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Colobinae evolution: Using GIS to map the distribution of leaf monkeys across Southeast Asia over time

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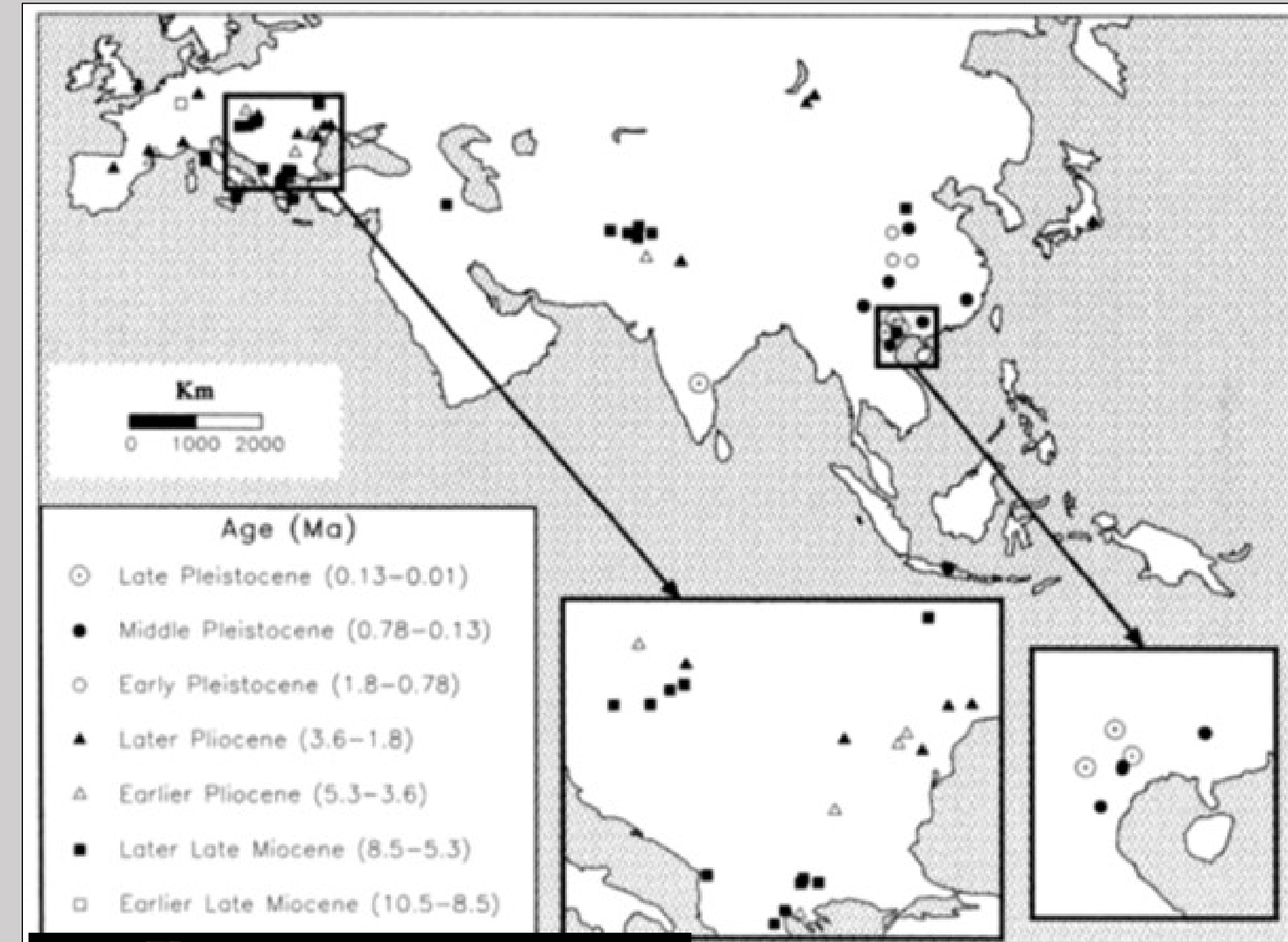
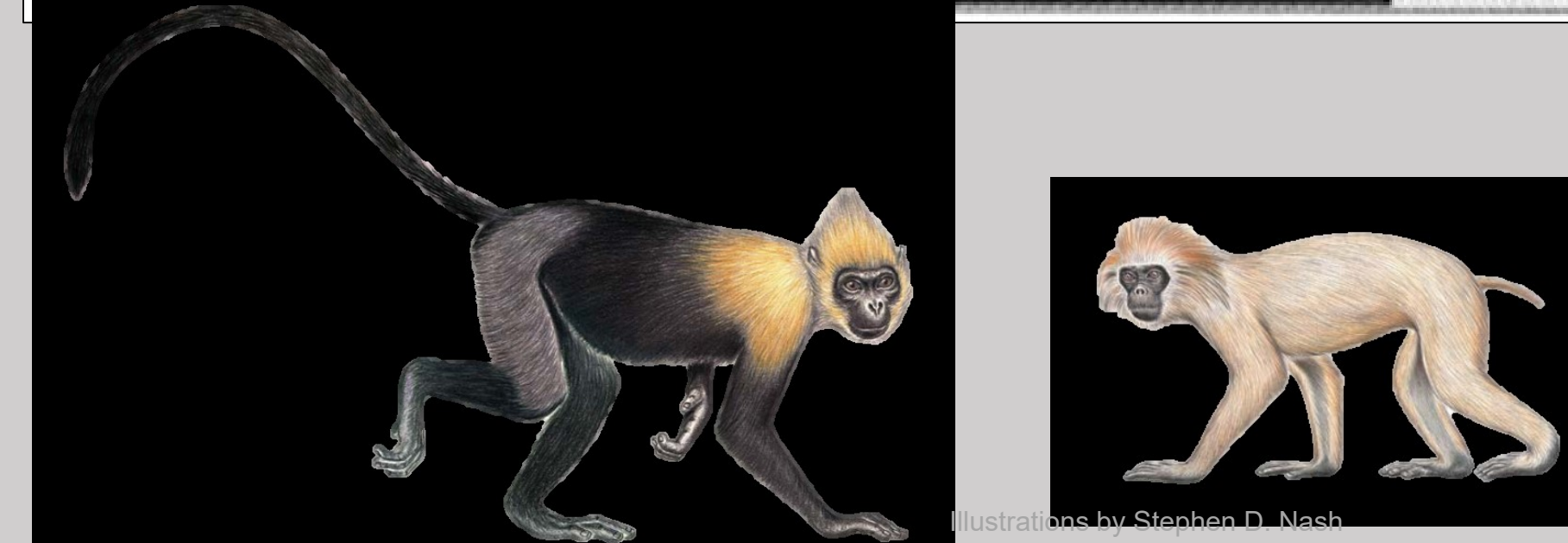MARIE VERGAMINI[1], CHRISTINA MCGRATH[2], LISA M. DAY[2]

