OPEN ACCESS

ARTICLE IN PRESS

JOURNAL OF ECO ASTRONOMY

Extinction Of Quaternary Mammalian Habitats of Megafauna in Sabaragamuwa Basin, Sri Lanka

[1]Aravinda Ravibhanu Sumanarathna, [2]Jinadasa Katupotha, [3]Kamal Abeywardhana, [4]Buddhika Madurapperuma

[1,3]Department of Research and Innovations, Eco Astronomy Inc.
[2]Department of Geography, University of Sri Jayewardenepura, Sri Lanka.
[4]Department of Forestry and Wildland Resources, Humboldt State University, Arcata, CA, USA.

ABSTRCT

Sri Lanka, a biogeographical relic of Gondwanaland, has emerged as a global hotspot of biodiversity and geodiversity, shaped by its prolonged geological isolation and dynamic climatic evolution. The island's intricate topography, altitudinal gradients, and diverse microclimates have driven extensive speciation processes, fostering high levels of endemism. However, anthropogenic activities and natural perturbations—including habitat degradation, geological events, climatic shifts, over-exploitation, invasive species proliferation, pollution, and disease outbreaks—have precipitated significant biodiversity loss. Despite these challenges, fossilized remains from the Jurassic, Miocene, and Quaternary periods provide critical archives of past biotic assemblages. Of particular significance are the Quaternary fossil deposits (2.58 Ma to 11,700 ybp) within the Sabaragamuwa Basin, which offer profound insights into the region's paleoecology. During the Quaternary, elevated precipitation in the basin supported marsh-adapted taxa, including diverse mammalian communities. However, the Pleistocene epoch was marked by extreme climatic oscillations and geological instability, culminating in the collapse of ecosystems in the Sabaragamuwa region and the extinction of numerous taxa. Current research by Eco Astronomy Inc. focuses on the systematic analysis of Quaternary fossils from alluvial deposits, particularly gem gravels in the Sabaragamuwa Basin. This study aims to document and preserve the paleontological records of the Rathnapura Fauna, shedding light on historical biodiversity and environmental conditions. This paper presents preliminary findings from selected fossil specimens, advancing our understanding of Quaternary paleoenvironments, extinction dynamics, and the evolutionary history of Sri Lanka's biota. These insights underscore the importance of integrating paleontological data with contemporary conservation efforts to mitigate future biodiversity loss in this ecologically unique region.

Article information | Key Words: Sri Lanka, Quaternary, Fossils, Extinction, Megafauna.

Citation

Sumanarathna, A. R., Jinadasa Katupotha, Kamal Abyewardhana, & Buddhika Madurapperuma. (2017). Extinction of quaternary mammalian habitats of megafauna in Sabaragamuwa Basin, Sri Lanka. *Journal of Eco Astronomy*, *01*(01), 16–31. https://ecoastronomy.edu.lk/journal-of-eco-astronomy/vol01-isuue-01-pp-16-31-2017/

DOI: 10.63119/JEA02.2017

ISSN: 3084-8792

Corresponding Author: Aravinda Ravibhanu | email: aravinda.ecoastronomy@gmail.com

Journal of Eco Astronomy | Online Published: 1 January 2017 | Publisher: Eco Astronomy Inc

INTRODUCTION

The Quaternary period, spanning approximately the last 2.58 million years, represents a crucial epoch in Earth's history, characterized by profound climatic oscillations and consequential ecological transformations. This period witnessed the cyclical advance and retreat of continental ice sheets, significantly influencing global biodiversity, faunal adaptations, and evolutionary trajectories. One of the most remarkable phenomena of the Quaternary is the prevalence of gigantism in terrestrial mammals, a subject of extensive interdisciplinary research. The emergence of large-bodied mammals during this period has been attributed to a confluence of environmental, ecological, and evolutionary pressures, including adaptation to colder climatic conditions favoring larger body sizes for thermoregulation, enhanced resistance to predation, and improved foraging efficiency. The fossil record provides compelling evidence of these adaptations, revealing a striking continuity between Pleistocene megafauna and their modern counterparts, a relationship first recognized by Charles Lyell in the early 19th century.

The foundational work of Lyell and subsequent paleontological advancements have significantly refined our understanding of Quaternary biodiversity. Since Lyell's initial observations in the 1830s, the study of Quaternary fossils has progressed through collaborative research under international organizations such as the International Union for Quaternary Research (INQUA), the International Geological Correlation Programmes (IGCPs), and the International Union for Geological Sciences (IUGS). These initiatives have fostered a deeper investigation into the extinction patterns and evolutionary trajectories of Quaternary megafauna. Such studies not only underscore the diversity of extinct marine and terrestrial fauna but also highlight the Quaternary's significance in unraveling the mechanisms driving megafaunal extinctions across diverse geographic regions. By elucidating the interplay of climatic, ecological, and anthropogenic factors shaping these extinctions, Quaternary research offers critical insights into broader patterns of biodiversity loss and ecosystem change throughout Earth's history.

Integral to the Quaternary period, the Pleistocene and Holocene epochs represent dynamic phases of climatic fluctuations, biogeographic shifts, and evolutionary transitions. The Pleistocene epoch (approximately 2.58 million to 11,700 years ago) was marked by cyclical glacial and interglacial phases, significantly influencing faunal dispersal and extinction events. The subsequent Holocene epoch (beginning around 11,700 years ago and continuing to the present) ushered in a period of relative climatic stability, facilitating the expansion of human civilizations and further shaping global biodiversity. The paleontological and paleoanthropological records of these epochs are instrumental in reconstructing past ecological dynamics, evolutionary processes, and the migration patterns of both faunal and hominin populations.

Sri Lanka, located at the southern tip of the Indian subcontinent, is a pivotal region for studying the Pleistocene-Holocene transition due to its strategic position along historical migration routes and its rich fossil-bearing deposits. Fossil remains from this period, predominantly recovered from the alluvial gem-bearing deposits of the Ratnapura District, provide crucial insights into the region’s paleoecology. Alluvial deposits, commonly found in fluvial, coastal, and lacustrine environments, serve as repositories of vertebrate and invertebrate fossils, preserving remnants of ancient ecosystems shaped by hydrodynamic processes. The discovery of faunal remains within these sediments suggests that torrents of water transported biological material into low-lying depositional environments, where they remained preserved for millennia. The faunal assemblages of Sri Lanka exhibit remarkable similarities to those of the Indian subcontinent, particularly the fossil records of the Narmada and Shivalik regions. This biogeographical affinity is attributed to historical land connectivity between India and Sri Lanka, facilitating faunal dispersal during periods of lower sea levels, especially during glacial maxima. Additionally, analogous or closely related faunal species identified in Java, Sumatra, Borneo, and Burma suggest a broader paleo biogeographical framework linking these regions to a once-continuous landmass, potentially influenced by geological events such as plate tectonics and sea-level oscillations.

The Indian subcontinent serves as a crucial repository of paleoanthropological data, encompassing pollen assemblages, isotopic records, vertebrate and invertebrate fossils, and prehistoric lithic artifacts. A significant portion of Quaternary fossil evidence, including hominin specimens, is derived from the fluvial sediments of the Narmada basin and other riverine environments. These deposits provide critical insights into early hominin occupation, faunal interactions, and environmental adaptations amidst Quaternary climate fluctuations. As the Pleistocene climate oscillated between glacial and interglacial stages, sea-level changes profoundly influenced faunal migration patterns, enabling the dispersal of both megafauna and microfauna across newly exposed land bridges. Notably, the last known land bridge connecting Sri Lanka to the Indian subcontinent emerged approximately 7,500 years before present (BP), marking a pivotal point in regional biogeography.

Sri Lanka's paleoanthropological significance is further reinforced by fossil and archaeological evidence retrieved from gem-bearing alluvial deposits and coastal sedimentary formations. Research conducted by Deraniyagala (1958, 1992) has substantiated the presence of diverse vertebrate and invertebrate assemblages alongside prehistoric lithic tools, offering a glimpse into the region’s ecological and cultural past. By integrating geological, paleontological, and archaeological perspectives, the study of Pleistocene and Holocene fossil records in Sri Lanka enhances our broader understanding of faunal evolution, migration dynamics, and early human occupation within the South Asian prehistoric landscape.

