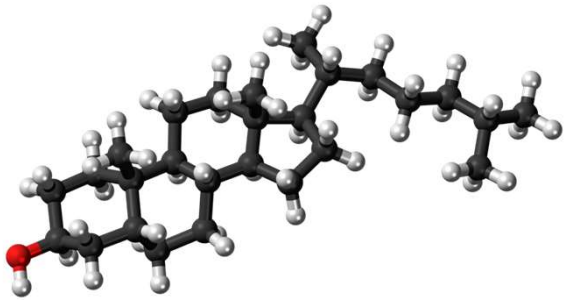
Chemical Biomarkers of Ancient Human Occupation

Garry Law

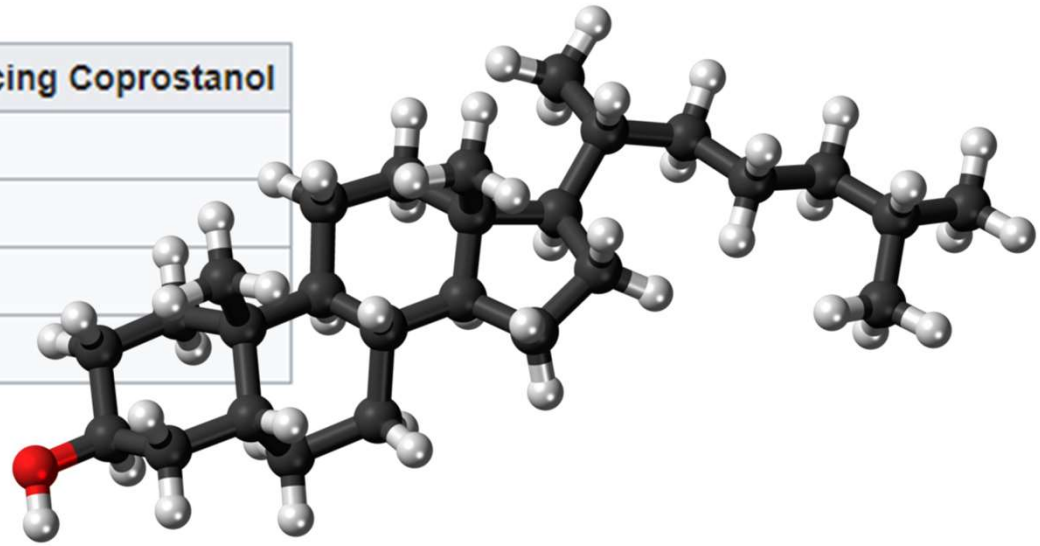


Coprostanol (5β-cholestan-3β-ol) is a metabolic product of cholesterol, formed by microbial action in the mammalian gut

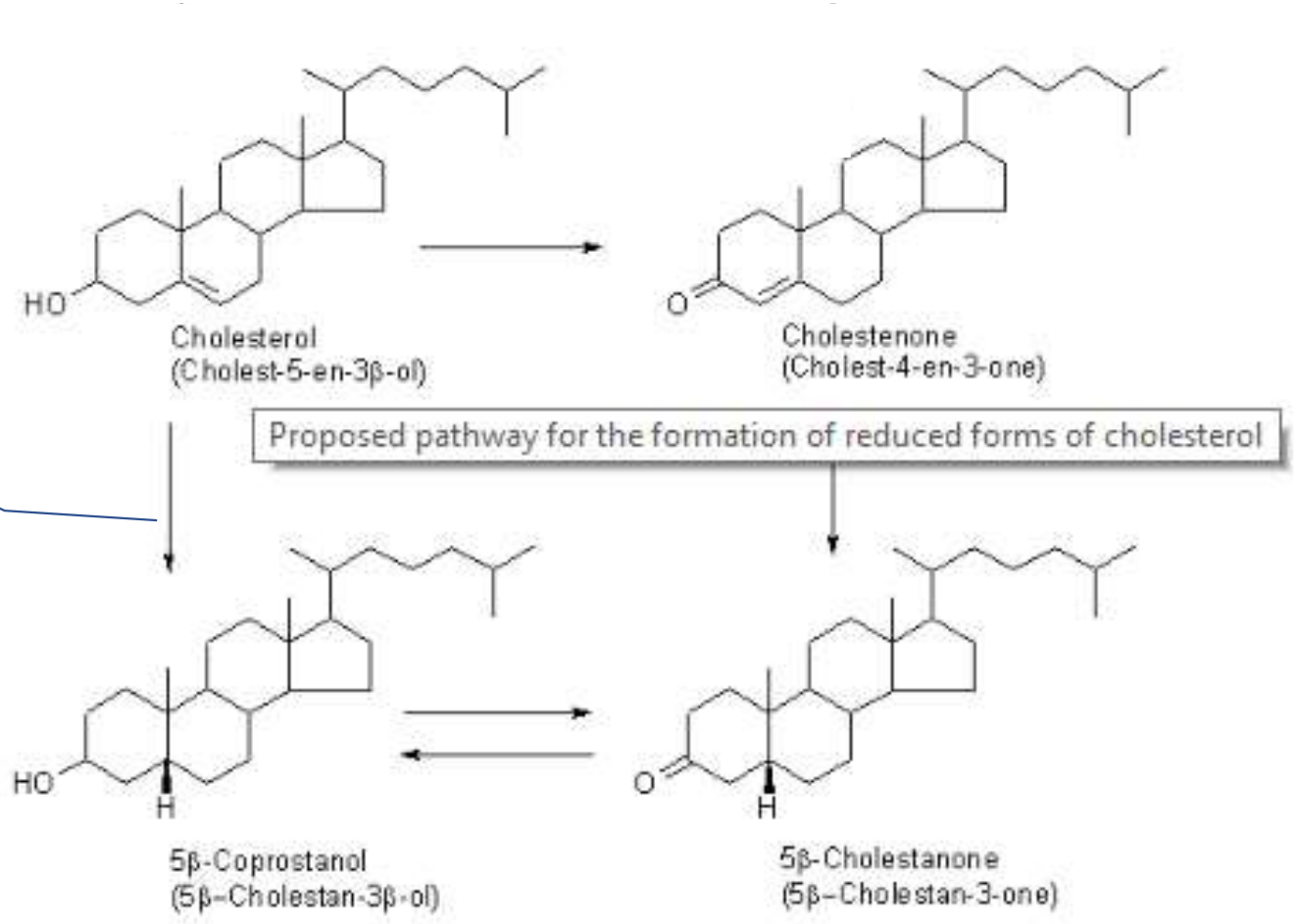
Coprostanol is the major sterol in human faeces, and has been routinely studied as a marker of (modern) sewage pollution in marine and lacustrine sediments.

