

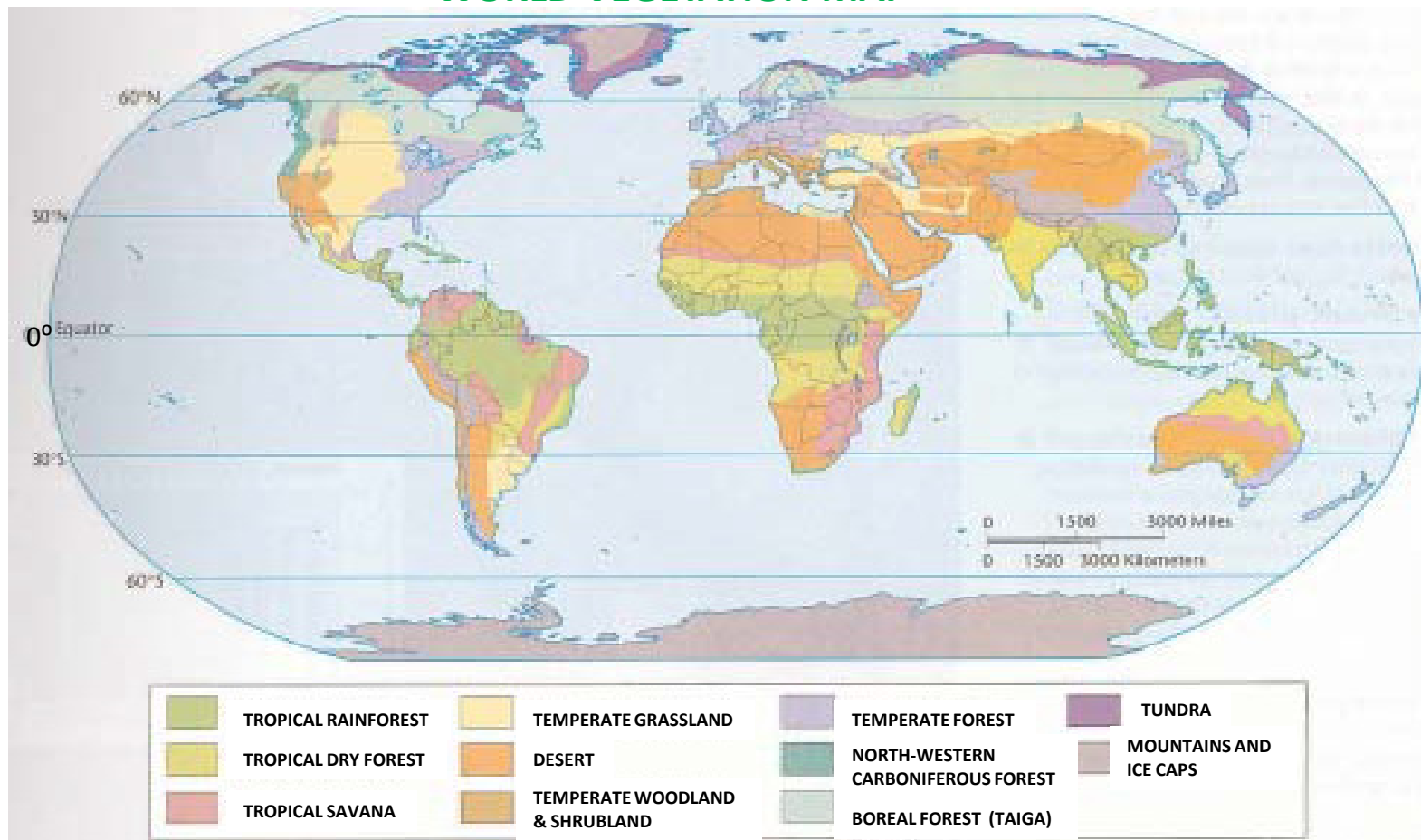


Endemic Rainforest and its geological past in the Indian Peninsula

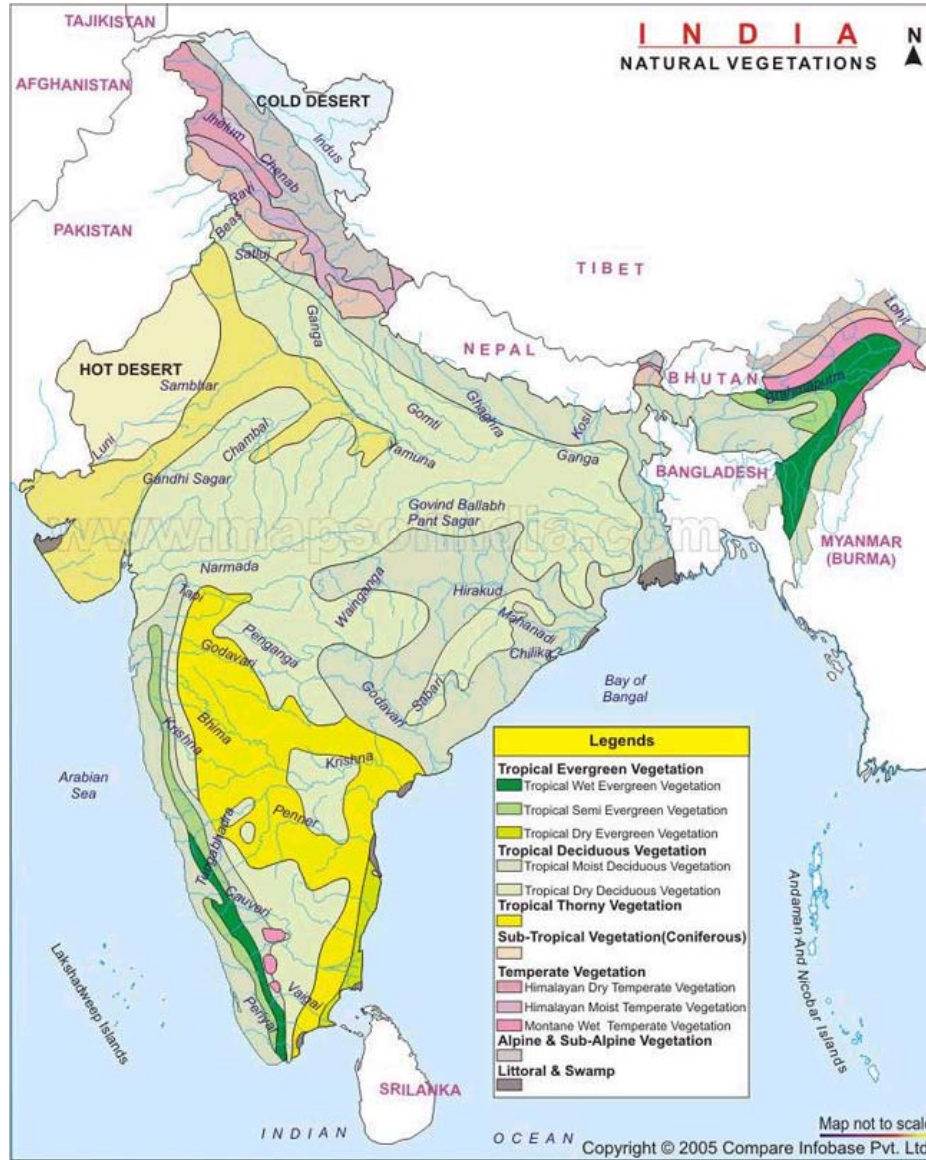
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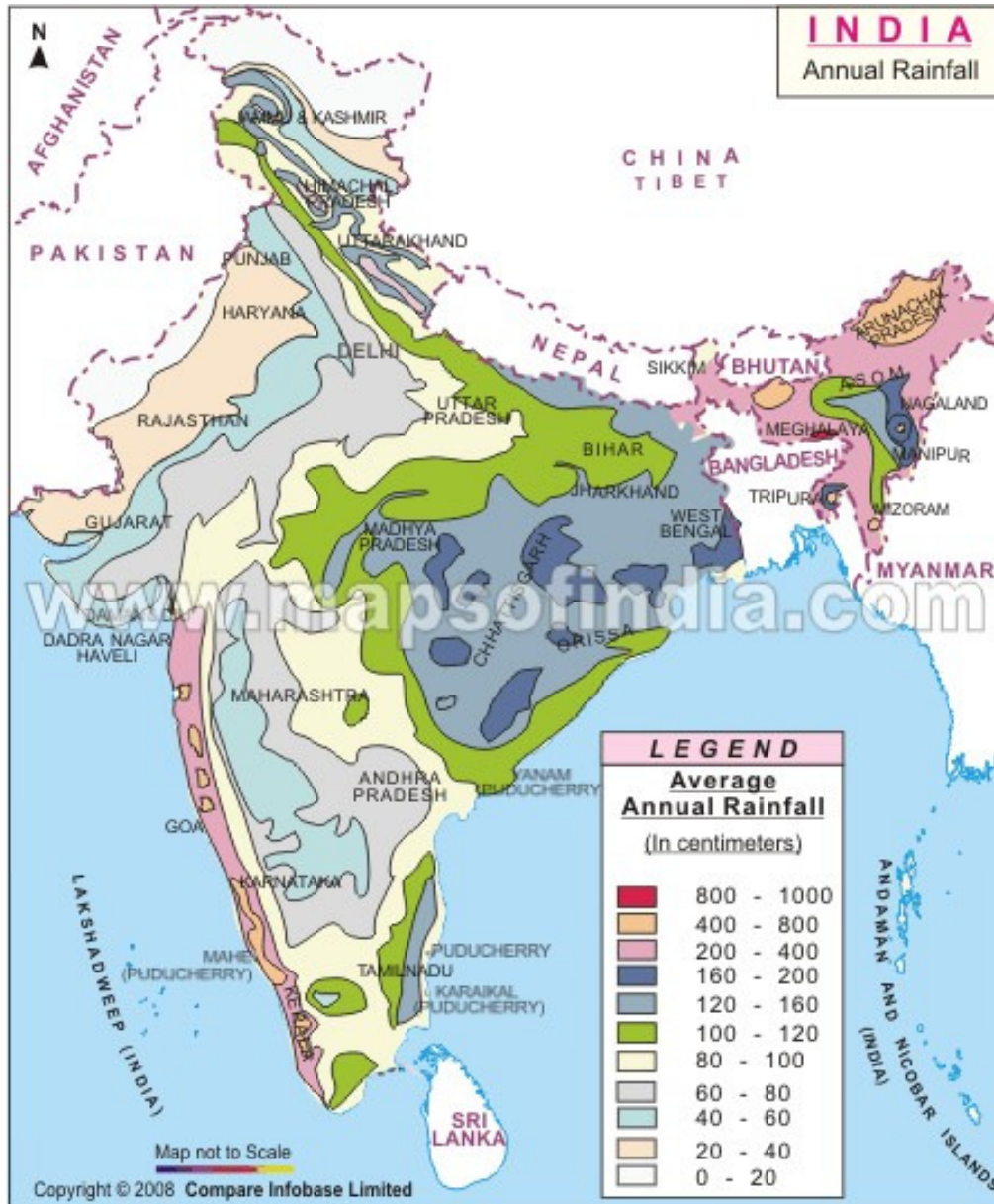
WORLD VEGETATION MAP



