

A Study of Pleistocene Rhinoceros in Sri Lanka based on the Fossilized Teeth found in a gem mine in the Kuruwita Area

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ශ්‍රී ලංකාවේ වාසය කළා යැයි සැලකෙන කඟවේනා හෙවත් රයිනෝසිරස් පිළිබඳ තොරතුරු හමුවන්නේ කුරුවිට ඇතුළු දිවයිනේ ප්‍රදේශ කිහිපයකින් පමණි.. මෙම සතුන් ප්ලයිස්ටෝසීන යුගයේදී විසූ බවට සාදක හමුවේ. වර්තමානයේදී කඟවේනා හෙවත් රයිනෝසිරස් සත්වයෝ ජීවත් වන ශ්‍රී ලංකාවට ආසන්නතම රට වන්නේ ඉන්දියාවයි. එම රටෙහි මෙම සතුන් වර්ග දෙකක් පමණ වාසය කරති. ශ්‍රී ලංකාවෙන් හමුවන රයිනෝසිරස් සත්වයෝ වර්තමාන ඉන්දියාවේ ජීවත්වන සතුන්ට සමාන වෙති. මෙම පර්යේෂණයේදී අප විසින් ප්‍රධාන වශයෙන් අධ්‍යයනය කරනු ලබන්නේ කුරුවිට ප්‍රදේශයේ මැණික් පතල්වලින් හමුවන රයිනෝසිරස්ට අයත් දත් වර්ග හා අනිකුත් අස්ථි වර්ග මත පදනම් වී ඇති තොරතුරුය. මෙම අධ්‍යයනයේදී එම සතුන් සැවානා පරිසරවල ගංගා සහ ස්වභාවික ජලාශ ආශ්‍රිතව ජීවත්ව සිටි බව හඳුනාගන්නට යෙදුණි. දැනට ලැබී ඇති දත් ආශ්‍රයෙන් මෙම සතුන් වැඩිහිටි සතුන් ලෙස සැලකිය හැකිය. මෙම සාධක හමුවන්නේ මීටර් පහළොවක් පමණ ගැඹුරු මැණික් පතල් වලිනි. එම දත් පොසලකරණයට ලක්ව ඉතා හොඳින් ආරක්ෂා වී තිබේ. මොවුන් සම්බන්ධ බොහෝ අස්ථි සාධක පතල් ආශ්‍රිතව කටයුතු කරන පුද්ගලයන්ගේ නොසැලකිලිමත්කම හා ඒ පිළිබඳ නොදැනුවත්කම මත විනාශයට පත්ව ඇත. කෙසේ වෙතත් මෙම අධ්‍යයනයේ දී ශ්‍රී ලංකාවේ වාසය කරන ලද කඟවේනා තමන්ට අනුකූලවන පරිසර පද්ධතිය තුළ මනා ලෙස සිය පරපුර වර්ධනය කරගනිමින් ජීවත්ව සිටි බව තහවුරු කර ගැනීමට හැකිවී ඇත. එමෙන්ම මොවුන්ට අවශ්‍ය ආහාර සහ අනිකුත් ජෛවීය අවශ්‍යතා ප්ලයිස්ටෝසීන යුගයේ රත්නපුර කුරුවිට ප්‍රදේශ ආශ්‍රිතව සැකසී තිබී ඇති බව අනාවරණය කර ගත හැකිය.

