



Skull Evolution Method and Analysis in The Rhinocerotidae: Phylogeny of Early Rhinocerotoids

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Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 15 Nov 2023	<p>After phylogeny is measurably disposed of, cranial elements utilized essentially for rumination ought to change most with hypsodonty (high-delegated cheek teeth). These structures should be least phylogenetically restricted. Corollary: structures with significant common ancestry will integrate more morphologically. All living rhinoceroses and many extinct European Plio-Pleistocene species We examined skull, mandible, and upper tooth row form in the dorsal, lateral, and occlusal perspectives using two-dimensional geometric morphometrics. Hypsodonty index was employed to represent eating behaviours. We divided form variation into function, phylogeny, and size using phylogenetically independent comparisons and variation partitioning. We used Escoufier's RV coefficient to evaluate morphological reconciliation. The mandible and upper tooth column covariate most with hypsodonty and least with phylogeny. Skull morphology corresponds least with hypsodonty and most with phylogeny. Low morphological joining between the top tooth line and different parts recommends it is the least phylogenetically restricted. As predicted, the chewing area is confined by function rather than phylogeny, unlike others.</p>
CC License CC-BY-NC-SA 4.0	Keywords: Skull Evolution Method, Rhinocerotidae, Phylogeny, Rhinocerotoids, Analysis.

1. Introduction

The Indian rhinoceros (*Rhinoceros unicornis*), or Indian rhino for short, otherwise called the more prominent one-horned rhinoceros or incredible Indian rhinoceros, is a rhinoceros animal types local to the Indian subcontinent. It is recorded as Helpless on the IUCN Red Rundown, as populaces are divided and confined to under 20,000 km² (7,700 sq. mi). In addition, the degree and nature of the rhino's most significant territory, the alluvial Terai-Duar savanna and prairies and riverine backwoods, is viewed as in decline because of human and animals' infringement. As of August, the worldwide populace was assessed to contain 3,588 people, remembering 2,939 people for India and 649 in Nepal. Kazi Ranga Public Park alone had an expected populace of 2,048 rhinos. Pobitora Untamed life Asylum in Assam has the most elevated thickness of Indian rhinos on the planet with 84 people in a space of 38.80 km² (14.98 sq. mi).

Indian rhinos once went all through the whole stretch of the Indo-Gangetic Plain, however over the top hunting and farming improvement diminished its reach radically to 11 destinations in northern India and southern Nepal. In the mid-1990s, somewhere in the range of 1,870 and 1,895 Indian rhinos were assessed to have been alive. From that point forward, numbers have expanded because of preservation estimates taken by the public authority. Be that as it may, poaching stays a persistent danger, as in excess of 150 Indian rhinos were killed in Assam. Almost 85% of the worldwide Indian rhinoceroses' populace is moved in Assam, where Kazi Ranga Public Park contains 70% of rhino populace. skull

evolution and its methods of analysis within the Rhinocerotidae family has been a subject of great fascination and importance in the field of palaeontology and evolutionary biology. Rhinocerotidae, commonly known as rhinoceroses, are a diverse group of large herbivorous mammals that have inhabited various ecosystems across the world for millions of years. Understanding the evolutionary history and phylogeny of early rhinocerotoids is crucial for shedding light on the intricate processes that have shaped the diversity and adaptations of this remarkable family

Phylogeny of Early Rhinocerotoids

Early rhinocerotoids' phylogeny gives a fascinating look into their evolution. The order Perissodactyl comprises horses, tapirs, and rhinoceros. Understanding the links between early rhinocerotoid animals and their role in mammalian evolution is essential to understanding Earth's past fauna. We examine the phylogeny of early rhinocerotoids, their origins, diversity, and role in evolution.

➤ **Ancestral Origins**

rhinocerotoid phylogeny started 56–34 million years ago in the Eocene. This geological epoch produced the first rhinocerotoid lineage members. These early rhinocerotoids developed different traits while sharing a similar ancestor with other perissodactyls. They differed from their four-toed forebears with their three-toed limb anatomy. Three-toed feet were a major adaptation, perhaps due to food and locomotion modifications.