METHOD

The process of fossil identification and characterization is a multifaceted scientific endeavor that integrates morphological, anatomical, and geospatial methodologies to reconstruct the evolutionary and geological history of life on Earth. In this study, fossil identification was meticulously conducted based on the analysis of specialized morphological characters inherent to the specimens, complemented by detailed anatomical comparisons. These comparisons were essential for establishing taxonomic relationships and inferring biological affinities, as documented by the Eco Astronomy Inc Research Center in Kuruwita (2015). To contextualize these fossils within the broader framework of Earth's history, relative dating techniques were employed. Relative dating, a cornerstone of stratigraphic analysis, allows for the placement of fossils within the geological time scale by determining the age of an object relative to another, rather than assigning absolute numerical ages. This approach was further refined through the application of biostratigraphy, which utilizes the distribution of fossil assemblages to establish a chronological sequence of sedimentary layers. However, it is important to note that this study did not incorporate numerical dating methods such as radiocarbon dating or thermoluminescence (TL), which provide absolute age estimates. Instead, the research relied on primary sources, including early scientific publications and foundational research, to support the interpretation of fossil data.

To ensure precision in the characterization of fossil specimens, advanced tools such as digital vernier calipers (150 mm: 6 inch) and scale bars were utilized. These instruments enabled the accurate measurement and documentation of specific morphological features, which are critical for taxonomic classification and the identification of evolutionary trends. Additionally, the geographic provenance of the fossil-bearing sites was determined using a Garmin 30 GPS device integrated with BaseCamp GIS software. This geospatial technology facilitated the precise mapping and localization of fossil sites, enhancing the reproducibility and accuracy of the research. Together, these methodologies underscore the interdisciplinary nature of paleontological research, combining anatomical, stratigraphic, and geospatial tools to unravel the complex history of life preserved in the fossil record.

RESULTS and **DISCISSION**

Pleistocene fossils have been discovered in association with the alluvial gem-bearing deposits ("Ratnapura deposits") within the Sabaragamu Basin of the Ratnapura District, Sri Lanka (Fig. 1). These fossil remains were collectively referred to as the "Ratnapura Fauna" by Deraniyagala (1958), who conducted a detailed taxonomic classification and analysis of their paleoecology, paleoclimatology, and paleoenvironment.

Based on Deraniyagala’s paleontological taxonomy, several fossil specimens have been categorized, including the following taxa:

- Reptilia:
    - *Geoemyda trijuga sinhaleyus* (Sri Lankan subspecies of the black pond turtle)
    - *Trionyx punctata sinhaleyus* (Sri Lankan subspecies of the Indian softshell turtle)
    - *Crocodylus sinhaleyus* (Sri Lankan subspecies of the crocodile)
- Mammalia:
    - *Hystrix sivalensis sinhaleyus* (Sri Lankan subspecies of the Sivalik porcupine)
    - *Cuon javanicus sinhaleyus* (Sri Lankan subspecies of the Javan dhole)
    - *Palaeoloxodon namadicus sinhaleyus* (Sri Lankan subspecies of the extinct straight-tusked elephant)
    - *Hypselephas hysudricus sinhaleyus* (Sri Lankan subspecies of the extinct pygmy elephant)
    - *Elephas maximus sinhaleyus* (Sri Lankan subspecies of the Asian elephant)
    - *Rhinoceros sinhaleyus* (Sri Lankan subspecies of rhinoceros)
    - *Rhinoceros kagavena* (another extinct rhinoceros’ species)
    - *Sus sinhaleyus* (Sri Lankan subspecies of wild boar)
    - *Hexaprotodon sinhaleyus* (Sri Lankan subspecies of the pygmy hippopotamus)
    - *Bibos sinhaleya* (Sri Lankan subspecies of the gaur or wild cattle)
    - *Gona sinhaleya* (an extinct bovid species)
    - *Panthera leo sinhaleyus* (Sri Lankan subspecies of the lion)
    - *Panthera tigris* (tiger species from the region)

The documented species constitute a diverse assemblage of extinct Quaternary mammalian megafauna from Sri Lanka, offering valuable insights into the faunal composition and paleoenvironmental conditions of the region during the Pleistocene epoch. Fossil specimens excavated from the Sabaragamuwa Basin between 1990 and 2013 are depicted in Figures 2–8, underscoring the paleontological significance of these findings. The fossils were primarily recovered from gem-bearing gravel deposits within the Sabaragamuwa Basin, specifically at the following sites: Kuruvita, Waladura, Paradise, Parakaduwa, Pohorabawa, Eheliyagoda, Karapincha, Ratnapura, and Pelmadulla.

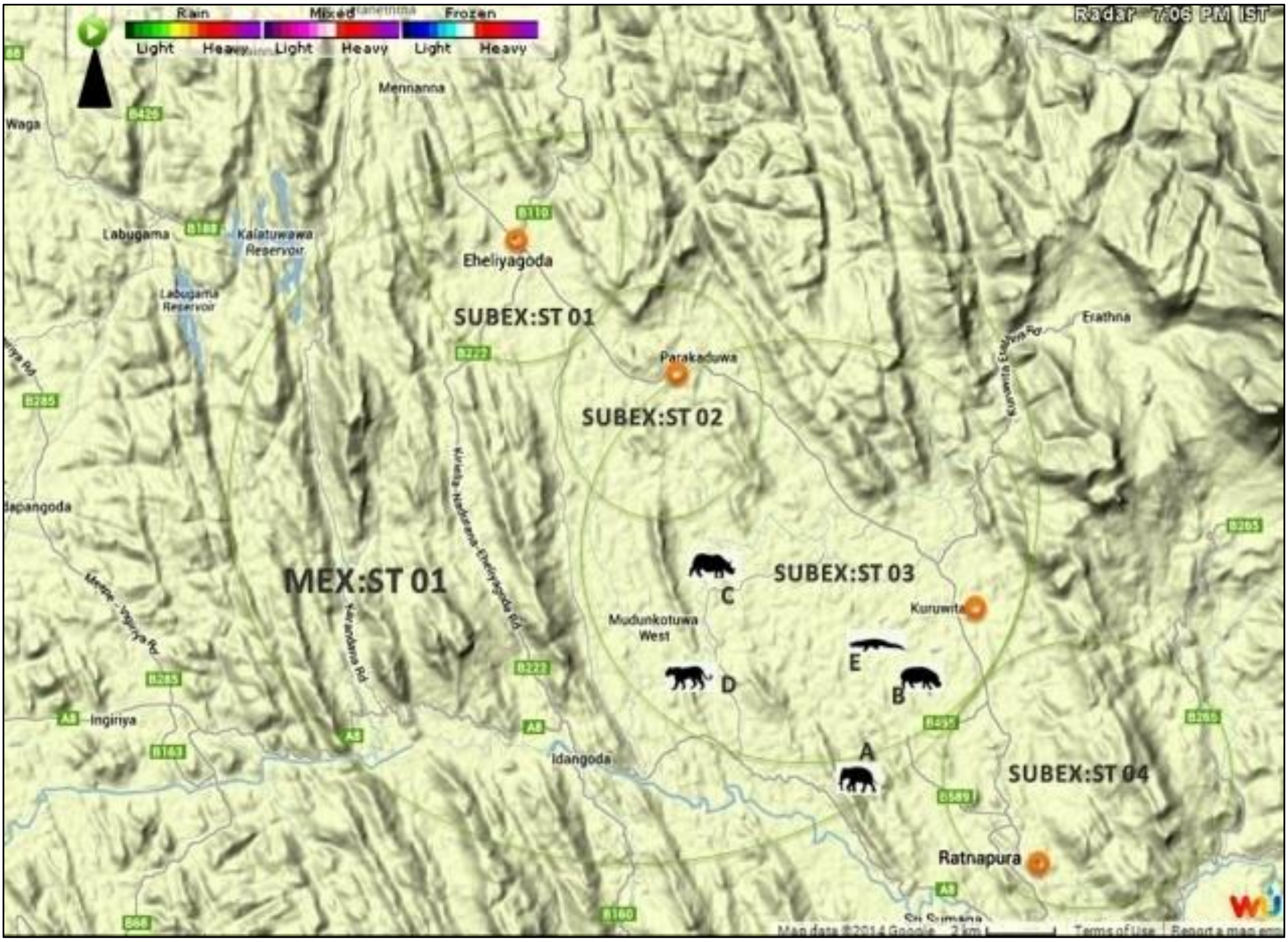

Figure 01: Presents a geological overview of the Sabaragamu Basin, highlighting the extinction patterns and distribution of mammalian species within the region. The study identifies several sub-excavation sites, including Eheliyagoda (SUBEX:ST01), Parakaduwa (SUBEX:ST02), Kuruvita (SUBEX:ST03), and Ratnapura (SUBEX:ST04). The primary excavation site (MEX:ST01) has yielded a significant abundance of Pleistocene megafaunal fossils, with notable taxa including *Elephas* spp. (A), *Hippopotamus* spp. (B), *Rhinoceros* spp. (C), *Panthera* spp. (D) (potentially *Panthera tigris* or *Panthera leo*), and *Crocodylus* spp. (E). These findings contribute to the understanding of prehistoric biodiversity and environmental conditions in the region.

