# Early Miocene vegetation across eastern Africa as reconstructed from phytolith data

**KINYANJUI, Rahab N.** [1], PEPPE, Daniel J.[2], MACLATCHY, Laura M.[3], KINGSTON, John D.[4], COTE, Susanne[5], DRIESE, Steven G.[2], FOX, David L.[6], JACOBS, Bonnie F.[7], LEHMANN, Thomas[8], LUKENS, William E.[9], ROSSIE, James B.[10] and MCNULTY, Kieran P.[11]

*(1)Earth Sciences Department, National Museums of Kenya, P.O Box 40658-00100, Nairobi, 254, Kenya,*
*(2)Terrestrial Paleoclimatology Research Group, Department of Geosciences, Baylor University, One Bear Place #97354, Waco, TX 76798,*
*(3)Department of Anthropology, University of Michigan, Ann Arbor, MI 48109,*
*(4)Department of Anthropology, University of Michigan, 101 West Hall, 1085 S. University Ave, Ann Arbor, MI 48109-1107,*
*(5)Department of Anthropology and Archaeology, University of Calgary, Calgary, AB 2N 1N4, Canada,*
*(6)Department of Earth Sciences, University of Minnesota, Minneapolis, MN 55455,*
*(7)Department of Geological Sciences, Southern Methodist University, P.O. Box 750395, Dallas, TX 75275-0395,*
*(8)Abteilung Paläoanthropologie und Messelforschung, Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, Frankfurt, D-60325, Germany,*
*(9)Terrestrial Paleoclimatology Research Group, Department of Geosciences, Baylor University, Waco, TX 76798,*
*(10)Department of Anthropology, Stony Brook University, Stony Brook, NY 11794,*
*(11)Department of Anthropology, University of Minnesota, 395 Hubert H. Humphrey Center, 301 19th Avenue South, Minneapolis, MN 55455.*

*CORRESPONDENCE : rkinyanji@gmail.com*

# Introduction

- East Africa, is one of the well known regions in the world for rich in prehistoric localities, preserving hominoid and hominid species dating back to early Miocene period.
- Numerous paleontological and geological studies have been carried out from these localities, with effort to understand the evolution pattern of primates and other mammals.
- However, to clearly understand this, it is paramount to understand the paleoenvironments which these faunal communities interacted with.
- So far, variety of habitats have been suggested by various proxies such as: stable isotopes, eco-morphology, paleopedology among others.
- Some of these proxies indicate presence of $C_4$ plants on the paleolandscapes and often has been disputed due the timing of expansion of grasslands around 10 Ma. Nevertheless, this do not rule out the possible appearance of $C_4$ grasses prior to this period.
- This study analysed fossil phytoliths (plants silica) recovered from early Miocene localities to reconstruct vegetation structure, determine how they vary between sites and in particular determine whether $C_4$ grasses were part of the vegetation component of the early Miocene landscapes

# Aim and objectives

- This project is part of a larger REACHE (Research on East African Catarrhine and Hominoid Evolution) project which seeks to understand early Miocene paleoenvironments and paleoclimates and their role in shaping Hominoid and Hominid evolution trajectories.
- Phytolith study is one of the multi-proxies approach, aimed to determine vegetation component of the paleoenvironments and how they varied through time and across space during the said period.
- Phytoliths are particularly important in identifying different grass subfamilies which grow under different habitats with specific environmental/climatic parameters. Panicoideae $C_4$ grasses thrive under warm and moist conditions, Chloridoideae $C_4$ grasses thrive under hot and dry conditions, Arundinoideae $C_4$ grasses in wetlands and swampy environments. Pooideae grasses in tropical Africa are mainly found in high altitudes and therefore reflect cool and moist climates.
- Paleosol samples were collected from all the localities with guidance from key geologists involved in the project Field work

