How could these technological features ***not*** disperse to India with the L3 lineage unless all these elements were somehow "lost in transit" during this dispersal?

Potential explanations for the “delayed” appearance of microlithic technologies in the interior areas of Central and Southern India

1. Ca 40,000 BP is a ***minimal*** date for the earliest microlithic industries in central India

2. Most areas of India very poorly surveyed for Paeolithic sites. Almost no sites reliably dated between 40,000 & 60,000 BP

3. The widely accepted coastal dispersal model predicts that the earliest archaeological traces of modern human colonisation should appear first along the coastlines of western India – to which the coastally dispersing groups were already adapted.
   (Many sites could now be submerged …)

Potential explanations for the “delayed” appearance of microlithic technologies in the interior areas of Central and Southern India

4. Population expansion from these coastal “founder” settlements into the interior areas of India would inevitably take time, and would require new adaptations to terrestrial environments and resources.

5. As the Petraglia/Clarkson model predicts, major environmental changes ca 40,000 BP (both inland and coastal) “force” human populations into ecologically-favourable interior habitats withy consequent population expansion as reflected in the expansion and diversification of the mtDNA ‘M’ lineages ca. 40,000 BP

6. **Test prediction**: future research will reveal evidence for microlithic technologies within coastal areas of South Asia prior to 40,000 BP


Ksar Akil
Boker
Tachtit
Red Sea
Patne
Jwalapuram
Bab-el-Mandeb
Strait
Malay
Peninsula
Niah Cave
Batadomba-lena
Norikiushin
Enkapune ya Muto
Mumba
Andaman Islands
Diepkloof
Klasies River
Blombos
Lake Mungo