Present Day Vegetation in India

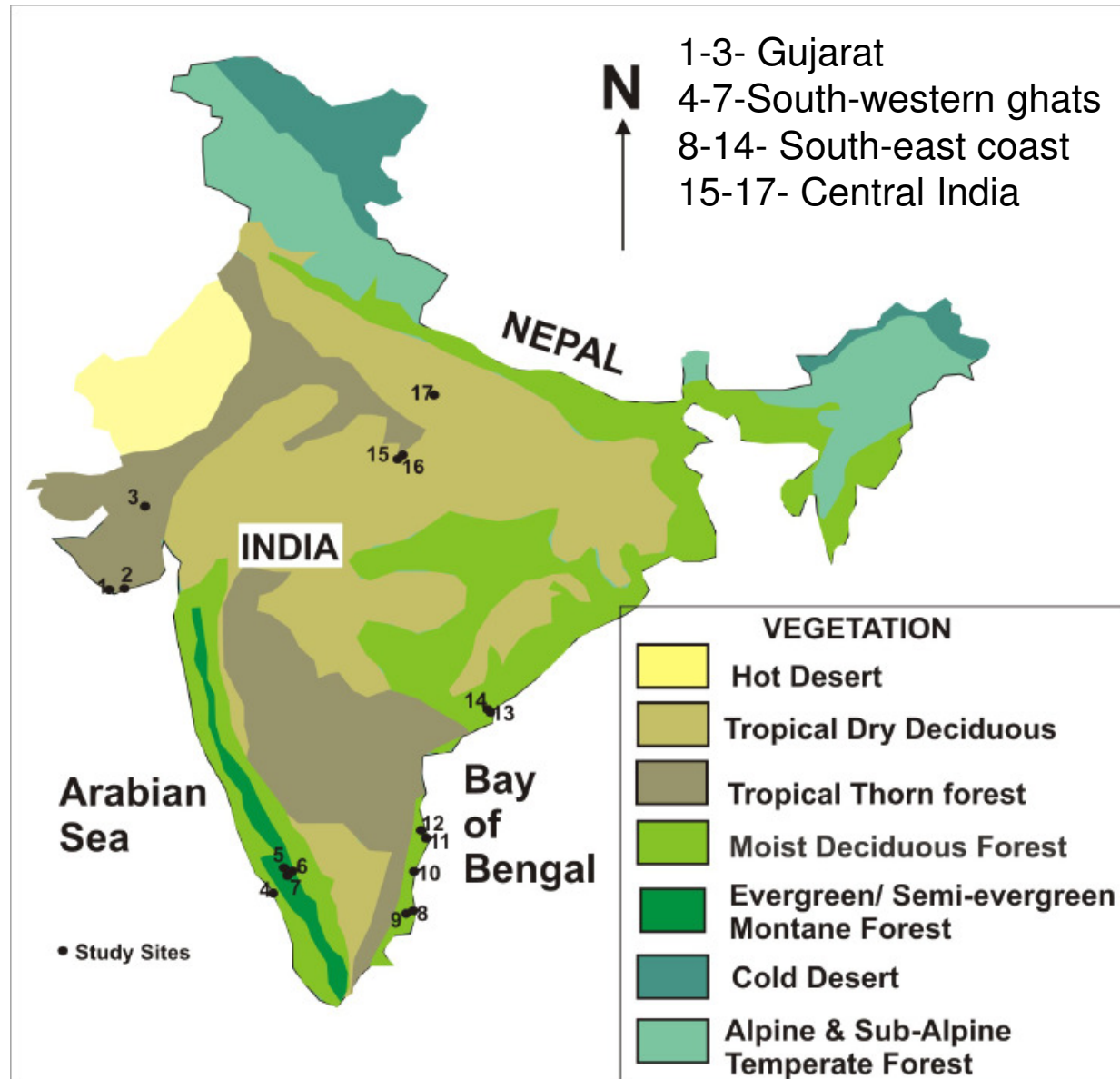


Present Day Rainfall pattern in India



Climate-Vegetation equilibrium in the Indian sub-continent

Sites for Palynological Study



The Western Ghats , India

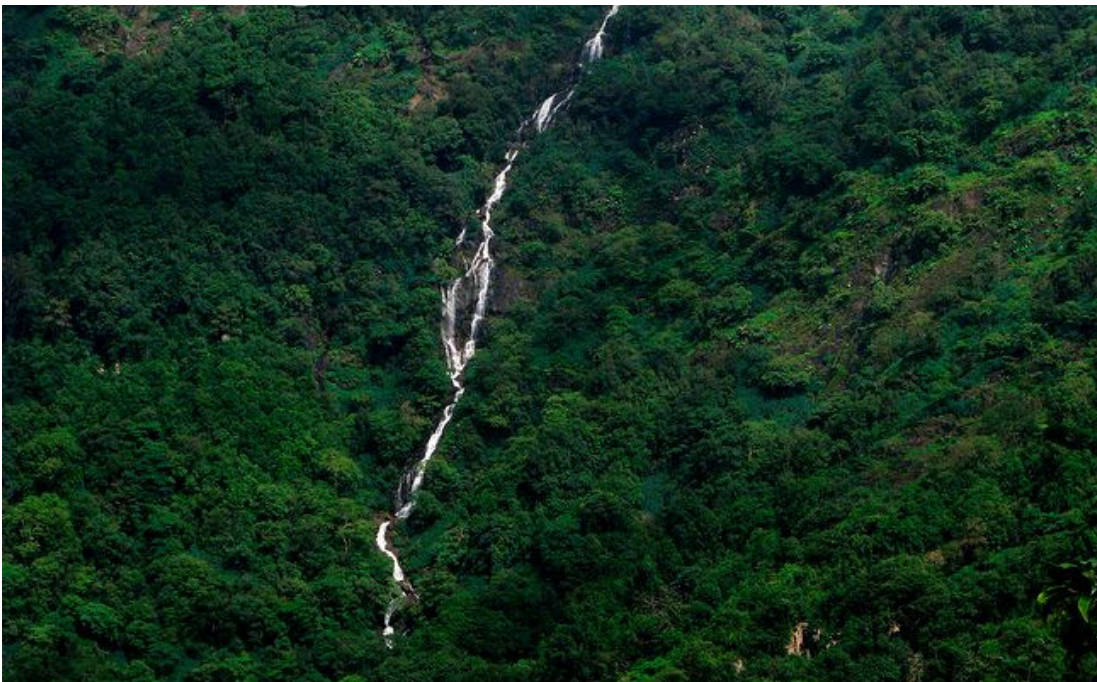
Over 5,000 different **plants** occur in the **Western Ghats**.

Around **1,700** of these are **found nowhere** else in the world .



- Savanna Grassland
- Heterogenous Flora





- **High rainfall**
- **Water drains in the broad valleys**
- **Several lacustrine deposits**
- **Lakes surrounded by Montane Forest at different Altitude**
- **Lakes are the Excellent Archives of past Vegetation**
- **Vegetation tends to remain in equilibrium with the prevailing Climate**
- **Palynological study provides clue to Climate changes in the past.**

CLIMATE-VEGETATION EQUILIBRIUM



- The Rainforest here occurs in the mist laden humid environment receiving 7-8 months of rainfall.
- **Strengthened Summer Monsoon and Winter Monsoon**
- The highlands (1500m altitude) obstructs the clouds resulting into heavy rainfall during SWM.