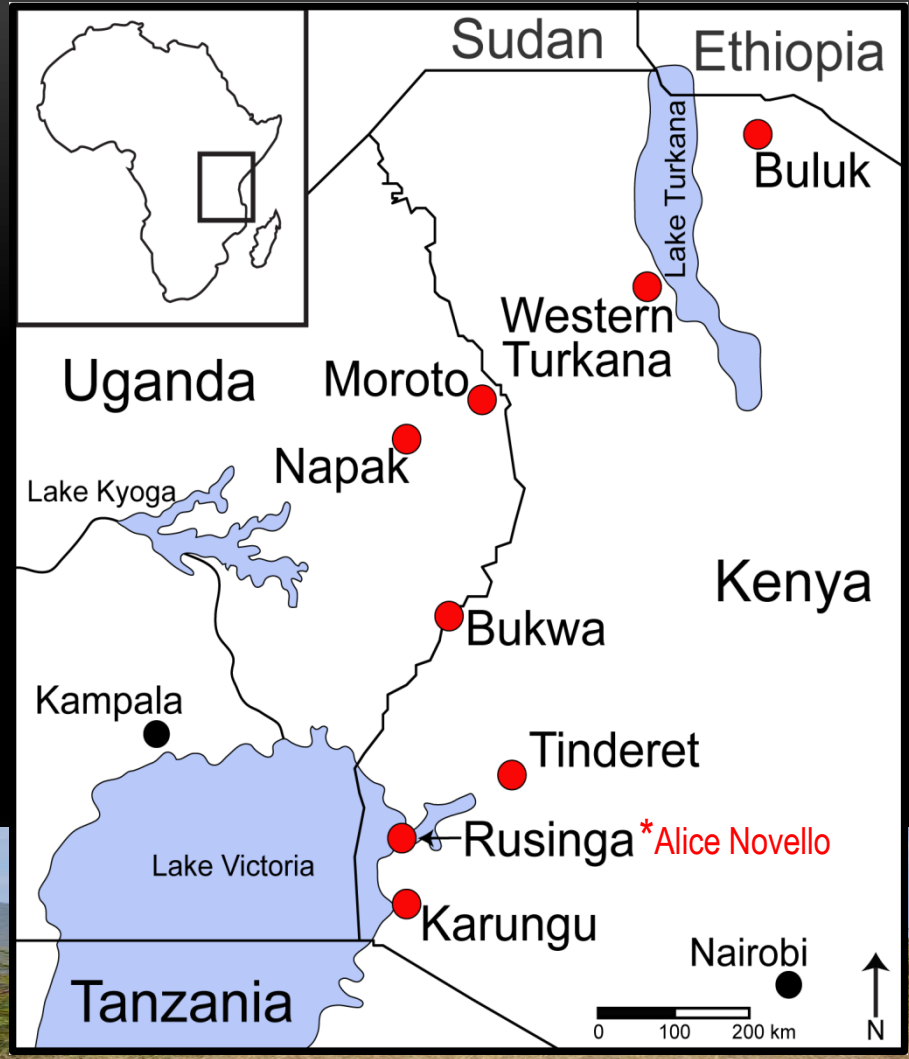
# Why phytoliths?

- Initial samples showed phytoliths are preserved in feasible amounts and the assemblage can be reliable to estimate the vegetation composition/structure of early Miocene environments.

- Phytoliths are particularly important in identifying different grass subfamilies which grow under different habitats with specific environmental/climatic parameters as follows:
  - Panicoideae $C_4$ grasses thrive under warm and moist conditions,
  - Chloridoideae $C_4$ grasses thrive under hot and dry conditions,
  - Arundinoideae $C_4$ grasses in wetlands and swampy environments,
  - Pooideae grasses in tropical Africa are mainly found in high altitudes and therefore reflect cool and moist climates.

# Research localities

- Phytoliths are often used as a proxy to determine and reconstruct past vegetation composition and structure, in addition to providing insights about past climates.
- Depending on depositional environments, both local and regional vegetation structure can be reconstructed.
- Preliminary phytolith data from six early Miocene localities; three in Uganda (Bukwa, Napak and Moroto II) and three in Kenya (Karungu, Tinderet, and West Turkana).
- These sites date between ca. 21.2 Ma and ca.16 Ma.