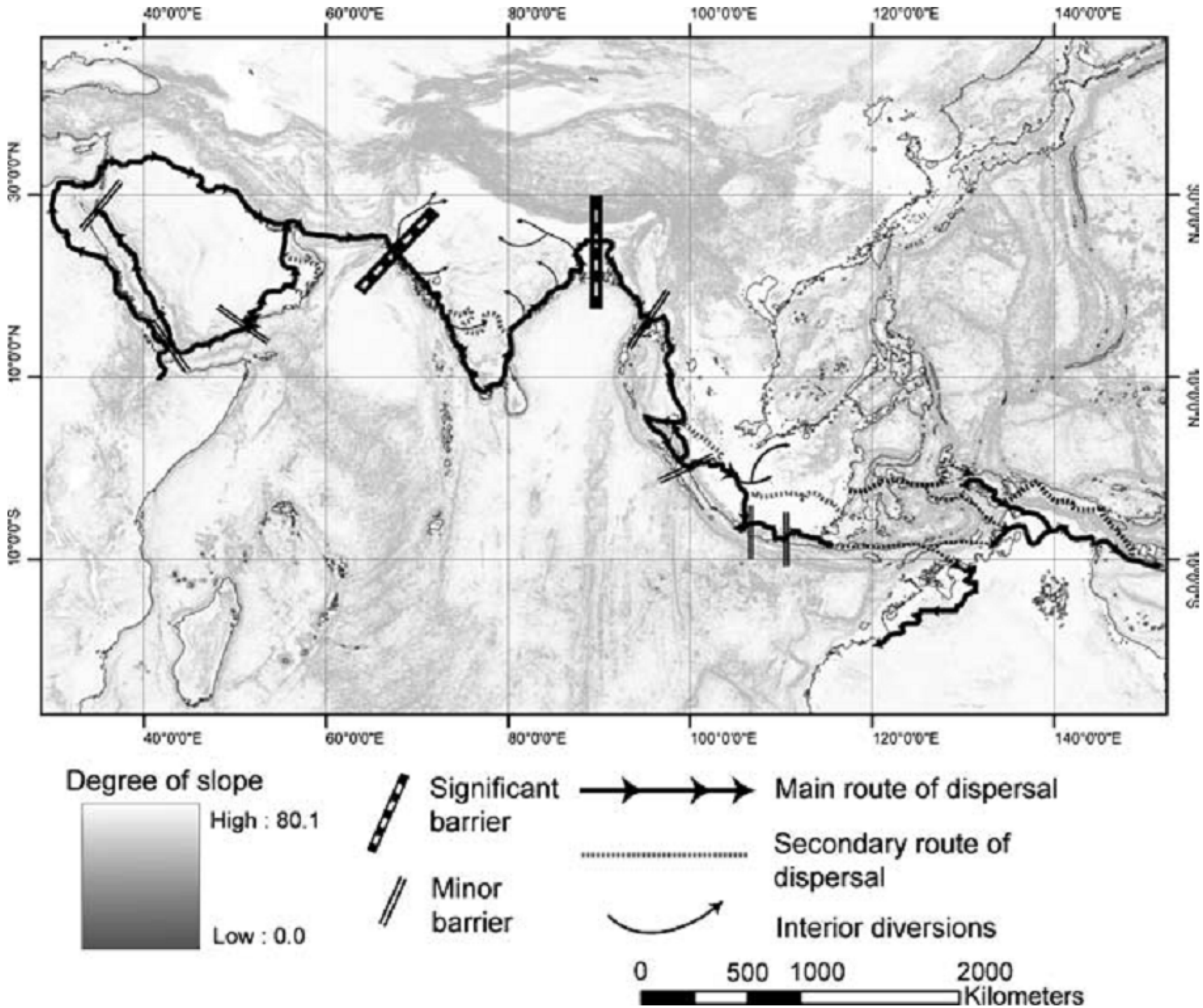
