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# Anatomical Characteristic of Hindlimb Skeleton of Sumatran Rhino (*Dicerorhinus sumatrensis*)

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## INTRODUCTION

Sumatran rhino (*Dicerorhinus sumatrensis*) is an endangered animal in Indonesia. Currently, Sumatran rhino only found on Sumatera and Kalimantan in very small populations. These herbivorous animals are classified into the order of Perissodactyla (odd-toed animals) and family Rhinocerotidae [1]. Sumatran rhino is one of the largest living land mammals, reaching 1000 kg [1], although this species has the smallest body weight among all extant rhinos. This animal has a round and long body shape, relatively short legs with three digits on each leg. These body structures correspond to their habitat in the highlands, so the Sumatran rhino has an excellent ability to pass steep terrain [2]. For this reason, a strong hind limb structure is needed to push the body when walking, running and climbing the steep slopes. Therefore, this study was carried out in order to analyze the correlation between the Sumatran rhino's hind limb skeleton and its functional roles.

## MATERIALS AND METHODS

This study used a set of female rhino hind limbs skeleton (named Dusun, about 25-30 years old). The skeleton was obtained from Sumatran Rhino Sanctuary (SRS), Way Kambas National Park, Lampung, Indonesia. General structure of the hind limbs skeleton and the specific parts of the bones were observed. The nomenclature of the bones and their parts referred to *Nomina Anatomica Veterinaria* [3].

## RESULT AND DISCUSSION

Sumatran rhino has a very strong, relatively short, and an upright construction of the hind limbs skeleton. In addition, Sumatran rhino has the relatively long body skeleton to support its weight. The hind limbs skeleton was formed by *os coxae*, *os femoris*, *os patella*, *ossa tibia et fibula*, *ossa carpi*, *ossa metacarpalia*, and *ossa digitorum pedis. Os coxae* were made up of three different bones: *os ilium*, *os ischii*, and *os pubis.* These three bones fused at *acetabulum,* a shallow spherical joint. *Facies glutea* widen dorsolaterally and formed a relatively wide *ala ossis ilii*. At the dorsomedial wing of illium, there was a *tuber sacrale*, while the lateral wing formed *tuber coxae* which have a medial and lateral bone extension. Wide gluteal surface, the origins of *m. gluteus medius,* is very well developed in the Sumatran rhino [4]. *Tuber ischiadicum, a tuberosity that was located at* the caudal part of the *os ischii,* has cranial, lateral and caudal processes.

*Os femoris* was a compact bone, and the bone shaft is rather thin in proximal and rounded distally. In the proximalis extremity, *caput femoris* was wide and spherically shaped, connected by a relatively short *collum femoris*, and in the lateral part of the femoral head, *trochanter major* was not well developed. A *trochanter minor* was relatively well developed in the *margo medialis* of the *corpus ossis femoris,* and a *trochanter tertius* that was very well developed in the *margo lateralis*, rectangular in shape and protrudes laterally. *Trochanter tertius* is the insertion of *m. gluteus superficialis* and the origin of *m. biceps femoris*, synergize with *m. semitendinosus* and m. Semimembranosus which originate from tuber *ischiadicum* [4] as an extensor muscles for hip joint and flexor of the knee joint. These four muscles play a role as a thrust function of the hind limbs, as an adaptation of the Sumatran rhinos to climb mountain easily [2]. Cruris skeleton was formed by *ossa tibia et fibula*. Both are relatively short and formed a joint each other in the proximal and distal extremities, and formed a *spatium interosseum cruris* which gives flexibility to the hind limb abduction in urination activity [2].

*Ossa tarsi* of the Sumatran rhino consist of seven bones which were arranged in three rows. A proximal row, consisting of the *os talus* and *os calcaneus*; *os tarsi centrale* in the middle row, and a distal row consisting of the *os tarsale I*, *II*, *III,* and *IV* which have processes with caudoplatar direction. These processes act for the attachment of footpad, as the origin of *mm. Interossei* and the adductor muscles of the digits [5]. Sumatran rhino has *ossa metatarsale II, III* and *IV* appropriate to the number of the digits. *Os metatarsale III* is the largest one and located between the two others.


Figure 1. Hindlimb skeleton of Sumatran rhino (*Dicerorhinus sumatrensis*)

A. Hindlimb skeleton (except *os coxae*); B. *Os coxae*; C. *Os femoris*; D. *Ossa tibia-fibula*; E. *Ossa tarsi-metatarsalia*; F. *Os patella*; G. *Acetabulum*; H. *Ossa tarsi* plantar view; I. *Ossa digitorum pedis*; a. *Os ilium*; b. O*s pubis*; c. *Os ischii*; d. Digit II; e. Digit III; f. Digit IV; 1. *Tuber coxae*; 2. *Alae ossis ilii*; 3. *Tuber sacrale,* 4. *Tuber ischiadicum,* 5. *Foramen obturatum*; 6. *Caput femoris*; 7. *Collum femoris*; 8. *Trochanter major*; 9. *Trochanter minor*; 10. *Trochanter tertius*; 11. *Os tibia*; 12. *Os fibula;* 13. *Tuberositas tibiae;* 14. *Spatium interosseum cruris;* 15. *Margo cranialis;* 16. *Maleoli lateralis*; 17. *Os calcaneus*; 18. *Os talus*; 19. *Os tarsi central;* 20. *Os tarsale I;* 21. *Os tarsale II*; 22. *Os tarsale III*; 23. *Os tarsale IV*; 24. *Os metatarsale II*; 25. *Os metatarsale III*; 26. *Os metatarsale IV*; 27. *Tuber calcanei*; 28. *Trochlea tali*; 29. *Sustentaculum tali;* 30. *Os phalanx proximalis*; 31. *Os phalanx media*; 32. *Os phalanx distalis.* Bar = 3 cm

*Digit III* was located in the middle, consisting of the larger *ossa phalanges* among the digital bones, while the *digit II* and *IV* widen in craniomediad and craniolaterad direction, respectively. The structure of the digits act like three supports of a tripod. Strong structure of the metatarsalia and digital skeleton was supported by the flexor and adductor muscles of the digits, and *mm. interossei* [5]. The muscles help Sumatran rhinos to gripping the ground when they run and climb the mountains.

## CONCLUSION

The hind limb skeleton of the Sumatran rhino has relatively short in size, with the very strong and compact structure. The bones have large tubercles and very well-developed processes. These structures support the main function of the hind limbs as a driving force for the body of the animal.


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