Eco Astronomy Database © 2015

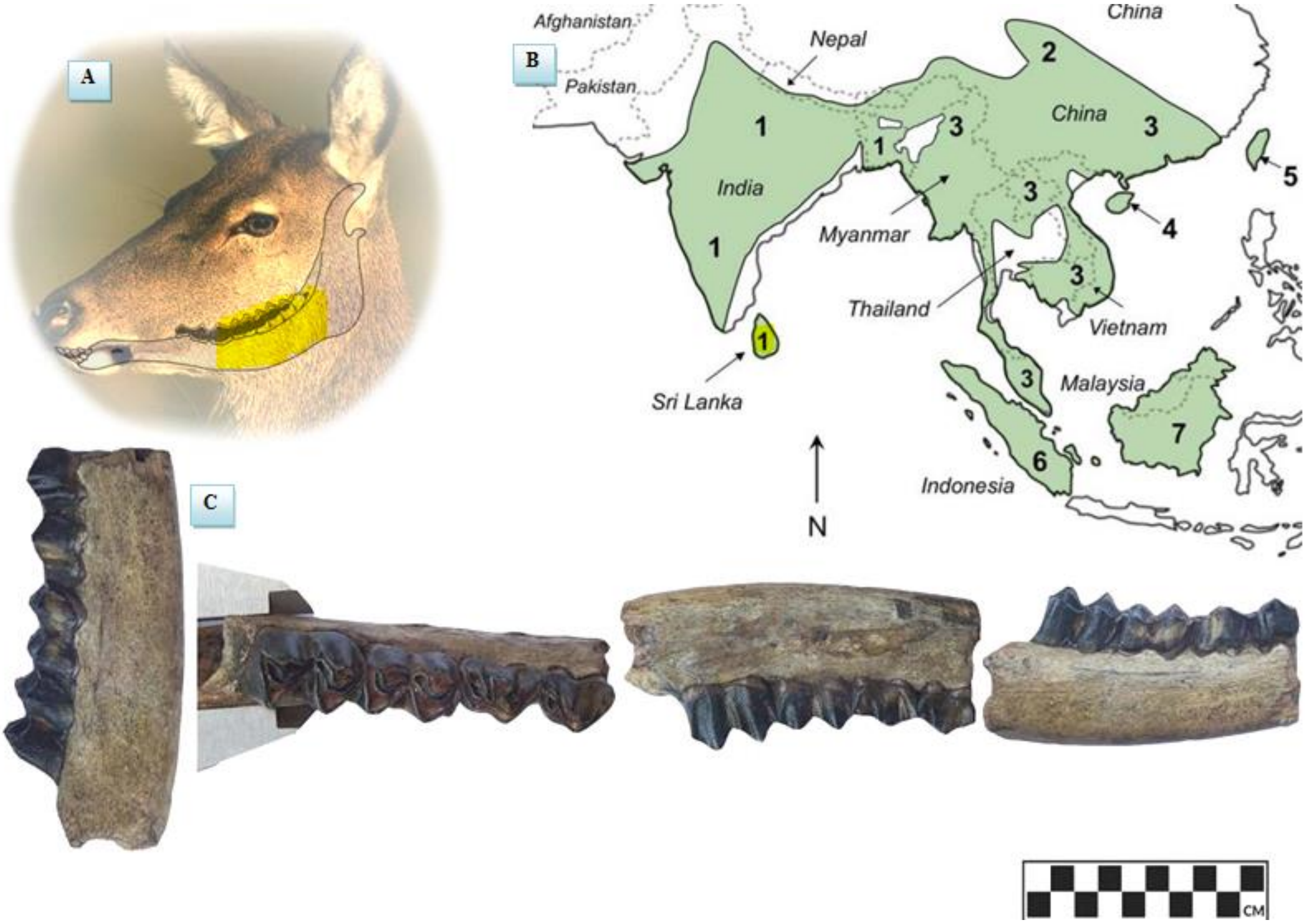

Figure 02: (A) A mature female *Rusa unicolor* and a lateral view of the mandible. (B) The geographical distribution of *Rusa unicolor* across Sri Lanka, India, southern China, and Southeast Asia, highlighting seven recognized subspecies: (1) R. u. unicolor, (2) R. u. dejeani, (3*) R. u. cambojensis*, (4) *R. u. hainana,* (5) *R. u. swinhoii,* (6) *R. u. equina*, and (7) *R. u. brookei*. (C) Fossil specimen *Rusa unicolor* (Catalog No. PSLSA01) – right mandible, displaying the outer (buccal) aspect with two premolars and molars. The fossil was excavated from Edandawela (Gem Pit), Kuruwita, Sri Lanka, as documented by Kamal & Aravinda Ravibhanu ©2007.

The sambar deer (*Rusa unicolor*) is a large cervid species native to the Indian subcontinent, Sri Lanka, South China, and Southeast Asia. It has been classified as a vulnerable species on the International Union for Conservation of Nature (IUCN) Red List since 2008 due to substantial population declines driven by severe hunting pressures, regional conflicts, and extensive habitat loss caused by industrial activities. Fossil evidence suggests that *Rusa unicolor* has a long evolutionary history, with fossilized remains discovered in the Sabaragamuwa region of Sri Lanka. These fossils, dating to the early Pleistocene, exhibit morphological characteristics similar to early deer species from the Pliocene. However, these ancestral forms share fewer similarities with modern cervines. It is hypothesized that the species originated in the tropical regions of southern Asia before expanding to its present distribution. The genera *Epirusa* and *Eucladoceros* have been proposed as potential ancestors of *Rusa unicolor* and its closest relatives.

Recent field observations indicate the absence of extant sambar deer populations in the Sabaragamuwa region, particularly in the vicinity of Paradise Kuruvita, a significant Quaternary fossil site. This shift in distribution is likely attributed to substantial climatic changes that have altered their paleo-habitats. Currently, the Sri Lankan sambar deer primarily inhabit lowland dry forests and montane ecosystems. One of the largest populations is found in Horton Plains National Park, where the species is the most commonly observed large mammal. Conservation efforts are crucial to ensuring the long-term survival of *Rusa unicolor* in the face of ongoing environmental and anthropogenic challenges.

Figure 03: Presents a comparative analysis of various tiger subspecies, fossil specimens, and related species.

Panel A illustrates three tiger subspecies: A1 features the Continental tiger (*Panthera tigris tigris*), A2 showcases the Sunda tiger (*Panthera tigris sondaica*), and A3 presents the Indochinese tiger (*Panthera tigris corbetti*), each distinguished by specific morphological traits. These subspecies represent the diversity within the *Panthera tigris* lineage, with adaptations to their respective ecosystems. Panel B contrasts the cranium and mandible of two extinct carnivores: the Saber-toothed cat (*Smilodon fatalis*, left) and the Bengal tiger (*Panthera tigris*), the latter being approximately related to Sri Lanka's extinct tiger subspecies. This comparison provides insights into the evolution and morphological differentiation between extinct and extant species of large carnivores. Panel C focuses on a fossilized canine tooth found in the right lower mandible of an individual from the *Panthera tigris* or *Panthera leo sinhaleyus* (Fossil No. PSLSA02), located in Galukagama MahaEla, Puwakattaovita (Gem Pit), Kuruwita, Sri Lanka, as documented by Kamal & Aravinda Ravibhanu in 2008. This fossil highlights the presence of a now-extinct tiger or lion subspecies that once roamed the island, contributing to our understanding of the paleontological record of Sri Lanka's megafauna. Finally, Panel D displays a side view of a lion's skull (*Panthera leo*), further expanding the comparison of cranial and mandibular structures across species within the *Panthera* genus.

Panthera leo sinhaleyus**,** or the Sri Lanka Lion, was a prehistoric subspecies of lion endemic to Sri Lanka. Fossils of this lion have been discovered in alluvial deposits at Kuruwita, with the holotype being a third lower left carnassial tooth housed in the Deraniyagala collection at the British Museum (Deraniyagala, 1958). This subspecies appears to have lived during the Pleistocene, with evidence suggesting it became extinct before the arrival of culturally modern humans, around 39,000 years ago. Its geographical range was limited to Sri Lanka, with early evidence indicating that lions originally inhabited both Sri Lanka and India. The Bengal tiger, which later spread into India from the Northeast, likely displaced the lion in the region. Notably, there is a linguistic connection between the African name "Simba," meaning lion, and the Indian equivalent "Simha," suggesting a shared etymological origin. The absence of lion fossils in Africa has led to the hypothesis that the African lion may have evolved from *Panthera leo sinhaleyus*. Fossil evidence of this lion is sparse, with only two teeth definitively identified, further complicating the study of this ancient species. Despite this, researchers such as Manamendra-Arachchi et al. (2005) have noted that Deraniyagala, who first described the subspecies, identified the holotype based on its unique morphological characteristics, specifically its narrower and more elongated shape compared to recent lions. Historically, lions were widespread across Africa, Eurasia, and the Americas, with their range in the Indian subcontinent extending south to 21º N and east to 87º E, as described by Pilgrim (1931) and Dutta (1976). However, the lion's presence in Asia beyond Bengal and in Sri Lanka was restricted to *Panthera leo sinhaleyus*, a distinctive subspecies that provides further insight into the evolutionary history of the lion.