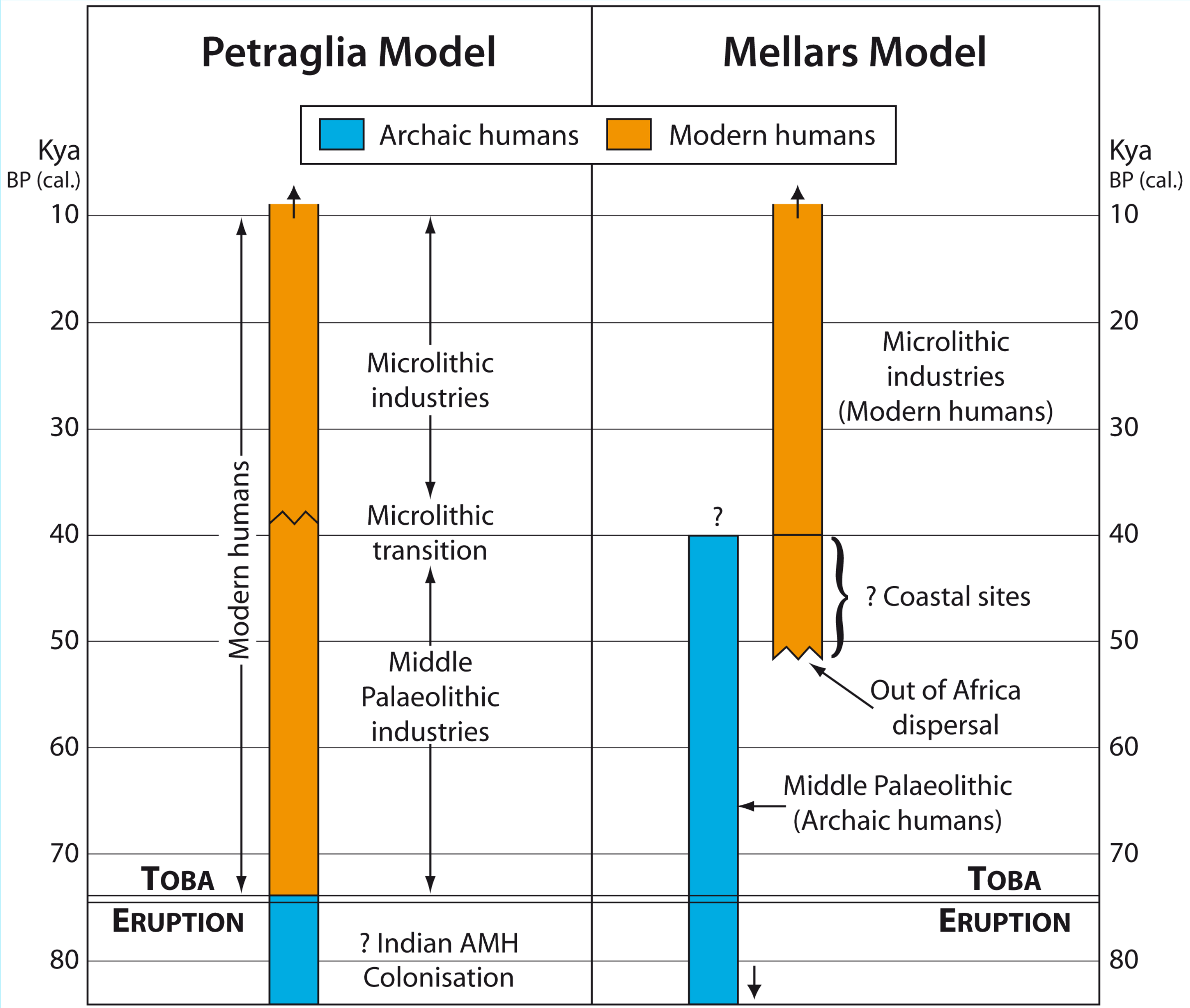