➤ **Diversification and Adaptations**

As early rhinocerotoids continued to evolve, they diversified into a wide array of forms, reflecting various adaptations to their respective environments. This diversification resulted in several distinct lineages, each characterized by unique cranial and dental features, body sizes, and ecological niches. Some early rhinocerotoids were small and adapted for browsing on leaves and soft vegetation, while others grew larger and became specialized grazers of tougher grasses

➤ **Significance In Mammalian Evolution**

Early rhinocerotoids are important to mammalian evolution. They evolved and diverged with grasslands and other herbivorous lineages like artiodactyls. The phylogeny of early rhinocerotoids illuminates mammalian evolution at a crucial time of Earth's history. Early rhinocerotoids also help molecular clock investigations gauge perissodactyl and other mammalian divergences and evolutionary speeds. This knowledge helps us comprehend mammalian evolution and adaptation to different settings over millions of years.

1.1. Skull Evolution in Rhinocerotidae

The skull, being a key anatomical structure, is crucial to rhinoceros evolution. Ecological factors, nutritional changes, and environmental adaptability have changed rhinocerotid skulls. These morphological modifications may reveal this family's evolutionary history and the circumstances that shaped its specific cranium characteristics. Skull development is crucial to Rhinocerotidae evolution. Rhinocerotid skulls have changed dramatically over millions of years to adapt to shifting diets, habitats, and ecological niches. We explore the interesting skull development of the Rhinocerotidae, revealing the main traits and adaptations that have formed these amazing species.

➤ **Cranial Morphology and Functionality**

Rhinocerotid skulls have several distinctive traits according to their ecological tasks. Different species have huge nasal horns, which vary in size and form. Horns are used for fighting, defences, and maybe foraging. These cranial appendages show how selection forces have formed rhinocerotid skulls. In addition, rhinoceros' dentition has changed dramatically. Early rhinocerotoids had more generalist dental morphology for browsing various plants. Some lineages gained teeth for grazing harder, fibrous grasses as the family diversified. Dental adaptations include tooth form, size, and arrangement, showing how food specialization affects cranium evolution.

➤ **Phylogenetic Significance**

Rhinocerotid Skull evolution explains family lineage and ecological adaptations. Skull morphology across species and time periods may be used to generate rhinoceros phylogeny trees. Rhinocerotidae horn development may suggest common and divergent lineages. This helps us understand rhinocerotid evolution and connections. The development of Rhinocerotidae skulls displays form and function in dynamic interplay. Rhinoceroses' cranial changes show their adaptability and diverse evolutionary history. These physical changes may help researchers comprehend rhinocerotid evolution and appreciate their resilience.

2. Literature Review

Prothero, D. R., & Schoch, R. M. (2002). "The Origin and Development of Perissodactyls The extensive research conducted by Prothero and Schoch offers a complete look at the development of perissodactyl animals. This essential work covers a broad variety of issues, including evolutionary connections, adaptations within the Perissodactyl order, and anatomy of the skull. This book provides scholars who are investigating the evolutionary history of perissodactyls with a basic reference for their work.

Deng, T., Wang, X., Fortelius, M., Li, Q., Wang, Y., & Tseng, Z. J. (2011). "This ground-breaking study investigates the origin of Ice Age megaherbivores, with a particular emphasis on the woolly rhinoceros. The examination was directed in Tibet and is named "Out of Tibet: Pliocene Woolly Rhino Recommends High-Level Beginning of Ice Age Megaherbivores." Deng et al. offer persuasive data showing that the high-altitude Tibetan Plateau played a vital role in the development of these famous Ice Age giants. This evidence suggests that the Tibetan Plateau had a role in the evolution of these iconic Ice Age giants. In order to provide insight on the evolutionary history of megaherbivores, this research integrates fossil evidence, DNA analysis, and data on paleoenvironmental conditions.

Orliac, M. J., & Antoine, P. O. (2010). "Skull osteology may provide light on the evolutionary connections between ancient world species. Despite the fact that its primary emphasis was on crocodylians, this research by Orliac and Antoine is noteworthy due to the in-depth investigation of skull osteology that it contains. This demonstrates the significance of cranial characteristics when it comes to comprehending the evolutionary connections that exist within a taxonomic group. The study of the evolution of rhinocerotid skulls may benefit from the insights gained from this research.

Bai, B., Wang, Y., Meng, J., & Evander, R. (2019). "Research on the evolution of Chinese Neogene rhinoceroses using cranial morphometrics as the major technique of analysis is the topic of a study that is based on cranial morphometrics research. This study focuses on the evolution of Chinese Neogene rhinoceroses. The research is a significant contribution to our knowledge of rhinocerotid evolution because it sheds light on the cranial adaptations and diversification of rhinoceroses in a particular geographic location.