Panthera tigris, the Bengal tiger, is a member of the Felidae family and the largest of the "big cats" in the genus Panthera. Native to India, Bangladesh, Nepal, and Bhutan, the Bengal tiger's evolutionary history provides significant insights into the species' biogeographical patterns. Genetic studies, including those by Kitchener and Dugmore (2000), suggest that tigers arrived in India approximately 12,000 years ago, with evidence of tigers in the fossil record dating back to approximately 2 million years ago. The earliest fossils, originating from northern China and Java, coincide with a time of significant glacial cycles during the Pleistocene, which likely contributed to the geographic isolation and subsequent expansion of tiger populations as they navigated fluctuating environmental conditions. Notably, the most recent common ancestor of tiger mitochondrial DNA (mtDNA) haplotypes was estimated to have lived between 72,000 and 108,000 years ago (Hemmer, 1987; Kitchener and Dugmore, 2000), reflecting the deep evolutionary lineage of the species. During the late Pleistocene, the subcontinent experienced geographic and climatic transformations that further shaped tiger distribution, with fossils from Sri Lanka, although rare, providing key evidence of their presence in the region as recently as 16,500 years ago (Manamendra-Arachchi, 2005). These findings, alongside the discovery of tiger fossils from the island of Ratnapura (Manamendra-Arachchi, 2009), suggest a complex historical presence of tigers across southern Asia. The Holocene range of *Panthera tigris* extends to the southern tip of peninsular India and tropical Asia, although the absence of fossils from Sri Lanka has led to the conclusion that tigers were unable to cross into the island due to the submergence of the India-Sri Lanka land bridge during the Late Pleistocene (Pocock, 1930). The earliest differentiation of the tiger species likely occurred during the early Pleistocene in northern China, with fossil evidence from this period pointing to smaller forms of the species, such as *Panthera palaeosinensis*, which may represent a precursor to the modern tiger (Mazak, 1981). Fossil records of *Panthera tigris* are widespread, with notable findings in Central Asia, northern China, Sumatra, and Java, and more recent remains found in the Caucasus, Borneo, and India (Mazak, 1981). These fossilized remains provide crucial evidence of the tiger's evolutionary trajectory, as well as its historical presence across a wide range of environments throughout the Pleistocene and Holocene epochs.

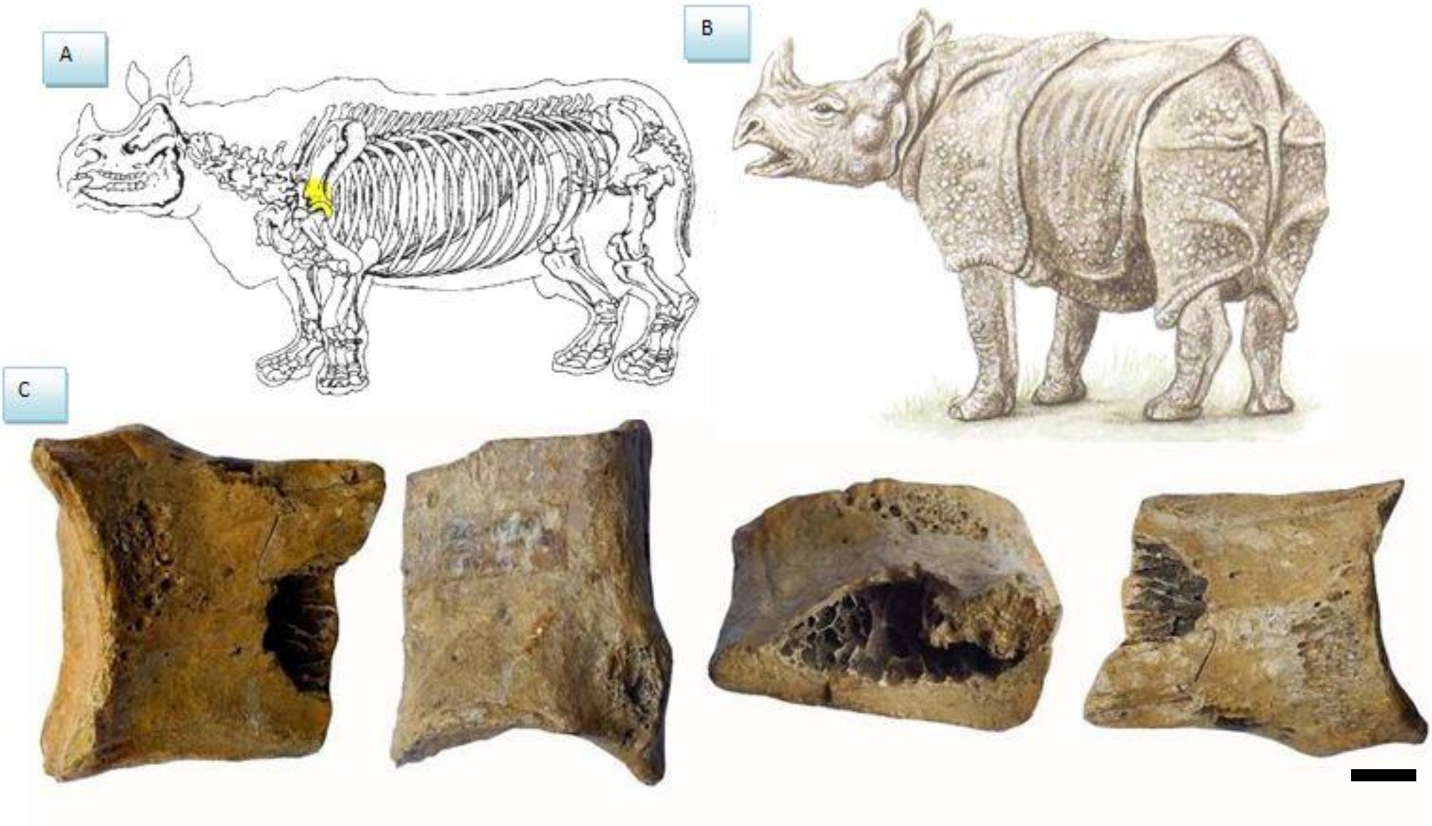

Figure 04: (A): The skeleton of *Rhicocéros unicorne*, showcasing the unique features of this species. (B): *Rhinoceros sondaicus Desmarest 1822*—also known as the Javan rhinoceros or Java-Nashorn—depicted in a historical illustration from Thomas Horsfield's *Zoological researches in Java, and the neighbouring islands* (1824). (C): *Rhinoceros sinhaleyus* (Fossil No PSLSA03), specifically a proximal portion of the scapula, found in Kuruwita, Sri Lanka. This fossil was identified and documented by Kamal & Aravinda in 2007.

The rhinoceros' family is distinguished by several unique characteristics, including their massive size, herbivorous diet, and thick, protective skin made of collagen layers. These large mammals, often reaching weights over one tone, are among the largest remaining megafauna. Despite their size, rhinoceroses possess relatively small brains, weighing between 400 to 600 grams. Their diet primarily consists of leafy materials, but they also possess the ability to digest more fibrous plants, thanks to their hindgut fermentation system. Unlike other perissodactyls, African rhinoceros species lack teeth at the front of their mouths and instead rely on their powerful molars and premolars for grinding plant matter. Most species have two horns, with the Indian and Javan rhinoceros having a single horn. The evolutionary history of rhinoceros' traces back to species like *Rhinoceros unicornis fossilis* and *Rhinoceros kendengindicus*, which lived during the middle Pleistocene. Fossils from these species have been found in regions like the Siwalik beds and Java. Furthermore, the fossil record includes species such as *Rhinoceros sinensis*, which shows intermediate characteristics between the two living species, linking it to *Rhinoceros unicornis*. The fossilized remains also include *Rhinoceros oweni*, an Upper Pliocene species, which is often associated with the genus *Sinorhinus*. This rich fossil evidence indicates the long evolutionary journey of modern rhinoceroses.

Rhinoceroses, also known as rhinos, are large, herbivorous mammals belonging to the family Rhinocerotidae within the order Perissodactyla. This order, predominantly represented in Sri Lanka by the Rhinocerotidae superfamily, consists of large, heavyset creatures that are characterized by their thick, gray to brown skin with minimal hair and one or two upright keratinous horns located on their snouts. The perissodactyls are distinguished by their odd number of toes, a key feature that sets them apart from other mammals.