- **The retreat of monsoon again showers rain in this region.**
- The windward side towards the coast receives most of the rainfall and thereby, the occurrence of Rainforest
- **Most of pollen from this region is transported to coastal /marine wetlands where they get preserved**
- Therefore, the coastal sediments and Marine sediments serve as potential archive for monitoring climate through palynology.

Adverse Climate: Low Rainfall (During Cold & Arid Conditions- Glacial periods)



➤ **Vegetation shrinks to Pockets in areas retaining soil moisture around water body, Crevices or shady areas where evaporation is minimum.**



➤ **Plant takes refuge in pockets**

Commercial Exploitation of the land in western Ghats

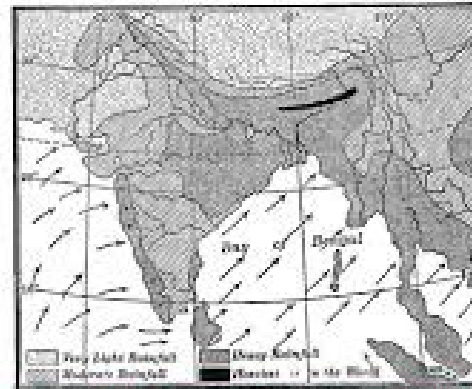
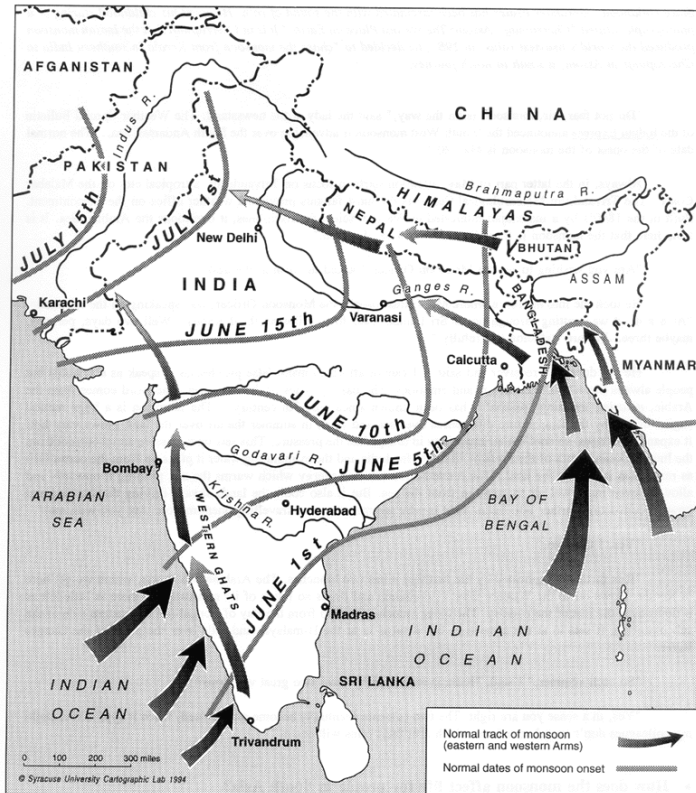


Loss in Plant Diversity

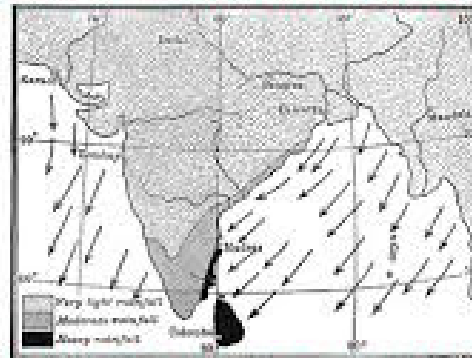
- Climate Change
- Enhanced by Anthropogenic activity



MONSOON SYSTEM OVER INDIA



SUMMER MONSOON WINDS



WINTER MONSOON WINDS

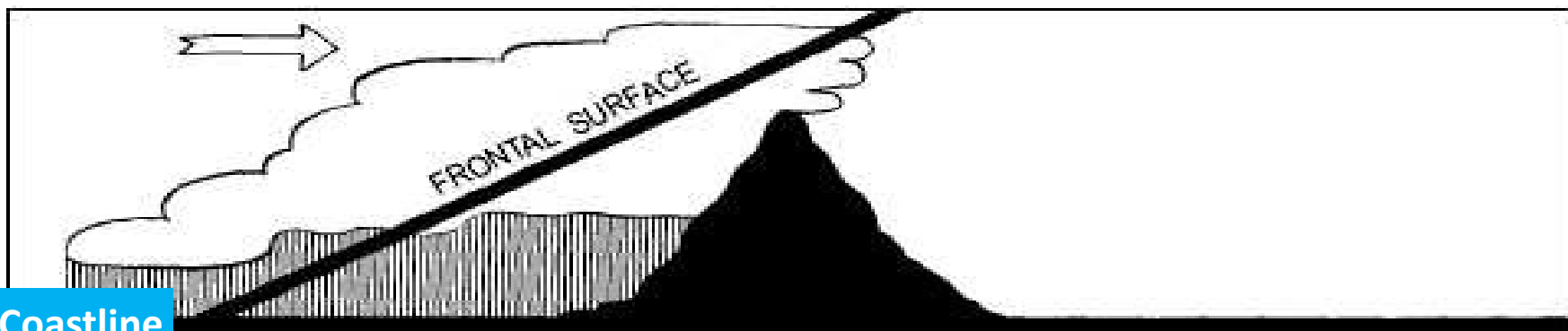
SWM- The Myanmar hills reflect the winds as a result the central part of India receives rainfall late in July.