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Background Information

The Colobinae, or leaf monkeys, are distributed geographically across Africa and Asia. Colobinae are specialized arborealists and leaf eaters with sacculated stomachs, sheering teeth, reduced thumbs, and very mobile shoulders. Colobinae diverged ~10.9 million year ago (Ma) from the Cercopithecidae in Africa, and Asian colobines appear in the fossil record in the late Miocene ~8.5 Ma. However, an incomplete fossil record means little is known about the evolutionary pressures that led to Asian colobine migration and diversification. Here, we use recent fossil discoveries and geospatial information to develop hypotheses about how geographic barriers played direct roles in Asian colobine evolution.

Map of Eurasian fossil colobines (Delson, 1995)

Age (Ma)
- ⊙ Late Pleistocene (0.13~0.01)
- ● Middle Pleistocene (0.78~0.13)
- ○ Early Pleistocene (1.8~0.78)
- ◇ Later Pliocene (3.6~1.8)
- △ Earlier Pliocene (5.3~3.6)
- ■ Later Late Miocene (8.5~5.3)
- □ Earlier Late Miocene (10.5~8.5)

Research Objective:
Develop an updated distribution map of fossil Colobinae to identify potential areas of evolutionary and biogeographic interest.

GIS Methods

- GPS points for fossil sites were acquired from New and Old Worlds Database of Fossil Mammals
- A CSV file was added to the map project in ArcPro as a standalone table. The XY Table to Point tool was used to create a new point feature class based on x-and-y coordinates defined in the standalone table. The geographic coordinate system was GCS WGS 1984.
- Queries were made from the point feature class layer using the Select by Attributes tool. The selected features were then made into a layer.
- Points were selected to highlight the differences within three groups: Colobinae (Odd-nosed and Langurs) and Cercopithecoids; extinct and extant Colobinae; and the epochs.