# Methods

1) Field work-

Sampling was carried from various REACHE project localities in Kenya and Uganda. Participation of local communities have been emphasized


2) Lab analyses-

Through consultations with key phytolith experts, most effective and efficient protocol (Stromberg et al.,) is being used

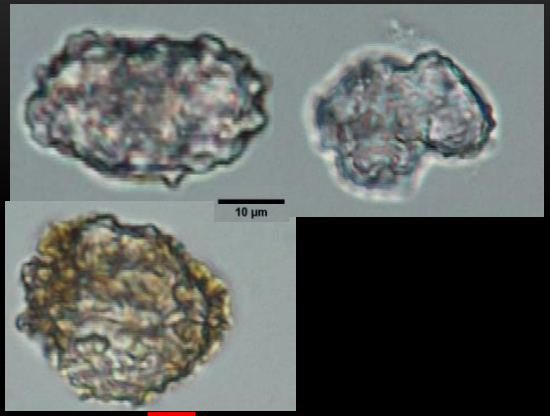
3) Collaborations-

- Alice Novello
- Caroline Stromberg

4) Publications

- The ultimate goal is to share our findings with scientific world and local communities

# Methods: key morphotypes




Woody/forest indicators


Grasslands indicators

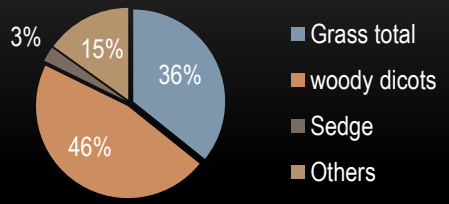
Non-diagnostic morphotypes

Image source: https://www.google.com/

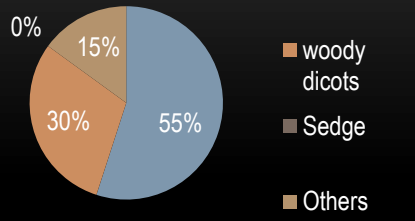
# Preliminary results

# Moroto II (ca. 21.2 Ma)

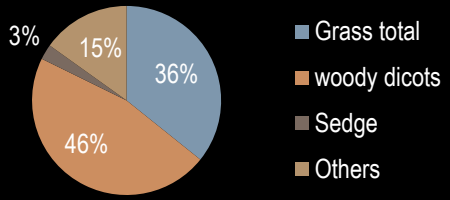
DP15-08-RK7



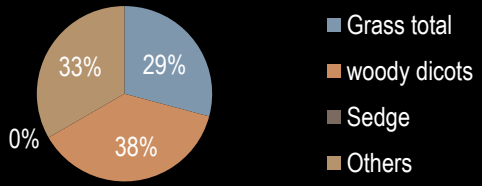

DP15-08-RK20(Bssg. Horizon)




DP15-07-RK9 (BKII Paleosol 95cm)



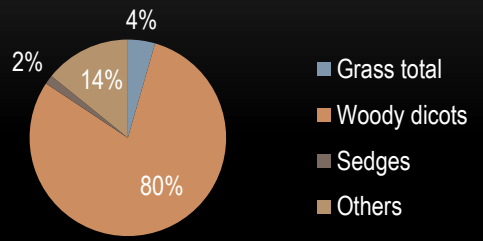

DP15-08-RK22 (Sandy paleosol, 3c Horizon)



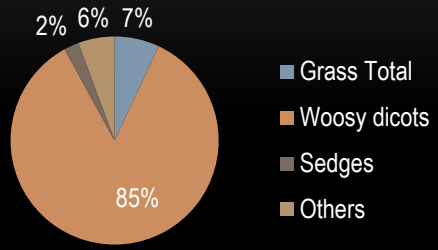

- A total of 12 samples were analysed, all of which yielded significant amount of woody and herbaceous dicots morphotypes.
- However, four sample yielded a significant amount (>20%) of Grass Silica Short Cells (GSSCs).