NWM- Winds passing over the land are drier.

Winds passing over Bay of Bengal is moisture laden. South-east coast receives more NEM than SWM.

West coast receives both the Monsoons.

Highlands of Western ghats obstruct the Moisture laden Winds

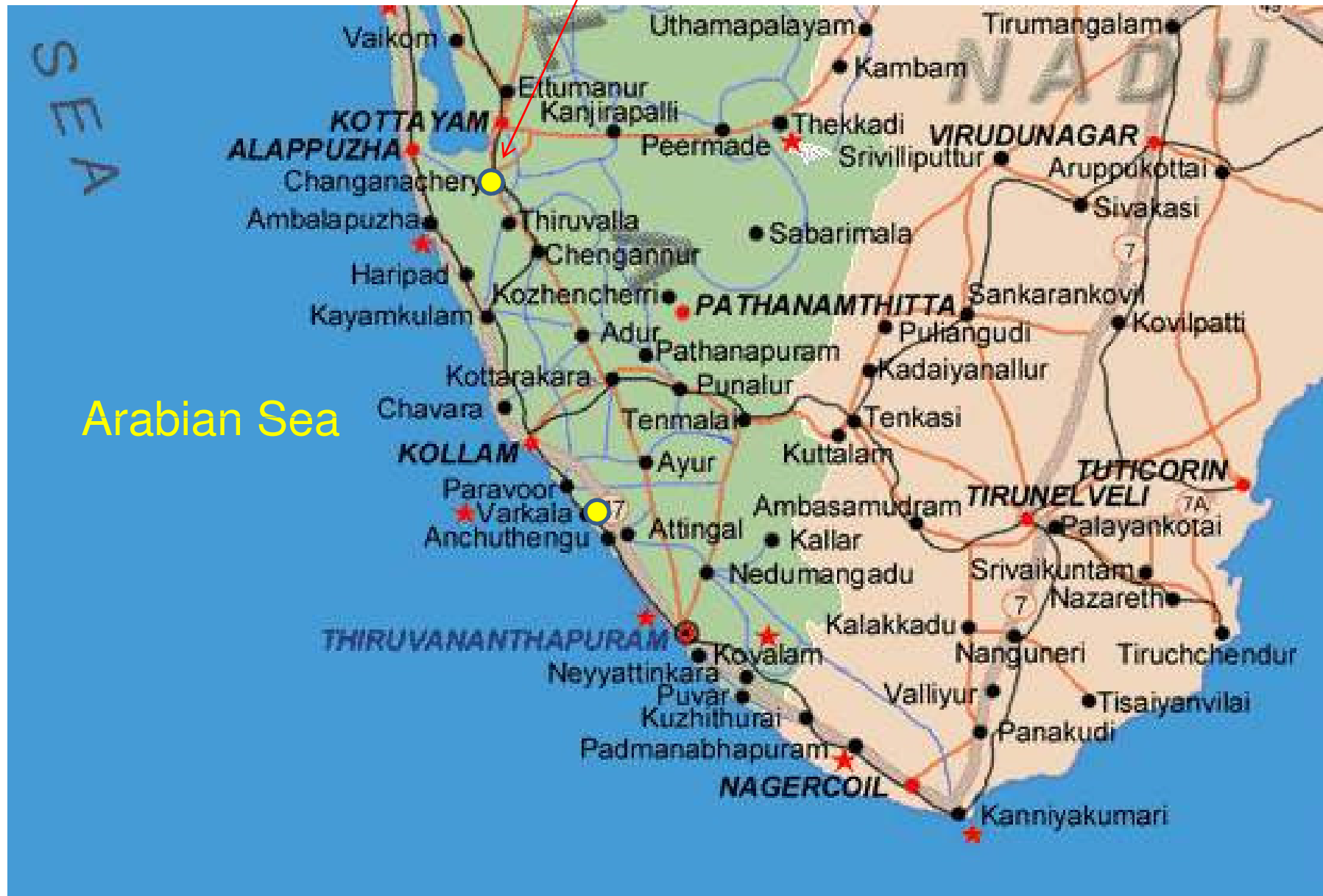


Coastline

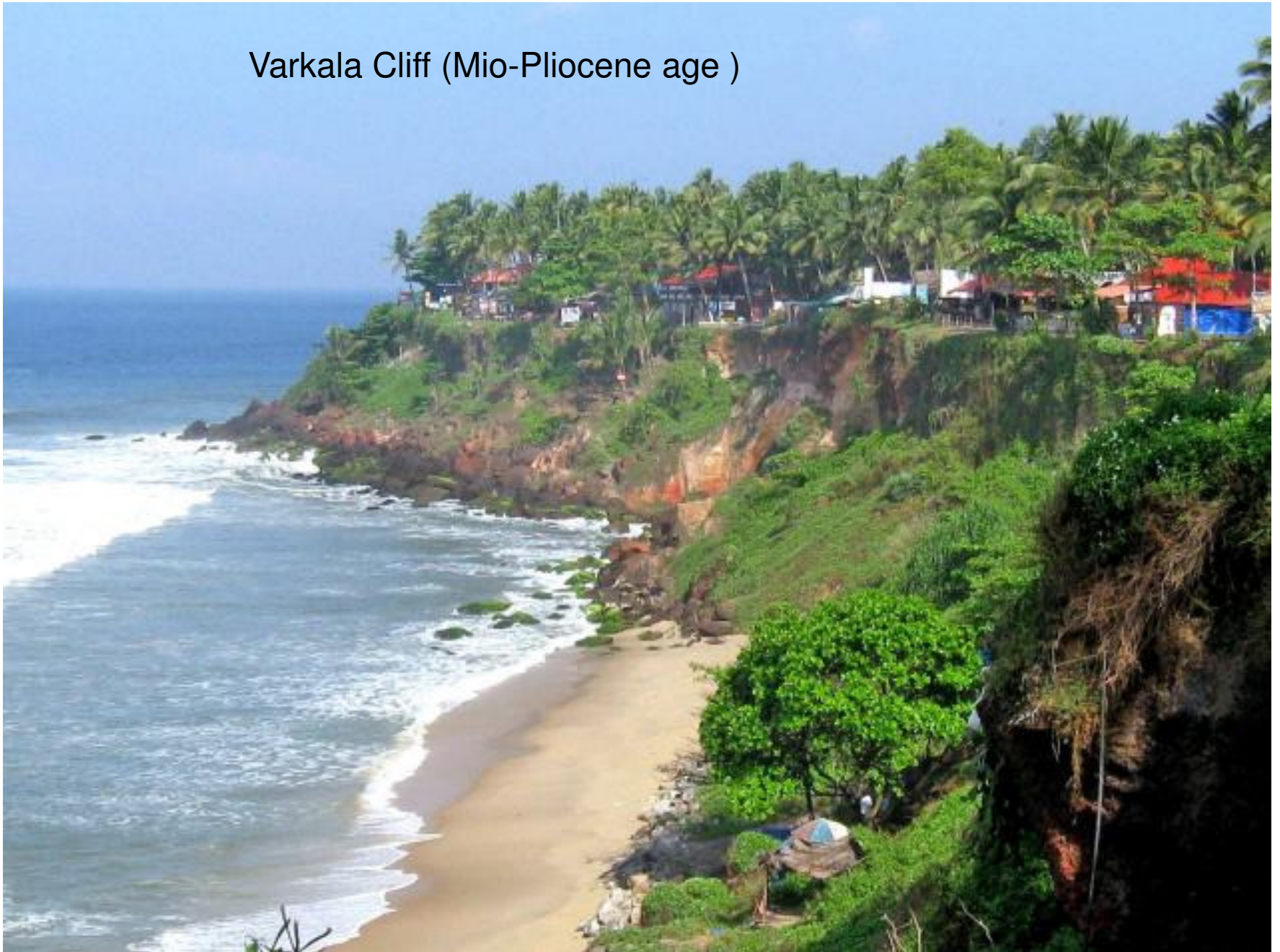


A semi-arid wasteland near Tirunelveli, Tamil Nadu. Monsoon clouds dump torrents of rain on lush forests that are only kilometres away in windward-facing Kerala, but are prevented from reaching Tirunelveli by the Agasthyamalai Range of the Western Ghats (background).