Fig. 14. Schematic diagram of potential routes of the Southern Dispersal. *Parallel bars* indicate the locations of barriers, while *arrows* indicate diversions into the interior.



Petraglia Model
Mellars Model
Archaic humans
Modern humans
Kya
BP (cal.)
10
20
30
40
50
60
70
80
Modern humans
Microlithic industries
Microlithic transition
Middle Palaeolithic industries
Toba
Eruption
? Indian AMH Colonisation
Microlithic industries (Modern humans)
?
? Coastal sites
Out of Africa dispersal
Middle Palaeolithic (Archaic humans)
Kya
BP (cal.)
10
20
30
40
50
60
70
80
Toba
Eruption

Environmental pressures

"Overall, for peninsular India, ca. 35 to25 ka we have reconstructed a semi-glacial-period mosaic environment, consisting of deserts, savannahs, tropical and deciduous woodlands, and limited tropical forests. ***There is an absence of mangrove pollen, indicating less attractive coastal environments than those that existed earlier*** or under Holocene conditions ….. Against this ecologically variable backdrop, human populations would have responded in diverse ways, with population decreases in some areas offset by demographic increases, dispersals and population packing in others."

(Petraglia et al 2009)

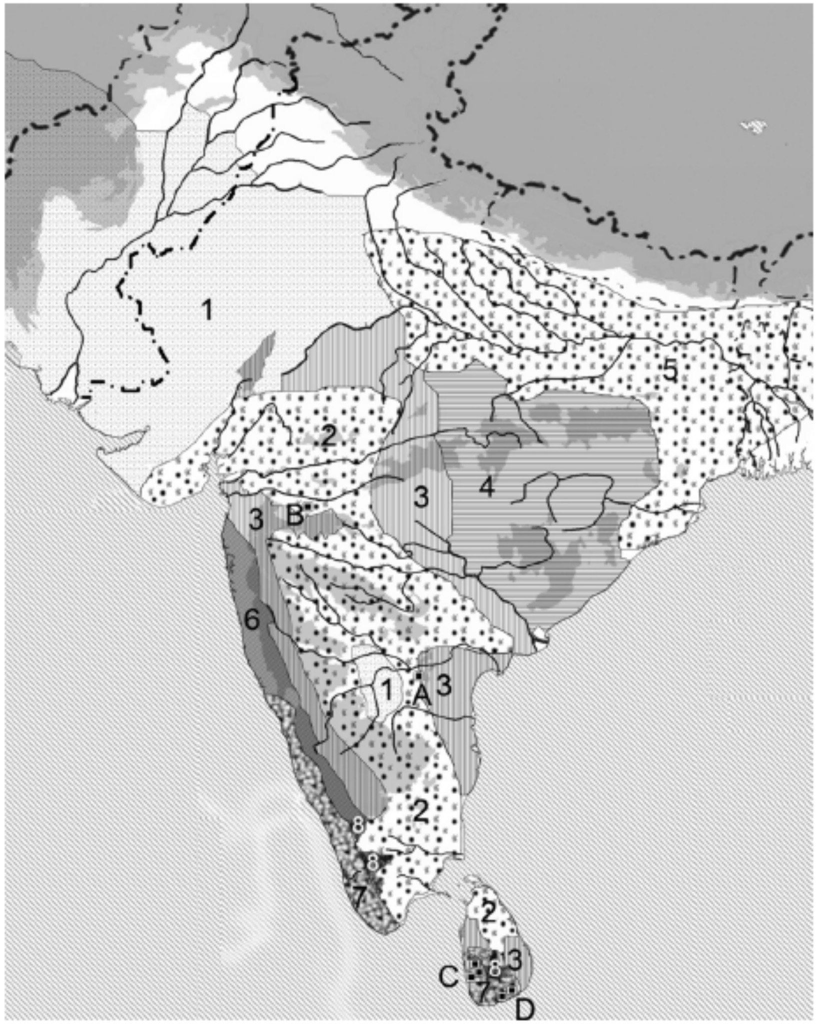


Fig. 2. South Asia, showing reconstructed vegetation zones for ca. 30 ka ago and location of microlithic sites. Sites indicated by letters are as follows: **A**, Jurreru Valley; **B**, Patne; **C**, Sri Lanka caves, from north to south Beli-lena Kitulgala, Batadomba-lena and Fa Hien; and **D**, Sri Lanka coastal sites 49 and 50. Vegetation zones indicated by numbers are as follows: **1**, desert and semidesert (*Caligonum-Salvadora-Prosopis-Acacia* and scattered grasses); **2**, savannah and tropical dry deciduous woodland mosaic (*Acacia-Anogeissus-Terminalia*, *Hardwickia* in some localities, abundant gatherable grasses and legumes); **3**, dry deciduous woodlands, including teak; **4**, dry deciduous woodlands, including *Shorea-Hopea*; **5**, deciduous *Shorea-Hopea* woodland and grassland/marsh mosaic; **6**, moist deciduous and scattered evergreen taxa; **7**, Tropical evergreen and semievergreen forest refugia; **8**, tropical/subtropical mountain forests.