Mihlbachler, M. C., & Solounias, N. (2006). "Coevolution of tooth crown height and diet in oreodonts (Merycoidodontid, Artiodactyla) was explored using phylogenetically independent contrasts in oreodonts (Merycoidodontid, Artiodactyla). Phylogenetically independent contrasts are contrasts that are not reliant on the phylogeny of the taxon. Oreodonts serve as the principal subject of the study that Mihlbachler and Solounias have done in order to explore the link between the growth of tooth crown height and the foods that people eat. The results of this research shed light on the importance of dental adaptations in herbivorous animals and demonstrate the need of conducting phylogenetically independent comparisons in the area of evolutionary research.

3. Materials And Methods

We photographed the skull, mandible, and upper tooth row in the dorsal, lateral, and occlusal perspectives of each live rhino, *Diacereins sumatrensis*. Analysed samples included the rhinoceros *unicornis* and six extinct species. We just assessed wild rhino examples from the living populace since bondage reproduced creatures regularly have development irregularities and bone tissue disfigurements. We disposed of intraspecific allometry (because of sex contrasts or minor age changes) by utilizing shape residuals from species-explicit relapses among structure and size.

Geometric morphometrics

Test photographs' milestones and semi-milestones were carefully recorded to show shape. Mammalian top row occlusal scanning alone corrected parallax and image measurement errors. All skulls, mandibles, and upper teeth were scanned using TpsDig2. GPA judges are produced by turning, adjusting, and scaling milestones to centroid size utilizing the square base of number of squared distances. Use source data to rotate scaled and translated landmarks. The sample's mean shape is created by rotating empirical reference-specimen sets. Rotation discrepancies decrease with mean-shape/rotation iteration. Original form revisions and measurement difficulties create discrepancies. Orthogonal axes exhibited the most PCA shape residual variation. Traditional geomorphology.

Rework curve landmarks with semi-landmarks. Participants should share curves or outlines, not points. Divides landmarks from semi-landmarks using Tps sliding semi-landmark file splitRLW. The application estimates relative warps from sliding-landmark data. Ten randomly selected images were re-digitized five times to see whether digitization faults affect interspecific shape variance. Form variance differences were computed.

Function: feeding categories and the hypsodonty index

A hypsodont (high-delegated) molar is the principal adaption for grass-eating in ungulates, including rhinos. A hypsodonty record (Hello there) was determined on upper third molars in current and terminated rhinos by isolating their level by tooth base width for each specie across various unworn teeth we estimated straightforwardly. Relapsing taking care of classification (the reliant variable) versus Greetings free factor showed that Hello is a decent eating regimen indicator prior to using it in any examinations. Ordinal direct relapse, which represents an ordinal ward variable, was used. As expected with ungulates, nourishment was classified in expanding request as slow eater, blended feeder, and program. ANOVA was finished on Rhinocerotine craniodental as the reliant variable and eating classes as the component.