Introduction

Rhinos, massive herbivorous creatures belonging to the Rhinocerotidae family, are renowned for their horned profile and robust, armored skin. With a fossil history spanning millions of years across the globe, these creatures encompass five existing species, the White Rhino, Black Rhino, Indian Rhino, Javan Rhino, and Sumatran Rhino, each with distinct traits adapted to diverse habitats. Rhinos are distributed across various regions, including Africa and Asia, thriving in ecosystems ranging from grasslands to tropical rainforests. Despite their formidable build, these herbivores primarily consume grasses, leaves, and fruits. However, one of the foremost challenges facing rhinos is poaching, driven by the high demand for their horns in traditional medicine and decorative arts, resulting in illicit hunting and trade. This decline has led to a substantial decrease in rhino populations, placing certain species in critical endangerment. Conservation initiatives are currently in progress to safeguard and maintain rhinos, encompassing anti-poaching strategies, habitat preservation, and captive breeding programs. Educational endeavors and awareness drives play a vital role in advocating for rhino conservation. In general, rhinoceroses are captivating beings with diverse evolutionary backgrounds. Grasping their biological intricacies, behavioral patterns, and conservation requirements is imperative to secure their existence amidst various obstacles.

Methodology

The approach to this study shall be interdisciplinary. It will combine paleontology, archaeology, and environmental science.

Problem Statement

Although rhinoceros fossils from Sri Lanka are recorded from the Pleistocene era, there are significant gaps in our knowledge with regard to diet, environmental interaction, and causes of extinction. Fossil teeth recovered from the Kuruwita gem mines offer a special opportunity for investigation into these aspects but have not been hitherto systematically studied in the context of past ecosystem reconstruction and the role of rhinoceroses therein.

Value of the Research

The study carries great scientific, ecological, and cultural significance, in that it will add knowledge on Pleistocene fauna in Sri Lanka and contribute to the advancement of research worldwide regarding paleontology and ecology. This would attempt to work out the evolutionary adaptations and interactions between the rhinoceroses and their environment. Environmental and Ecological Insights Pleistocene climatic and habitat conditions reconstruction in Sri Lanka. Understanding species distribution and extinction patterns about climatic changes

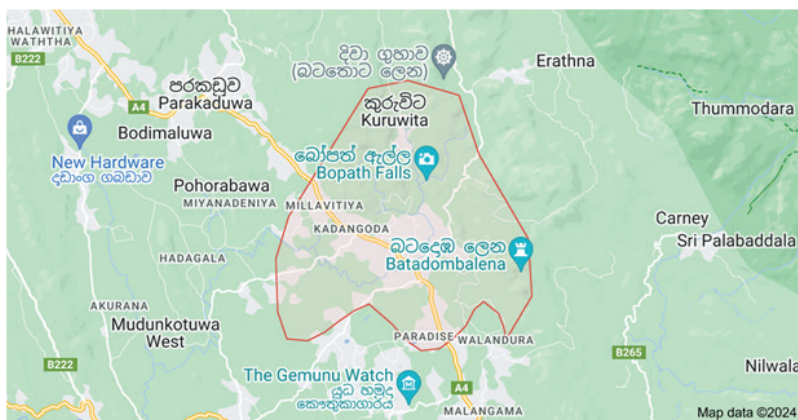
Cultural and Heritage Value

Outlines Sri Lanka's paleontological richness, thus justifying its status as a global heritage and biodiversity hotspot. Links past biodiversity to modern-day environmental issues to raise awareness of conservation.

Discussion

The youngest of the geological epochs is the Pleistocene and as such it contains a wealth of information the final change undergone by the earth, its flora, and its fauna. (Deraniyagala, P.E.P, 2001) During the Pleistocene epoch, from approximately 2.6

million to 11,700 years ago, the environmental conditions in Rathnapura, Sri Lanka would have markedly differed from the present day. The Pleistocene was characterized by alternating ice ages and interglacial phases, leading to fluctuations in temperatures and sea levels. In Rathnapura, situated in the southwest of Sri Lanka, it is hypothesized that the region experienced a more moderate climate during the Pleistocene era compared to the current tropical conditions. This inference is drawn from fossil findings within the area, which include the remnants of extinct species like elephants, giant tortoises, and large predators such as leopards.