A list of the animals in which 5β-coprostanol has been identified in the faecal matter.

Animals Producing Coprostanol	Animals NOT Producing Coprostanol
Humans	dogs
Cattle	
Sheep	
Birds	



Via gut bacteria



Alcohols

Ketones

As a lipid it has low solubility in water.

Recently people have been looking for it in lake sediments as an indicator of the presence of humans.

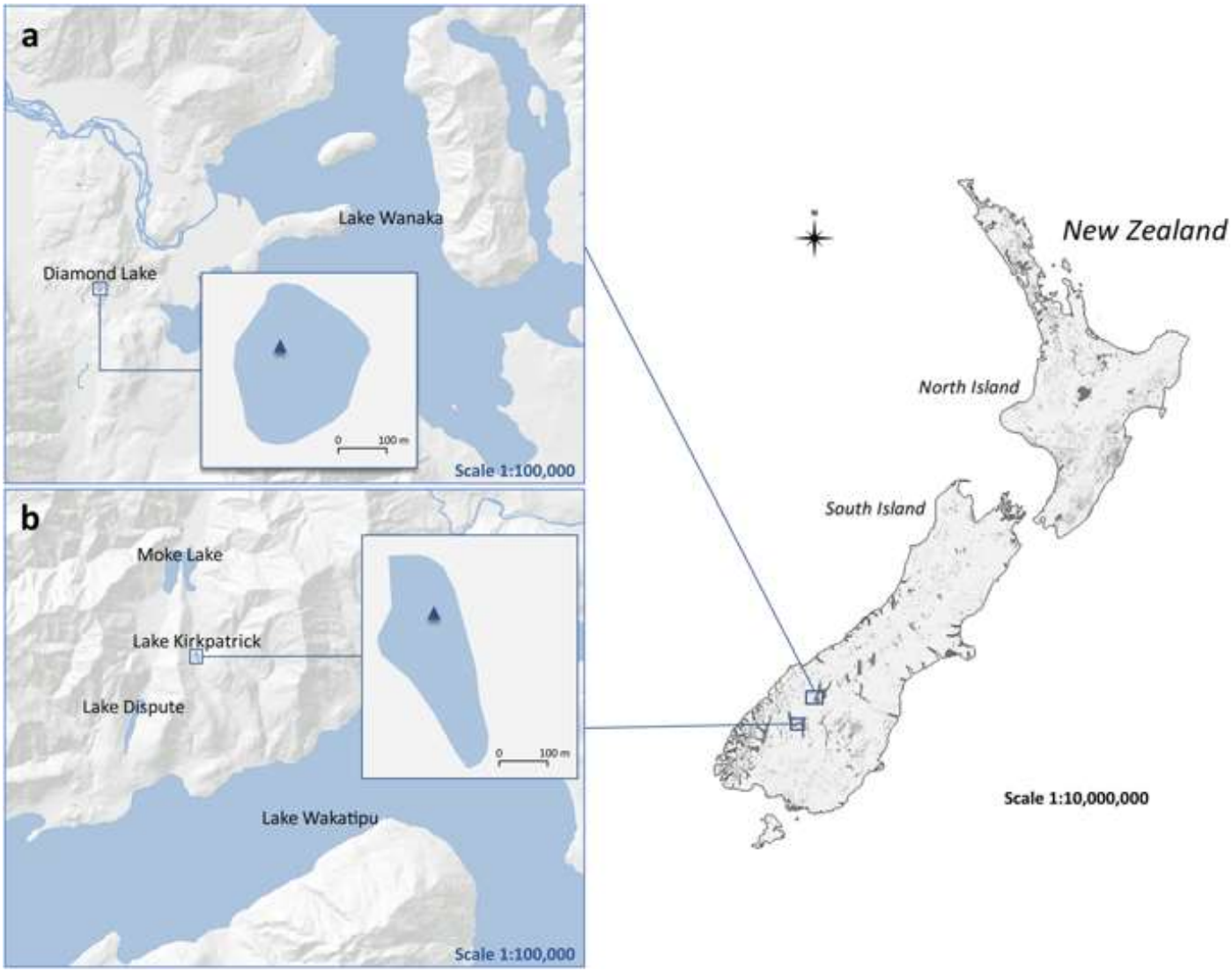
Low solubility – so will stay in place in sediment.