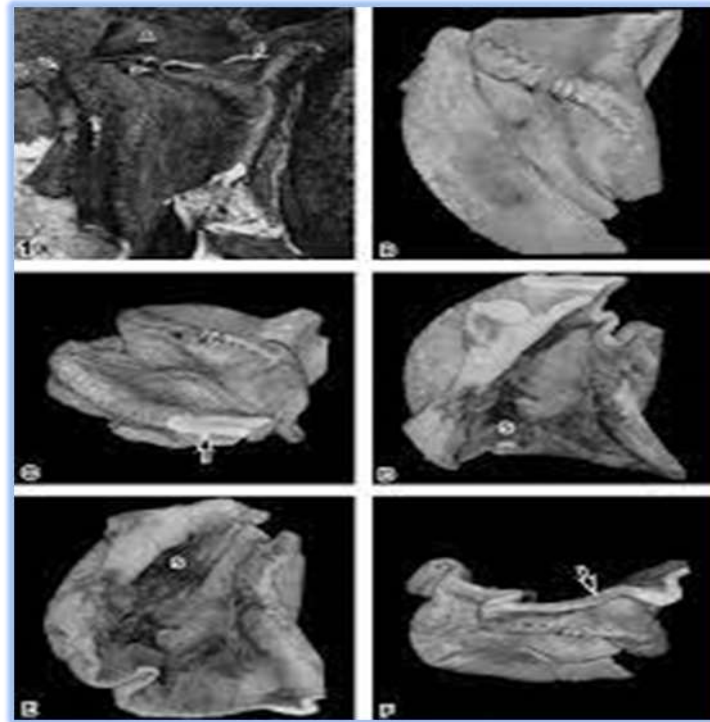


Figure 1: Rhinocerotine craniodental morphology

Shape-size and shape-hypsodonty list connections

For every milestone setup (skull in dorsal and parallel perspectives, mandible in horizontal view, and upper tooth column in the occlusal view), separate multivariate relapses between Procrustes shape organizes (subordinate factors) and (autonomous variable) were performed, to evaluate worldwide morphological changes related with. A similar methodology was performed utilizing size (logCS) as a free factor to investigate morphological variety related with interspecific size contrasts (intraspecific contrasts were officially eliminated by utilizing residuals of per-species relapses among shape and size). was utilized to perform multivariate relapses. Its calculation returns a vector of relapse scores for shape that addresses the shape connected the most with the free factor.

Phylogeny

A phylogenetic tree including all species concentrated on here (Fig. 2) was inherent Mesquite (Maddison for the surviving rhinoceroses, late papers in view of hereditary good ways from which we hold the tree geography, were utilized. Branch lengths were adjusted in huge number of years (Mama) in light of the fossil record. For topological, geological, and biochronologically data concerning the terminated rhinoceroses of the family Stephanorhinus, we utilized the tree geography proposed by for the variety we followed and for Coelodonta, and for the clan Elasmotheriina, we followed Ceratotherium and Diceros, we followed and For the Asiatic genera Dicerorhinus and Rhinoceros.

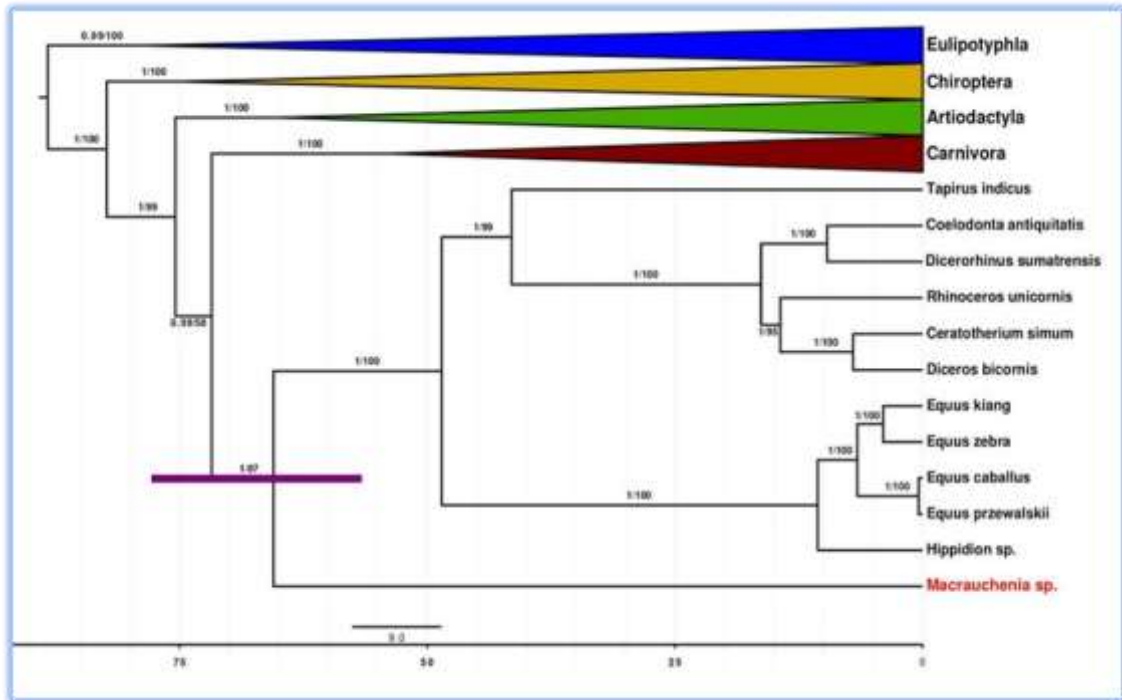


Figure 2: Phylogenetic tree utilized for this review. Scale is in huge number of years.

• **Comparative phylogenetic approaches**

In near investigations of creatures' characteristics, the perceptions are seldom free of one another as a result of phylogenetic connections to consider the non-autonomy of data of interest because of phylogeny, various similar methods have been proposed in the writing. The greater part of these has their Rhinocerotinae craniodental morphology 905 Fig. 3. Phylogenetic tree utilized for this review. Scale is in large number of years (Mama). advantages and disadvantages subsequently embracing more than one method whenever is prudent. We followed this suggestion and applied both phylogenetically autonomous differences (PICs) and variety dividing.