Sea level Highstand ~80 ka in Changanacherry, Kerala



Varkala Cliff (Mio-Pliocene age)



National Geological Monument



Palynological study from south-western ghats

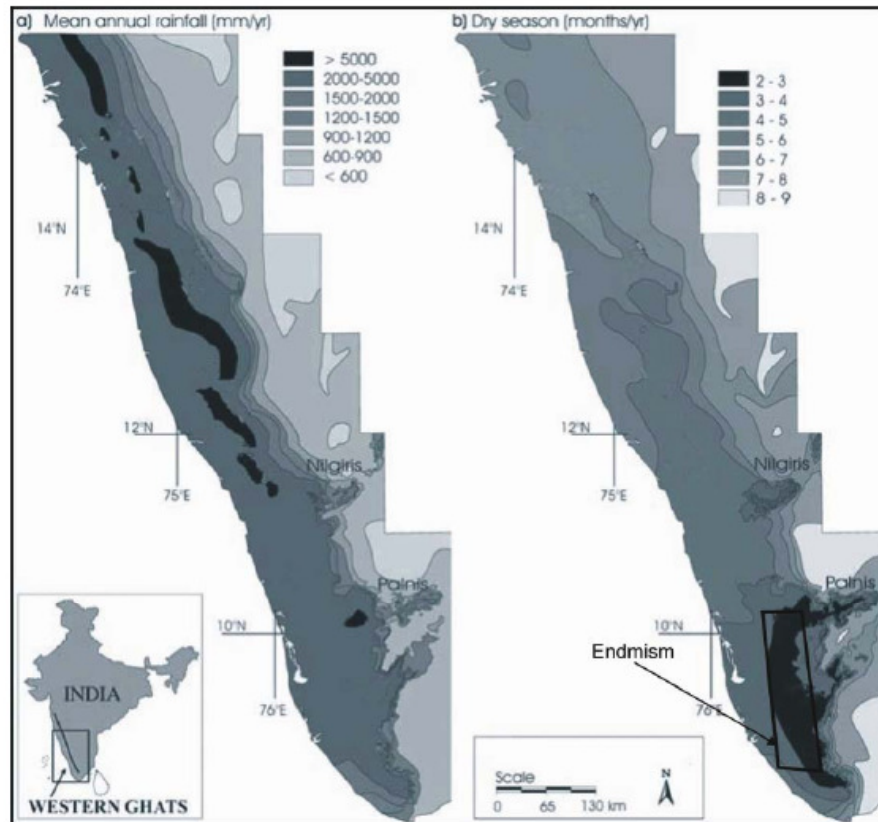


Figure 4. Map showing relative to mean annual rainfall and the length of the dry season in the Western Ghats, South India (after Pascal 1982; Barbani *et al.* 2003).

Holocene and Pre LGM record

Shola Forest in western ghats

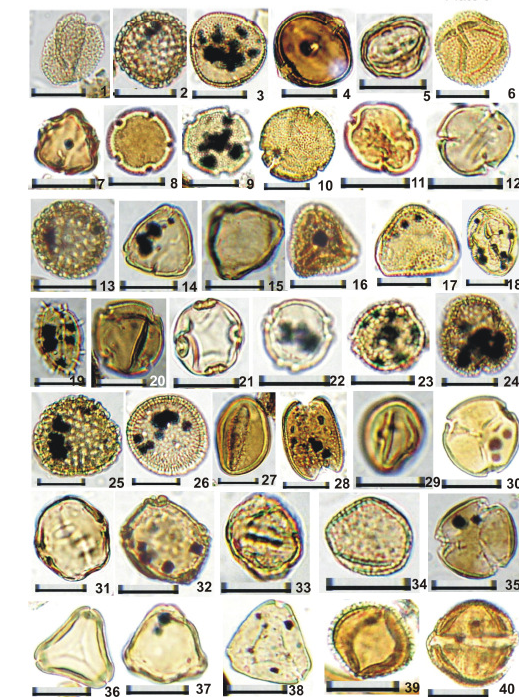
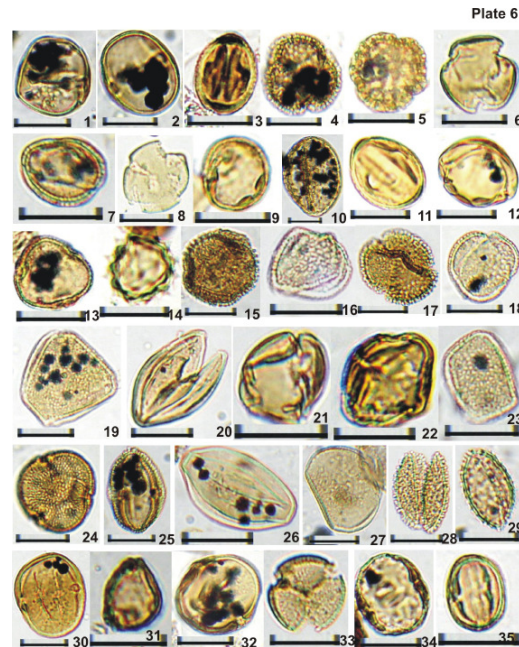
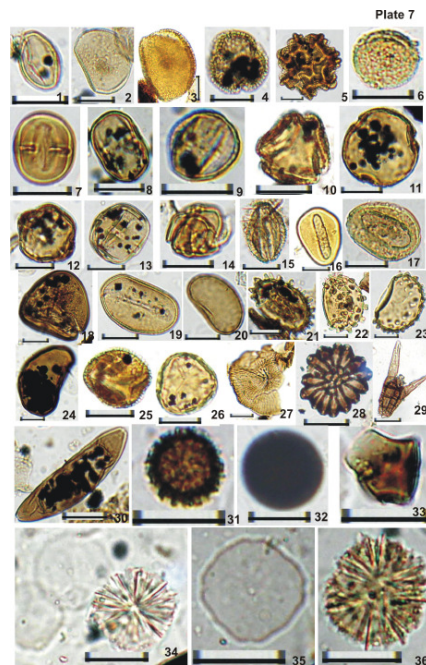
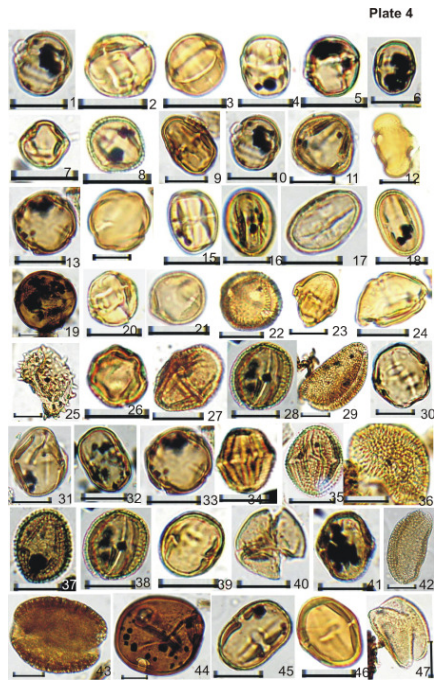
Nilgiri Hills ~35-15 ka Shola forest invaded grassland (40 ka record)
(Vishnu- Mittre & Gupta, 1971; Gupta 1973; 1970; Blasco & Thanikaimoni, 1974; Vasanthi, 1988)

Palni Hills ~12ka- invasion of shola forest (50 ka record) Gupta & Bera, 1998; ~14-7 ka- Bera & Farooqui, 2000.