Slow breakdown to epi-coprostanol

Taking the two, coprostanol and epi-coprostanol, they seem to be stable enough to be useful.

Done on sediment cores analysed by successive short sections cut from the core – commonly also look at pollen (+ fern spores) to see if there is human induced changes and charcoal to see if the flux of charcoal from the catchment might indicte human initiated burning. C14 dates to give scale.

NZ South Island Lakes



Lake Kirkpatrick

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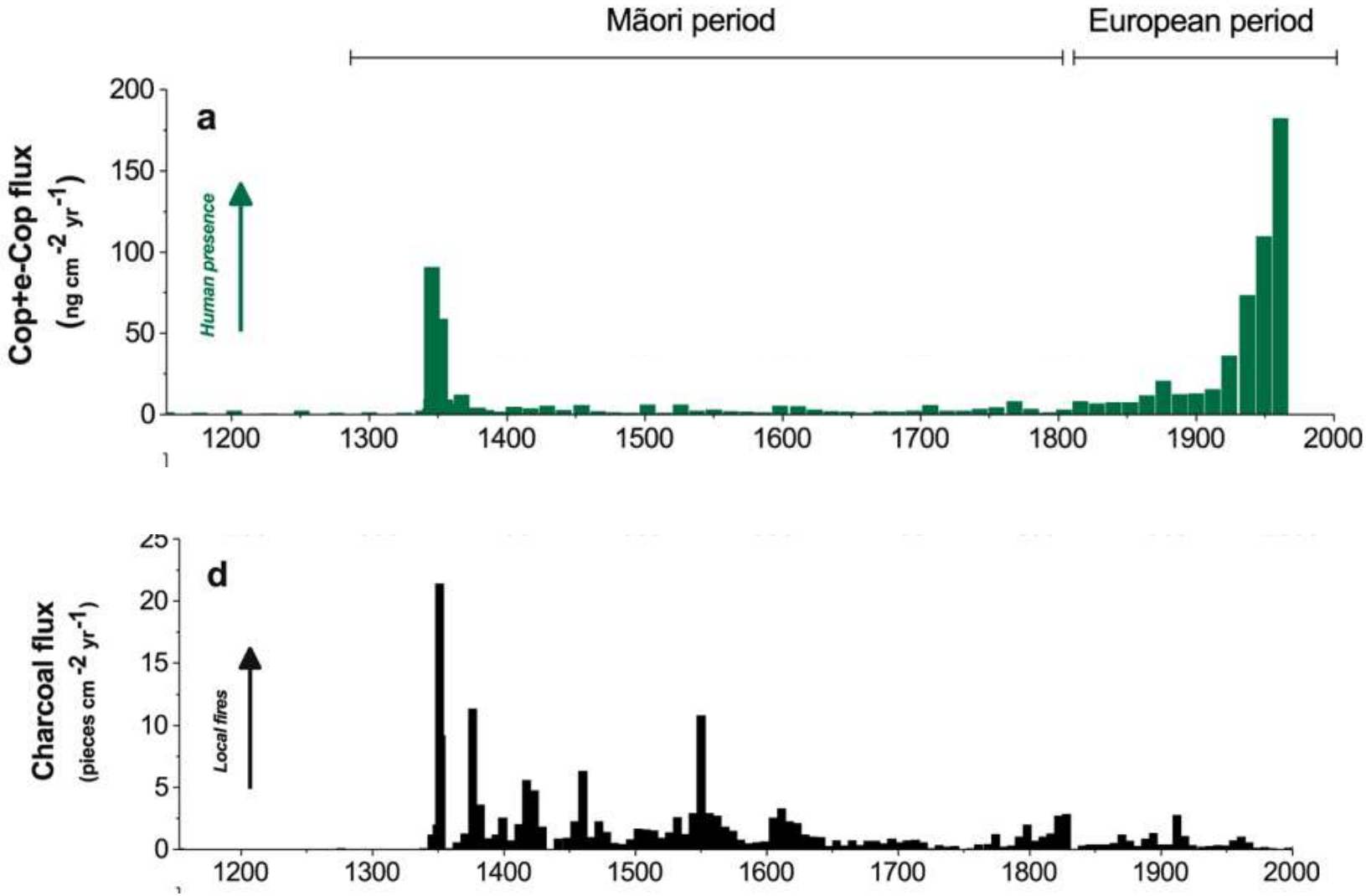
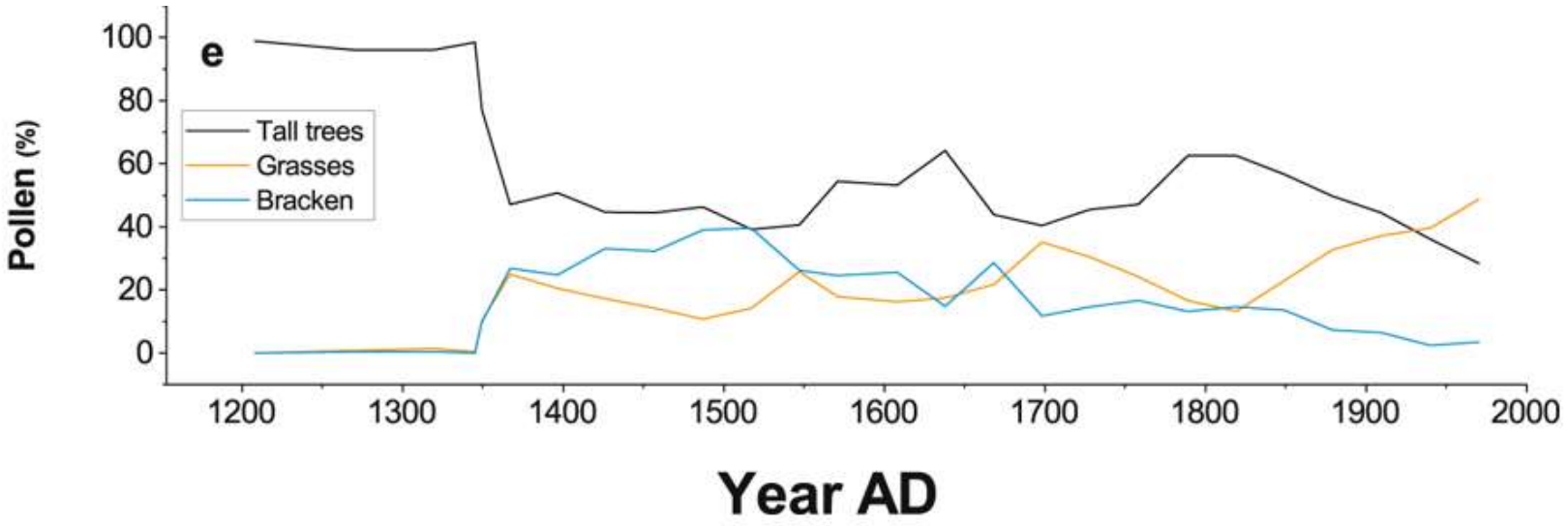
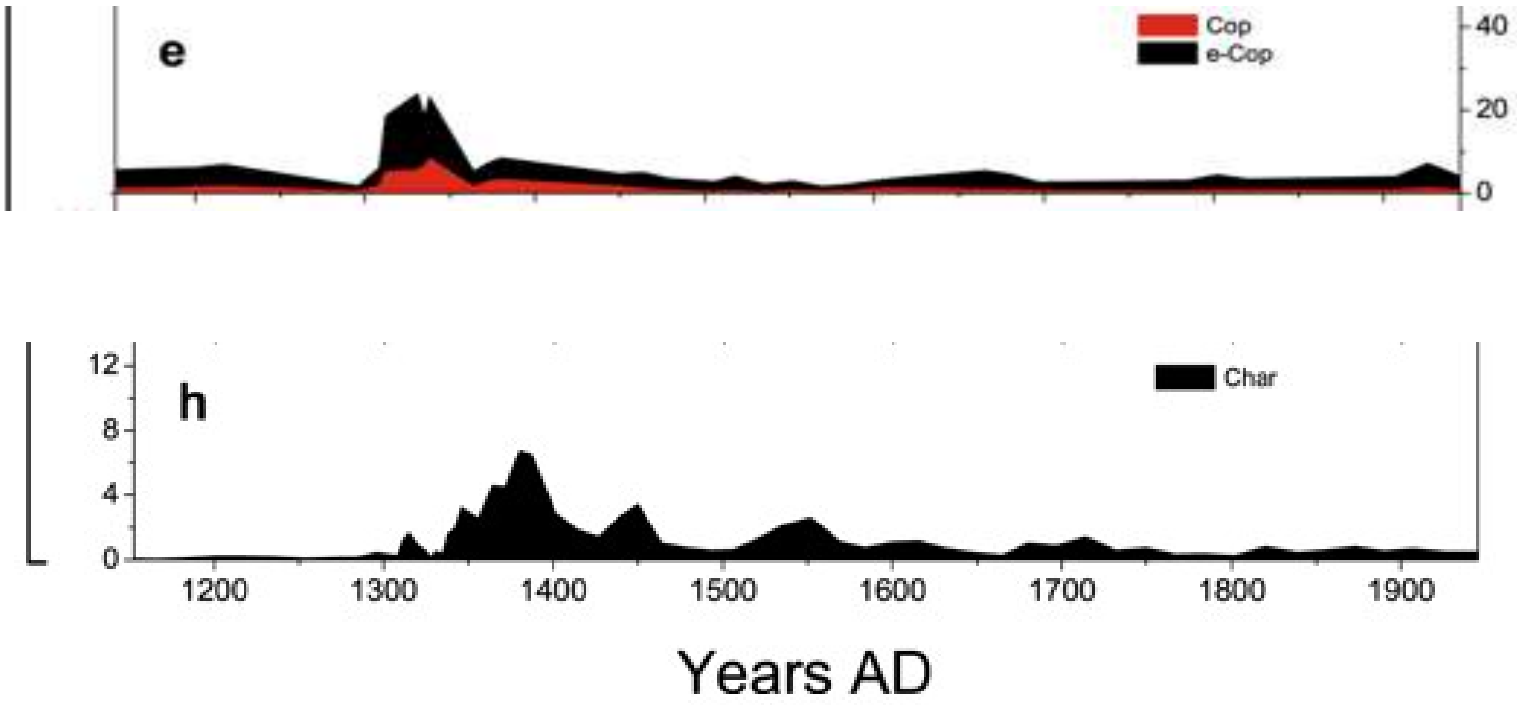