# Napak sites (ca. 20 Ma)

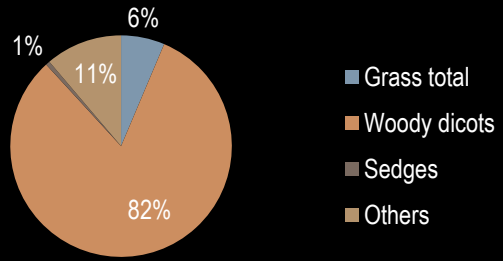
DP15-01-RK1 (Red paleosol Napakl)




DP15-04-RK6 (DP-04-Paleosol II Napak C-IV)



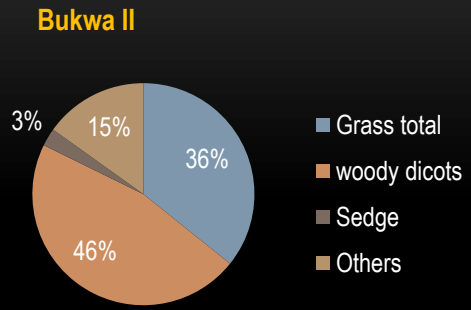

DP15-01-RK2 (Green paleosol Napak I

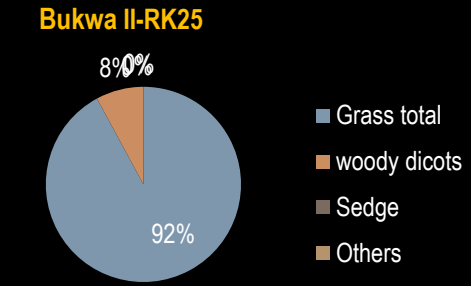



Phytolith assemblages from Napak I and CCIV are dominated with woody dicots.
> 80% of the total assemblage were woody dicots.
GSSCs and sedge morphotypes were rare but present in the assemblage

# Bukwa II( ca. 19 Ma)

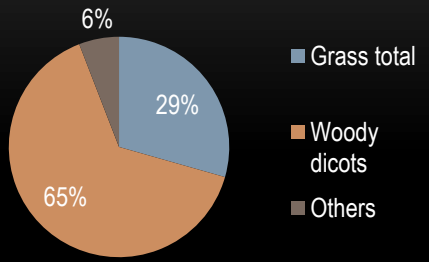
Phytolith assemblage is dominated by GSSCs . One sample produced 92% of the total assemblage



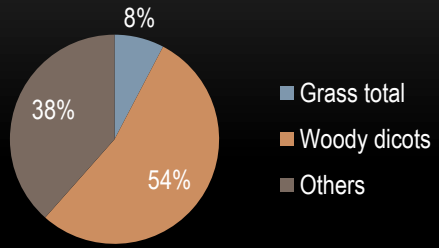



# Tinderet sites (ca. 20-19 Ma

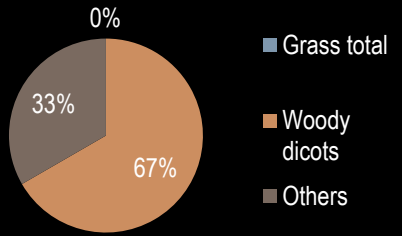
LG21-M4 PHY Leget-Hill Koru)



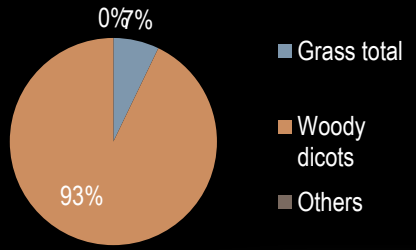

SG-M6-H1 PHY Songor




LG21-M6 PHY Leget-Hill Koru)