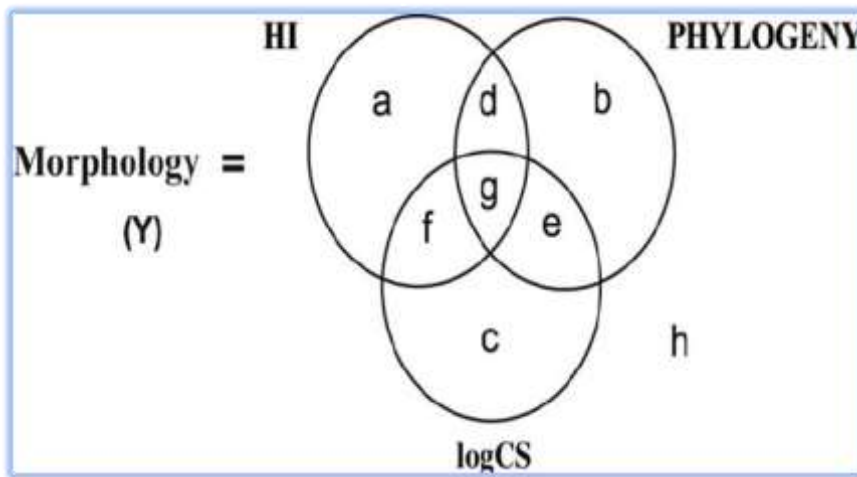


Figure 3: Disintegration conspire for the variety parcel analysis made sense of in the text.

• **Morphological coordination**

We tried that the shape arrangement (module) most impacted by unadulterated Hey (and the least by unadulterated phylogeny; see underneath) was less coordinated with the others. Mix and particularity are concentrated by dissecting the covariation among modules. Here we utilized a measurement of covariation between the different arrangements of factors: the RV coefficient. This coefficient was initially The RV coefficient is practically equivalent to the R-square in the univariate case. The condition for computing RV in this manner addresses how much covariation scaled by how much variety inside the two arrangements of factors, which is similar to the estimation of the connection coefficient between two factors. RV might take any worth from 0 to.

3. Results and Discussion

Geometric morphometrics

The disparity between reshaped sets is altogether more modest than between arbitrary sets (mandibles, skulls, teeth, recreated $P = 0.045-0.025-0.030$). This infers that digitization batch doesn't influence shape analysis. The initial 15 primary parts make sense of 95% of structure variety in the four arrangements. PC1 and PC2 collaborations for every one of the four mixes are displayed in Figure 4. In parallel skull view, low PC1 values show an exceptionally curved, dolichocephalic skull with a shallow nasal entry point, while high qualities demonstrate a less sunken skull with an aft uprooted occiput and profound nasal cut. As the nasal entry point contracts, positive PC2 values build up the nasal bone. The circle is low and the premaxilla short at similar qualities. Along PC1, the skull occiput, nasal, and parietal bones fill in the dorsal skull view. High PC2 readings are connected to long, slim nasal bones and little occiputs. Along PC1, the rising ramus abbreviates and the level ramus limits. On PC2, the level ramus is curved and the rising ramus slants posteriorly from low to high scores. As sure PC1 scores increment, the upper tooth column turns out to be meager, has more buccal peaks, and has a more modest M3. PC2's tooth line has labially moved sews and bends.

Relationship Between Hypsodonty File and Taking care of Classifications

Ordinal relapse among Greetings and taking care of classifications is Anticipated eating regimen classes are show in While nibblers and programs are accurately ordered, the blended feeders are delegated programs. The ANOVA is huge as well as the phylogenetic ANOVA Hence, we can expect that Greetings is a decent indicator of taking care of propensities for surviving and terminated rhinos and can be utilized in the accompanying factual examinations.