Research into the fossil record of rhinoceroses has revealed fascinating insights into the evolutionary development of these animals. Deraniyagala (1936) identified two distinct species of rhinoceros in Sri Lanka, with the older and less developed species being *Rhinoceros sinhaleyus*. This species, characterized by squarer and lower teeth, predates the more recently discovered *Rhinoceros kagavena*, a species with more rectangular teeth found in the Ratnapura fauna. According to Deraniyagala's 1958 observations, *Rhinoceros sinhaleyus* went extinct earlier than its successor. Fossils of rhinoceroses, including specimens found in the Kuruwita gem pit near Hiriliyadda, Talavitiya, provide valuable data for understanding the prehistoric environment of Sri Lanka. Although the fossils are undated, they are likely from the Middle Pleistocene era. The discovered form shows minimal differences from *Rhinoceros unicornis*, a species that is also represented in Javanese fossils. Notably, these fossils often occur alongside a race of *Rhinoceros unicornis*, highlighting the presence of multiple rhinoceros' species during the same geological period. The study of rhinocerotids offers significant insights into the ancient biodiversity of both Sri Lanka and the broader Asian and African regions, contributing to the understanding of mammalian evolution. Their fossilized remains serve as crucial evidence of past ecosystems, offering glimpses into the dynamics between different species and their habitats across different geological eras.

Figure 5: First upper molar tooth of *Rhinoceros spp.* (Fossil No. PSLSA06) recovered from the Galukagama, Maha Ela (Gem Pit) site, Kuruwita, Sri Lanka. The specimen was documented by Kamal & Aravinda Ravbhanu (1994).

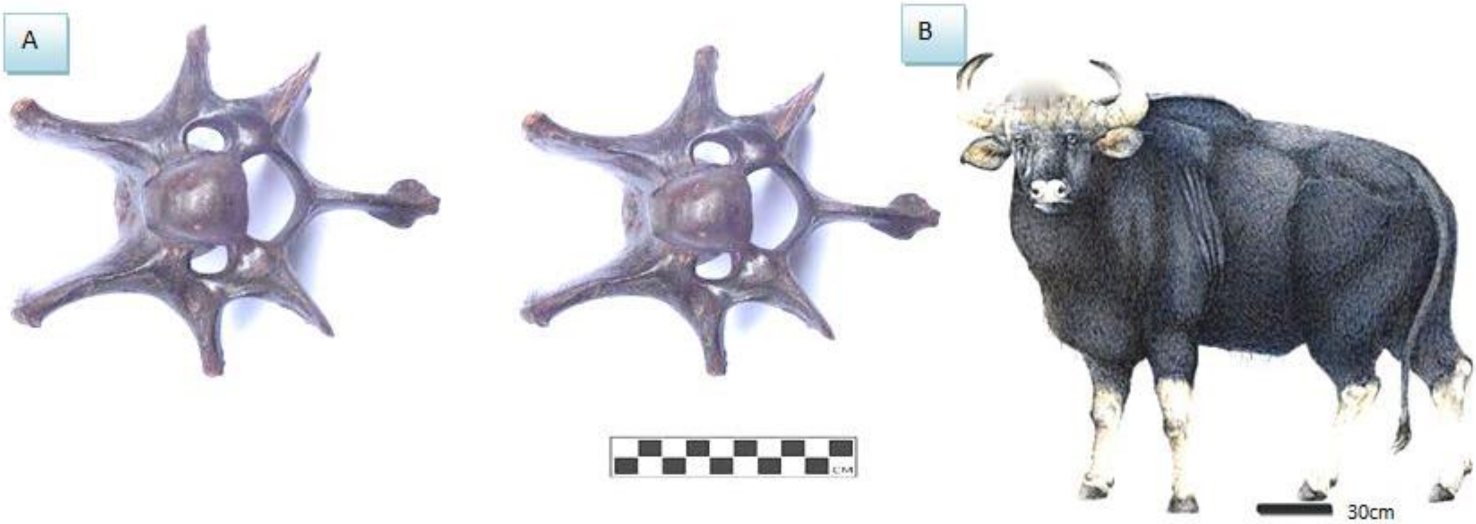

Figure 6. A: Bovine vertebra of *Bibos sinhaleyus* (Fossil No. PSLSA05), found at Ovita Kumbura, Khenagaa West (20 feet below in the gem pit) Kuruwita, Sri Lanka, as described by Kamal & Aravinda (2005). B: Illustration of the Gaur, *Bibos gauris*, also known as the Indian bison.

Figure 7: Molars of Elephas maximus sinhaleyus (Fossil No. PSLSA07) discovered at Mawee Kubura (Gem Pit), Kuruwita, Sri Lanka. Source: Kamal & Aravinda, 1993.

The Asian elephant (*Elephas maximus*) is among the most critically endangered species of large mammals, with its conservation status exacerbated by both natural and anthropogenic factors. As one of the few remaining terrestrial mega-herbivores, it plays a significant ecological role in shaping landscapes, particularly in its native habitats across the Indian subcontinent and Indo-China. The species is geographically distributed across 13 countries, including islands like Sri Lanka, Sumatra, and Borneo, though its population is estimated to number between 35,000 and 55,000 individuals in the wild, far fewer than the African elephant, with only about one-tenth of its population size (Hendavitharana et al., 1994).

Historically, the Asian elephant was more widespread, as evidenced by fossil records. Deraniyagala's (1958) pioneering work on Sri Lankan fossils identified the extinct Sri Lankan elephant as a subspecies, *Elephas maximus sinhaleyus*, characterized by smaller molars, wider mandibular spouts, and the presence of tusks, a feature relatively uncommon among modern Asian elephants. His research also recognized several extinct subspecies, including *Elephas maximus asurus* (Mesopotamia), *Elephas maximus eondaicus* (Java), and *Elephas maximus rubridens* (China). These discoveries emphasize the broader historical distribution of the Asian elephant and its various evolutionary branches. Further fossil evidence links the extinction of ancient elephant species, such as *Hypselephas hysudricus sinhaleyus* and *Elephas hysudricus*, to climatic and environmental changes occurring approximately 100,000 years ago (Deraniyagala, 1937; Manamendra-Arachchi, 2008). Among the most significant finds is the discovery of *Elephas maximus sinhaleyus* fossils in Sri Lanka in 1947, particularly in gem pits near Kuruwita, where the fossils were buried at a depth of 6.5 meters. These remains often occur in association with fossils of other Pleistocene megafauna, such as hippopotamuses and rhinoceroses, particularly in the Gatahatta to Pelmadulla region (Deraniyagala, 1958). The origin of *Elephas maximus* itself has long been debated. Fossils discovered in Sri Lanka in the 1930s provided the first significant insight into its evolutionary history. Earlier, the species was believed to have appeared suddenly and relatively late in the prehistoric timeline (Deraniyagala, 1958). The discovery of *Elephas maximus* fossils in Sri Lanka, as opposed to other regions such as Japan—where fossil records previously misidentified remnants of *Palaeoloxodon namadicus*—suggests that the species evolved from an ancient Plio-Quaternary proboscidean, becoming isolated on the island following its separation from mainland Asia. This isolation, coupled with climate-driven shifts, allowed for the species' subsequent migration during the Pleistocene when the island of Ceylon was temporarily reconnected to the Indian subcontinent. As the Ceylonese elephants moved northward, they eventually encountered the Himalayan mass, spreading eastward to areas near Wallace's Line, which serves as a biogeographical boundary between Asia and Australia (Deraniyagala, 1958).

Over time, the unique evolutionary pressures of this expansive region—spanning from 40 degrees north to 10 degrees south—gave rise to various subspecies of *Elephas maximus*. The evolution of twelve subspecies was driven by significant geographic barriers, including land subsidence, river system alterations, and the isolation created by expanding deserts and mountain ranges (Deraniyagala, 1958). This complex history highlights the adaptive versatility of the Asian elephant, though the ongoing threats to its survival now jeopardize its rich evolutionary legacy. The Asian elephant (*Elephas maximus*) is a species with a geographically distinct distribution across Asia, with three recognized subspecies that occupy different regions of the continent. *Elephas maximus maximus* is confined to the island of Sri Lanka, while *Elephas maximus sumatranus* is restricted to the island of Sumatra. The remaining populations of *E. maximus* are classified under the subspecies *Elephas maximus indicus*, which occupies much of the mainland range in Asia, extending across various countries, including India, Bangladesh, Bhutan, Nepal, and parts of Southeast Asia. This species is recognized for its adaptability to diverse habitats, ranging from tropical forests to grasslands. Fossil evidence shows that the genus *Elephas* has a long evolutionary history, with ten distinct fossil species identified. The earliest evidence of *Elephas* dates back to the middle Pliocene, approximately 4.5 million years ago, in the Ekora beds of southeastern Turkana, Kenya (Shoshani & Eisenberg, 1982). The African continent was home to two of these early *Elephas* species, while three species are believed to have originated in southern Asia, providing valuable insight into the historical distribution and evolutionary development of the genus. These ancient fossils serve as a foundation for understanding the current biogeographical distribution of the species, which reflects both historical and environmental factors shaping the modern Asian elephant's ecological niche.