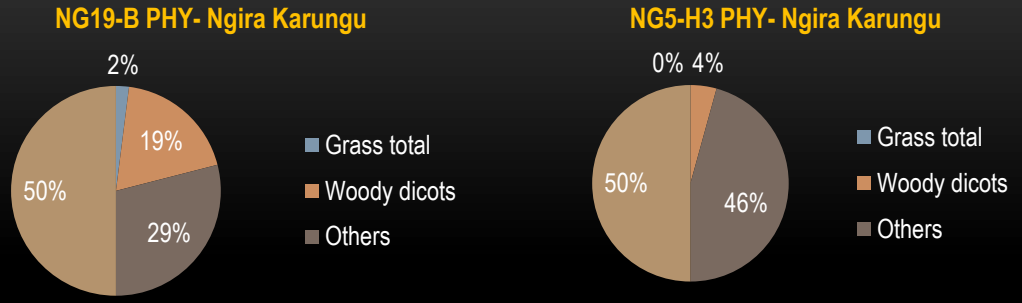



SG-M3- PHY Songor



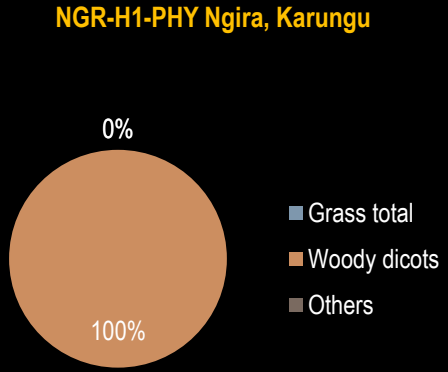

- Of the 5 samples analysed, 4 yielded phytoliths.
- Phytolith assemblage is dominated with woody morphotypes

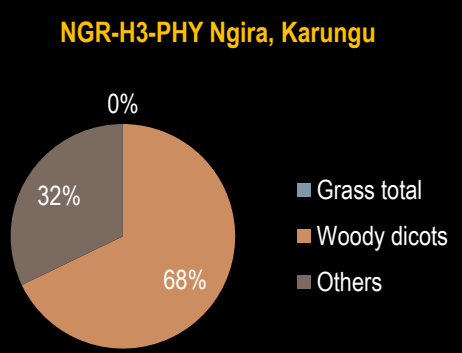
# Karungu (ca. 18Ma)







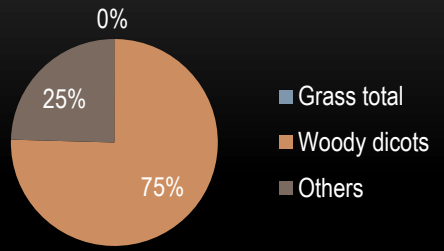


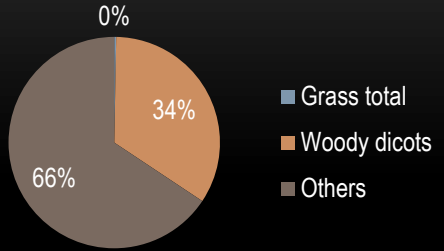

- Of the five samples analysed, four yielded phytoliths
- Phytolith assemblage is dominated by woody indicators.
- GSSCs are absent except the insignificant presence in one sample