- A digital elevation model "Terrain: hillshade" showing natural barriers, a basemap Vintage Shaded Relief, and maps of major watershed, rivers, and terrestrial habitats in the regions were acquired through All Portal.
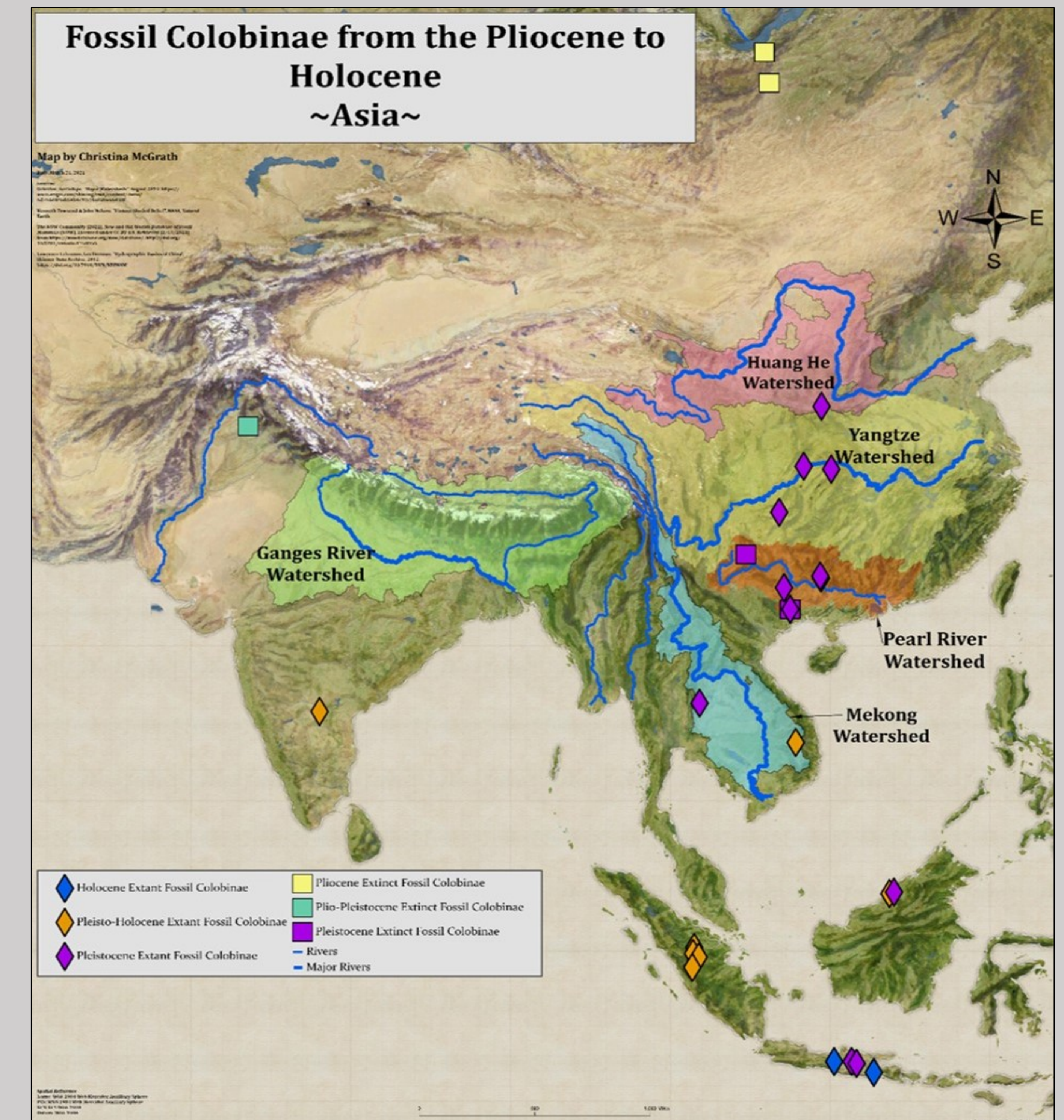
Results and Discussion

- Asian Colobinae split from African Colobinae during the late Miocene, but established species emerged in East Asia during the Pliocene (Roos et al., 2011)
- Overlaying biogeographical information with fossil sites allows us to better visualize areas of interest. Large rivers and mountains were barriers influencing speciation.
- While the extant distributions of Odd-Nose colobines and Langurs overlap in South East Asia, the fossil record suggests speciation occurred in isolated areas of mainland Asia.
- With this visualization, we can pinpoint areas of biogeographic interest, including major rivers, mountains, or forested habitats that likely served as distribution corridors.

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Maps

Fossil Colobinae from the Pliocene to the Holocene
~Asia~
Map by Christina McGrath

Legend:
- ◆ Holocene Extant Fossil Colobinae
- ◆ Pleisto-Holocene Extinct Fossil Colobinae
- ◆ Pleistocene Extant Fossil Colobinae
- Pliocene Extinct Fossil Colobinae
- Plio-Pleistocene Extinct Fossil Colobinae
- Pleistocene Extinct Fossil Colobinae
- Rivers
- Major Rivers

Fossil Langurs and Odd-Nosed Monkeys from the Pliocene to the Holocene
~Asia~
Map by Christina McGrath

Legend:
- ◆ Extant Fossil Langur
- ◆ Extant Fossil Odd-nosed
- ● Extinct Fossil Colobinae

Habitats
- Boreal coniferous forest
- Boreal mountain system
- Boreal tundra woodland
- Subtropical desert
- Subtropical dry forest
- Subtropical humid forest
- Subtropical mountain system
- Subtropical steppe
- Temperate continental forest
- Temperate desert
- Temperate mountain system
- Temperate oceanic forest
- Temperate steppe
- Tropical desert
- Tropical dry forest
- Tropical moist deciduous forest
- Tropical mountain system
- Tropical rainforest
- Tropical shrubland