The deep evolutionary roots of *Elephas maximus* offer critical insights into the dynamics of elephant populations, their migration patterns, and adaptation to varied environmental conditions, providing context for ongoing conservation efforts aimed at preserving the dwindling populations of this magnificent species in the present day.

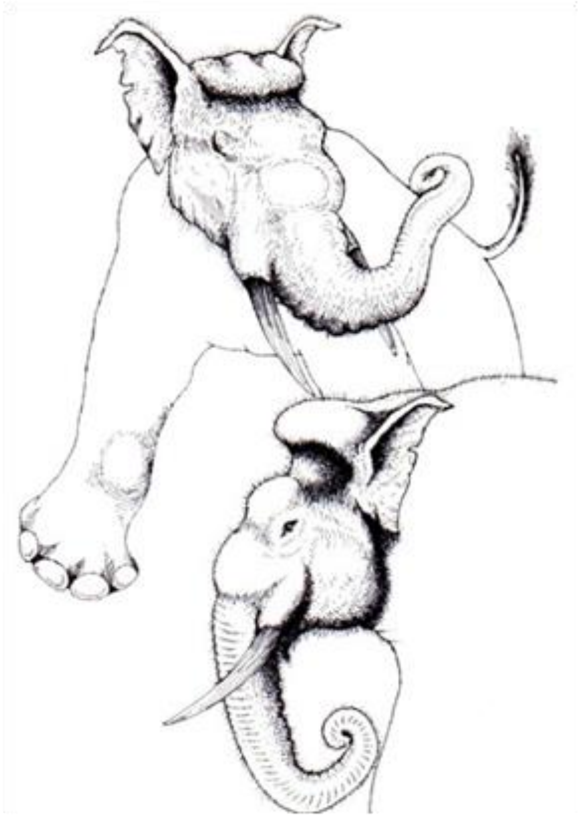

Figure 8: *Hypselephas hysudricus sinhaleyus,* an extinct elephant species native to Sri Lanka, as illustrated by Deraniyagala (1958)

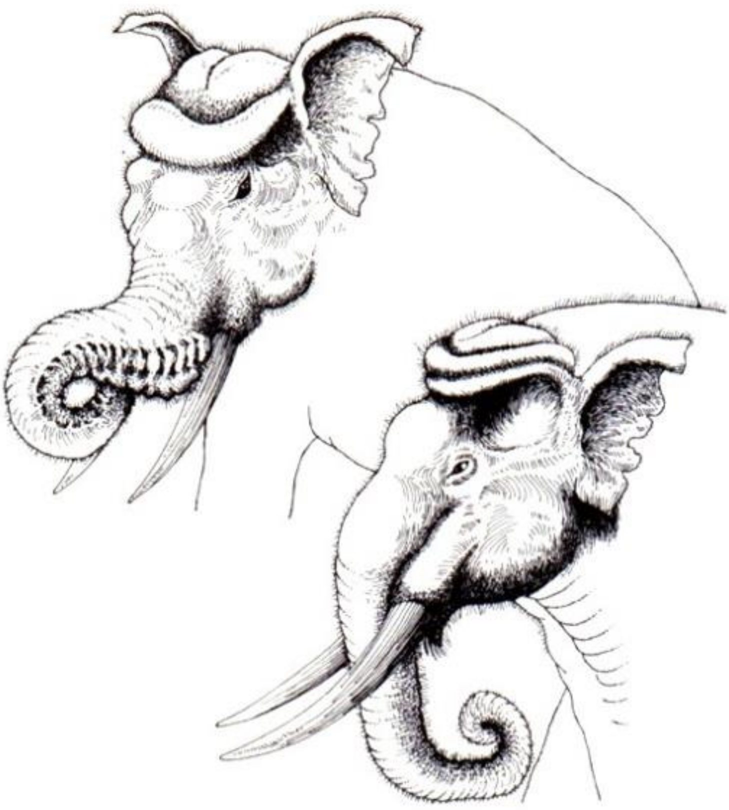

Figure 9: *Palaeoloxodon namadicus sinhaleyus*, an extinct elephant species native to Sri Lanka. Illustration by: Deraniyagala (1958).

The hippopotamus (*Hippopotamus amphibius*), known colloquially as the hippo, is a strikingly large, semi-aquatic mammal that inhabits the rivers and lakes of sub-Saharan Africa. Its name, derived from the ancient Greek "river horse," reflects its close ties to aquatic environments. As one of the largest extant land mammals, second only to the elephant, the hippopotamus holds the distinction of being the heaviest living artiodactyl, despite its significantly shorter stature when compared to the giraffe. While it is predominantly herbivorous, the hippopotamus exhibits a complex social structure, with territorial males presiding over groups of females and juveniles. These groups often number between 5 and 30 individuals, and their lifestyle is intricately tied to the water. During the day, the hippos remain submerged to stay cool, engaging in a solitary feeding routine at dusk when they emerge to graze on grass. Unlike their semi-aquatic resting habits, grazing is a solitary and non-territorial activity, reflecting the species' flexibility in its social and ecological dynamics.

Interestingly, the family *Hippopotamidae* includes another species, the pygmy hippopotamus, and was once home to several now-extinct relatives, including those that once roamed across Ceylon (now Sri Lanka). In the Pleistocene epoch, fossil evidence found by Deraniyagala (1936, 1939, 1944, and 1958) in Sri Lanka reveals the existence of *Hexaprotodon sinhaleyus*, a species of hippopotamus distinct from its African counterparts. Fossilized remains of this animal, including lower jawbones and teeth, suggest that it had six incisor teeth, in contrast to the four seen in modern African hippopotamuses. The discovery of these remains, buried at a depth of 6.5 meters in various sites around the Ratnanapura area, offers a fascinating glimpse into the past. This extinct species is believed to have been a victim of environmental changes, particularly the shift in climate from abundant rainfall and large water bodies to a more arid environment. Such changes are thought to have led to the extinction of the Ceylon hippopotamus, marking the loss of one of the world's heaviest land mammals from the island around the mid-Pleistocene period.

The evolutionary lineage of the hippopotamus extends deep into history. The earliest known fossils, belonging to the genus *Kenyapotamus*, date back to around 80,000 years ago in Africa. The relationship between the hippopotamus and other large mammals, such as the rhinoceros, is also significant, with evidence indicating cohabitation during the Pleistocene. Furthermore, the extinction of the *Hexaprotodon* species, including the Indian hippopotamus which disappeared around 50,000 years ago, points to the dramatic shifts in climate and ecosystems that characterized the middle Pleistocene, providing crucial insights into the forces that shaped the fate of these once-dominant mammals.

The study of these ancient species offers a profound understanding of how climate, geography, and evolutionary pressures have influenced the survival and extinction of large mammals. The unique case of the Ceylon hippopotamus underscores the delicate balance of environmental factors that govern the persistence of species, with implications not only for understanding the prehistoric past but also for the conservation of modern-day relatives.

CONCLUSION

The end of the Pleistocene epoch was characterized by significant climatic changes, leading to the extinction of numerous animal species and the fossilization of their remains within alluvial deposits. The conclusion of the last ice age, approximately 14,000 years ago, has been temporally correlated with global shifts in temperature; however, its direct connection to Earth's axial precession remains uncertain. The Earth's precessional cycle, spanning roughly 26,000 years, influences celestial orientation, with the North Celestial Pole continuously shifting due to the gravitational interactions of the Sun and Moon. These astronomical phenomena have been hypothesized to drive temperature fluctuations, which, in turn, affect extinction patterns, species distribution, and evolutionary trajectories through changes in the geomagnetic field.

Despite the cessation of the Pleistocene, the wave of extinction extended into the Holocene epoch, exacerbated by rising sea levels that profoundly impacted insular ecosystems. Paleontological and sedimentological investigations propose two primary extinction drivers: natural climate change and anthropogenic overkill. The rapid technological and cultural advancements of Homo sapiens, who emerged in the Middle Pleistocene and expanded across previously uninhabited territories in the Late Pleistocene and Holocene, significantly influenced megafaunal decline. The 'Ratnapura Fauna,' an assemblage representing three elephant species, two rhinoceros species, and additional taxa such as hippopotamus, lion, tiger, gaur, wild dog, wild boar, black turtle, and soft-shelled terrapin, underwent complete extinction. Notably, while Younger Dryas-type impact events contributed to this biodiversity loss, additional anthropogenic and ecological pressures further accelerated the extinction process Several mechanisms contributed to this widespread megafaunal loss, including: Habitat Loss and Fragmentation: The destruction or alteration of natural environments, reducing species' viable living spaces. Overexploitation: Excessive hunting and resource extraction leading to population collapse. Invasive Species Introduction: The displacement of native species by non-native competitors, disrupting ecological balances. Coextinction Events: The extinction of interdependent species due to trophic chain disruptions. Demographic and Genetic Factors: Small population sizes increasing vulnerability to stochastic extinction pressures. Climate Change: Rising temperatures and sea levels leading to resource scarcity and habitat unsuitability.