# Kalodirr (ca. 17-16 Ma)

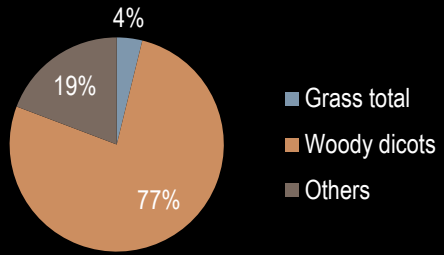
KAL-TP-H1-RK1



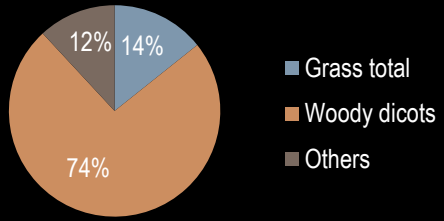

KAL-TP-H4-RK2




KAL-TP-H1-RK2



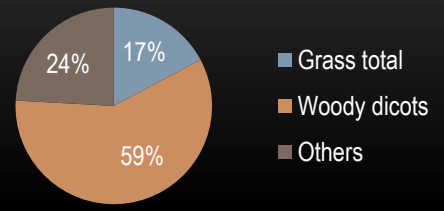

KAL-UG-H1-RK1



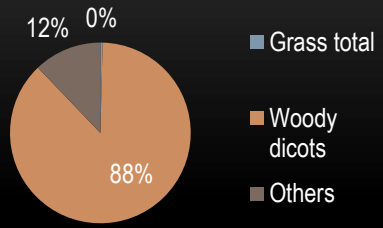

- All four samples processed yielded.
- Phytolith assemblage was dominated by woody dicots.
- GSSCs are rare in the sites while sedges are completely absent

# Muororot (ca. 17-16 Ma)

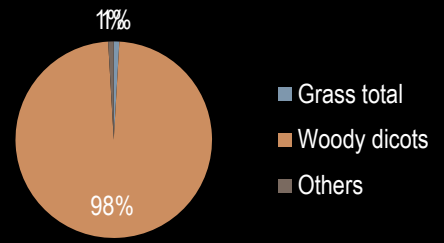
**Mon-H4-RK4 (Muororot)**



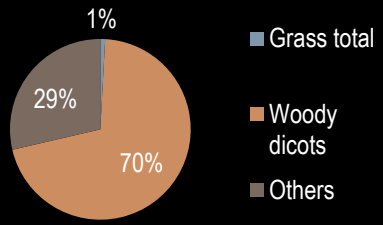

**Mon-H6-RK3**



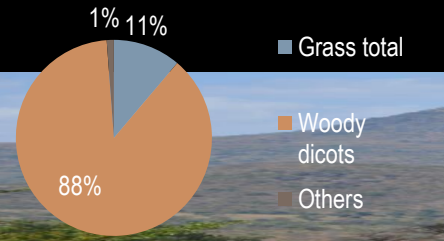

**Mon-H9-RK1**



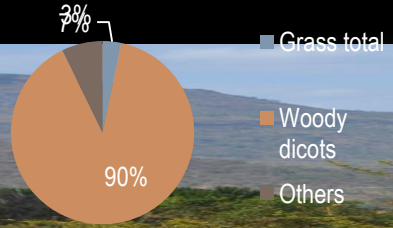

**Mon-H7-RK2**




**Mon-H5-RK2**

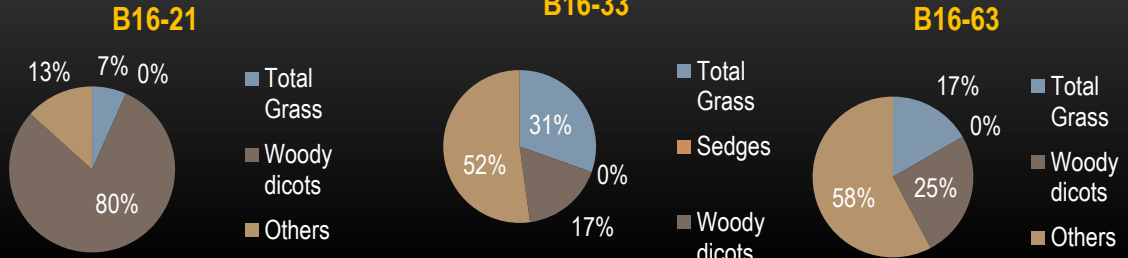



**Mon-H2-RK1**




- Muororot assemblage is dominated by woody indicators.
- Grasses are rare to absent
- Sedges are absent