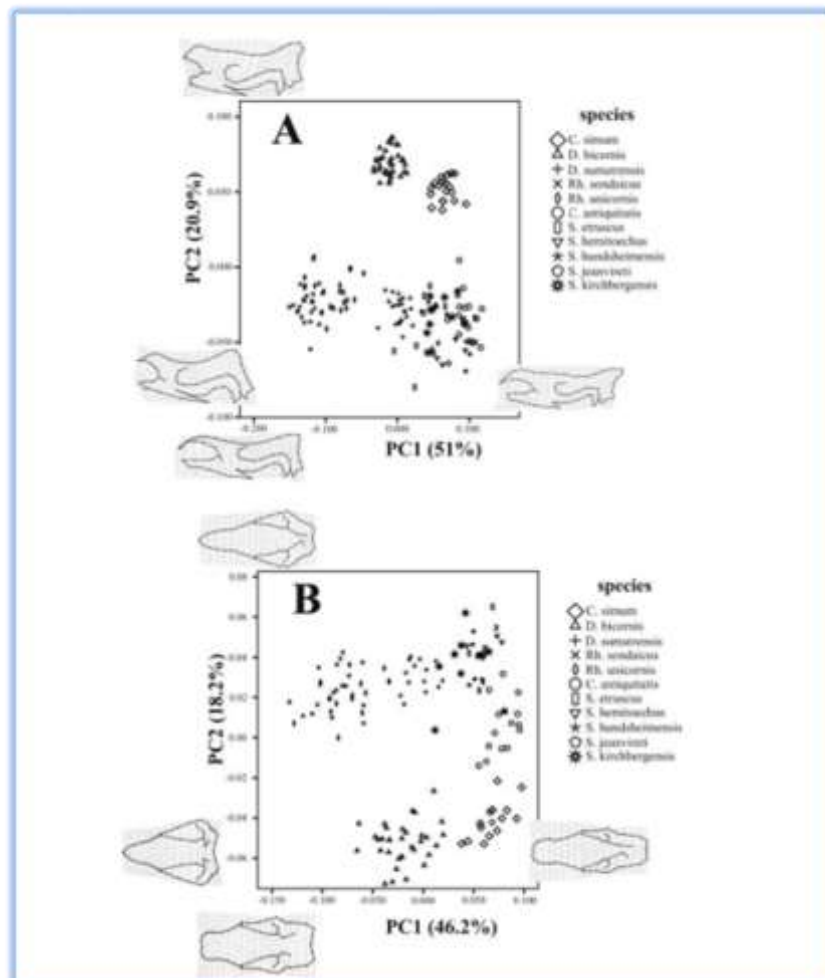


Figure 4: Scatterplots somewhere in the range of PC1 and PC2 for the four setups: (A) skull in horizontal view, (B) skull in dorsal view.

Shape–size and shape–hypsodonty index relationship

Form factor LogCS Multivariate dorsal skull view regression Goodall's F-test skull dorsal alterations show size explains 12.95 percent of shape variation. Big skulls have occipital, nasal-parietal, and orbital bones. Significant multivariate regression between form factors and HI explains 20.78% of Goodall F-

test form. High HI values provide a short, large nasal-parietal skull and well-developed occiput. Significant multivariate regression between form factors and logCS for lateral skull view Size explains 12.73 percent of Goodall F-test form variation. Solid back occiput, nasal bones, profound nasal entry point, and more limited tooth column influence level. Howdy related skull horizontal morphology. Significant multivariate regression between form factors and HI Goodall F-test shows form variance.

An advanced back occiput, huge and short nasal bones, shallow nasal cut, and low orbital position are connected with high Hello their values. Multivariate relapse between shape factors and logCS is critical for mandible). Size explains 15.55 percent of form variation, according Goodall's F-test. Long tooth row and slender horizontal ramus for little stature. Significant multivariate regression between form factors and HI accounts for 25.52% of Goodall F-test-induced mandible alterations form variance.

High Hey values are connected with a major mandible with an advanced sunken shape at the ventral line of the level ramus and back to the climbing ramus. Multivariate relapse between shape factors and logCS is huge for upper tooth column. Size explains 3.69% of form, Goodall F-test. Big teeth flatten labial margins. Significant multivariate regression between form factors and HI. Goodall F-tests explain 15.92% form with HI. HI alters upper teeth. labially flattened and squared for high HI.

Comparative methods

OLS and PICs relapses on shape-Hello and shape-logCS connections for the four designs are displayed in Table 1. Every PIC regression except the skull dorsal view shape–HI and upper teeth row shape–size associations is significant. From this, we utilized VARPART to extract pure HI, phylogeny, and size fractions from entire their contributions. The four designs' VARPART assessments displayed in the two methods showed that phylogeny enormously influences skull structure emphatically impacts the mandible and upper tooth line. Unadulterated Hello is higher in the mandible and lower in the top tooth column, while unadulterated phylogeny declines from skull to mandible to top tooth line.

Table 1: OLS and PICs dissect for shape-Hello there and shape - size relationship.