(<https://www.google.com/maps/>)

The existence of these sizable creatures indicates that Rathnapura housed a rich and diverse ecosystem during the Pleistocene. It is plausible that the region encompassed a mosaic of grasslands, forests, and wetlands, offering varied habitats for a multitude of species. The presence of water bodies like rivers and lakes would have been instrumental in sustaining this diverse ecological landscape. These aquatic resources would have provided essential drinking water for the fauna and supported the proliferation of vegetation. Overall, the environmental conditions in Rathnapura during the Pleistocene period would

have been conducive to a wide array of plant and animal species. However, with changing climates and the culmination of the ice ages, many of these species either perished or adapted to evolving surroundings. Presently, Rathnapura is renowned for its tropical rainforests and is recognized as a significant biodiversity hotspot in Sri Lanka. The earliest indication of rhinoceros presence in Sri Lanka dates back to the Late Pleistocene era, approximately 125,000 years ago. Fossil remnants of a rhinoceros species identified as *Rhinoceros sivalensis* have been unearthed in various locations across the country, including the Rathnapura District, Mannar, and Jaffna coastal regions. The fossilized remains of 2 *Rhinoceros* were discovered in a gem mine at the foot of the Rilaulu hill range in Lunugala in Madolsima in 1996. These pre-historic animals lived in this area, which is a thick rain forest. Dr. Mohan Abeyratne from the Faculty of Bio-Science of the University of Peradeniya examined the fossils and confirmed that they were those of *Rhinoceros* that lived 80,000 years ago. According to experts, these *Rhinoceros* had died in a Meteoric shower that took place more than 80,000 years ago. Two skulls were found 65 feet below ground level, and Fauna Specialist Kelum Nalinda Manamendra Arachchi confirmed that they were the skulls of *Rhinoceros* that lived in the Pleistocene age. Fauna Specialist Kelum Nalinda Manamendra Arachchi who obtained the samples of the fossilized teeth after examining them of *Rhinoceros* said that one *Rhinoceros* was a mother and the other was its young.



The fossilized teeth from Lunugala

Pleistocene fossils were discovered in association with “Ratnapura (alluvial deposits) gem pits” from Sabaragamu Basin in the Ratnapura district of Sri Lanka (Fig. 1) . Fossils were described as the “Ratnapura Fauna” by Deraniyagala (1958), and he attempted to identify, classify, and taxonomically describe their palaeoecology, palaeoclimatology and palaeoenvironment. Table 1 shows the list of extinct mammalian megafauna in Sri Lanka during the Quaternary period. A pictorial representation of fossils found in the Sabaragamu Basin during 1990-2013 is given by Figures 2, 3, 4, 5, 6, 7 and 8.

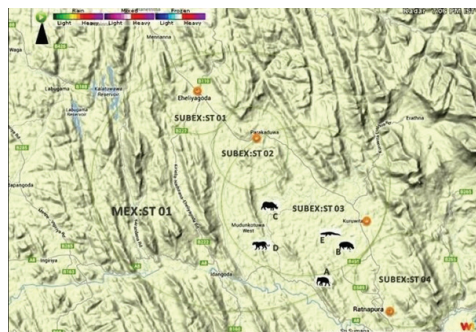


Figure 1: Geological view of Sabaragamu Basin, which

shows the extinctions of mammalian distribution in Sabaragamu Basin in Ratnapura District, Sri Lanka.[SUBEX:ST01-Sub excavation point Eheliyagoda, SUBEX:ST02- Sub excavation point Parakaduwa, SUBEX:ST03-Sub excavation point Kuruvita, SUBEX:ST04-Sub excavation point Rathnapura, Most abundance animal fossils of main excavation site (MEX:ST01)-A: Elephas spp., B: Hippopotamus, C: Rhinoceros spp., D:Tiger or leo, E: Crocodiles spp.