Lake Kirkpatrick



Diamond Lake

Initial Maori settlement of NZ now thought to be 13th Century – probably second half

Within a century were utilising remote inland valleys in the South Island – and permanently changing the vegetation – by burning, leaving much less forest.

What were they there for? – Probably bird harvest, possibly a devastating first pass at the forest species – little, or maybe never, repeated.

Little bush moa *Anomalopteryx didiformis*

North and South America Settlement

DNA suggests first American populations separate from Asians 20- 30K years ago

However the earliest good dates for North America are less than 15K years ago

Monte Verde site near tip of South America – first occupation there 14.5K years ago

Missing 5-15K years

Two Explanations:

1. Some archaeologists say the DNA result is wrong – the first people traveled from Asia c. 15K years ago and either:
    - went through the ice- free passage that opened up about then, or
    - travelled by sea down the continent edge (would need boats)
2. Others lead by the DNA say there must have been a refuge during the time between the population separation and the move into North America – (by either of the same routes)

North and South America Settlement

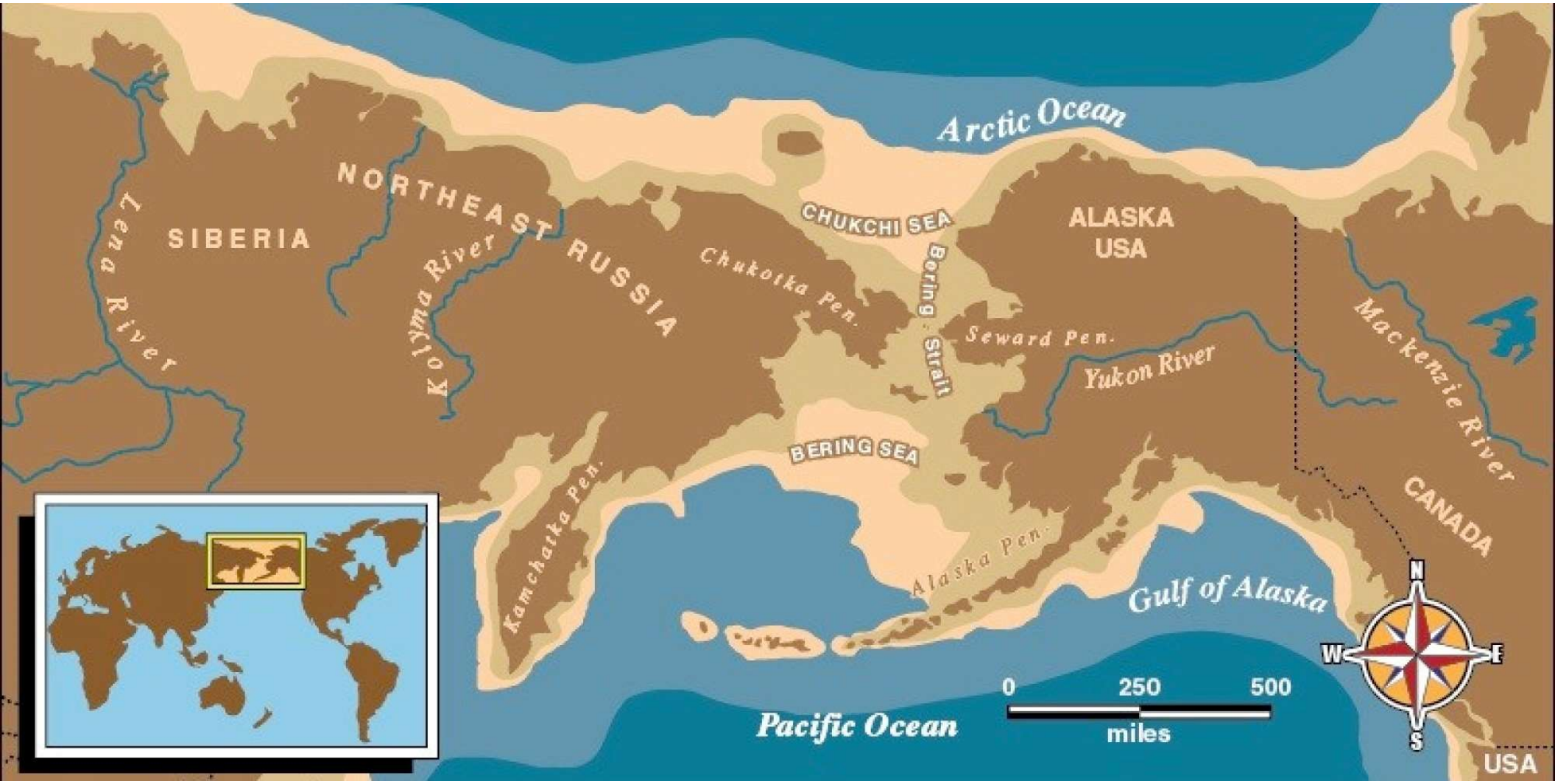
If there was a refuge conventional wisdom was it was in eastern Asia

However in the low sea level of the time the strait did not exist – was land called Beringia covering Bering Strait and into Asia and Alaska that largely remained unglaciated.

Indeed climate modeling suggests that even in the depths of the last ice advance its summer temperatures were quite warm

Sceptics say there is no evidence it was occupied then

Northern Yukon site Bluefish Caves 27.7K BP possible candidate site – cut marks on bone from there but are disputed as to if they are human made.


Arctic Ocean
SIBERIA
NORTHEAST RUSSIA
Lena River
Kolyma River
Chukotka Pen.
CHUKCHI SEA
Bering Strait
ALASKA
USA
Seward Pen.
Yukon River
Mackenzie River
BERING SEA
CANADA
Kamchatka Pen.
Alaska Pen.
Gulf of Alaska
Pacific Ocean
0
250
500
miles
N
W
E
S
USA