Late Quaternary Record

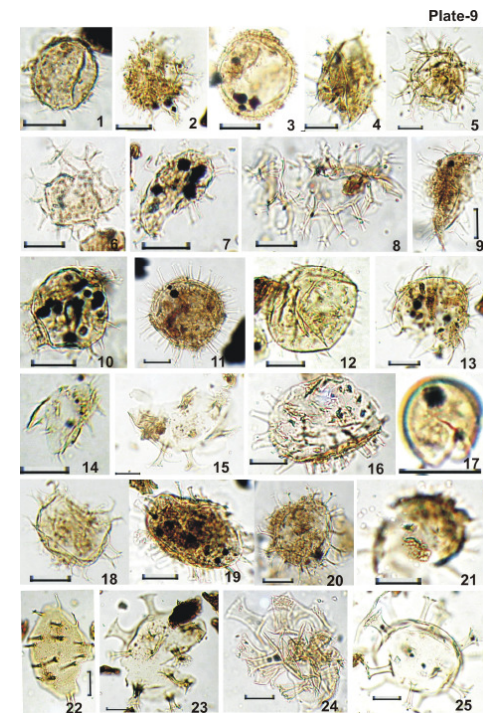
Chaganachery Well Section Kerala:

Pollen grains of about 80 taxa of rain forest and mangroves along with the Dinoflagellate cysts were recorded along with the YTT – Glass Shards (MIS 5.1).



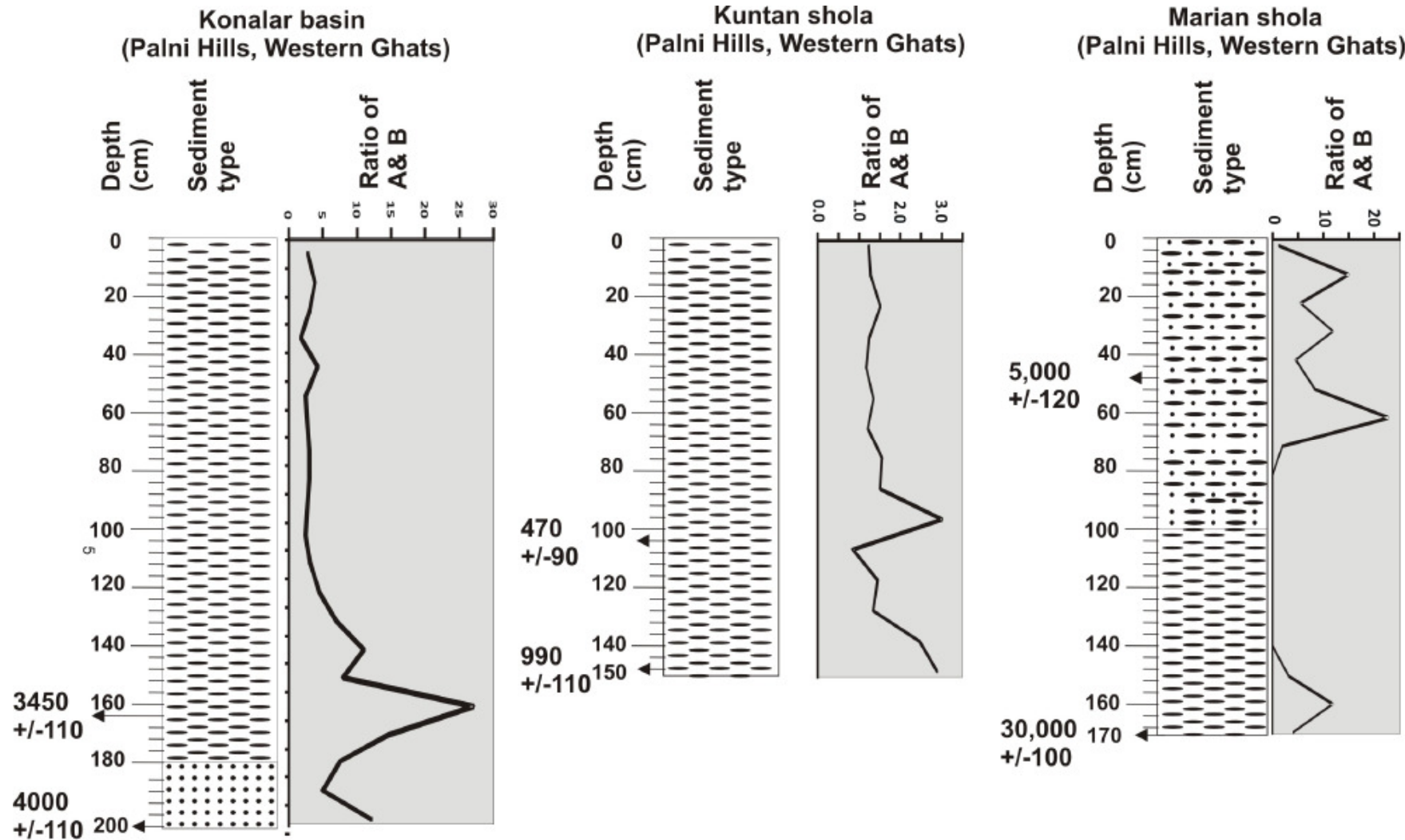
**Pollen grains during MIS 5a
from Chaganachery Kerala**