Table 1. Extinctions of mammalian megafauna species during the transition from the Pleistocene to the Holocene epoch in Sri Lanka

Familia	Sub familia	Genus	Species	Subspecies	English Name & Locality	Other References
Felidae	Pantherinae	Panthera	Panthera leo (extinct)	Panthera leo sinhaleyus (Deraniyagala, 1939) 39,000 yr	Sri Lanka Lion	Kelum et al., 2005
Felidae	Pantherinae	Panthera	Panthera tigris (extinct)	16,500 yr	Tiger	Panthera tigris sudanensis Deraniyagala, 1951 ?
Felidae		Panthera	Panthera pardus	Panthera pardus kotiya	Tiger ?	
Canidae	Caninae	Canis	Canis lupus		?	
Bovidae	Bovinae	Boselaphus	Boselaphus tragocamelus (extinct)		Four-horned Antelope	
Bovidae	Antilopinae	Antelope	Antelope cervicapra (extinct) ?		?	
Bovidae	Bovinae	Bos	Bos gaurus (extinct)	Bos sinhaleyus , 1962	Sri Lankan Gaur	
Canidae	Caninae	Cuon	Cuon alpinus		Wild Dog ?	
Hippopotamidae		Hippopotamus Linnaeus	Hippopotamus amphibius (extinct)	Hexaprotodon sinhaleyus , 1937		
			(extinct)	Rhinoceros sinhaleyus , 1936		
			(extinct)	Rhinoceros kagavena , 1956		
			(extinct)	Elephas maximus sinhaleyus		Sri Lankan Elephant
Bovidae	Bibos	Bovinae	Bovinae sinhaleyus			

Source: Action plan for conservation & sustainable use

of palaebiodiversity in Sri Lanka, 2016: Biodiversity Secretariat, Ministry of Environment & Renewable Energy and Personal Observations.

These fossil findings suggest that rhinoceroses once inhabited the island of Sri Lanka during this epoch. The evidence of rhinoceros includes teeth, skull fragments, and segments of long bones discovered in Sri Lanka. Instead of individual names, credit for the discovery and analysis of rhinoceros fossils in Sri Lanka should be attributed to the collective efforts of paleontologists and scientists. The specific identities of these researchers may vary depending on the unique fossil discoveries.

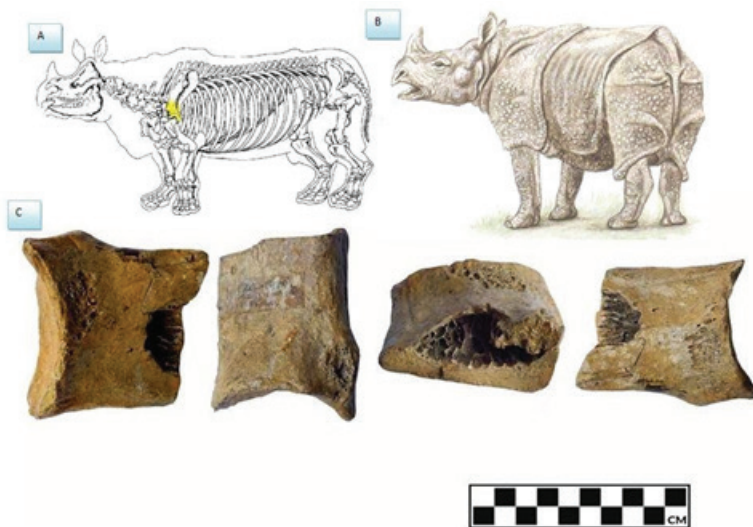


Figure 4. A: Skeleton of *Rhinoceros unicornis*, B: *Rhinoceros sondaicus* Desmarest 1822- Java-Nashorn - Javan Rhinoceros [Bildquelle: Horsfield, Thomas: Zoological researches in Java, and the neighbouring islands, 1824], C: *Rhinoceros sinhalensis* (Fossil No PSLSA03) =(Proximal portion of Scapula. Location- Kuruwita, Sri Lanka.



FIGURE 49: Most probably proximal portion of scapula bone of *Rhinoceros* sp. | Location: Paradise, Kuruvita | Depth: 55ft. © SMKA 1999. Scale = 1cm. Image: ©Aravinda Ravibhanu 2019.