Beringia

Arctic Ocean
Pacific Ocean
This map illustrates the geography of Beringia, the land bridge that formed between North America and Asia during the last glaciation. Sea-level dropped ~120 m at glacial maximum due to the growth of ice sheets and glaciers on the continents, which exposed the continental shelf. The Quaternary period (2.6 million years to present) is characterized by large fluctuations in global temperature and multiple glaciations occurred. Beringia forms during major glaciations and would have persisted for 1000s of years at a time. During warmer periods, such as our current interglacial, the land bridge is submerged. Exposure of the land bridge allowed plants and animals to be dispersed between the continents. Humans crossed Beringia from Asia to North America during the glacial period depicted on this map. Lakes and drainages have been reconstructed to provide a better perspective on the environment of the land mass according to bathymetric data having a grid spacing of 1 km (100 m for Norton Sound). Some of the lake basins are shallow and may have been wetlands rather than open water bodies. Drainage of the Yukon River is determined where it crosses onto the continental shelf. A southerly route leads the Yukon River to the Pacific Ocean, whereas a northerly route results in drainage to the Arctic Ocean. Holocene marine sedimentation has undoubtedly changed the topography of the continental shelf and was not accounted for in this reconstruction. The Arctic Ocean is depicted with sea-ice cover.
Paleodrainage map of Beringia
Last Glacial Maximum (~18,000 years ago)
compiled and interpreted by
Jeffrey D. Bond
Yukon Geological Survey
Open File 2019 - 2
Yukon
References
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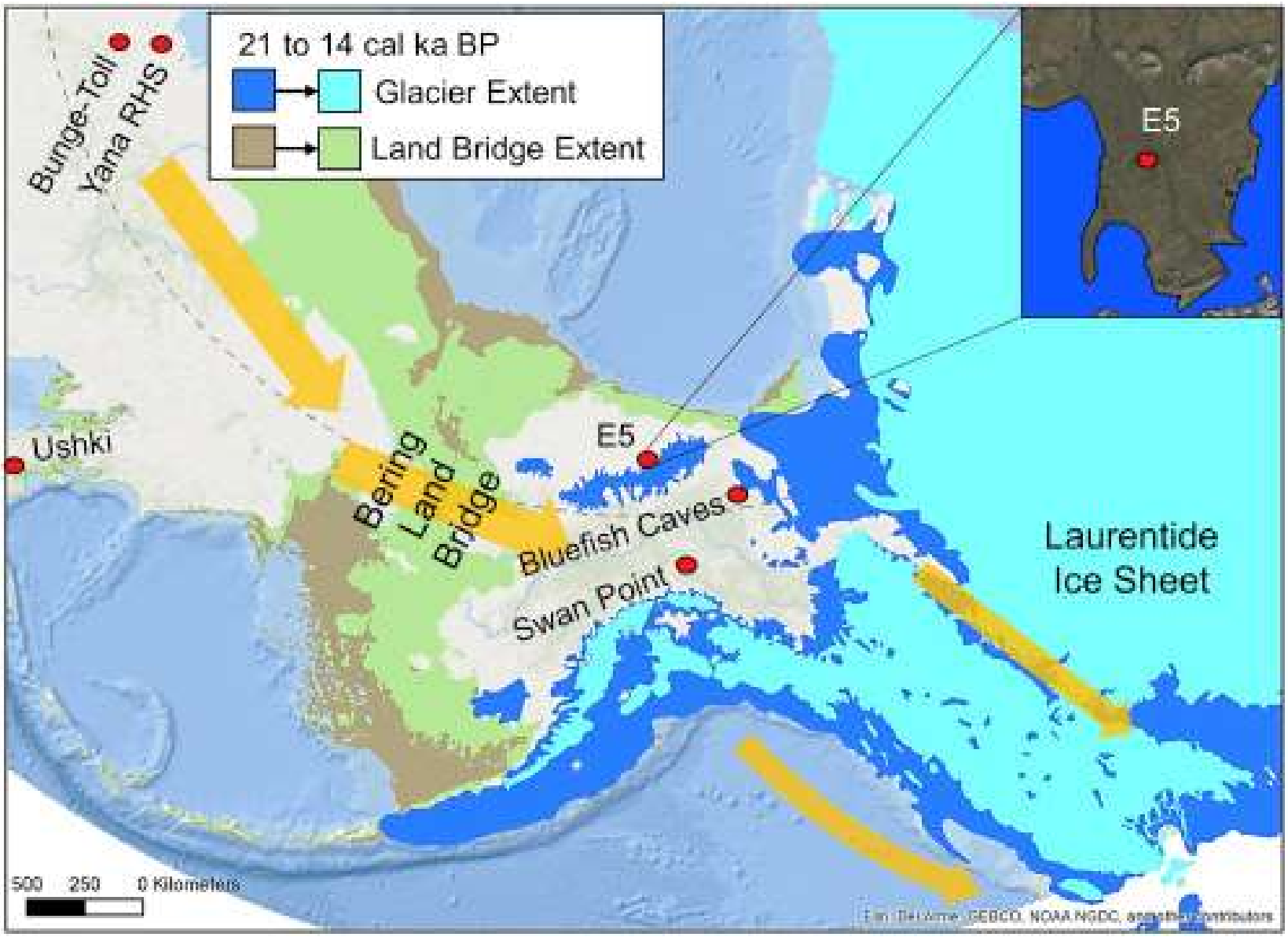
Bathymetry:
Dartnell, S.L., Dobbins, E.L., Jakobsson, M., Johnson, M.A., Weingartner, T.J., Williams, W.J. and Zarayskaya, Y., 2016. Sounding the northern seas, Eos, 96, doi:10.1029/2015EO040975.
Prescott, M.M., and Zimmermann, M., 2015. Smooth sheet bathymetry of Norton Sound: U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-298, 23 p. doi:10.7289/V5V69GJ9.
World Imagery:
Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.
Acknowledgements
This map benefited from a review completed by Dr. Julie Brigham-Grette, Quaternary geologist (UMass, Amherst), Dr. Grant Zazula, Beringian palaeontologist (Yukon Palaeontology Program) and Kristen Kennedy, surficial geologist (Yukon Geological Survey). Assistance accessing the bathymetric data was provided by Dr. Seth Danielson, physical oceanographer (University of Alaska, Fairbanks). Technical editing was completed by Karen MacFarlane (Yukon Geological Survey). We welcome your comments and feedback, please email: jeff.bond@gov.yk.ca
Recommended citation: Bond, J.D., 2019. Paleodrainage map of Beringia. Yukon Geological Survey, Open File 2019-2.
Exposed continental shelf during glaciations
0 m (modern sea-level)
50 m below modern sea-level
100 m below modern sea-level