Highstand during MIS 5a



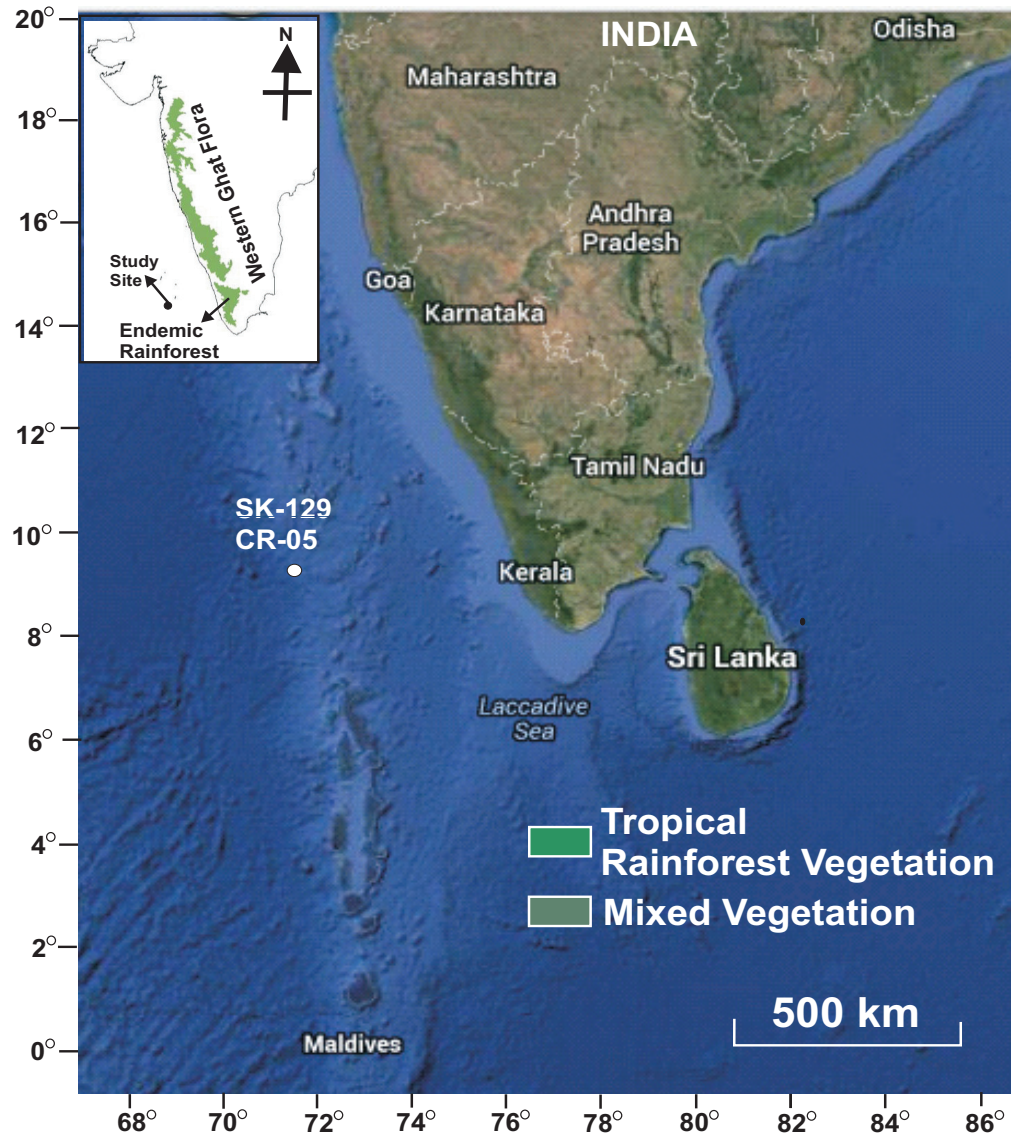
Farooqui et al., 2010

Palynological Study in sediment cores from Palni Hills, South-western Ghats



S.K. Bera, A.Farooqui and H.P. Gupta (BSIP)

Study area and Sediment Core location



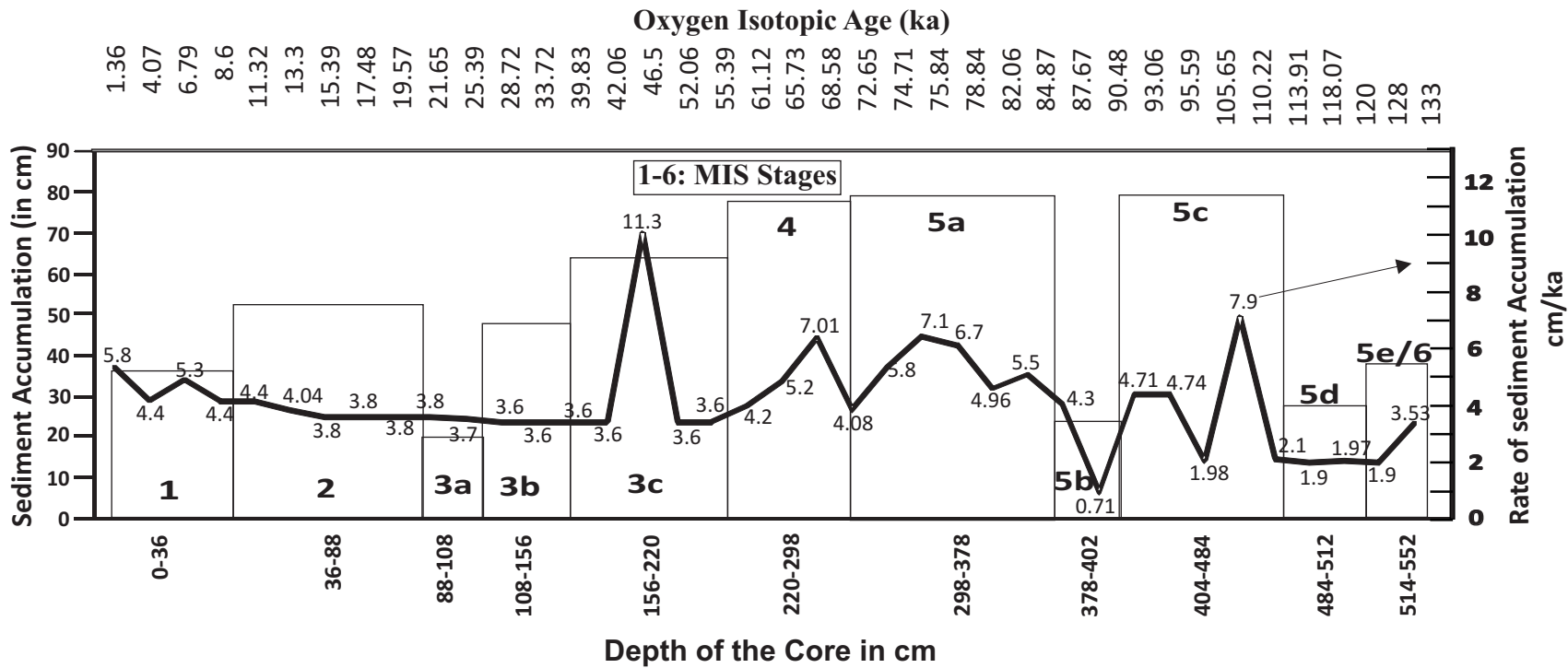
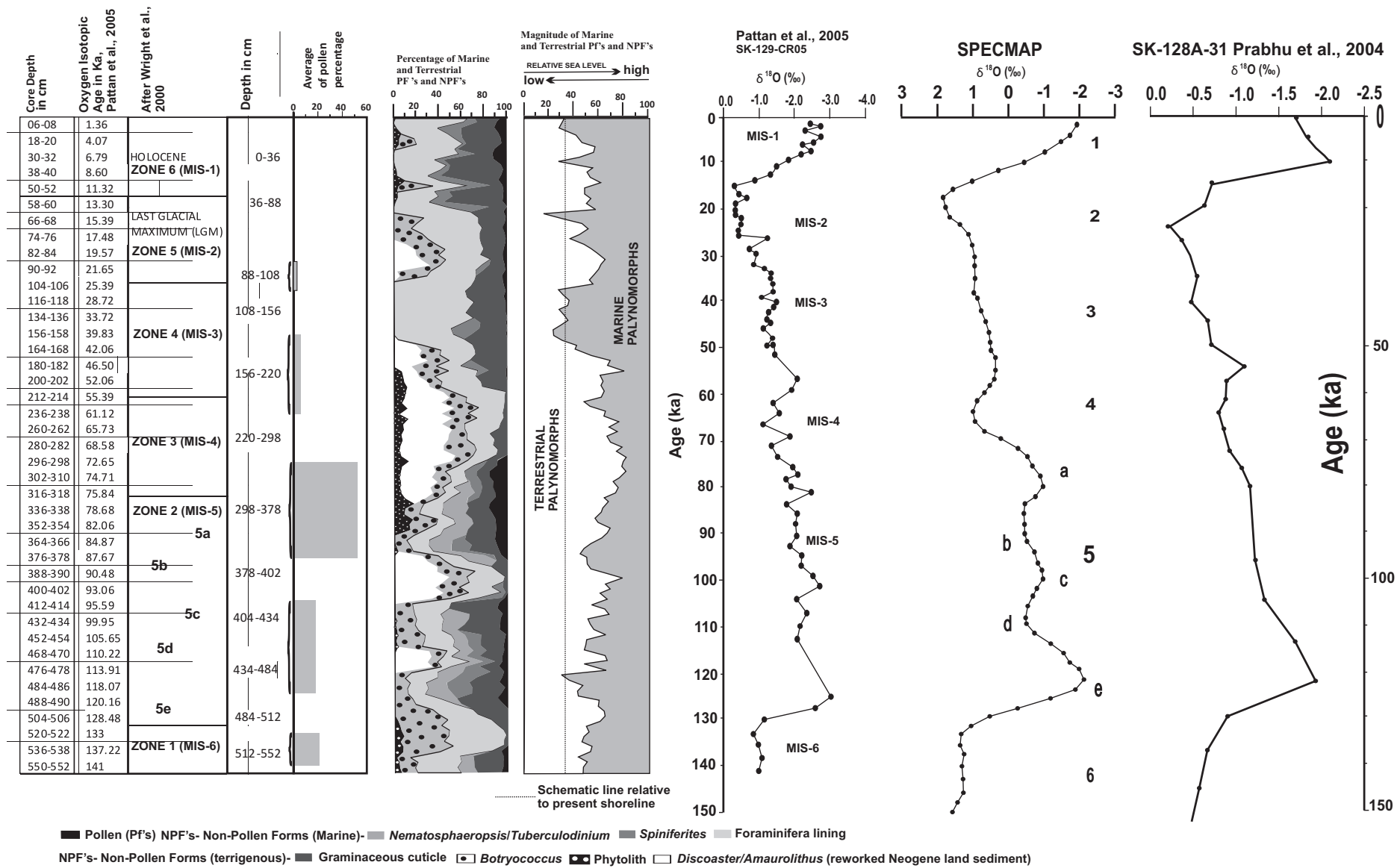