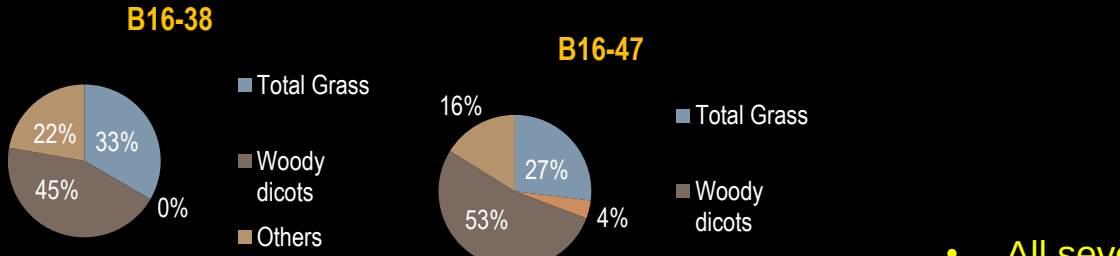
# Buluk (17-16 Ma)





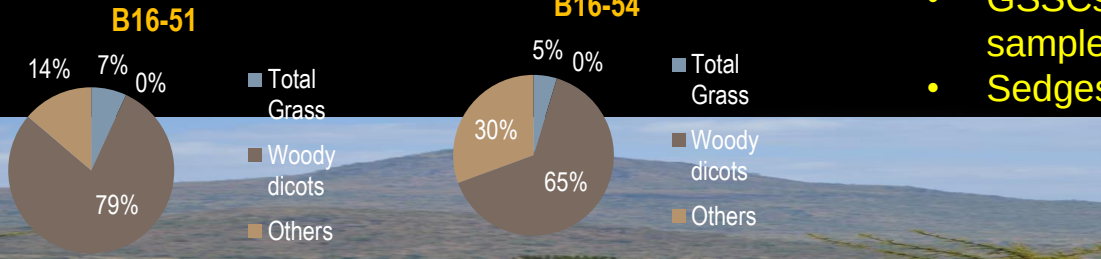








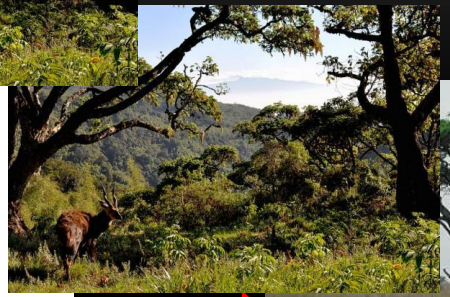






- All seven samples processed yielded phytoliths
- Woody dicot dominate the assemblage
- GSSCs are significantly present in at least in 3 samples >20% occurrence.
- Sedges only present in one sample

ried vegetation habitats in various
ndscapes



Age (Millions of years)

15
16
17
18
19
20
21
22
23

Maboko
Buluk
Rusinga
Kalodirr & Moruorot
Karungu
Tinderet
Songhor & Koru
Bukwa
Napak
Moroto
Meswa Bridge

Miocene Fossil Locality

# Diverse early Miocene habitats

- In summary, these preliminary results suggest varied vegetation structure on the early Miocene landscapes.

- There is a clear indication of presence of $C_4$ grasslands especially in Moroto II (ca. 21.2 Ma) and Bukwa II (ca.18 Ma) in Uganda and Buluk site (ca.16 Ma) in Kenya

- These diverse habitats, may have been as a result of either varied local climatic factors, especially precipitation, or local topographic orientation or both.

- These results corresponds with other data analysed from various proxies such as stable isotopes, palaoe-pedological analyses (REACHE TEAM).

# Acknowledgement

- *Funding*
  - *National Science Foundation (BCS # 1241807, 1241811, 1241812, 1241817, 1241918, 1053549)*
  - *The Leakey Foundation,*
  - *The Paleo Society*

- *Collaborating Institutions*
  - *The National Museums of Kenya*
  - *Southern Methodist University*
  - *Baylor University*
  - *University of Michigan*
  - *University Of Calgary*
  - *University of Minnesota*
  - *Stony Brook University*
  - *Abteilung Paläoanthropologie und Messelforschung, Forschungsinstitut und Naturmuseum.*
  - *Makerere University*
  - *University of Washington*


GSA 2017

22-25 October


Thank you all for listening ☺