Rhinos exhibit a distinctive dentition pattern, featuring prominent incisors and canines in the anterior region, succeeded by premolars and molars towards the posterior. Being herbivores, their dental structure is specialized for masticating plant matter. The molars are characterized by elevated crowns adorned with ridges and cusps, aiding in the breakdown of fibrous plant material.



First upper molar tooth with eroded roots of *Rhinoceros sinhaleyus*.| Location: Galukagama maha ela. Kuruvita | Depth: 55ft. © SMKA 1995. Scale = 1cm. Image: ©Aravinda Ravibhanu 2019.



Lower third molar tooth of *Rhinoceros kagavena*.|
Location: Kahingama west, Kuburu yaya Kuruvita | Depth: 57ft.
© SMKA 1998. Scale = 1cm. Image: ©Aravinda Ravibhanu
2019.

The weathering patterns observed in rhinoceros within Sri Lanka offer valuable insights into the historical presence and environmental conditions that influenced these large herbivores. By analyzing the wear on rhinoceros teeth, researchers can deduce information regarding their diet, age, and the environmental factors that shaped past ecosystems in Sri Lanka. Rhinoceros in Sri Lanka likely had a diverse diet, consuming various vegetation such as grasses, leaves, and potentially fruits. The types of plants and their silica content would have impacted the wear patterns on their teeth. Furthermore, factors like age and the diverse climates from dry zones to wet tropical forests in Sri Lanka would have resulted in varying degrees of tooth weathering among rhinoceros populations. Different types of teeth weathering are observed in these rhinoceros, including attrition from chewing, abrasion from environmental grit and particles, and erosion from acidic foods or environmental acids. Each type of wear provides information about the dietary habits and environmental conditions experienced by these animals. Studying the tooth wear in fossilized rhinoceros teeth from Sri Lanka aids in reconstructing past environments, and understanding the vegetation, and climatic conditions present. These wear patterns also help in studying the age structure of ancient rhinoceros populations and their ecological interactions with other species and plants in Sri Lanka. Research conducted in Sri Lanka, such as excavations at sites like the Ekneligoda, Kuruvita, has unearthed rhinoceros remains that offer valuable insights into the dietary preferences and environmental contexts of these animals during specific historical periods.



Most probably *Rhinoceros kagavena* molar tooth. | Location:..Ekneligoda, Kuruvita | Depth: 35ft. © SMKA 1998. Scale = 1cm. Image ©Aravinda Ravibhanu 2019.

In conclusion, the study of teeth weathering in the Sri Lankan rhinoceros is crucial for unraveling the historical aspects and adaptations of these animals. Through detailed analysis of tooth wear patterns, researchers can illuminate the diets, habitats, and lifespans of rhinoceros that once inhabited Sri Lanka, providing a deeper understanding of the ecological history of the region and enriching our knowledge of its diverse natural heritage. (Deraniyagala. S.U.1990)

Family Rhinocerotidae Owen

In Asia, this family ranges from Miocene to Recent and comprises some nine or ten sub-families, some possessing—

(a) two horns, upper incisors usually vestigial or absent, e.g., the Ceratocerotinae of Asia, Africa, and Europe, with living genera and species in the first two continents;

(b) one horn, upper incisors blade-like, developed, e.g., the Rhinocerotinae Dollo, with living and extinct species restricted to Asia.

(c) a vestigial horn and elongated body with short limbs, e.g., the Teleocerotinae Hay, of North America and Europe, extinct;

(d) A vestigial horn and body of normal shape, upper incisors present, e.g., the Aceratheriinae Dollo of Europe and Asia, extinct;

(e.) No trace of a horn or upper incisor, build slender, e.g., the Turkanatheriinae Deraniyagala, from the Pliocene of East Africa, extinct. (Deraniyagala, P.E.P. 2001)

Subfamily Rhinocerotinae Dollo

Premaxillaries are strong, with well-developed blade-like incisors. Two genera are restricted to Pleistocene and Recent of Asia. One of them occurs in Ceylon.