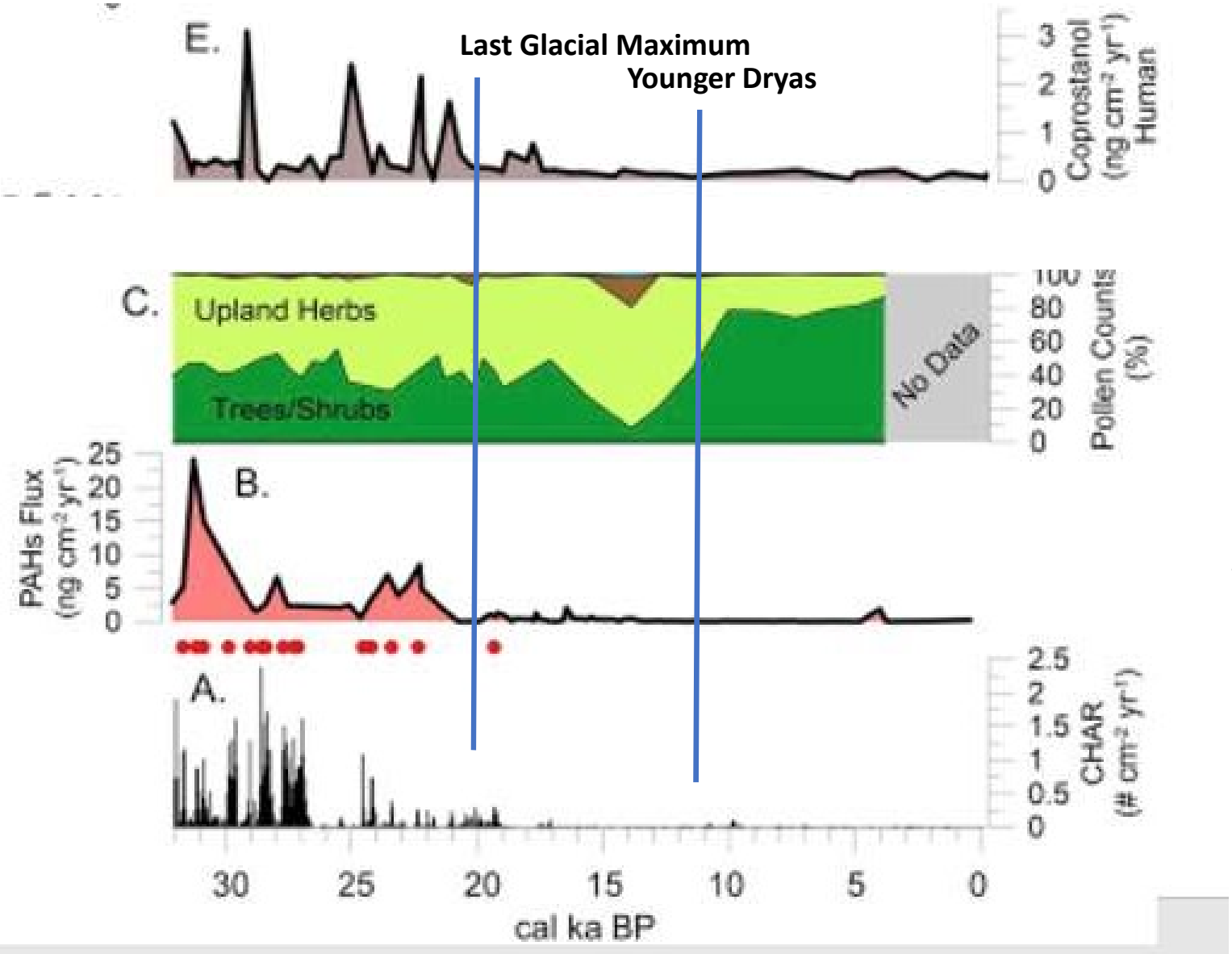
Lake E5 on the Alaskan north slope

GL1

Lake E5 (Summer) Never glaciated – though freezes in winter

Slide 16

GL1 Garry Law, 2/11/2019



Copropstanol

Pollen

Polycyclic aromatic hydrocarbons – from fires

Charcoal

Seems to be evidence of at least periodic human presence in this Alaskan part of Beringia 20-35K years ago.

Perhaps E5 was on the fringe of the Beringian refuge that was used through to 15K years ago, but was locally too cold after the glacial maximum to sustain people. Then perhaps the refuge was located further south or west.

Pooh is proving useful!