	OLS % Predicted (p- value)	PICs% Predicted (P-value)
Shape-HI relationship		
Skull, dorsal view	18.5(0.13)	19.4(0.054)
Skull, lateral view	18.5(0.14)	29.2(0.006)
Mandible	27.6(0.04)	44.5(0.002)
Upper tooth row	30.4(0.039)	30.9(0.01)
Shape-size relationship		
Skull, dorsal view	19.1(0.12)	22.6(0.039)
Skull, lateral view	19.48(0.22)	31.5(0.027)
Mandible	32.9(0.0028)	65.4(0.0001)
Upper tooth row	6.27(0.7)	14.6(0.35)

In the wake of representing evolutionary covariation across functional ordered classifications, the shape-Greetings association is huge for all setups aside from skull dorsal view. An organic relationship exists between cranial shape and crown level. VARPART might concentrate on phylogeny and make difference informative parts autonomously. In all cases, phylogeny control's structure fluctuation. Unadulterated phylogenetic extent diminishes and develops from noggin to upper tooth column to mandible. On the off chance that phylogeny is to a great extent disposed of, taking care of transformation impacts food processing more.

Our results confirmed that the module with the greatest pure correlation and lowest pure phylogenetic correlation should be least integrated. RV coefficients reveal reduced skull-mandible integration in the upper tooth row. Top tooth row form seems to have been influenced by contemporaneous adaptation rather than evolution, unlike other structural traits examined here. Through coordinated selection, morphological integration predicts considerably covarying module co-evolution.

Functional integration is essential for common components. Integrating highly integrated components limits their response to independent selection factors. Functional specialization may diminish module functional and developmental interconnections, causing temporary evolvability loss. Growing Miocene grasslands modified ungulate nutrition. Rhinos and clades browse with low-crowned teeth. The principal grass-eating adaptation was hypsodont molars. We found that rhinos' top tooth row grazing response is more evolvable due to the need for longer teeth roots to the skull. From teeth to mandible, impacts increase. Like predators, rhino crania teeth develop most.

4. Conclusion

In both living and extinct rhinoceroses, phylogeny and function have differing effects on the craniodental. When two separate comparison methodologies are used, this idea is valid. As expected, ruminant highlights show minimal covariation with phylogeny and the best covariation with the hypsodonty record. Conversely, the impact of unadulterated Hello on shape variety ascends from the skull to the mandible to the upper tooth line in Rhinocerotine craniodental morphology 921 in the wake of utilizing the variety apportioning analysis. Be that as it may, when the effect of the last option is assessed in connection with phylogeny (phylogenetically organized utilitarian variety), skull morphology shows major areas of strength for a with Hey. This recommends that variation to different taking care of styles happens somewhere down in the rhino tree as opposed to at the tips (that is, it applies over the species level). Such morphological changes in rhinos incorporate a particular plan for the rear of the skull, which is truly known to shift contingent upon dietary patterns. Significant pieces of the morphological variety can't be made sense of by the designs' unadulterated size alone. Escoufier's RV coefficient upholds the speculation that the construction that is least associated with phylogeny and generally related with virtue ought to likewise be the most un-coordinated with different designs. This suggests that the upper tooth line is more liberated to advance since it is less influenced by covariation with other cranial elements, while the mandible and skull are limited by phylogeny and (formative) combination between one another. This examination upholds prior discoveries on carnivores, emphasizing that mammalian teeth are the most versatile skull highlight regarding evolution.

References:

1. Ackermann, R.R. and Cheverud, J.M. 2000. Phenotypic covariance structure in tamarins (genus *Saguinus*): a comparison of variation patterns using matrix correlation and common principal component analysis. *Am. J. Phys. Anthropol.*, 111: 489–501.
2. Agusti, J. and Anton, M. 2002. *Mammoths, Sabretooths and Hominids: 65 million Years of Mammalian Evolution in Europe*. New York: Columbia University Press.
3. ant, G.; Maraseni, T.; Apan, A. & Allen, B.L. (2020). *Global Ecology and Conservation*. **23**: e01180.
4. Arthur, W. 2001. Developmental drive: an important determinant of the direction of phenotypic evolution. *Evol. Develop.*, 3: 271–278
5. Bai, B., Wang, Y., Meng, J., & Evander, R. (2019). Evolution of the Chinese Neogene rhinoceroses: A study based on cranial morphometrics. *PLOS ONE*, 14(1), e0209034.
6. Bales, G.S. 1996. Skull evolution in the Rhinocerotidae (Mammalia, Perissodactyl): Cartesian transformations and functional interpretations. *J. Mammal. Evol.*, 3: 261–279.
7. Deng, T., Wang, X., Fortelius, M., Li, Q., Wang, Y., & Tseng, Z. J. (2011). Out of Tibet: Pliocene Woolly Rhino Suggests High-Plateau Origin of Ice Age Megaherbivores. *Science*, 333(6047), 1285–1288.
8. Goswami, A. 2006. Cranial modularity shifts during mammalian evolution. *Am. Nat.*, 168: 270–280
9. Kahlke, R.D. and Lacomat, F. 2008. The earliest immigration of woolly rhinoceros (*Coelodonta tologojensis*, Rhinocerotidae, Mammalia) into Europe and its adaptive evolution in Palaeartic cold stage mammal faunas. *Quat. Sci. Rev.*, 27: 1951–1961
10. Konasakawa, A. & Koiso, M. (2018). ". In D. Firenze; G. M. Jamison; R. W. Law; M. Vidale & R. H. Meadow (eds.). *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia*. Oxford: Archaeopress Publishing Ltd. pp. 292–317.
11. William, P., Shrivastava, A., Chauhan, P.S., Raja, M., Ojha, S.B., Kumar, K. (2023). Natural Language Processing Implementation for Sentiment Analysis on Tweets. In: Marriwala, N., Tripathi, C., Jain, S., Kumar, D. (eds) *Mobile Radio Communications and 5G Networks*. Lecture Notes in Networks and Systems, vol 588. Springer, Singapore.
12. K. Maheswari, P. William, Gunjan Sharma, Firas Tayseer Mohammad Ayasrah, Ahmad Y. A. Bani Ahmad, Gowtham Ramkumar, Anurag Shrivastava, "Enterprise Human Resource Management Model by Artificial Intelligence to Get Befitted in Psychology of Consumers Towards Digital Technology", *JRTDD*, vol. 6, no. 10s(2), pp. 209–220, Sep. 2023.
13. Anurag Shrivastava, S. J. Suji Prasad, Ajay Reddy Yeruva, P. Mani, Pooja Nagpal & Abhay Chaturvedi (2023): IoT Based RFID Attendance Monitoring System of Students using Arduino ESP8266 & Adafruit.io on Defined Area, *Cybernetics and Systems*.
14. P. William, G. R. Lanke, D. Bordoloi, A. Shrivastava, A. P. Srivastava and S. V. Deshmukh, "Assessment of Human Activity Recognition based on Impact of Feature Extraction Prediction Accuracy," 2023 4th International Conference on Intelligent Engineering and Management (ICIEM), London, United Kingdom, 2023, pp. 1-6, doi: 10.1109/ICIEM59379.2023.10166247.
15. P. William, G. R. Lanke, V. N. R. Inukollu, P. Singh, A. Shrivastava and R. Kumar, "Framework for Design and Implementation of Chat Support System using Natural Language Processing," 2023 4th International Conference on Intelligent Engineering and Management (ICIEM), London, United Kingdom, 2023, pp. 1-7, doi: 10.1109/ICIEM59379.2023.10166939.
16. Lacomat, F. (2005). In Fulconis, R. (ed.). *Save the Rhinos: EAZA Rhino Campaign 2005/6*. London: European Association of Zoos and Aquaria. pp. 46–49.
17. Medhi, A. & Saha, A. K. (2014). "Land Cover Change and Rhino Habitat Mapping of Kaziranga National Park, Assam". In Singh, M.; Singh, R. B. & Hassan, M. I. (eds.). *Climate Change and Biodiversity*. Proceedings of IGU Rohtak Conference. Vol. 1, Part II. Springer Japan. pp. 125–138.

18. Muhlbachler, M. C., & Solounias, N. (2006). Coevolution of tooth crown height and diet in oreodonts (Merycoidodontid, Artiodactyl) examined with phylogenetically independent contrasts. *Journal of Mammalian Evolution*, 13(1), 11-36.
19. Orliac, M. J., & Antoine, P. O. (2010). Evolutionary relationships of the old world Gavialidae (Crocodylia, Crocodyloidea) as revealed by the skull osteology of *Eosuchus lerichei* from the Paleocene of France. *Zoological Journal of the Linnean Society*, 158(3), 613-656.
20. Prothero, D. R., & Schoch, R. M. (2002). *The Evolution of Perissodactyls*. Oxford University Press.