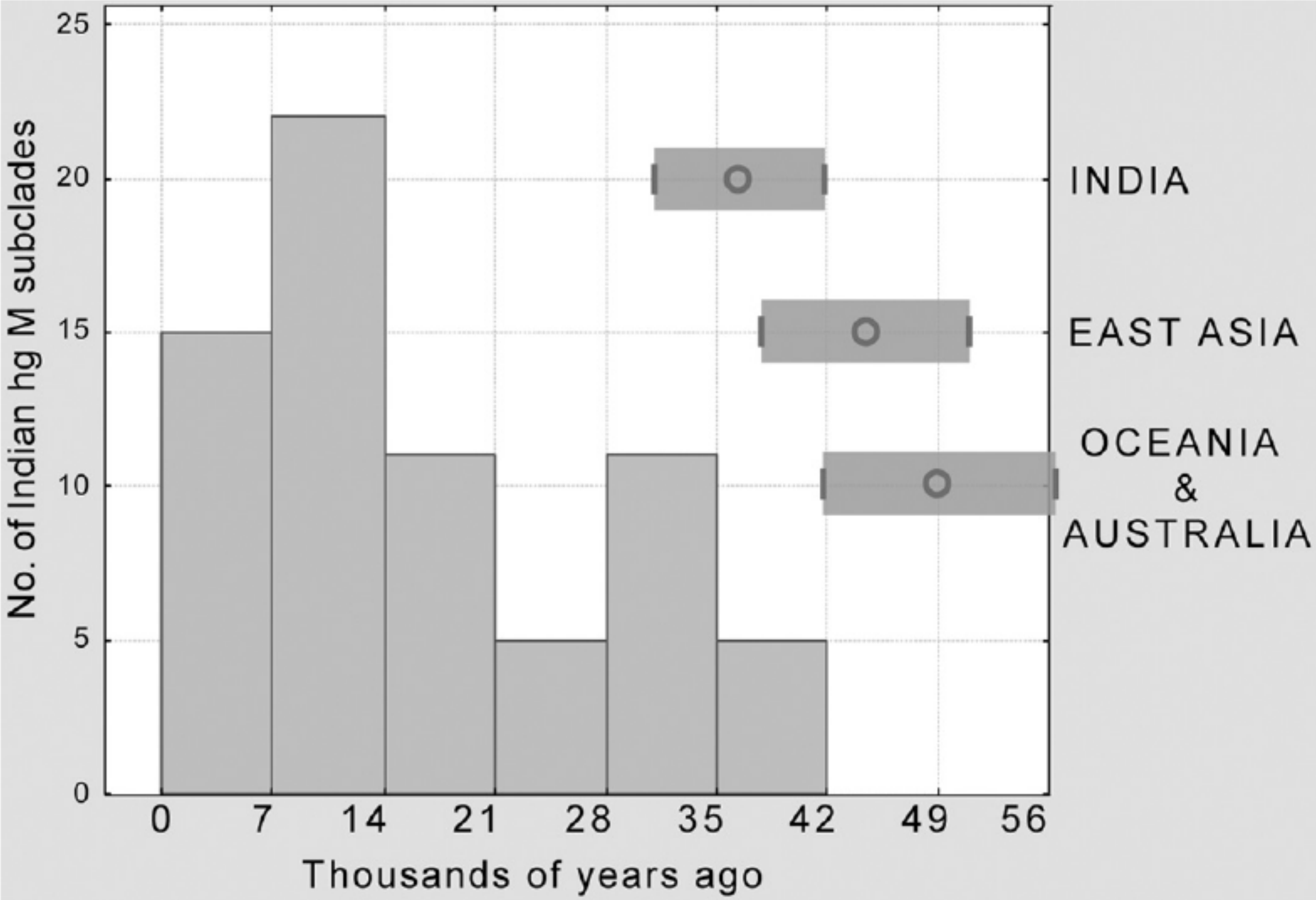


Fig. 1. Distribution of Indian haplogroup (hg) M subclades age estimates (bar graph), with a peak 35–28 ka ago indicating a locally derived demographic event at this time. A second, larger population expansion is seen following the Last Glacial Maximum and continuing into the Holocene. Also shown are the regional hg M coalescence times for India, East Asia, and Oceania, with means (circles) and standard error range. The Indian coalescence date is anomalously young, as a result of the later significant deviations from a random demographic expansion history.

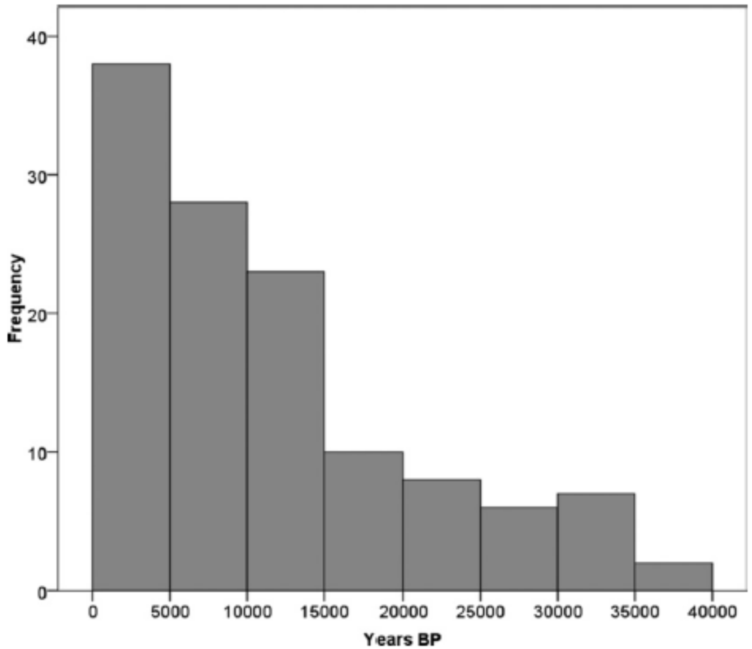


Fig. S5. Radiocarbon database for South Asian sites associated with microlithic industries (compiled from refs. 38, 39, and ages reported in Table S1; $n = 122$ calibrated radiocarbon ages).

Microlithic Sites in India by Age