The Sabaragamuwa Basin, a key paleontological and geological site, exhibits extensive exposure to weathering and erosion processes. Investigations of alluvial, residual, and fluvial deposits in the Kuruvita Paradise region reveal substantial fossil preservation. The activation of alluvial and fluvial fan systems during the Quaternary period significantly influenced sediment deposition, yielding fossilized remains at depths ranging from 2 meters to 90 meters within the Sabaragamuwa Province. Notably, large tree trunks, suggestive of a sunken forest, have been discovered within these deposits at depths of 5 to 50 meters, indicative of significant geomorphic and climatic transitions.

The migratory behavior of megafauna during the Quaternary underscores Sri Lanka's biogeographical connectivity with the Indian subcontinent. Fossil evidence suggests the movement of large terrestrial fauna across a corridor spanning Sabaragamuwa, Muthurajawela, Talaimannar, and Adam's Bridge, linking Sri Lanka to India. Genetic studies indicate potential phylogenetic correlations between Sri Lanka's extinct megafauna and contemporary species in India, Africa, and Southeast Asia. However, to confirm these evolutionary linkages, further investigations utilizing absolute dating techniques and ancient DNA analysis are required. The preservation challenges inherent to the Sabaragamuwa Basin, where fossil samples are primarily found in altered geological contexts, complicate DNA extraction and genomic reconstruction efforts.

Future interdisciplinary research combining paleontology, sedimentology, geochronology, and molecular biology is crucial for unraveling the complex history of megafaunal extinctions and their ecological consequences. Such studies will not only enhance our understanding of past biodiversity shifts but also provide critical insights into contemporary conservation strategies in the face of ongoing climate change and anthropogenic pressures.

The Ratnapura phase represents a critical period in paleoecological history, marked by an extensive assemblage of vertebrate fauna indicative of a diverse and dynamic environment. The paleontological evidence suggests that the extinct vertebrates of this phase inhabited a heterogeneous landscape consisting of savannah ecosystems interspersed with dense rainforest regions, extensive riverine systems, and large lacustrine bodies fed by substantial precipitation. This environmental complexity provided a range of ecological niches, supporting a diverse faunal community adapted to varying hydrological and vegetative conditions.

Hydrological and Climatic Conditions: The presence of vertebrate species associated with both torrential riverine systems and lentic water bodies indicates significant hydrological variation. The existence of species such as *Melanochelys trijuga sinhaleyus* (black turtle) and *Lissemys punctata sinhaleyus* (soft-shelled terrapin) suggests the presence of slow-moving water bodies and swampy habitats, whereas *Crocodylus sinhaleyus* (crocodile) likely occupied both freshwater rivers and adjacent terrestrial environments. These hydrological conditions were largely sustained by heavy monsoonal rainfall, contributing to the dynamic and interconnected ecosystem structure.

Mammalian Fauna and Ecological Dynamics: The mammalian assemblage of the Ratnapura phase highlights the presence of both apex predators and diverse herbivorous species. The identification of *Homo sapiens* suggests human interaction within this paleoenvironment, potentially influencing faunal distributions and ecological interactions. The presence of large carnivores such as *Panthera tigris* (tiger) and *Leo sinhaleyus* (lion) implies a well-structured trophic hierarchy with significant predation pressures exerted on herbivore populations. Additionally, *Cuon javanicus sinhaleyus* (wild dog) and *Hystrix sivalensis sinhaleyus* (porcupine) reflect adaptations to mixed forest and grassland environments, further corroborating the savannah-rainforest mosaic hypothesis. Among the large herbivores, the diversity of proboscideans such as *Hypselephas hysudricus* (now classified under *Elephas* sp.) and *Palaeloxodon namadicus* suggests the presence of both open grasslands and dense woodland areas capable of supporting megafauna. Rhinocerotids, represented by *Rhinoceros kagavena* and *Rhinoceros sinhaleyus*, further indicate the prevalence of both forested and floodplain environments conducive to their browsing and grazing requirements. The presence of *Hexaprotodon sinhaleyus* (hippopotamus) reinforces the significance of extensive aquatic ecosystems within the Ratnapura phase.

Ungulate Community and Habitat Inference: The ungulate species present during this phase provide insight into the vegetation structure and primary productivity of the landscape. *Rusa unicolor* (sambar deer) and *Axis axis* (spotted deer) signify a mixed woodland-grassland habitat with sufficient undergrowth for foraging. The discovery of *Bos sinhaleyus* (gaur), *Bubalus bubalus* (wild buffalo), and *Gona sinhalaya* (wild cattle) supports the hypothesis of extensive grazing lands interspersed with water sources. These large herbivores likely played a role in maintaining open landscapes through their grazing activities, further shaping the ecosystem.

Eminent paleontologist, zoologist, and artist, Deraniyagala of Sri Lanka, has extensively specialized in the study of fauna and human fossils of the Indian subcontinent. His contributions have provided significant insight into the evolutionary history of the region, with a focus on the complex interplay between climatic variations and biotic responses over geological time scales. Jurassic and Miocene fossils found in Sri Lanka are particularly valuable for comparative analyses with those from other global locations. These fossils serve as critical markers for understanding evolutionary adaptations under shifting climatic regimes. However, the entire island has undergone Quaternary glacial cycles, characterized by alternating phases of glacial advances and retreats. These changes contributed to drastic environmental fluctuations, including warmer, cooler, and drier climatic conditions, all of which have played a pivotal role in shaping the evolution of hominids and associated cultures, as well as influencing megafaunal extinctions, sediment deposition, and soil formation processes.

Evolutionary Processes and Species Adaptation: As a consequence of these evolutionary pressures, some ancestral species from earlier geological periods faced extinction, while others adapted to new environmental conditions, leading to the emergence of novel taxa. The interplay between climatic variability and biotic responses in Sri Lanka provides a unique lens through which scientists can examine speciation events and ecological adaptations over geological timescales.

Pleistocene Flora and Its Preservation Challenges: The Pleistocene flora of Sri Lanka has been primarily studied through pollen analysis and fossilized plant fragments obtained from alluvial deposits, particularly from gem pits. Puri (1941) documented a cylindrical monocotyledonous stem fragment identified as *Bambusa vulgaris* from the Ratnapura beds. Additionally, a dicotyledonous leaf from the same bed was classified as *Wrightia flavido-rosea*. Further pollen analyses by Vishnu-Mittre and R.D. Robert (1965) in soil samples from Ellavala, Ratnapura District, revealed an arboreal vegetation dominated by Myrtaceae, with substantial undergrowth comprising *Strobilanthes*.

Other identified vegetation included taxa from families such as Moraceae, Sapindaceae, Anacardiaceae, and Rutaceae. Ground vegetation was composed of Gramineae, Cyperaceae, Geraniaceae, and *Impatiens*, alongside species from Caryophyllaceae and Labiatae. Ferns such as *Adiantum*, Polypodiaceae, *Polypodium*, and *Pteris* were also identified. Chowdhury (1965) documented additional wood remains from Upper Pleistocene gem pits in Sabaragamuwa, identifying *Mesua* sp. (47,000 BP) from Pelmadulla and *Lagerstroemia speciosa* (7520 ± 150 BP) from Balahapuva. The relative scarcity of Pleistocene flora within gem deposits is likely due to the rapid decomposition of organic material in alluvial soil conditions. Notably, pollen studies on cave deposits remain underexplored, though seed sieving methods have successfully identified species such as *Canarium* sp., *Cyathea* sp., *Artocarpus* sp., and *Elaeocarpus* sp., primarily due to their robust seed structures.

Despite the significant paleontological discoveries made in Sri Lanka, there remains a glaring absence of legislative frameworks dedicated to the protection and preservation of fossils. As a consequence, the rich paleo-biodiversity heritage of the island is under continuous threat, primarily due to anthropogenic activities. This issue is particularly pressing in regions such as the Sabaragamuwa Basin, where a wealth of Pleistocene-era fossils has been identified.