Genus Rhinoceros Linne

Rhinoceroses with the nasal bones expanded into a boss for carrying only one horn, upper incisors enlarged and blade-like, lower ones procumbent, skull short and with occipital area sloping forwards from condyle, auditory meatus closed inferiorly by fusion of post-tympanic and post-glenoid processes, cheek teeth sub-hypsodont. Posterior angle of mandible with a protuberance. Six extinct and two living species. Pleistocene to Recent of Asia.

Rhinoceros *sinhaleyus* is somewhat smaller than the living Indian *R. indicus* and possesses a strong outer genial prominence to the angle of the mandible. The upper molars are mesodont or almost brachydont, and possess a feebly wavy labial aspect to the ectoloph; the parastyle buttress is moderately developed, and not as pronounced as in *R. sondaicus*. In this character, it resembles *R. unicornis*. The crochet is well developed, bifid or trifid, and apt to unite with the crista to form a medifossette. The ante-crochet is absent, the crista is variable being present in some teeth and wanting in others, tubercles are present at the entrance to the median valley in some premolars but are generally wanting in the molars, the cingulum is best defined anteriorly and often wanting lingually. It is sometimes represented by a tubercle at the entrance to each of the two valleys. The lower cheek teeth lack the conical prominence in the entoflexid of *R. sivalensis*. (Deraniyagala. P.E.P.2001)

Table summarizing aspects of tooth weathering in rhinoceroses

Aspect	Details
Definition	Gradual wear and damage to rhino teeth are caused by environmental and dietary factors.
Causes	- Diet: High-fiber vegetation like grasses and shrubs.- Abrasive Materials: Sand or soil mixed with food.- Aging: Natural wear with time.- Environment: Arid conditions lead to more abrasive materials in food.
Types of Weathering	- Attrition: Tooth-to-tooth contact wear.- Abrasion: Wear from external particles like sand.- Erosion: Chemical wear from acidic substances.
Effects	- Changes in tooth morphology.- Exposure of dentine and pulp.- Difficulty in food processing.- Potential for infections or abscesses.

Indicators	- Smooth or polished surfaces.- Cracks, pits, or grooves.- Flattening of chewing surfaces.- Discoloration or fractures in extreme cases.
Environmental Factors	- Habitat type (grasslands, forests, or arid regions).- Availability and type of forage.
Implications	- Affects feeding efficiency and nutrition.- May provide insight into diet and habitat from fossilized remains.
Study Relevance	- Helps in understanding dietary adaptations.- Useful in paleontological and archaeological research.
Conservation Context	- Tooth wear can affect health and longevity, which is important for managing endangered species.
Prevention in Captivity	- Providing softer food alternatives.- Minimizing exposure to abrasive materials.

This table outlines the causes, types, effects, and implications of tooth weathering in rhinoceroses, useful for understanding their biology and aiding in conservation efforts.

Conclusion

These rhinoceros teeth, fossilized from Sri Lanka, reflect important clues regarding the adaptations and lifestyle of these majestic animals in the Pleistocene. Advanced studies of wear patterns in teeth have shed light on feeding behavior, interaction with the environment, and climatic variations that took place over thousands of years. Such studies will add to our knowledge of the region's ecological history and the role rhinoceros have played in its biodiversity. These studies, beyond their scientific merit, also highlight the importance of natural heritage preservation in Sri Lanka. Further research into this field will add to the knowledge of paleontology and bring greater awareness of the complex relationships between ancient species and their ecosystems for

better conservation.

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(Molar teeth of a fossilized rhino)
(Deraniyagala. P.E.P, 1958)



(Molar teeth of fossilized rhino)
(Deraniyagala. P.E.P, 1958)



(Premolar teeth of fossilized rhino) (Deraniyagala. P.E.P, 1958)