Figure 3



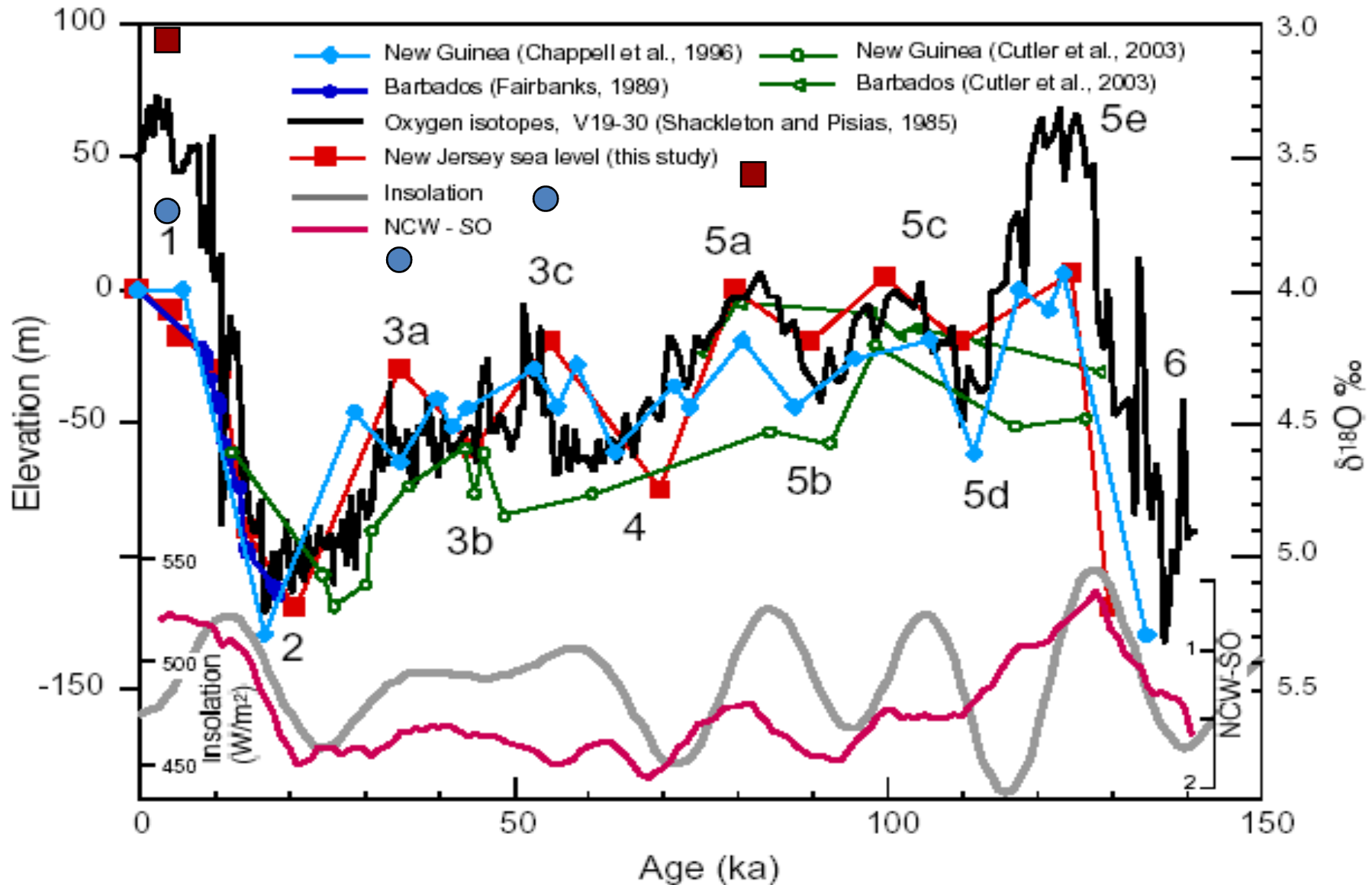
Highlights of palynological study in Sediment core from south-eastern Arabian Sea

- 140 ka pollen record of western ghat rainforest from Arabian sea, India.
- Sea level highstand during MIS-6,5 & Holocene supported by high terrestrial clasts.
- *Ongoeckia gore* relates to Gondwana lineage of rainforest flora in southern India.
- Similar monsoon circulation over South India since the Middle Miocene Climate Optimum.
- Drastic decline in rainforest diversity post LGM

Inferences from Palynological Record related to global Interglacial and Glacial Cycles

● HST & Rainforest in Eastern ghats

■ HST & Rainforest in Western ghats



CONCLUSIONS

- Sea level highstands recorded both on the west coast (MIS 5a) and east coast (MIS 3a & 3c) correlate well with the global records.
- During these periods Rainforest was dominant in western ghats & eastern ghats.
- LGM was most vulnerable period that reduced the vegetation to Savanna grassland in western ghats as well as in most parts of the Indian sub-continent.
- Plants took Refuge in pockets during the glacial periods in favourable areas such as near water bodies, crevices or as riparian forest where soil moisture was sufficient for sustenance.
- Trees such as *Cullenia*, *Dipterocarpus*, *Hopea*, *Shorea*, *Nypa* etc shows its palynological evidence until middle Holocene in east coast as well.
- The advent of Holocene warmer climate and high rainfall rejuvenated the plant refugia in most parts of India which continued until around 3000 yrs. BP.
- A decline in moist forest is evident since ~3-2 ka in most parts of India.
- Several endemic rainforest taxa are at the verge of decline from south-western ghats.
- Rainforest pollen is recorded from Varkala formation (Miocene) along the Kerala coast. The pollen morphology shows its affinity with present day pollen of rainforest present in South-western ghats.
- The Rainforest of south-western ghats shows endemism and is called as fossil flora.
- Our study of Pleistocene record points that the rainforest existed in continuity since Tertiary Period although the species extinction or migration cannot be ruled out.
- The monsoon circulation over southern India was similar since the Middle Miocene Climate Optimum and the flora in the south-Western ghats is a fossil ecosystem.
- During the late-Holocene, shortening in the length of the monsoon season in response to decreasing solar insolation was due to continuous southward migration of mean summer ITCZ (Fleitmann et al., 2007) from 7.8 ka to present. This could be responsible for the climatic changes that have occurred during this duration.

THANK YOU