The gem mining industry in Sri Lanka, particularly in the Sabaragamuwa Basin, has played a pivotal role in the destruction of invaluable fossil specimens. The widespread use of mechanized excavation equipment, such as JCB machines, has accelerated the degradation of fossilized remains that provide critical insights into the prehistoric flora and fauna of the region. The uncontrolled extraction of gem-bearing sediments has not only led to the loss of these paleontological artifacts but has also significantly disrupted the stratigraphy of the fossil-bearing deposits.

Recognizing the urgency of this issue, Eco Astronomy Inc., an organization committed to the conservation of paleo-biodiversity, initiated efforts to systematically document and preserve the fossils discovered in the Sabaragamuwa Basin from 1990 to 2013. As a foundational step, the organization has compiled and disseminated critical research findings on these fossils through peer-reviewed scientific publications. These research contributions serve as essential references for both academia and conservation policymakers.

In addition to scholarly documentation, Eco Astronomy Inc. has devised a comprehensive strategy to exhibit and safeguard the fossilized remains through the "Project Batadomba Cave Geo-Tourism" initiative. This project aims to integrate fossil conservation with sustainable tourism, thereby fostering greater public awareness and appreciation for Sri Lanka's paleontological heritage. The initiative is being carried out in collaboration with provincial councils and relevant government agencies, ensuring a coordinated approach to conservation and geo-tourism development.

The need for a robust fossil preservation framework in Sri Lanka is more critical than ever. Given the scientific importance of these fossils in reconstructing past ecosystems and understanding evolutionary processes, the establishment of legislative protection and conservation policies is imperative. Through interdisciplinary efforts that combine conservation science, policy-making, and community engagement, Sri Lanka has the potential to safeguard its paleo-biodiversity heritage for future generations.

REFERENCES

1. Chauhan, P.R. 2008. Large mammal fossil occurrences and associated archaeological evidence in Pleistocene contexts of peninsular India and Sri Lanka (abs). *Quaternary International*, 192(1): 20-42.

2. Corbet, G.B. & Hill, J.E. 1992. *The Mammals of the Indo-Malayan Region: A Systematic Review*. Natural History Museum Publications, Oxford University Press.

3. Daniel, B.F. 2011. Quaternary. *Encyclopædia Britannica*. Retrieved from http://www.britannica.com/EBchecked/topic/486563/Quaternary.

4. Deraniyagala, P.E.P. 1955. *Some Extinct Elephants, Their Relatives and the Two Living Species*. Director of Museum, Ceylon.

5. Deraniyagala, P.E.P. 1958. *The Pleistocene of Ceylon*. Ceylon National Museums, Colombo. ix+164 pp., 58 pl.

6. Deraniyagala, P.E.P. 1963. Some mammals of the extinct Ratnapura Fauna of Ceylon Part V, with reconstructions of the hippopotamus and the gaur. *Spolia Zeylanica*, 30: 5–25, pls. 1–5.

7. Deraniyagala, S.U. 1992. *The Prehistory of Sri Lanka: An Ecological Perspective*. Memoir 8, 2nd ed. Archaeological Department, Colombo. 813 pp.

8. Deraniyagala, S.U. 2001. *The Prehistory of Sri Lanka: An Ecological Perspective: Addendum 1B*. Retrieved from www.the-prehistory-of-sri-lanka.de, accessed 15 Feb. 2005.

9. Deraniyagala, S.U. 2004. *Prehistoric Basis for the Rise of Civilization in Sri Lanka and Southern India*. Sri Lanka Deputy High Commission in Chennai. 28 pp.

10. Desa, M., Ramana, M.V., & Ramprasad, T. 2006. Seafloor spreading magnetic anomalies south off Sri Lanka. *Marine Geology*, 30: 227-240.

11. Garmin 30 Satellite-Based Navigation System, 2010. Retrieved from http://www.garmin.com/us/maps.2013.

12. Gary, H. 2007. A review of some attacks on the overkill hypothesis, with special attention to misrepresentations and doubletalk. *Quaternary International*, 169–170: 84–94.

13. Hendavitharana, W., Dissanayake, S., de Silva, M., & Santiapillai, C. 1994. The Survey of Elephants in Sri Lanka. *Gajah - Journal of the Asian Elephant Specialist Group*, 12: June 1994.

14. Hemmer, H. 1987. The phylogeny of the tiger (*Panthera tigris*). Pp 28-35 in R.L. Tilson & U.S. Seal, (eds). *Tigers of the World: The Biology, Biopolitics, Management, and Conservation of an Endangered Species*. Noyes, Park Ridge, New Jersey.

15. IUCN & MOENR. 2007. *The 2007 Red List of Threatened Fauna and Flora of Sri Lanka*. Prepared by The World Conservation Union (IUCN) in Sri Lanka and the Ministry of Environment and Natural Resources (MOENR).

16. Katupotha, J. 1995. Evolution and geological significance of Holocene emerged shell beds on the southern coastal zone of Sri Lanka. *Journal of Coastal Research*, 11(4): 1042-1061.

17. Katupotha, J. 2013. Palaeoclimate change during Glacial Periods: Evidence from Sri Lanka. *Journal of Tropical Forestry and Environment*, 3(1): 42-54.

18. Lamar, A.T. 2009. A Geochemical Paleoecological Analysis of Miocene Mammalian Mega Fauna of Fort Polk, Louisiana. *A Thesis Submitted to the Graduate Faculty of Louisiana State University and Agricultural and Mechanical College*, 2006-2009.

19. Landsat Data, 2013. SIO, NOAA, US Navy, NGA, GEBCO with imported Garmin 30 waypoints.

20. Manamendra-Arachchi, K., Pethiyagoda, R., Dissanayake, R., & Meegaskumbura, M. 2005. A second extinct big cat from the late Quaternary of Sri Lanka. In: Yeo, D.C.J., K.L. Ng & R. Pethiyagoda (eds.) *Contribution to Biodiversity Exploration and Research in Sri Lanka*. *The Raffles Bulletin of Zoology*, 12: 423-434.

21. Manamendra-Arachchi, K.N. 2012. Nuthana manayawa "Apprikawen nikmayana niyaaya" saha Bundala pathirajawela. *Welipila Archaeological Magazine*, 8: Central Cultural Fund, pp. 23 -36.

22. Norman, A., Bassam, A., & von Khalaf-Sakerfalke, J.T. 2008. The Sri Lanka leopard (*Panthera pardus kotiya*, Deraniyagala 1956). *The Palestinian Biological Bulletin*, 76: April 2008.

23. Olaf, B.R.P., Marcel, C., Kate, J.E., Ross, M.D.E., Beck, B.M.D.R., Richard, G., Samantha, P.A., Rutger, V.A., John, G.L., & Andy, P. 2007. The delayed rise of present-day mammals. *Nature*, 446.

24. Robin, G. 2004. Examining the extinction of the Pleistocene megafauna. *Stanford Undergraduate Research Journal*, 22-27.

25. Sumanarathna, A.R., Pathmakumara, J., Abyewardanana, K., & Sudasinghe, A. 2015. Paleontological evidences of Pleistocene, interpret the coming of intelligence & harbor life of planet earth. *International Journal of Advanced Research in Science, Engineering & Technology*, 2(11): 1063-1070.

26. Sumanarathna, A.R., Pathmakumara, J., Abyewardanana, K., & Sudasinghe, A. 2016. Eco Astronomy & Paleontology May Interpret the Harbored Life of the Planet Earth; A Study from Sri Lanka. *The Royal Asiatic Society of Sri Lanka, Annual Research Conference 2016*, pp. 61.

27. Sumanarathna, A., Madurapperuma, B., Kuruppuarachchi, J., et al. 2016. Morphological Variation and Speciation of Acavidae Family: A Case Study from Fossil and Living Species of Batadombalena Cave Pre-historic Site in Sri Lanka. *Annals of Valahia University of Targoviste, Geographical Series*, 16(2), 59-68. Retrieved 11 Nov. 2016, from doi:10.1515/avutgs-2016-0005.

28. International Chronostratigraphic Chart 2015. Retrieved from www.stratigraphy.org.

29. Image Landsat Data, 2013. SIO, NOAA, US Navy, NGA, GEBCO with imported Garmin 30 waypoints.

9 773084 879008

Scan me!

ISSN 3084-8792

JOURNAL OF ECO ASTRONOMY

Extinction Of Quaternary Mammalian Habitats of Megafauna in Sabaragamuwa Basin, Sri Lanka.

Citation: Sumanarathna, A. R., Jinadasa Katupotha, Kamal Abyewardhana, & Buddhika Madurapperuma. (2017). Extinction of quaternary mammalian habitats of megafauna in Sabaragamuwa Basin, Sri Lanka. *Journal of Eco Astronomy*, *01*(01), 16–31. https://ecoastronomy.edu.lk/journal-of-eco-astronomy/vol01-isuue-01-pp-16-31-2017/